# DETUNED CAPACITOR BANKS (D- and DW-series)

## INSTRUCTIONS FOR INSTALLATION, USE AND MAINTENANCE

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## CONTENTS



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# 1. GENERAL

**CAUTION**

The purpose of this manual is to give guidance on the installation, use and maintenance of Nokian Capacitors 200...1000 V detuned capacitor banks of the D- and DW-series manufactured by Grid Solution Ltd.

Capacitors are to be installed, used and maintained by persons with due experience and training only.

The instructions in this manual were written with this kind of reader in mind.

This manual does not supersede national and local safety regulations and instructions nor training.

If the instructions and regulations are not complied with, the warranty on the capacitor bank will lapse, and the manufacturer is absolved from the liability for the proper functioning and safety of the capacitor bank.

# 2. APPLICATION, CONSTRUCTION AND OPERATION

## 2.1 Application

Detuned capacitor banks are designed to be used for centralized power factor correction, usually either at main switchboard or sub-switchboard level.

Detuned capacitor banks are used in electric networks **where harmonics are generated**. Harmonics are generated, for example, by d.c. drives, inverter drives, UPS equipment, electric-arc furnaces, electrostatic precipitators, different discharge lamps, and arc-welding equipment. Grid Solution Ltd. provides on request more information on using capacitor equipment in networks where harmonics are generated.

If the local power company uses a ripple control system for tariff and load control, it is necessary to use capacitor banks equipped with blocking reactors to avoid remote signals from being attenuated in capacitor banks.

It is not to be recommended that both capacitor banks and detuned capacitor banks or filters are used in a network supplied by the same transformer.

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## 2.2 Construction

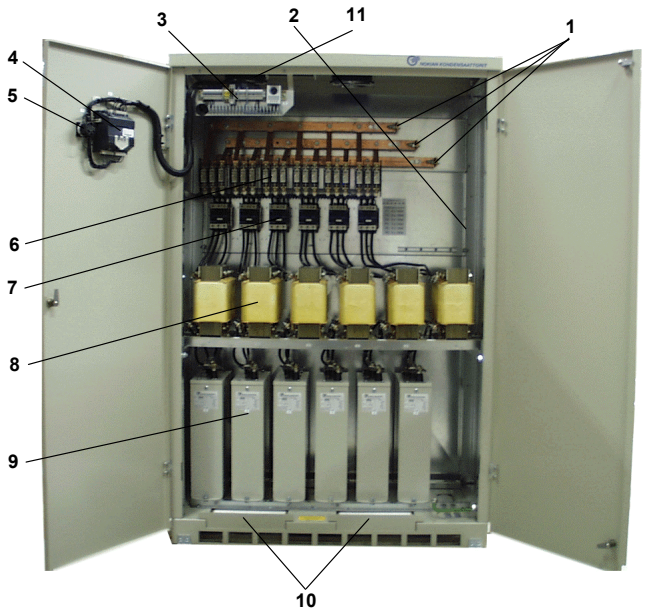
Detuned capacitor banks are built in cubicles that are made of steel sheet and painted with epoxy powder.

A detuned capacitor bank consists of a power factor controller and steps, each with a fuse, contactor, reactor, and capacitor.

A detuned capacitor bank can, if necessary, also feature a master switch or fuse-switch, in which case the main power cables are connected to the switch terminals.

The control wires are connected to a terminal block (designed for wires of max. 4 mm2).

## Detuned capacitor bank D-series




1. Main power cable terminals L1, L3, L2,
2. Main earth terminal
3. Terminal block for control wires / thermostat
4. Power factor controller
5. Control switch
6. Fuse holder
7. Contactor
8. Reactor
9. Capacitor
10. Air filter
11. Cooling fan

