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Further information
Safety instructions

Contents of this chapter

This chapter represents the use of warnings in the manual and instructs in safe installation, start-up, use and maintenance of the PVS800-MWS substation.

Use of warnings

Warnings caution you about conditions which can result in serious injury or death and/or damage to the equipment, and advise on how to avoid the danger. The following warning symbols are used in this manual:

Electricity warning warns of hazards from electricity which can cause physical injury and/or damage to the equipment.

General warning warns about conditions, other than those caused by electricity which can result in physical injury and/or damage to the equipment.
Safe installation, start-up and maintenance

This section contains the safety instructions which you must follow when installing, commissioning and maintaining the substation. If ignored, physical injury or death may follow, or damage may occur to the equipment.

Only authorized electricians are allowed to install, start-up and maintain the substation. Working methods, tools, components etc. must follow the IEC regulations.

Always follow the local safety regulations concerning the substations.

PVS800-MWS is a medium voltage device. Before you are allowed to work in the medium voltage (switchgear and transformer) compartments, you must receive the task-specific instructions from the on-site foreperson in charge of the electrical installation work. The general instructions given in this manual never substitute the compulsory task specific instructions.

If others must be close by while the doors are opened, warn them, and if required, provide supervision and guidance.

General safety instructions

WARNING! Before any work, repeat the seven steps safety precautions described below.

1. Clearly identify the work location.
   Read the safety instructions of the work area and the component you are working on. See the subsections below and component-specific manuals.

2. Disconnect and secure against reconnection.
   Disconnect all possible power supplies. Lock the disconnectors to open position and attach a warning notice to them. After disconnection of the inverters, always wait for 5 minutes to let the intermediate circuit capacitors to discharge.

3. Protect against any other live parts.

4. Take special precautions when close to bare conductors.

5. Check the installation is dead.
   Always ensure by measuring that there is no voltage connected.

6. Carry out earthing (grounding) and short circuiting.

7. Issue a permit to work.

Working areas

The substation is divided in to three working areas based on the precautions needed for safe working: switchgear compartment, transformer compartment and inverter compartment. There are separate safety instructions for each of these compartments.
Safety instructions for the switchgear compartment

WARNING! Perform the procedure below before starting the work on the switchgear. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

1. Identify the switchgear and read its safety instructions. Check the operation of the capacitive voltage indicators in all switchgear bays (all phase LEDs are switched on when voltage is connected).

2. Disconnect the switchgear from all possible power supplies (grid, solar generator and parallel connected substations), and secure by locking and tagging.
   i. Stop the inverters. Open the DC disconnecting switches [Q2] in both inverter units ([PVS1] and [PVS2]), lock and add a warning notices.
   ii. Open the AC disconnecting switches [Q1] in both inverters units ([PVS1] and [PVS2]), lock and add a warning notices.
   iii. Switch off auxiliary power to both inverters.
   iv. Open the breaker or fuse switch on the transformer side of the switchgear.
   v. Turn the disconnecting switch on the transformer side of the switchgear (if any) to open position. Lock and add warning notice.
   vi. Disconnect the switchgear terminals from all possible external power supplies (grid and parallel substations). See the user's manual of the feeding device. Lock and add warning notices.

3. Check that all shrouds/screens are on place.

4. Check that you will not be near any live parts while working. Disconnect the live circuits or protect with shrouds/screens.

5. Check that the switchgear is dead.
   i. Check the status of the voltage indicators in all switchgear bays (all phase LEDs which were on at step 1 are now switched off).

6. Earth the switchgear and inverters.
   i. Turn the earthing switches of the switchgear to "earthed" position, lock and add warning notices. If the substation is connected to parallel substations, make sure that you also turn the appropriate earthing switches to "earthed" position.
   ii. Temporary ground the switchgear terminals at all possible external power supplies (grid and parallel substations). See the user's manual of the feeding device. Lock and add warning notices.
   iii. Temporary ground the inverter ([PVS1] and [PVS2]) AC sides with appropriate temporary grounding set.

7. Issue a work permit.
12 Safety instructions

Safety instructions for the transformer compartment

WARNING! Perform the procedure below before starting the work on the transformer. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

1. Identify the transformer and read its safety instructions.

2. Disconnect the transformer from both possible power supplies (switchgear and solar generator), and secure by locking, earthing and tagging.
   i. Stop the inverters. Open the DC disconnecting switches \([Q2]\) in both inverters units \([PVS1] \text{ and } [PVS2]\), lock and add a warning notices.
   ii. Open the AC disconnecting switches \([Q1]\) in both inverters units \([PVS1] \text{ and } [PVS2]\), lock and add a warning notices.
   iii. Switch off auxiliary power to both inverters.
   iv. Open the breaker on the transformer side of the switchgear.
   v. Turn the disconnecting switch on the transformer side of the switchgear (if any) to open position. Lock and add warning notice.

3. Check that all shrouds/screens are on place.

4. Check that you will not be near any live parts while working. Disconnect the live circuits or protect with shrouds/screens.

5. Check that the transformer is dead (high voltage terminals, low voltage terminals, any auxiliary power and instrumentation). Use an appropriate high voltage tester only for the high voltage side, and multimeter with suitable testing heads for the low voltage side.

6. Earth the transformer side of the switchgear and inverters.
   i. Temporary ground the inverter \([PVS1] \text{ and } [PVS2]\) AC sides with appropriate temporary grounding set.
   ii. Turn the earthing switch on the transformer side of the switchgear to “earthed” position, lock and equip it with a warning notice.

7. Issue a work permit.
Safety instructions for the inverter compartment

**WARNING!** Perform the procedure below before starting the work on the inverters. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

1. Identify the inverter which you need to work on. Read the inverter safety instructions.

2. Disconnect the inverter from both possible power supplies (transformer and solar generator), and secure by locking and tagging.
   i. Stop the inverters. Open the DC disconnecting switches [Q2] in both inverters units ([PVS1] and [PVS2]), lock and add a warning notice.
   ii. Open the AC disconnecting switch [Q1] of the appropriate inverter unit ([PVS1] or [PVS2]), lock and add a warning notice. After disconnection of the inverter, always wait for 5 minutes to let the intermediate circuit capacitors to discharge.
   iii. Switch off auxiliary power to both inverters.
   iv. Open the breaker on the transformer side of the switchgear.
   v. Turn the disconnecting switch at the transformer side of the switchgear (if any) to open position. Lock and add warning notice.
   vi. Disconnect all inverter DC supplies. The DC disconnectors are usually located in the junction boxes on the solar field. Lock and add warning notices.

3. Check that all shrouds/screens are on place except the one that prevent access to the parts that you must work on currently.

4. Check that you will not be near any live parts while working. Disconnect the live circuits or protect with shrouds/screens.

5. Check that the circuit is dead: AC and DC terminals of the inverters and other accessible parts in the main circuit. Use a multimeter with suitable testing heads.

6. Temporary ground the inverter.
   i. Temporary ground the inverter ([PVS1] or [PVS2]) AC and DC sides with appropriate temporary grounding set.

7. Issue a work permit.
Safe operation

This section contains the safety instructions which you must follow when operating the substation. If ignored, physical injury or death may follow, or damage may occur to the equipment.

⚠️ WARNING! Keep all doors of the substation locked while the substation is operating. Allow access to the keys of each compartment to the authorized personnel only.
Introduction to this manual

Contents of this chapter
This chapter gives information on the manual such as applicability, audience and contents. It also lists the related documents.

Applicability
The manual is applicable with the PVS800-MWS substations.

Target audience
This manual is intended for persons who transport, store, plan the installation, install, commission and maintain the PVS800-MWS substation.

Read the manual before working on the substation. You are expected to know the fundamentals of electricity, wiring, electrical components and electrical schematic symbols.

The manual is written for readers worldwide.

