Kraftelektronik AB

# Supplemental installation manual for charging rectifier type PCR in parallel operation and double system

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# CONTENTS

# APPENDIX

A TYPE DIAGRAM

*We retain the rights to make changes to these specifications without further notice.*

# 1 GENERAL

This description only treats installation of charging rectifiers with type designation PCR1 and PCR3. The description mainly applies to designers and personnel that are responsible for installation, service and maintenance. It is a supplement to the ordinary installation manual and deals with subjects that are specific for charging rectifiers in parallel operation and charging rectifiers in double DC systems. It should be used together with the ordinary installation manual that also contains the necessary qualification demands and safety instructions.

Charging rectifiers in parallel operation means that a number of charging rectifiers connected in parallel together with a common battery, load and distribution makes a complete DC system.

Charging rectifiers in double DC systems means that two, each a complete system as above, with or without parallel operation, can alternate between separated and joined operation.

For information regarding usage of the charging rectifier, see the *Users manual*.

The term “charging rectifier” will henceforth be substituted by the term “rectifier”.

# 2 FUNCTIONAL DESCRIPTION

## 2.1 PARALLEL OPERATION

### 2.1.1 General

Rectifiers in parallel operation means that a number of rectifiers are connected in parallel in order to either gain higher available power or create redundancy in the system. Compared to rectifiers in individual operation, some functions will be slightly different while some new are added. The rectifiers interchange information via the serial communication link KraftNet.

### 2.1.2 Master/Slave

A system of rectifiers in parallel operation always consists of one master rectifier and at least one slave rectifier. The master rectifier is the “deciding” unit while the slaves operates subordinated.

### 2.1.3 Alarm

Some alarms are always blocked in the slaves and are handled only by the master. Which alarms this concerns is seen in the *Users manual*.

The master gathers information of the alarm relay status from the slaves. The master will then add its own relay status with the slave relay status and put the total result on its own relays. It means that only the alarm relays in the master has to be connected since they are showing the sum of all rectifiers relay status. In the master, a certain alarm will also inform the operator if there is a slave rectifier alarm. Note that it is only activated alarm relays in the slaves that will give this alarm. I e, if a slave has an alarm that is set not to activate any alarm relay at all, that alarm will not appear at all in the master rectifier.

### 2.1.4 Operators panel in a slave

On slave panels, the led:s for indication of earth fault and battery fault are always turned off because these functions are taken over by the master.

### 2.1.5 Copying of settings

Most of the settings should be done vis the master. Which settings that needs to be done separately in each slave are seen in the *Users manual*.

All settings that should be done via the master as above, are automatically copied to the slaves in a continuous process. It means that all rectifier always carries the same set of parameters. This will make it easier if for example if the master rectifier has to be replaced. Any of the slaves can then very easily be turned into a master without the need of checking all the settings. It is the same if a slave needs to be replaced because the slave will automatically receive correct parameters after only a short while.

### 2.1.6 Loadsharing

For gaining active loadsharing, the master puts out a fixed voltage level as reference in the system while the slaves continuously contributes there share of the system mean current.

At low currents and currents close to rated current, the system works only with passive loadsharing.

### 2.1.7 Equalizing charging/battery circuit test

Both functions, equalizing charging and battery circuit test, can only be initiated via the master. The changing of voltage level will appear in all rectifiers simultaneously.

### 2.1.8 Earth fault measuring

Measuring of earth fault is done exclusively by the master. The slave measuring input for earth fault measuring is galvanically separated internally in the rectifier. Therefore it actually does not matter whether the measuring input in the slave is connected to earth or not.

### 2.1.9 Temperature regulated voltage

The battery temperature is measured and monitored only by the master. The slaves will get the temperature information from the master so they also can perform the same temperature regulation.

## 2.2 DOUBLE SYSTEMS

### 2.2.1 General

Double systems means that there are two individual DC systems that can operate both joined and isolated. In isolated operation, the two systems are operating “stand alone”. In joined operation however, the systems needs to cooperate in matters like earth fault measuring and battery circuit test.

### 2.2.2 System 1 and 2

The two systems are divided into system number 1 and system number 2. They will have slightly different roles in both the way of connection and settings.

Which system that will be number one and two respectively is decided by the setting of the rectifier address.

The two systems are not interconnected through KraftNet. Instead they are connected via alarm relay D in the master rectifier of system 1 to the input for parallel operation in the master rectifier of system 2. This connection is used to request for lowering of the voltage during battery circuit test.

### 2.2.3 Alarm relays

Since alarm relay D is occupied for signalling between the systems, any alarms associated to alarm relay D should be reassociated to some of the other three alarm relays. Alarms that remains associated to relay D however, will not be dropped but will automatically activate alarm relay C instead.