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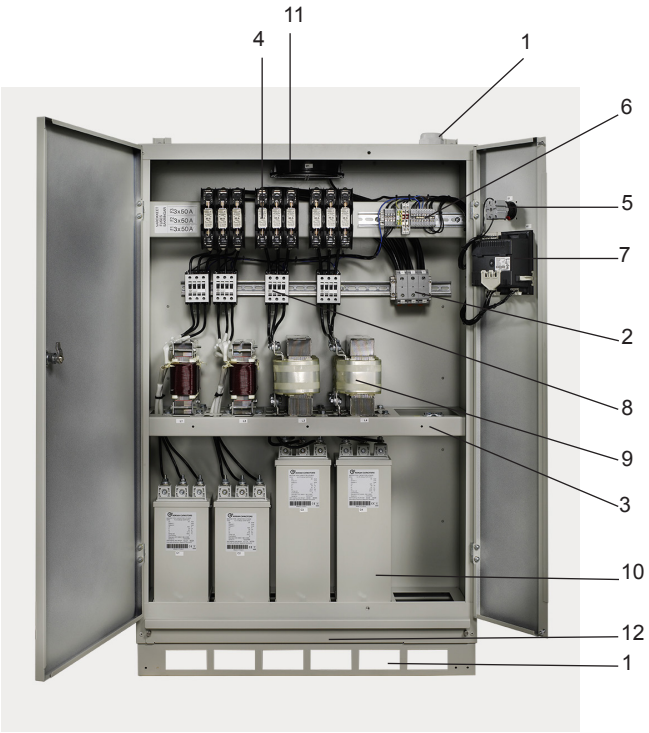
## DW-series




1. Main power and control cables, input from top or bottom
2. Main power cable terminals L1, L2, L3
3. Main earth terminal
4. Fuse holder/fuses
5. Control switch
6. Terminal block for control wires
7. Power factor controller
8. Contactor
9. Reactor
10. Capacitor
11. Cooling fan
12. Air filter (below door)

## 2.3 Operation

In the case of a detuned capacitor bank equipped with an automatic power factor controller, the steps switch on and off automatically according to the network's demand for reactive power. To be able to control the operation of the steps, the power factor control needs measurement data from the current transformer on current (secondary current: 1 A or 5 A) and voltage (range: 230...400 V). The current transformer must be upstream from the capacitor bank and loads.

If the on-off switching of the steps is controlled by other means than a power factor controller, the steps must stay switched off for at least 60 s before every switching on. This is to make sure that any residual charge remaining in the capacitors runs out.

Improper use of capacitor banks will cause their warranty to drop.

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# 3. TRANSPORT AND STORAGE

If deviations from the specified ambient temperature, humidity, etc. are expected (e.g. in the case of deliveries to the Tropics or by sea), please consult the manufacturer.

If not otherwise agreed, the temperature limits for transport and storage is -25oC...+55oC. Temporarily (for a maximum of 24 h) the temperature is allowed to rise to +70oC.

Do not store capacitor banks in a place where they are exposed to impurities. Keep capacitor banks in their original packaging until installation if possible. Keep capacitor banks dry, since humidity may cause corrosion of the electric and electronic components.

Packaged capacitor banks are placed on a pallet in vertical position. It is recommended to transport capacitor banks on these original pallets. To hoist a capacitor bank, use the lifting eyes on top of the cubicle.

Keep capacitor banks in vertical position during transport, handling, and storage!

If it is not possible to keep a capacitor bank in vertical position all the way to the site of installation (because of doorways, etc.), it can, for a moment, be carried with the side left of the front downwards.

# 4. INSTALLATION

## 4.1 Ambient conditions

Detuned capacitor banks are designed to be used indoors in a dry, dust-free environment (usually in the switchboard room). The protection class of standard detuned capacitor banks is IP 20C.

The ventilation of the room must be efficient enough to cool the capacitor bank. The power dissipation of a detuned capacitor bank usually amounts to 4...7 W/kvar, depending on the step size, voltage and tuning frequency.

Requirements set for ambient temperature:
max. +40°C
min. 0°C
24-h average: +35°C
1-year average: +25°C

Too high temperatures may have detrimental effects on capacitors and switch gear and shorten their service life.

## 4.2 Mechanical installation

Floor-mounted detuned capacitor banks have holes in the bottom of the cubicle for mounting. These capacitor banks are mounted by fixing the cubicle directly to the floor, or by means of L-iron bars attached to the sidewalls of the cubicle. Cubicle must be installed on a flat surface with no inclination.

Leave about 300 mm of free space above the cubicle to ensure the circulation of air, and make sure that cooling air has unobstructed access to the cubicle through the grille below the door.

DW-series cabinet can be installed also on wall with the fixing rails (at the back).