Contents of the manual
Safety instructions
Introduction to this manual
Hardware description
Storing, lifting and transporting
Mechanical installation
Electrical installation
Related documents

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<th>Document</th>
<th>Applicability</th>
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</thead>
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<td><strong>Manuals</strong></td>
<td></td>
</tr>
<tr>
<td>PVS800-MWS substation hardware manual (3AUA0000092830 [English])</td>
<td>Whole substation</td>
</tr>
<tr>
<td>PVS800-57 hardware manual (3AUA0000053689 [English])</td>
<td>Inverters</td>
</tr>
<tr>
<td>PVS800 central inverters firmware manual (3AUA0000058422 [English])</td>
<td>Inverters</td>
</tr>
<tr>
<td>Instructions manual for dry-type transformers (1LES100001-YB) OR EcoDry transformers manual (1LDE000005)</td>
<td>Transformer</td>
</tr>
<tr>
<td>Self-Powered Feeder Protection REJ603 user’s and technical manual (1MDB07208-YN)</td>
<td>Transformer protection relay</td>
</tr>
<tr>
<td>SF6 Insulated Ring Main Unit and Compact Switchgear Installation and Operating Instructions (6-24 kV) (1VDD005976 GB)</td>
<td>Switchgear</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
</tr>
<tr>
<td>Main circuit diagram of the substation</td>
<td>Whole substation</td>
</tr>
<tr>
<td>Main circuit diagrams of the inverters</td>
<td>Whole substation</td>
</tr>
<tr>
<td>Part list</td>
<td>Whole substation</td>
</tr>
<tr>
<td>Commissioning checklist</td>
<td>Whole substation</td>
</tr>
<tr>
<td>PVS800 test report</td>
<td>Inverters</td>
</tr>
<tr>
<td>Transformer test report</td>
<td>Transformer</td>
</tr>
<tr>
<td>Safe ring routine test report</td>
<td>Switchgear</td>
</tr>
<tr>
<td>Accessory documents</td>
<td>Accessory</td>
</tr>
</tbody>
</table>
## Terms and abbreviations

<table>
<thead>
<tr>
<th>Term/Abbr.</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>Alternating current</td>
</tr>
<tr>
<td>CCF</td>
<td>Construction of ABB Safering switchgear. See subsection <em>Switchgear</em> on page 22.</td>
</tr>
<tr>
<td>CCV</td>
<td>Construction of ABB Safering switchgear. See subsection <em>Switchgear</em> on page 22.</td>
</tr>
<tr>
<td>DC</td>
<td>Direct current</td>
</tr>
<tr>
<td>DeF</td>
<td>Construction of ABB Safering switchgear. See subsection <em>Switchgear</em> on page 22.</td>
</tr>
<tr>
<td>DeV</td>
<td>Construction of ABB Safering switchgear. See subsection <em>Switchgear</em> on page 22.</td>
</tr>
<tr>
<td>LV</td>
<td>Low voltage (50 - 1000 V AC)</td>
</tr>
<tr>
<td>LVRT</td>
<td>Low voltage ride-through</td>
</tr>
<tr>
<td>mpp</td>
<td>Maximum power point. See also <em>mppt</em>.</td>
</tr>
<tr>
<td>mppt</td>
<td>Maximum power point tracker. MPPT is a technique that solar inverters use to get the maximum possible power from solar panels.</td>
</tr>
<tr>
<td>MV</td>
<td>Medium voltage (1 - 35 kV)</td>
</tr>
<tr>
<td>REJ603</td>
<td>Feeder protection relay by ABB</td>
</tr>
<tr>
<td>SF6</td>
<td>Sulfur hexafluoride. Gas type used in the Safering switchgear.</td>
</tr>
<tr>
<td>SWG</td>
<td>Switchgear</td>
</tr>
<tr>
<td>THD</td>
<td>Total harmonic distortion</td>
</tr>
<tr>
<td>TN-S</td>
<td>Earthed network</td>
</tr>
</tbody>
</table>
Introduction to this manual
Hardware description

Contents of this chapter
This chapter contains an introduction of the PVS800-MWS substation.

Overview
PVS800-MWS substation includes the equipment needed for the connection of a solar power generator to the medium voltage power grid. The substation is built inside a container. The main components are:

• inverters which invert the direct current (DC) and voltage from the solar generator to alternating current (AC) and voltage for the power grid. Inverters also control the power flow, monitor and protect the power generator.

• transformer which transforms low voltage from inverters to medium voltage for the power grid.

• switchgear which is the connection point to the power grid. It is also the main protecting, switching, breaking and disconnecting equipment of the medium-voltage side of the solar power plant.
**Layout drawing**

Compartments:

| A | Switchgear compartment |
| B | Transformer compartment |
| C | Inverter compartment |

Main components:

<table>
<thead>
<tr>
<th>A</th>
<th>1</th>
<th>Switchgear</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>Lead-through holes for power grid cabling, and the terminal for the external earthing electrode (in base plate, at end of switchgear compartment)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B</th>
<th>3</th>
<th>Transformer</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>C</th>
<th>4</th>
<th>Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>Lead-through holes for cabling from solar generator (on both sides of the substation)</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Cooling air inlet</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Cooling air outlets</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Concrete base</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Lifting eyes (four in total, two on both sides)</td>
</tr>
</tbody>
</table>
Main circuit diagram

The diagram below shows the main circuit equipped with type CCV SafeRing switchgear (option +F251) with auxiliary transformer (option +G344).

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Switchgear compartment</td>
</tr>
<tr>
<td>B</td>
<td>Transformer compartment</td>
</tr>
<tr>
<td>C</td>
<td>Inverter compartment</td>
</tr>
<tr>
<td>1</td>
<td>DC input</td>
</tr>
<tr>
<td>2</td>
<td>Inverters</td>
</tr>
<tr>
<td>3</td>
<td>Transformer</td>
</tr>
<tr>
<td>4</td>
<td>Switchgear</td>
</tr>
<tr>
<td>5</td>
<td>Power grid (AC) connection (and to parallel substation (if any))</td>
</tr>
<tr>
<td>6</td>
<td>Auxiliary power supply</td>
</tr>
</tbody>
</table>

Aux. voltage transformer (option +G344)


Switchgear

Substation is always equipped with ABB SafeRing switchgear. Type DeV is used as standard but other types are also available:

- DeV consists of two modules:
  - De is the grid-side module equipped with power cable terminals and an earthing switch.
  - V is the transformer-side module equipped with the circuit breaker and an earthing switch.

- CCV consists of three modules:
  - C is the grid-side module with the grid cable terminals, and a disconnecting and earthing switch.
  - The other C module is the grid connection point of the parallel-connected substation.
  - V is the transformer-side module, equipped with the circuit breaker, and an earthing switch.

- DeF or CCF type switchgears are also possible. F stands for a switch-fuse disconnector and an earthing switch. See the switchgear manual for more information.

The diagram below illustrates the alternative switchgear types with the types and the option codes in a container delivery.

![Diagram of switchgear types](image)

Transformer

See the transformer manual for information on the transformer.

Inverter

See the inverter manuals for information on the inverters.
Type designation label

The figure below shows the type designation label. The label contains the basic data of the substation. It is located inside of the inverter compartment door.

![Type designation label](image)

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 62271-202</td>
<td>High-voltage switchgear and controlgear – Part 202: High-voltage/low-voltage prefabricated substation</td>
</tr>
<tr>
<td>Serial nr</td>
<td>Serial number. Each substation has a unique serial number.</td>
</tr>
<tr>
<td>Type</td>
<td>Type designation of the substation</td>
</tr>
<tr>
<td></td>
<td>xxxx = Size of the substation in kilowatts</td>
</tr>
<tr>
<td></td>
<td>zz= AC voltage of the container in kV</td>
</tr>
<tr>
<td></td>
<td>+yyyy = Option code. For example: +F251.</td>
</tr>
<tr>
<td></td>
<td>For more information, see section Type designation key on page 23.</td>
</tr>
<tr>
<td>Prodyear</td>
<td>Production year and week</td>
</tr>
<tr>
<td>Order no</td>
<td>Order number</td>
</tr>
</tbody>
</table>

**Type designation key**

Type designation describes the composition of the substation. The type designation is visible on the type designation label which is attached to the substation. The complete type designation is divided in sub codes:

- The first 1…18 digits form the basic code. It describes the basic construction of the substation. The fields in the basic code are separated by hyphens.
- The option codes follow the basic code. Each option code starts with an identifying letter (common for the whole product series), followed by descriptive digits. The option codes are separated by plus signs.
The table below describes the fields of the basic code.