### 2.2.4 Earth fault measuring

There must never be more that one unit at a time measuring earth fault in a system. Otherwise there will be a measuring error because they will measure each others measuring input resistance. To prevent this the rectifiers do like this:

The master of system 2 is always measuring earth fault resistance.

The master of system 1 however, is measuring earth fault resistance only while the input for parallel operation is inactive (closed). Active (open) input tells that system 1 and 2 are joined which means that the master of system 1 closes down its earth fault measuring by galvanically isolating the earth fault measuring input from the control circuits.

Slaves never measures earth fault resistance.

### 2.2.5 Battery circuit test

As long as the two systems are kept apart, each system will perform battery circuit tests independent of each other. In joined operation (announced by the parallel operation input in the master of system 1) it is system 1 that will initiate battery circuit tests. By energizing the alarm relay D, who is connected to the input for parallel operation in the master of system 2, system 2 will also lower its voltage during the test.

### 2.2.6 Loadsharing

Loadsharing between two joined systems will only be done a passive way (through a light built-in RI compensation). No active loadsharing between the two systems will take place.

### 2.2.7 System configurations

One example of system configuration with the connections that are specific for double systems, is shown in appendix A. It is mainly based on the configuration mentioned in the standard SS4281902.

The only difference between different configurations, from the rectifiers point of view, is the number of distribution boards that via cross connection switches in different ways can be connected to the two systems. Regardless of the complexity in this, it still remains only two simple tasks that needs a solution:

1. Inform system 1 whether the two systems are joined or not.
   Normally closed auxiliary switches on the cross connection switches. Connected to the parallel operation input in master of system 1. Arranged in such a way that you get an open loop as soon as the two systems are joined in any point.

2. Inform each system whether equalizing charging is permitted or not.
   Normally closed auxiliary switches on the cross connection switches. Connected to the input “equalization charging blocking” in each master. Arranged in such a way that you get an open loop as soon as the system, in which the master is a part of, is connected to any load. Possibly also in series with a battery compartment vent flow monitor.

# 3 INSTALLATION INSTRUCTIONS

## 3.1 GENERAL

Note that this is only a supplemental instruction beside the ordinary installation manual. Therefore, always read the ordinary installation manual before the instructions here are used.

## 3.2 MEASURING INPUTS

### 3.2.1 Battery voltage

Monitored battery voltage should be connected in all rectifiers, master as well as slaves.

### 3.2.2 Midpoint voltage

The midpoint voltage of the battery is normally connected only to the master rectifier.

In case of double battery strings, the midpoint from battery number 1 is connected to the master while a slave can be used for measuring of midpoint voltage from battery number 2. The settings of the used slave must then be adapted for measuring of midpoint voltage, see *Users manual*.

### 3.2.3 Measuring earth

Earth fault measuring is connected to the master in each system.

### 3.2.4 Temperature sensor

Temperature sensor for measuring of the battery temperature is connected to the master of each system.

## 3.3 BLOCKING OF EQUALIZATION CHARGING

Normally, you want a blocking of equalizing charging as soon as the system is connected to any load. In that case you use normally closed auxiliary switches on the cross connection switches in the system. Arrange these in such a way that you get a loop that opens as soon as the two systems are connected to any load. Possibly also in series with a normally closed battery compartment vent flow monitor. Connected the both ends of the loop to the input in the master for blocking of equalization charging.

A type example is shown in appendix A.

## 3.4 INPUT FOR PARALLEL OPERATION

If the plant has only one system, the input is closed as usual.

If the plant has double systems, we make difference between master in system 1 and master in system 2.

### 3.4.1 Master in system 1

The input for parallel operation in master 1 should feel an open loop when the systems are joined. I e, attach normally closed auxiliary switches on the cross connection switches that is part of the system. Arrange these in such a way that you get an open loop as soon as the two systems are joined at any point.

A type example is shown in appendix A.

### 3.4.2 Master in system 2

The input for parallel operation in master 2 should feel a closed loop when a request for lowering of voltage for battery circuit test appears. The closing comes from the alarm relay D in master 1. I e, connect the input for parallel operation in master 2 to alarm relay D in master 1, terminal X16:10 (C) and X16:11 (NC).

## 3.5 ALARM OUTPUT RELAYS

### 3.5.1 General

Alarm relay status from all rectifiers in the system are read into the master. The master adds the result and puts it on its own alarm relays. I e, you need only connect the alarm relays of the master. They contain all necessary information.

### 3.5.2 Master in system 1

In case of double systems, the alarm relay D in the master of system 1 should be connected to the input for parallel operation in the master of system 2. See the section *Input for parallel operation* above.

Any alarms associated to alarm relay D should be reassociated to some of the other three alarm relays. Alarms that remains associated to relay D however, will not be dropped but will automatically activate alarm relay C instead.

## 3.6 KRAFTNET

KraftNet should be connected between each rectifier within each system.

Note that in case of double systems, there should **not** be any KraftNet connection between the two systems.