Leave free space in front of the capacitor bank door as specified in the regulations.

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## 4.3 Installation of main power cables

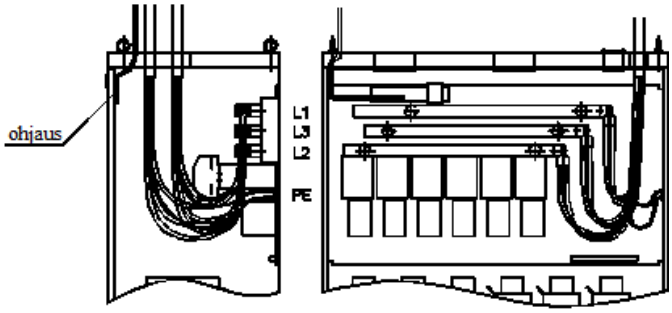
The locations of the cable and control-wire terminals (D-series) are shown in the figures next sheet.

If the main power cables are connected from above, make sure they do not obstruct the airflow to the fan.

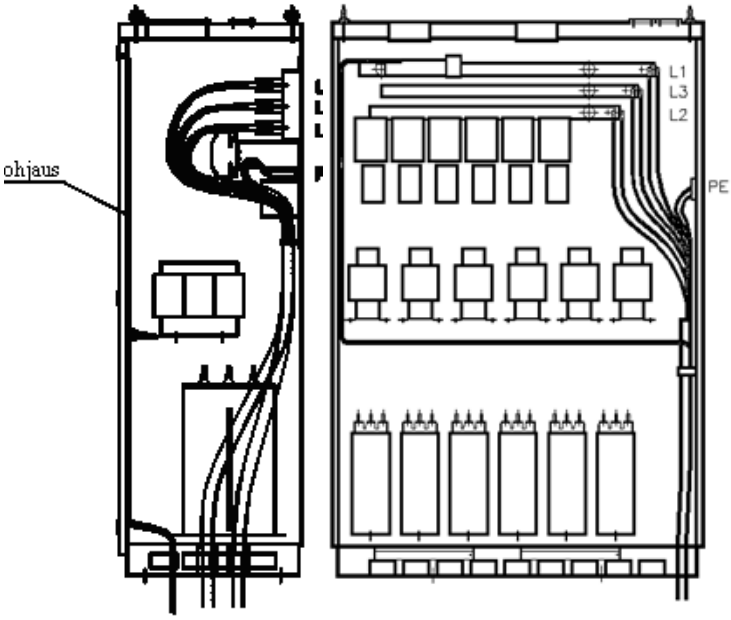
The terminal block for control wires and its mounting plate (fastened with 3 screws) can, if necessary, be removed and turned on to the cabinet wall for the installation of the main power cables .

Note! The terminal block is not allowed to be let hang from the control wires.

Connection from above




Connection from bottom




The main power cables of high-power capacitor banks must always be connected from above, since the capacitor bank takes up all the space down in the cubicle.

In the case of a master switch or fuse-switch, the main power cables are connected to the switch terminals.

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## 4.4 Selection of main power cables

The main power cables are to be selected in conformance with the relevant national standards, taking into consideration the conditions prevailing at the site of installation.

The rated current of a detuned capacitor bank is given in the name plate, and in the main power diagram appended to the capacitor bank manual.

If future extensions to the capacitor bank are possible, the cables must be designed for the max. possible total power/current of the capacitor bank.

If Al cables are used instead of Cu cables, the cross-section must usually be two sizes bigger. Example: a Cu cable of 3×70+35 mm2 can be replaced with an Al cable of 3×120+70 mm2.

The best way to connect the main power cables of a detuned capacitor bank is by means of cable lugs. Al cables must be connected to the Cu busbars of the capacitor bank by means of Cu/Al lugs or similar.

**⚠ CAUTION**

If the main power cables are connected in parallel, make sure not to cross-connect the phases. During commissioning, use a clip-on ammeter to check that the current divides equally between the two cables.

## 4.5 Controlwires

It is essential for the functioning of a capacitor bank that the control wires are connected exactly as shown in the circuit diagram appended to the capacitor bank manual.
Check whether the voltage connection arrangement of the capacitor bank is
LN = phase-neutral (230 V) or LL = phase-phase (400 V).