<table>
<thead>
<tr>
<th>Digit no.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 … 6</td>
<td>PVS800 product series</td>
</tr>
<tr>
<td>7 … 10</td>
<td>Construction. -MWS =</td>
</tr>
<tr>
<td></td>
<td>• Container built, IP56 inverter compartment and IP23D SWG and transformer compartment, concrete base, steel frame with corrosion class C4, double-staged air filtering for inverters. Customer need to acquire and install: 3~ 400 V external control voltage, cable lead-through entry and exits on the concrete base.</td>
</tr>
<tr>
<td></td>
<td>• PVS800-57 central inverter with options +C176 doors with left hinges on left side (one inverter), +G300 cabinet heater, +8H382 8 x fuse protected DC input connections, +Q951 Emergency stop, +C175 Container construction</td>
</tr>
<tr>
<td></td>
<td>• Safering 20 kV, 400 A, 16 kA/3s, DeV, with REJ603 protection relay, with cable bushings interface C (400 bolted), 630 A</td>
</tr>
<tr>
<td></td>
<td>• Vacuum coil cast dry type transformer DTE 1000 A8D (for 1000kW) and DTE 1250 A8D (for 1250kW), with winding temperature monitoring device</td>
</tr>
<tr>
<td>11 … 17</td>
<td>Size</td>
</tr>
<tr>
<td></td>
<td>• -1000kW = 1000 kW</td>
</tr>
<tr>
<td></td>
<td>• -1250kW = 1250 kW</td>
</tr>
<tr>
<td>18 … 20</td>
<td>Voltage rating</td>
</tr>
<tr>
<td></td>
<td>• - 20 = 20 kV</td>
</tr>
<tr>
<td></td>
<td>• - 6.6 = 6.6 kV (option)</td>
</tr>
<tr>
<td></td>
<td>• - 11 = 11 kV (option)</td>
</tr>
</tbody>
</table>

The table below describes the option codes.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Medium voltage switchgear options</strong></td>
<td></td>
</tr>
<tr>
<td>F251</td>
<td>MV switchgear for ring connected networks. Safering CCx module instead of De.</td>
</tr>
<tr>
<td>F292</td>
<td>MV Fuse protected for Transformer. Safering xxF (fuse) module instead of xxV (circuit breaker) (REJ 603 relay will be removed).</td>
</tr>
<tr>
<td><strong>Main transformer options</strong></td>
<td></td>
</tr>
<tr>
<td>F271</td>
<td>Grounding terminals to main transformer. 25 mm grounding terminals on MV busbars of main transformer.</td>
</tr>
<tr>
<td>F293</td>
<td>High efficiency transformer. ABB Resibloc Basic.</td>
</tr>
<tr>
<td><strong>Container options</strong></td>
<td></td>
</tr>
<tr>
<td>G396</td>
<td>Auxiliary power supply voltage 3~173 V AC (100 V AC phase voltage)</td>
</tr>
<tr>
<td>G413</td>
<td>UPS support for auxiliary power (needed in LVRT)</td>
</tr>
<tr>
<td>G414</td>
<td>Installation rack for external components including 230 V power supply (e.g monitoring system)</td>
</tr>
<tr>
<td>G344</td>
<td>6 kVA auxiliary power transformer supplied from main AC side (no additional aux power supply needed)</td>
</tr>
<tr>
<td>1H357</td>
<td>Cable lead trough system cover set 1. Includes HSI-150 system coners for DC, auxiliary, control and 1 phase MV cables.</td>
</tr>
<tr>
<td>2H357</td>
<td>Cable lead trough system cover set 2. Includes HSI-150 system coners for DC, auxiliary, control and 3 phase MV cables.</td>
</tr>
<tr>
<td><strong>Container specialities</strong></td>
<td></td>
</tr>
<tr>
<td>P902</td>
<td>Customized (see the project-specific documentation)</td>
</tr>
<tr>
<td>P926</td>
<td>Extended warranty 24/30 months for switchgear transformer and container (excluding Inverter).</td>
</tr>
<tr>
<td>P927</td>
<td>Extended warranty 36/42 months for switchgear, transformer and container (excluding Inverter).</td>
</tr>
</tbody>
</table>
Storing, lifting and transporting

Contents of this chapter
This chapter contains instructions on storing, lifting and transporting the PVS800-MWS substation.

Storing

• To avoid any condensation inside the substation, store it indoor in a dry (heated) warehouse. If that is not possible, supply and switch on the internal heaters to keep the inside temperature above the temperature outside.
• Place the substation on a solid, flat, dry, and vegetation-free ground. The ground must support the substation evenly from below, ie, there must be no twisting or stress.
• Place the substation on wooden support beams. Locate the beams under the lifting points and at the middle.
• Protect the interior of the substation from rain water and dust. At the minimum, cover the air inlet and outlet gratings.
Lifting

Obey these instructions and the additional information given in section Lifting drawing on page 63:

• Protect the corners of the substation against shock.
• Lift the substation from the lifting eyes (a). Use ring clutches TPA-R1 10.0.
• Protect concrete base and substation with wooden support below the ring clutches during lifting (b).
• Use long enough spreaders (c) to avoid damage to the substation. The lifting slings may not scratch the walls.
• Adjust the lengths of the lifting slings so that the substation does not tilt during the lifting.

**WARNING!** Ignoring the following instructions can cause physical injury or death, or damage to the equipment:

• Use only authorized lifting equipment and personnel.
• Prevent anybody getting under the load.
• Do not stand on the roof while fastening the lifting slings or while lifting.
• Do not throw slings or hooks onto the roof.
Transporting

Obey these instructions and the additional information given in section *Dimensions, layout, transportation details* on page 60:

- Protect the substation with wooden corners, plastic film, etc. The substation is delivered unpacked from the factory as standard.

- Protect the interior of the substation from rain water and dust. At the minimum, cover the air inlet and outlet gratings (a).

- Lay the substation directly on the transportation chassis to prevent sliding and to keep the height as low as possible. We recommend to use friction enhancement mats (rubber) below the substation. The maximum thickness of the mat is 2 cm.

- Fasten the substation firmly onto the chassis with heavy-duty transport straps. Fasten the straps to the lifting eyes (b) with ring clutches of type TPA-R1 10.0. Alternative fastening points (c) are on the short sides of the substation: there are Rd36 threaded holes in which you can install suitable anchors bolts.

---

**Warning!**

Transport the substation on an open heavy-duty chassis. Do not use a closed-top trailer. The substation always moves somewhat during the transportation, and it might get scratched to the walls of the trailer.

Keep the transportation height as low as possible. Do not use wooden beams below the substation during transportation. Make sure that the total height of the transportation is not above the maximum allowed height for the planned route.

Do not throw hooks over the roof.
Storing, lifting and transporting
Mechanical installation

Contents of this chapter

This chapter contains the instructions for selecting the location, and constructing the foundation for the PVS800-MWS substation. These instructions do not substitute the local regulations which you must obey always.

General guidelines

- Place the substation higher than the surroundings

Place the substation a little higher than the surroundings to prevent corrosion caused by surface water collecting against the substation.

- Tilt the surface of the surrounding ground min. 3 cm per meter. This makes sure that there is a proper flow of the surface water away from the substation.

- Height of the concrete base is 39 cm. Bury it mostly into the ground but do not allow the ground level to reach the metal walls. The concrete base must be about 8 cm visible.

- Consider the local conditions such as frost, rain (humidity) and drought.
Construct a sturdy foundation for the substation

The substation is heavy. Pay attention to the proper planning and constructing of the foundation. Improper foundation may cause settling of the substation, difficulties to open the doors, etc.

Make a deep enough hole for the foundation. Always dig into frost proof depth and drain the hole. If possible, connect the foundation hole to the general drainage network or lead the draining pipes to a well-drained terrain where the water does not cause harm.

Construct proper support for the substation:

- On a solid sandy soil, gravel is usually enough. See subsection Foundation option 1 – Supporting the substation with gravel below.
- On a normal soil (solid, non-sandy), construct two concrete support beams under the substation. See subsection Foundation option 2 – Supporting the substation with concrete beams below.
- On a difficult soil (non-sandy, non-solid), construct concrete support pipes under the substation. See subsection Foundation option 3 – Supporting the substation with concrete pipes below.

Fill the foundation hole with gravel according to the normal construction practices. Use a glass fiber cloth to prevent mixing of fill gravel with the surrounding soil. Start the filling with crushed stone or coarse gravel, and continue with finer material. Compress the filling in layers. Use fine gravel (size 2 - 5 mm) for the surface layer. Smooth and compress the surface.

Layers of gravel: from coarse to fine

Constructing the foundation
■ **Construct an earthing electrode**

Construct an earthing electrode for the substation according to the local regulations. Lead the connection wire of the electrode to the position from where it will be easy to connect it to the earthing terminal of the substation. The earthing terminal is located on the concrete base beside the lead through holes of the power grid cable. See section *Earthing (grounding) the substation* on page 36 for the minimum requirements for the electrode.

■ **Finalize the surroundings**

Construct two rows of 500 × 500 mm concrete tiles at the substation’s service sides. They will form a dry standing place for the personnel during service and prevent removal of gravel.

Do not plant trees near the substation. If bushes will be planted, ensure that the planting compost base is at least one meter from the substation housing, and that the fully-grown bushes will not prevent maintenance access to the substation. Ensure also that the plantation does not discharge dust or seeds that could hinder the cooling air flow.

**Foundation option 1 – Supporting the substation with gravel**

Support the substation with a gravel foundation when placing it on a solid and sandy soil. Build the foundation as instructed in the section *General guidelines* above.

**Note:**
- Tilt the surface of the surrounding ground min. 3 cm per meter.
- Leave the concrete base 8 cm visible.
- Consider the local conditions such as frost, rain (humidity) and drought.
Foundation option 2 – Supporting the substation with concrete beams

Support the substation with concrete beams when placing it on a normal soil (solid, non-sandy) as follows:

1. Build the foundation as instructed in the section *General guidelines* above.
2. Cast two concrete support beams under the long sides of the substation. Width: min. 200 mm. Depth: min. 500 mm or into frost free depth.
3. Level the top of the beams horizontally and with the surface of the ground.

**Note:**
- Tilt the surface of the surrounding ground min. 3 cm per meter.
- Leave the concrete base 8 cm visible.
- Consider the local conditions such as frost, rain (humidity) and drought.
Foundation option 3 – Supporting the substation with concrete pipes

Support the substation with concrete pipes when placing it on a difficult soil (non-sandy, non-solid) as follows:

1. Acquire the concrete support pipes.
   Number: min. 6, Diameter: min. 150 – 200 mm. Length: min. 1100 mm. This vary depending on the case. Use as long pipes as necessary.

2. Drill holes for the support pipes.

3. Put the pipes on place, and level them vertically.

4. Fill the bottom of the holes outside the pipes with concrete (1/3 of the whole depth).

5. Fill the top (rest 2/3) of the holes outside the pipes with soil. Compress as you fill.

6. Fill the pipes with concrete.

Note:
- Tilt the surface of the surrounding ground min. 3 cm per meter.
- Leave the concrete base 8 cm visible.
- Consider the local conditions such as frost, rain (humidity) and drought.
34 Mechanical installation

Placing the substation on the foundation

1. Measure the level of the foundation and the tilting of the surface of the surrounding ground around the foundation. Make sure that you obey the rules in section *Place the substation higher than the surroundings* on page 29. Do not place substation too low! Adding gravel around a substation which you place too high, is much easier than reinstalling the substation.

2. Measure the straightness of the foundation. Maximum tilting of the foundation surface below the substation is 0.1 degrees.

3. Lift the substation on the foundation. Obey the instructions in section *Lifting* on page 26.

4. After you put the substation on the foundation, measure again the height and tilting of the substation, and the tilting of the surface of the surrounding ground around the substation. Make sure that you obey the rules given in step no. 2 above and in section *Place the substation higher than the surroundings* on page 29.
Electrical installation

Contents of this chapter
This chapter contains general instructions for earthing, and cabling of the PVS800-MWS substation. The instructions do not substitute the local regulations which must always be obeyed.

WARNING! Only an authorized electrician is allowed to install the cabling to the substation. Follow the safety instructions. See chapter Safety instructions on page 9, and the local safety regulations. If ignored, physical injury or death may follow, or damage may occur to the equipment.

Routing the cables
Route the input DC power cables, AC power cables and control cables in separate paths. Minimum distance between the control cables and DC (or AC) power cables is 500 mm when run in parallel.

Do not install the control cables in the same cable trenches with DC cables.

Where control cables must cross power cables, ensure they are arranged at an angle as near to 90 degrees as possible.

Use separate cable lead-through holes for different cable types.

Do not run extra cables through the substation.

Locations of the cable entries
See the chapter Drawings for the location of the cable entries.
Earthing (grounding) the substation

Always construct an earthing electrode for the substation. Follow the local regulations. At the minimum, the electrode must meet these requirements:

- wire size: min. 16 mm² Cu, 35 mm² Al or 50 mm² steel
- depth: 50 to 80 cm from the surface of the soil
- route: round the substation, distance 1 m from the outer wall

Connect the earthing electrode to the terminal located at the base of the substation beside the power grid cable lead-through holes. Terminal type is HEA-M12/70 by Hauff Technik. Use joint lubricant to protect the connection point against corrosion. Tightening torque (M12 bolt) is 50 N·m.

Protective earthing (grounding) inside the substation

The protective earth (PE) terminals or frames of all main components inside the substation have been connected to the main PE busbar at the factory. On the installation site:

- Ensure the continuity of all internal PE connections by measuring the conductivity between each protective earth terminal and the main PE busbar of the substation.
- Earth the shields, armors and protective conductors of all incoming cabling to the appropriate earthing terminals of the substation.

The diagram below shows the factory-installed internal PE connections inside the substation, and the connection point of the external grounding electrode.
Measuring the insulation resistances

Insulation resistance of the components and the internal cabling have been measured at the factory. Do not retest. Do the following tests on field:

- Test the external cabling before connecting it to the station.
- Test the transformer and its cabling both from the primary and secondary side:
  - Primary side: Ensure that the disconnecting switch at the transformer side of the switchgear is open but not in “earthed” position. Measure the insulation resistance between the earth and each phase conductor of the transformer cable.
  - Secondary side: Ensure that the AC disconnecting switches [Q1] are open in both inverters units [PVS1] and [PVS2]. Measure the insulation resistance between the earth and each phase conductor of the transformer cable.

Measuring voltage ($U_{test}$) and minimum resistance ($R_{min}$) values are:

- In medium voltage side $U_{test} = 5000 \text{ V}$ and $R_{min} = 1 \text{ Mohm per each 1 kV of the grid voltage}$. Example: For a 20 kV system, the resistance is 20 Mohm.
- In low voltage side $U_{test} = 500 \text{ V}$ and $R_{min} = 2 \text{ Mohm}$.

Connecting the cabling from the solar generator to the inverters

See *PVS800-57 hardware manual* (3AUA0000053689 [English]) and the wiring diagrams delivered with the unit.

1. Dismantle the covers of the cable lead-through holes.
2. Dig suitable cable trenches and protect the cables according to the local requirements. Use pipes, ducts, etc.
3. Lead the cables inside the substation and construct a tight cable lead-through. The holes are equipped with Hauff HSI 150 K/70 lead-through elements as standard. Compatible cable pipe adapters, sleeving, etc. sealing accessories are available from Hauff Technik (http://www.hauff-technik.com).
4. Connect the cables to the appropriate terminals in the inverters. Tighten the connection to torque specified in the inverter manual.
5. Fill the cable trenches and seal the cable lead-through as instructed in section *Finalizing the installation* on page 39.
**Connecting the control cabling**

See section *Connecting the cabling from the solar generator to the inverters* above. Follow the same principle when connecting the control cables.