**Make sure the current transformer is correctly positioned in the system**, that is, upstream from the capacitor bank and loads (s. circuit diagram).
For the settings of the power factor controller, see the appended instruction manual for power factor controller.

The control wires are connected to the terminal block (for wires of max. 4 mm2) of the capacitor bank. For the size of the switchboard fuse for control voltage, see the wiring diagram (usually 10 A or 6 A).

## 4.6 Settings

**Power factor controller:** See the appended instruction manual.

**Cooling fan thermostat:** The thermostat is set at the factory to start up the cooling fan at +30oC (DW-series at +35°C).

## 4.7 Commissioning

Before connecting any voltages to the capacitor bank, check the wiring by eye, and make sure there are no loose connections in the capacitor bank.

Put the fuses of the supplying main power cable (the main fuses) in their places. Put the fuse for control voltage in its place. Switch on the control voltage with the control switch of the capacitor bank.

Test the power factor controller as instructed in the appended instruction manual. Check during the test that every contactor responds correctly to the signals sent by the controller. Put the power factor controller into operation as instructed in Chapter 'Starting the operation' of the instruction manual.

**⚠ WARNING**

If the main power cables are connected in parallel, make sure not to cross-connect the phases. During commissioning, use a clip-on ammeter to check that the current divides equally between the two cables.

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# 5. MAINTENANCE

## 5.1 General

BEFORE MAINTENANCE, SWITCH OFF THE VOLTAGE SUPPLY, AND WAIT AT LEAST 5 MIN FOR THE RESIDUAL CHARGE OF THE CAPACITORS TO RUN OUT.

See also national instructions for occupational safety in electrical engineering. To make sure that the capacitors are completely discharged, short-circuit the terminals of every capacitor. The first service shall take place 2 to 3 months after commissioning. After that, the capacitor bank shall be serviced at intervals of about one year, or in connection with other periodical services.

Warranty: Capacitor banks have a 1-year warranty starting from the date of commissioning nevertheless at most 18-month warranty starting from the date of delivery. The warranty covers any defects resulting from defective material or workmanship.

## 5.2 Capacitor banks

Check:
- tightness of wire connections
- condition of fuses
- controller operation
- contactor operation
- fan operation
- condition of air filter (see 5.4 below)
- condition of contact protections
- condition of warning and other signs

## 5.3 Capacitors

- Measure the capacitance of every capacitor with a capacitance meter. **Bear in mind caution during measurements!**
- Check the capacitor casings for bulges and other signs indicating an electrical fault inside. In case of damages, replace the capacitor.
- Clean the capacitor bank (insulators, etc.) if necessary.
- Clean plastic parts, if necessary, e.g. with spirit or a damp cloth. Do not use any agents that are harmful to plastic (acetone, chlorotone, trichloroethylene, etc.)

## 5.4 Air filter cassettes

The condition of air filter cassettes must be checked regularly. If the capacitor bank is used in an environment where it is exposed to impurities, the filter cassettes must be checked more often than once a year in connection with annual services.

The filter cassettes are mounted down in the capacitor bank cubicle (s. pictures in 2.2).

CLEANING AND EXCHANGE OF FILTER CASSETTES:

This action is now easy (D-series after year 2005 and new DW-series), the filter cassette is below the cabinet door. You open one or two screws (DW-series) and pull out the cassette.

Still in some models this cassette is behind the cabinet door, then follow the instruction below:

- If the network load permits, switch off the capacitor bank with the control switch. Wait 3 min for the residual charge of the capacitors to run out.

**⚠ CAUTION**

The control switch cuts off the voltage supply to the section below the contactors only. The busbars, fuses, and fuse holders are still live.
If a filter cassette must be cleaned or replaced with the capacitor bank (incl. reactors and capacitors) on, the following must be carried out with extreme caution.

- Open the cubicle door.
- Remove the 2 screws of the filter cassette holder mounted down in the cubicle.
- Pull out the holder.
- Remove the filter cassette from the holder.