Connect the cables to appropriate terminals. See the connection diagrams delivered with the substation.

**Connecting the power grid cabling to the switchgear**

See the switchgear manual and the wiring diagrams delivered with the unit.

1. Dismantle the covers of the cable lead-through holes.
2. Dig suitable cable trenches and protect the cables according to the local requirements. Use pipes, ducts, etc.
3. Lead the cables inside the substation and construct a tight cable lead-through. The holes are equipped with Hauff HSI 150 K/70 lead-through elements as standard. Compatible cable pipe adapters, sleeving, etc. sealing accessories are available from Hauff Technik (http://www.hauff-technik.com).
4. Terminate the cables according to cable manufacturers instructions and connect the cables to the switchgear. The standard cable terminations installed in the switchgear are shown in the figure below.
5. Fill the cable trenches and seal the cable lead-through as instructed in section *Finalizing the installation* on page 39.

---

**Standard cable termination**

*Interface C, 400 series*

*Bolted type, M16 × 2 metric threads*
Finalizing and checking the installation

Contents of this chapter

This chapter instructs in finalizing and checking the installation of the PVS800-MWS substation.

⚠️ **WARNING!** Only an authorized electrician is allowed to finalize and check the installation. Follow the safety instructions. See chapter *Safety instructions* on page 9, and the local safety regulations. If ignored, physical injury or death may follow, or damage may occur to the equipment.

Finalizing the installation

Clean the substation of all dirt.

Repair any damage caused to the exterior painting during the transport or installation. See section *Checking and repairing the painted surfaces* on page 52.

If you have not yet sealed the lead-through holes by no means (such as suitable lead-through elements by Hauff Technik), cover the cable lead-through with sand and sprinkle a handful of cement over the sand. In a few days the cement is hardened with the moisture content of the sand, and it forms a firm barrier against small animals and plants.
Landscaping the substation

The suitability of the substation to its environment can be improved by planting bushes around the substation.

Do not plant trees near the substation. If bushes will be planted, ensure that the planting compost base is at least one meter from the substation housing, and that the fully-grown bushes will not prevent maintenance access to the substation. Ensure also that the plantation does not discharge dust or seeds that could hinder the cooling air flow.

Checking the installation

<table>
<thead>
<tr>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Check all mechanical operating functions by operating them twice.</td>
</tr>
<tr>
<td>☐ Check the earthing (grounding) of the substation and its components against the earthing (grounding) schematic. Pull the earthing wires at the terminals to ensure that the connections are tight.</td>
</tr>
<tr>
<td>☐ Remove all foreign objects such as loose screws, nuts or tools from all compartments. They can cause a short-circuit faults.</td>
</tr>
<tr>
<td>☐ If there is sand or dirt inside the inverter, transformer or switchgear compartments, clean them. See chapter Maintenance.</td>
</tr>
<tr>
<td>☐ Check the main circuit clearance distances, cable terminations and connections against the main circuit diagram. Check also that the connections have been tightened.</td>
</tr>
<tr>
<td>☐ If there is a measuring cubicle in the switchgear, check that the instrument transformer ratios are correct.</td>
</tr>
<tr>
<td>☐ Check that all necessary warning labels have been attached to the substation.</td>
</tr>
<tr>
<td>☐ Check that the insulation resistances of the external power cables have been measured.</td>
</tr>
<tr>
<td>☐ Perform the installation checks detailed in the device specific manuals. See subsection Related documents on page 16 for a list of manuals.</td>
</tr>
<tr>
<td>☐ Carry out the inspection procedures required by the respective authorities.</td>
</tr>
</tbody>
</table>
Start-up

Contents of this chapter

This chapter instructs in the start-up of the PVS800-MWS substation.

WARNING! Only an authorized electrician is allowed to start-up the substation. Follow the safety instructions. See chapter Safety instructions on page 9, and the local safety regulations. If ignored, physical injury or death may follow, or damage may occur to the equipment.

Tools needed

- Computer with Drive window PC tool installed (for the inverter diagnostics and settings)
- Multimeter
- Current injection device (for the testing of the protection relay of the switchgear)
- Insulation resistance measurement device. See section Measuring the insulation resistances on page 37 for the measuring voltages and resistance values.
## Start-up tasks

<table>
<thead>
<tr>
<th>Task</th>
<th>Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-checking the switchgear (voltage not connected)</strong></td>
<td></td>
</tr>
<tr>
<td>□ Check the SF6 tank gas level from meter.</td>
<td><strong>SF6 Insulated Ring Main Unit and Compact Switchgear Installation and Operating</strong></td>
</tr>
<tr>
<td>□ Operate all devices once.</td>
<td>Instructions (6-24 kV) (1VDD005976 GB)</td>
</tr>
<tr>
<td>□ Check the settings of protection relay are according to the factory test report.</td>
<td>Tune the settings according to local utility grid and the transformer type in use. Follow the instructions in the product manual of the relay.</td>
</tr>
<tr>
<td>• Protection relay REJ603: Check the condition of current transformers with multimeter.</td>
<td><strong>Self-Powered Feeder Protection REJ603 user’s and technical manual (1MDB07208-YN).</strong></td>
</tr>
<tr>
<td>• Protection relay REJ603: Test the relay tripping.</td>
<td>Current injection test described in the manual.</td>
</tr>
<tr>
<td><strong>Pre-checking the transformer (voltage not connected)</strong></td>
<td></td>
</tr>
<tr>
<td>□ Perform the transformer pre-checking routines.</td>
<td><strong>Instructions manual for dry-type transformers (1LES100001-YB) or EcoDry transformers manual (1LDE000005)</strong></td>
</tr>
<tr>
<td>□ Check the insulation resistance of the transformer and its cabling if they have not been done on site recently.</td>
<td><strong>Measuring the insulation resistances on page 37</strong></td>
</tr>
<tr>
<td><strong>Pre-checking the inverters (voltage not connected)</strong></td>
<td></td>
</tr>
<tr>
<td>□ Perform the inverter commissioning tasks/checks to be done before the power-up.</td>
<td><strong>PVS800-57 hardware manual (3AUA0000053689 [English]) and PVS800 central inverters firmware manual (3AUA0000058422 [English]).</strong></td>
</tr>
<tr>
<td><strong>Connecting the substation to the solar power generator and commissioning the inverters</strong></td>
<td></td>
</tr>
<tr>
<td>□ Measure the DC supply voltage level at each input terminal of inverter [PVS1].</td>
<td></td>
</tr>
<tr>
<td>□ Close the DC disconnector [Q2] of the first inverter [PVS1].</td>
<td></td>
</tr>
<tr>
<td>□ Perform the inverter commissioning tasks/checks that can be done with only the DC supply connected.</td>
<td><strong>PVS800-57 hardware manual (3AUA0000053689 [English]) and PVS800 central inverters firmware manual (3AUA0000058422 [English]).</strong></td>
</tr>
<tr>
<td>□ Repeat the above commissioning tasks for the second inverter [PVS2].</td>
<td></td>
</tr>
<tr>
<td>□ Simulate transformer faults (unpowered) and ensure that the inverters detect the fault indications and trip.</td>
<td></td>
</tr>
<tr>
<td><strong>Connecting the substation to the power grid</strong></td>
<td></td>
</tr>
<tr>
<td>□ Check that AC disconnectors [Q1] of both inverters [PVS1] and [PVS1] are open.</td>
<td>Consult the local power grid owner.</td>
</tr>
<tr>
<td>□ Ensure that all checkings required by the local power grid owner have been done.</td>
<td></td>
</tr>
<tr>
<td>Task</td>
<td>Additional information</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Turn the earthing switch at the grid-side of the switchgear to “not earthed” position.</td>
<td></td>
</tr>
<tr>
<td>Ask the power grid owner to connect the substation to the power grid.</td>
<td>Only authorized personnel is allowed to perform the connection.</td>
</tr>
<tr>
<td>Wait until the substation has been connected to the power grid before proceeding.</td>
<td></td>
</tr>
<tr>
<td>Turn the disconnecting switch at the grid side of the switchgear to closed position.</td>
<td></td>
</tr>
<tr>
<td>Turn the earthing switch at the transformer side of the switchgear to “not earthed” position.</td>
<td></td>
</tr>
<tr>
<td>Turn the disconnecting switch at the transformer side of the switchgear to closed position.</td>
<td></td>
</tr>
<tr>
<td>Close the main breaker of the transformer.</td>
<td></td>
</tr>
<tr>
<td>Check that the voltage level on the low voltage side of the transformer is correct. Adjust the transformer tap settings if needed.</td>
<td>Transformer monitoring relay and AC busbars of the inverters.</td>
</tr>
</tbody>
</table>
| Run the transformer with no load for several hours before proceeding to the tasks under the subsection **Connecting the inverters to AC supply**. | If the ambient temperature is:  
  • 10 °C or above, run 3 hours.  
  • below 10 °C, run 6 hours. |
| Observe the transformer for any malfunction. Monitor the temperature, check for audible changes etc. |                        |

**Connecting the inverters to AC supply**

<table>
<thead>
<tr>
<th>Task</th>
<th>Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close the AC disconnector [Q1] of the first inverter [PVS1] to be commissioned.</td>
<td></td>
</tr>
<tr>
<td>Perform the rest of the inverter commissioning tasks (if any).</td>
<td>See PVS800-57 hardware manual (3AUA0000053689 [English]).</td>
</tr>
<tr>
<td>Close the AC disconnector [Q1] of the second inverter [PVS2] to be commissioned.</td>
<td></td>
</tr>
<tr>
<td>Repeat the commissioning tasks (if any) for the second inverter.</td>
<td></td>
</tr>
</tbody>
</table>
Start-up
Contents of this chapter

This chapter contains the maintenance intervals table, and related maintenance instructions.

The symbols in square brackets, for example [U1], refer to the device designations used in the circuit diagrams.

General

The recommended maintenance intervals and component replacements are based on specified operational and environmental conditions. ABB recommends annual inspections to ensure the highest reliability and optimum performance. Consult your local ABB Service representative for more details on the maintenance.

WARNING! Only an authorized electrician is allowed to service the substation. Follow the safety instructions starting from page 9, and the local safety regulations. If ignored, physical injury or death may follow, or damage may occur to the equipment.
# Maintenance intervals

The table below lists the routine maintenance intervals recommended by ABB.

<table>
<thead>
<tr>
<th>Maintenance task</th>
<th>Interval</th>
<th>Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaning the inverter compartment</td>
<td>Every 2 years (First check after commission)</td>
<td>See section <a href="#">Cleaning the inverter compartment on page 47.</a></td>
</tr>
<tr>
<td>Replacing intake air filters on the wall and on the door of inverter compartment</td>
<td>Every 2 years (yearly check)</td>
<td>See section <a href="#">Replacing the intake air filters of the inverter compartment on page 47.</a></td>
</tr>
<tr>
<td>Replacing stirrer fan in the inverter compartment</td>
<td>Every 10 years (yearly check)</td>
<td>See section <a href="#">Replacing the stirrer fan in the inverter compartment on page 48.</a></td>
</tr>
<tr>
<td>Replacing UPS battery (option +G413) in the inverter compartment</td>
<td>Every 5 years</td>
<td>See section <a href="#">Replacing the UPS battery (option +G413) in the inverter compartment on page 48.</a></td>
</tr>
<tr>
<td>Cleaning intake air filter on the door of transformer compartment</td>
<td>Every 2 years (yearly check)</td>
<td>See section <a href="#">Cleaning the intake air filters on the doors of transformer compartment on page 49.</a></td>
</tr>
<tr>
<td>Replacing intake air filter on the door of transformer compartment</td>
<td>Every 5 years (yearly check)</td>
<td>See section <a href="#">Replacing the intake air filters on the doors of transformer compartment on page 50.</a></td>
</tr>
<tr>
<td>Cleaning transformer and switchgear compartment</td>
<td>Every 5 years (First check after commission, then yearly check)</td>
<td>See section <a href="#">Cleaning the transformer and switchgear compartments on page 49.</a></td>
</tr>
<tr>
<td>Replacing cooling fan in the switchgear compartment</td>
<td>Every 10 years (yearly check)</td>
<td>See section <a href="#">Replacing the cooling fan in the switchgear compartment on page 51.</a></td>
</tr>
<tr>
<td>General condition check, checking and repairing painted surfaces</td>
<td>Every year (First check after commission)</td>
<td>See section <a href="#">Checking and repairing the painted surfaces on page 52.</a></td>
</tr>
<tr>
<td>General condition check, checking grounding bar</td>
<td>Every 5 years</td>
<td>See section <a href="#">Checking and cleaning the grounding bars and points on page 54.</a></td>
</tr>
<tr>
<td>General condition check, checking tilting of solar station</td>
<td>After 2 years of installation, and after 10 years of installation.</td>
<td>See the dimensional layout drawing for reference (1VPD000012X0036).</td>
</tr>
</tbody>
</table>

The main components of the substation have their own routine maintenance schedules in addition to the tasks listed in the table above. See the appropriate manuals listed in section [Related documents on page 16.](#)
Inverter compartment

Cleaning the inverter compartment

- **WARNING!** Do the steps given in section *Safety instructions for the inverter compartment* on page 13. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

1. Clean the floor plates with a vacuum cleaner.
2. Remove floor plates and check the cleanliness of the concrete base.
3. Clean the base with a vacuum cleaner.
4. Put the floor plates back.
5. Clean outer surfaces of inverters [PVS1, PVS2], control cabinets/enclosures and the compartment heater [E1] with a vacuum cleaner.

Replacing the intake air filters of the inverter compartment

1. Stop the inverters [PVS1, PVS2], and the stirrer fan [U1] located on the ceiling of the compartment. The fan is supplied from the Local power enclosure [EAB].
2. Loosen the screws on the filter supports on 3 sides.
3. Remove one filter support on each filter frame.
4. Replace the air filters. Before you add a new filter, check and clean the sand boxes and door interior with a vacuum cleaner.
5. Install the filter support frames back and tighten the screws.
6. Check and clean the sand boxes and door interiors with a vacuum cleaner.
Replacing the stirrer fan in the inverter compartment

The stirrer fan [U1] is located on the ceiling of the compartment. The circuit breaker supplying the fan is in the Local power enclosure [EAB].

1. Switch off the circuit breaker supplying the stirrer fan [U1]. Prevent the accidental switch-on of the breaker during the maintenance procedure.
2. Check by measuring that no voltage is connected to the fan.
3. Replace the fan.
4. Power up the fan and check that it is blowing the air to right direction, ie, towards the door of the compartment.

Replacing the UPS battery (option +G413) in the inverter compartment

**WARNING!** Do the steps given in section *Safety instructions for the inverter compartment* on page 13. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

1. Switch off the main switch of the Local power enclosure [EAB] to cut the supply for the inverters and their UPS battery (option +G413).
2. Open the door of the auxiliary control cubicle of the inverter cabinet. The UPS battery (option +G413) is located on the floor.
3. Ensure by measuring that no voltage is connected to the USP battery.
4. Replace the battery by following its user’s guide.
Transformer and switchgear compartments

Cleaning the transformer and switchgear compartments

**WARNING!** Do the steps given in section *Safety instructions for the switchgear compartment* on page 11 and *Safety instructions for the transformer compartment* on page 12. Use safety glasses and respiratory protector if using compressed air. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

1. Ensure that the transformer has cooled down before you proceed.
2. Use a vacuum cleaner to clean floor, doors, and interior metal beams on concrete base. If necessary use duster or pressured air as help around corners with no proper access with vacuum cleaner.
3. Clean the surface of the transformer with a duster. In case of lot of dust, use compressed air for cleaning the transformer.
4. Clean the insulators of the transformer with ethanol.