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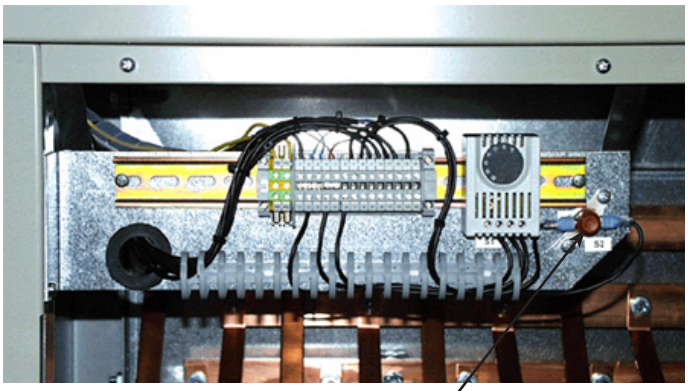
- Remove the filter cassette from the holder.
- To clean the filter cassette, blow air to the filtering area from the 'clean' side, or suck up the dirt from the 'dirty' side with a vacuum cleaner. Do not use water, chemicals, or any equipment that could damage the surface of the filter cassette.

If the surface of the filter cassette is damaged, or if it won't get clean, the cassette must be replaced (Grid solution Ltd. supply filter cassettes for their own capacitor bank models).
- Insert the filter cassette in its holder.
- Push the holder back in its place.
- Fasten the holder with the 2 screws.
- Close the cubicle door.
- Switch on the capacitor bank.

## 5.5 Slave capacitor banks with overtemperature switches



Overtemperature switch (push button)

Slave capacitor banks have an overtemperature switch under the mounting plate of the terminal block (s. figure below).

If the temperature inside the cubicle of the slave capacitor bank exceeds +50°C, the overtemperature switch cuts off the voltage supply to the controller of the master capacitor bank, and all steps controlled by the controller are disconnected from the network. The overtemperature switch does not break the circuits of any other components (fans, etc.)

When an over temperature switch is triggered, do not reset it until the reason for the overheating has been found out.

Possible reasons are:
- malfunction in the fans
- dirty filter
- insufficient air circulation
- high ambient temperature (tmax = +40°C)

To reset the switch, press the push-button on it.

**⚠ CAUTION**

A triggered overtemperature switch must be reset manually, since it won't return to its original state automatically after the temperature has gone down.

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## 6. TECHNICAL SPECIFICATION

Short-circuit protection:
rated short-time (1 s) withstand current (Icw) 25 kA

Rated insulation voltage (Ui): Ui = Un

Insulation test voltage (a.c., 10 s) 3 kV

Max. permissible operating voltage: 1,1 × Un (max. continuous voltage)

Dissipation: 4...7 W/kvar

Protection by enclosure: IP20C

Protection by enclosure when the door is open: IP00 (as standard)

Compartmentation: 1 (no compartmentation)

Electromagnetic compatibility (EMC): environments B and A (EN 61439-1)

Ambient temperature:
max.: +40°C
min.: 0°C
24-h average: +35°C
1-year average: +25°C

Colour: RAL 7035

Impact protection: IK08

Air filter cassette
filtering area: 2,4 m2
filter class: EU7

Compatibility level for harmonic voltages is according to IEC 61000-2-2.

## 7. STANDARDS AND CERTIFICATES

Capacitor banks are manufactured and tested in accordance with:

IEC/EN 61439 1&2
IEC/EN 60831 1&2
IEC/EN 60529 (IP-code)
EN 62262 (IK-code)

Certificates:

SGS FI 26351 Certificate
SGS FI-certificate*

*SGS FI-certificate is accorded by SGS FIMKO Ltd. SGS FIMKO Ltd. is an international commercial testing and certification company which is totally independent and impartial. It is also a Competent Body or Notified Body under several European Union directives and is able to verify the conformity of the products within the countries of the European Union.

## 8. DECOMMISSIONING

Dry, all-plastic low-voltage capacitors do not need to be taken to a hazardous-waste disposal plant.

Dispose of them according to the local regulations. Metal parts can be scrapped and recycled.

## 9. APPENDICES

1. Main power diagram (specifies rated current and recommended fuse size)
2. Instruction manual for power factor controller
3. Circuit diagram
4. List of capacitor bank components
5. Drawing with the dimensions and weight of the capacitor bank
6. Production check list
7. Separate instructions (if any) for single capacitor bank componentsµ

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