Cleaning the intake air filters on the doors of transformer compartment

**WARNING!** Do the steps given in section *Safety instructions for the transformer compartment* on page 12. Use safety glasses and respiratory protector while using compressed air. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

1. Blow compressed air gently from inside to outside through the filter until the dust will come off.
Replacing the intake air filters on the doors of transformer compartment

**WARNING!** Do the steps given in section *Safety instructions for the transformer compartment* on page 12. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

1. Remove the metal frames of the filters.
2. Replace the filters.
3. Install the metal frames.
Replacing the cooling fan in the switchgear compartment

WARNING! Do the steps given in section Safety instructions for the switchgear compartment on page 11. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

1. Switch off the circuit breaker supplying power supply for the cooling fan in the switchgear compartment. The circuit breaker is located in the local power enclosure [EAB] in the inverter compartment. Prevent the accidental switch-on of the breaker during the maintenance procedure.

2. Check by measuring that no voltage is connected to the fan.

3. Replace the fan and power it up.

4. Check that fan blows air to right direction. Use temperature controller of the transformer [ETT] to start the fan temporarily (enable the fan relay test). The fan rotates to right direction if air flows out from the switchgear compartment. Change the direction of the fan when necessary.
Substation

- Checking and repairing the painted surfaces

Materials
- Sand paper
- Cleaning towels and liquids
- Primer below paint on rusted or/and scratched surfaces: Hempel zinc primer 16490 or Würth Rost Stop 0890 191 (or similar)
- Finishing paint: Hempel Hempathane HS 55610 two-component polyurethane paint (or similar)
- Paint colors: See Paint colors on page 56.

Note! Obey the instructions given by the material manufacturers.

Procedure

**WARNING!** Do the steps given in section Safety instructions for the switchgear compartment on page 11. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

If there is lost finishing paint but no damage to the metal beneath or no rust visible:
1. Clean the damaged area with suitable detergent followed by a water clean.
2. Let the surface dry completely and keep it clean.
3. Cover the damaged area with the finishing paint.

If there are scratches and bare metal or rust visible (see a in figure below):
1. Remove rust gently with sand paper.
2. Clean the damaged area and its surrounding.
3. Coat the damaged area with primer. Let it dry thoroughly.
4. Add top paint on the damaged area.

*Lost paint but no damage beneath it*  
*Scratch to the metal and rust*
Checking and repairing the non-painted, zinc coated surfaces

Materials

- Sand paper
- Cleaning towels and liquids
- Zinc coating on non painted surfaces: Würth Zinc 300 0892 200 with brush or Zinc Spray Perfect 0893 114 113 (or similar)

Note! Obey the instructions given by the material manufacturers.

Procedure

WARNING! Do the steps given in section Safety instructions for the switchgear compartment on page 11. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

Pay special attention on doors and lower parts of the walls. Those areas have potentially corrosive elements like dust and humidity.

1. If there is rust, remove the rust gently with sand paper.
2. Clean the damaged area and its surrounding.
3. Coat the damaged area with zinc coat. Würth Zinc 300 preferred due to thicker coat. On larger areas Würth Zinc Spray Perfect can be used to speed up the work and to do even better looking surface.
Checking and cleaning the grounding bars and points

Materials

- Steel wool
- Ensto SR1 joint compound (or similar)
- 42839 Würth Protective Wax Spray (or similar).

Procedure

WARNING! Do the steps given in section Safety instructions for the switchgear compartment on page 11 and Safety instructions for the transformer compartment on page 12. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

1. Check the condition of grounding bar and grounding cables in switchgear compartment. In case of visible corrosion, remove the cables and remove the corrosion with steel wool. Apply then joint compound onto the grounding bar and cable terminals.

2. Change the spring lock washers. Tighten the cables with nominal torque values (Torque for a M12 bolt is 50 N·m).

3. In case there was a of lot of corrosion, apply protective wax spray on the grounding bar and the cable terminals.
Technical data

Contents of this chapter
This chapter contains the technical data of the PVS800-MWS substation.

Technical data

<table>
<thead>
<tr>
<th>Central inverter type</th>
<th>PVS800-MWS-1000kW-20</th>
<th>PVS800-MWS-1250kW-20</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ratings: Input data (DC)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temp</td>
<td>40 °C</td>
<td>40 °C</td>
</tr>
<tr>
<td>( P_{PV, \text{MAX}} ) [kWp]</td>
<td>2 × 600</td>
<td>2 × 750</td>
</tr>
<tr>
<td>( U_{DC, \text{mpp}} ) [V DC]</td>
<td>450…825</td>
<td>525…825</td>
</tr>
<tr>
<td>( U_{DC, \text{max}} ) [V DC]</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>( I_{DC, \text{max}} ) [A DC]</td>
<td>2 × 1145</td>
<td>2 × 1230</td>
</tr>
<tr>
<td>( U_{PV, \text{ripple}} ) [%]</td>
<td>&lt;3</td>
<td>&lt;3</td>
</tr>
<tr>
<td>Number of inputs</td>
<td>2 × 8 (+/-)</td>
<td>2 × 8 (+/-)</td>
</tr>
<tr>
<td>Number of mppt trackers</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Ratings: Output data (AC)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temp</td>
<td>40 °C</td>
<td>40 °C</td>
</tr>
<tr>
<td>( P_{AC, N} ) [kW]</td>
<td>1000</td>
<td>1250</td>
</tr>
<tr>
<td>( I_{AC, N} ) [A AC]</td>
<td>28.9</td>
<td>36.1</td>
</tr>
<tr>
<td>( U_{AC, N} ) [V AC]</td>
<td>20000</td>
<td>20000</td>
</tr>
<tr>
<td>( f_N ) [Hz]</td>
<td>50/60</td>
<td>50/60</td>
</tr>
<tr>
<td>Harmonic distortion [%]</td>
<td>&lt;3</td>
<td>&lt;3</td>
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</table>
## Auxiliary power

<table>
<thead>
<tr>
<th></th>
<th>PVS800-MWS-1000kW-20</th>
<th>PVS800-MWS-1250kW-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allowed electrical system type</td>
<td>400 V 3-phase TN-S</td>
<td>400 V 3-phase TN-S</td>
</tr>
<tr>
<td>Terminal size (per conductor) [mm²]</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Aux power, running (without options) [W]</td>
<td>&lt;1140</td>
<td>&lt;1140</td>
</tr>
<tr>
<td>Aux power, standby (without options)) [W]</td>
<td>&lt;150</td>
<td>&lt;150</td>
</tr>
<tr>
<td>Additional max. heating power [W]</td>
<td>2200</td>
<td>2200</td>
</tr>
</tbody>
</table>

### Efficiency

<table>
<thead>
<tr>
<th></th>
<th>PVS800-MWS-1000kW-20</th>
<th>PVS800-MWS-1250kW-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>$h_{\text{max}}$ [%]</td>
<td>97.8</td>
<td>97.8</td>
</tr>
<tr>
<td>$h_{\text{euro}}$ [%]</td>
<td>97.1</td>
<td>97.3</td>
</tr>
</tbody>
</table>

(at minimum mppt DC voltage, standard transformer, no auxiliary power included)

### Cooling

<table>
<thead>
<tr>
<th></th>
<th>PVS800-MWS-1000kW-20</th>
<th>PVS800-MWS-1250kW-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inverter compartment cooling air flow [m³/h]</td>
<td>6720</td>
<td>6720</td>
</tr>
<tr>
<td>Inverter cooling method</td>
<td>Forced air cooling</td>
<td>Forced air cooling</td>
</tr>
<tr>
<td>Transformer and switchgear cooling method</td>
<td>Natural cooling</td>
<td>Natural cooling</td>
</tr>
</tbody>
</table>

### Dimensions and weight

<table>
<thead>
<tr>
<th></th>
<th>PVS800-MWS-1000kW-20</th>
<th>PVS800-MWS-1250kW-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width / Height / Depth [mm]</td>
<td>6930 / 3070 / 2430</td>
<td>6930 / 3070 / 2430</td>
</tr>
<tr>
<td>Weight [tons]</td>
<td>approx. 20</td>
<td>approx. 21</td>
</tr>
</tbody>
</table>

### Power cable lead-through and terminals

<table>
<thead>
<tr>
<th></th>
<th>PVS800-MWS-1000kW-20</th>
<th>PVS800-MWS-1250kW-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switchgear compartment</td>
<td>See Drawings on page 59.</td>
<td>See Drawings on page 59.</td>
</tr>
<tr>
<td>Inverter compartment</td>
<td>See Drawings on page 59 and the inverter hardware manual.</td>
<td>See Drawings on page 59 and the inverter hardware manual.</td>
</tr>
<tr>
<td>Cable lead-through type</td>
<td>HSI-150 system covers. See Dimensions, layout, transportation details on page 60.</td>
<td>HSI-150 system covers. See Dimensions, layout, transportation details on page 60.</td>
</tr>
</tbody>
</table>

### Paint colors

<table>
<thead>
<tr>
<th></th>
<th>PVS800-MWS-1000kW-20</th>
<th>PVS800-MWS-1250kW-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walls</td>
<td>RAL 7035 (light beige, semigloss)</td>
<td>RAL 7035 (light beige, semigloss)</td>
</tr>
<tr>
<td>Roof</td>
<td>RAL 7012</td>
<td>RAL 7012</td>
</tr>
</tbody>
</table>

### Degree of protection and ambient conditions

<table>
<thead>
<tr>
<th></th>
<th>PVS800-MWS-1000kW-20</th>
<th>PVS800-MWS-1250kW-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of protection</td>
<td>IP54 (inverter compart.) / IP23d (other compart.)</td>
<td>IP54 (inverter compart.) / IP23d (other compart.)</td>
</tr>
<tr>
<td>Ambient temperature range (max.) [°C]</td>
<td>-15...40 (50) no frost allowed. See Derating below.</td>
<td>-15...40 (50) no frost allowed. See Derating below.</td>
</tr>
<tr>
<td>Relative humidity [%]</td>
<td>15 to 95%, no condensation allowed</td>
<td>15 to 95%, no condensation allowed</td>
</tr>
<tr>
<td>Corrosivity category of environment</td>
<td>C4 (EN ISO 12944-2)</td>
<td>C4 (EN ISO 12944-2)</td>
</tr>
</tbody>
</table>

### Fuses and protection relays

<table>
<thead>
<tr>
<th></th>
<th>PVS800-MWS-1000kW-20</th>
<th>PVS800-MWS-1250kW-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main circuit AC protection relay</td>
<td>REJ603-CT2</td>
<td>REJ603-CT2</td>
</tr>
<tr>
<td>Inverter DC fuses (option+8H382)</td>
<td>See inverter manual</td>
<td>See inverter manual</td>
</tr>
</tbody>
</table>
### Applicable standards

<table>
<thead>
<tr>
<th>Sub-station</th>
<th>IEC 62271-202 High-voltage/low-voltage prefabricated substation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformer</td>
<td>IEC 60076-11 Power Transformers, DIN EN 60076-11, VDE 0532-76-11</td>
</tr>
<tr>
<td>Switchgear</td>
<td>IEC 60694 Common specifications for high-voltage switchgear and controlgear standards, IEC 62271-100 High-voltage switchgear and controlgear - Part 100: High-voltage alternating-current circuit-s, IEC 62271-102 High-voltage switchgear and controlgear - Part 102: Alternating current disconnectors and earthing switches, IEC 62271-105 High-voltage switchgear and controlgear - Part 105: Alternating current switch-fuse combinations, IEC 62271-200 High-voltage switchgear and controlgear - Part 200: A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV, IEC 60265-1 High-voltage switches- Part 1: Switches for rated voltages above 1 kV and less than 52 kV, IEC 60529 Degrees of protection provided by enclosures (IP code)</td>
</tr>
<tr>
<td>Inverter</td>
<td>See PVS800-57 hardware manual (3AUA0000053689 [English]).</td>
</tr>
</tbody>
</table>

### Product compliance

| Safety and EMC CE conformity | According to LV and EMC directives |
| Grid compliance              | According to country requirements |

### Cable lead-through data

See chapter **Drawings**.

### Derating

In altitude from 1000 to 2000 m (3300 to 6600 ft) above sea level, the derating is 1% for every 100 m (328 ft). If the installation site is above 2000 m (6600 ft) above sea level, contact your ABB distributor or office for further information.

In temperature range +40 °C (+104 °F) to +50 °C (+122 °F), the nominal output current must be derated 2% for every additional 1 °C (1.8 °F). The output current is calculated by multiplying the nominal current by the derating factor.

**Example:** If the ambient temperature is +50 °C (+122 °F), the derating factor is 100% - 2%/°C · 10 °C = 80% or 0.80. The actual output current is then 0.80 · **Nominal output current**.

![Derating graph](image)
Drawings

Contents of this chapter
This chapter contains the additional drawings of the PVS800-MWS substation.
Dimensions, layout, transportation details
Secure that in the final installation the installation ground touches only concrete foundation, not any metal walls. The concrete foundation must be about 8cm visible above the ground level.

Construct two rows of 50x50mm concrete tiles at the substation's service sides. They will form a dry standing place for personnel during service and prevent removal of gravel. Make sure that the concrete foundations of the MVS stations is about 8cm visible above the tiles.

Place the substation a little higher than the surrounding to avoid surface water collecting against the foundation. Consider the local conditions such as frost, rain (humidity) and drought.

To secure proper flow of surface water away from station use 30mm tilting angle with ground or and with the tiles around the MVS station.

Note:
- Site work with foundation:
  - Support the substation with a gravel found or only when placing it on a solid and hard soil.
  - Ground geometrical tolerance when supporting the substation: with 4mm maximum local height variation +/-20mm tilting of ground 1meter
  - After setting the MVS station on ground, check tilting of MVS station. The check need to be done on all 4 sides against reference line marked in the drawing.
  - Recommended maximum angular tilting of the MVS container 1mm/meter = 27mm in lengthwise, total 2.5mm sidewise.

Post checking settlement:
- Improper foundation may cause of the MVS station during years. This may lead to difficulties to open the doors, etc.
- Recommended check interval to check ground stability: 1st check 2 years, 2nd check 3 years after start of operation.
- Recommendation for maximum allowed tilting of MVS station after settlement 2mm/meter = 14mm in lengthwise, total 5mm sidewise.

Drawing Reference: 1VD200012X0036
Note:
- The center of gravity of the lifted station shall be exactly below the hook of the crane. This is done by adjusting the individual lengths of the lifting chains accordingly.
- Lifting equipment Frimeda Transport Anchor System from HALFEN is to be used. The lifting equipment is fastened to the lifting eyes by means of ring clutches type TPA-R1 10.0
- In order to avoid any unnecessary stress and twisting of the enclosure it is very important that all four lifting chains engage the load at the same time.
- The length of the lifting chains is to be adjusted so that the substation does not tilt more than 3° during lifting.
- Lifting equipment shall match, and fulfil needs for total lifting weight.
- Important: Ensure personnel safety during lifting by using authorized lifting equipment and preventing anybody getting under the load.

Total weight: 20000kg*
Valid only with ABB DTE 1000 or DTE 1250 transformers

*valid only with ABB DTE 1250 transformer installed

ABB Technology Ltd
Location of cable entries

- **Ground cable**
- **MV cables**
  - 2 pcs Hauff Technik HSI 150
- **Auxiliary power supply inlet/outlet cables**
  - 1 pcs Hauff Technik HSI 150
- **DC cables for inverter 1**
  - 3 pcs Hauff Technik HSI 150
- **DC cables for inverter 2**
  - 3 pcs Hauff Technik HSI 150
- **Control cables**
  - 1 pcs Hauff Technik HSI 150

Note: The control cables must not be installed into same pit with DC cables. Follow minimum distances between control and DC cables stated in the PVS 800-57 Hardware Manual (Chapter 5).
Further information

For more information on ABB products and services for solar applications, navigate to www.abb.com/solar.