# 4 SETTINGS

## 4.1 GENERAL

Some settings must be done specifically for each rectifier in parallel operation or double systems. Only these parameters are dealt with here. See further the *Users manual*.

For rectifiers in parallel operation applies, with certain exceptions (see *Users manual*), that parameters are set via the master. They will then automatically be copied into the slaves.

## 4.2 MIDPOINT VOLTAGE MEASURING

In the menu *Function selection, Umid,* you select whether the input for midpoint voltage measuring should be used or not. Also the location of the midpoint is stated.

The location of the midpoint is set via the master.

Umid, yes or no, is set separately in each rectifier. The reason is that it should be possible to connect midpoint measuring to both master and slave in order to be able to monitor the midpoint voltage in two battery strings.

## 4.3 NUMBER OF RECTIFIERS

State the number of rectifiers in the system, master + slaves. To be set in the master while copying to the slaves will be done automatically.

## 4.4 RECTIFIER ADDRESS

For master in system 1, set “master 0".
For slaves in system 1, set “slave 1" for first slave, “slave 2" for second slave and so on up to maximum 7.

For master in system 2, set “master 10".
For slaves in system 2, set “slave 11" for first slave, “slave 12" for second slave and so on up to maximum 17.

This parameter must be set in each rectifier individually.

## 4.5 NUMBER OF SYSTEMS

In case of individual system, set “Number of systems” = 1.

In case of double systems, set “Number of systems” = 2.

This parameter should be set in each master rectifier.

# 5 STARTING UP

## 5.1 GENERAL

This instruction only deals with subjects that arises around parallel operation or double systems. Always follow the instructions for starting up that are stated in the ordinary installation manual first.

## 5.2 CHECKING OF RECTIFIERS IN PARALLEL OPERATION

Turn on all the rectifiers in the system. Check that they are communicating by making sure that no rectifier shows any alarms concerning communication faults. Look into the menu *Show, Show operational status* (see *Users manual*) and check that each rectifier are showing expected result concerning system belonging (none if only one system), master/slave and slave number.

## 5.3 CHECKING OF DOUBLE SYSTEMS

Look into the menu *Show, Show operational status* (see *Users manual*) and check that each rectifier are showing expected result concerning system belonging (none if only one system), master/slave and slave number.

Place the master of system 2 into the menu *Show, Show operational status* (see *Users manual*). Check that the display is showing "float charging". Then start a manual battery circuit test (the menu *Charge control*) from the master of system 1 and check that the display on master of system 2 during the test shows "Teststate, Usink". It indicates that the systems are correct interconnected.

Place each master respectively in the menu *Show, Show digital inputs* (see *Users manual*). Through "Eq. blocked" = Yes/No you can check the auxiliary switch loop for blocking of equalizing charging. "Eq. blocked" = Yes means that blocking happens while "Eq. blocked" = No means that equalizing charging is permitted.

Place the master of system 1 in the menu *Show, Show digital inputs* (see *Users manual*). Through "// operat." = Yes/No you can check the auxiliary switch loop for indication of joined systems. "// operat." = Yes means that the systems are joined while "// operat." = No means that the systems are separated.

# 6 ACTIONS IN CASE OF FAULT

## 6.1 OPERATION IN CASE OF FAULT

If one of several rectifiers in parallel is broken down, the remaining rectifiers will continue the operation, but without some functions like active loadsharing and temperature regulated output voltage. By the actions described in the following sections, you can restore to normal operation with reduced number of rectifiers, which may be desirable during the time for replacement or repair.

## 6.2 FAULT IN SLAVE UNIT

If a slave unit breaks down, you can restore the remaining system to normal operation during repair time. Do like this:

1. Dismount the disabled rectifier.
2. Enter the last slave rectifier and set the address to the address of the disabled rectifier. Example: If slave 1 is disabled in a system of 4 rectifiers, then set the slave number 3 to be slave number 1.
3. Enter the master rectifier and set “Number of rectifiers” to one less than before.
4. Now all should be OK again.

When the repaired slave rectifier arrives you can choose between restoring all addresses to its original or simply let the repaired rectifier get the next available slave address. In the master rectifier you restore “Number of rectifiers” to its original number. Then it should be ready.

If the system consists of just one master and one slave, it will be the master that will form the remaining system. In that case, point 2 above is not relevant.

## 6.3 FAULT IN MASTER UNIT

Also if a master unit breaks down, you can restore the remaining system to normal operation during repair time. If you can accept to live without temperature regulated voltage and without midpoint measuring you do like this:

1. Dismount the disabled rectifier.
2. Enter the last slave rectifier and set the address to master 0 and master 10 respectively.
3. Set “Number of rectifiers” to one less than before.
4. Now, everything should be up and running again, but with alarm for internal fault 04 (temperature sensor fault) and possible battery fault (midpoint measuring). If you want to avoid this you can enter the menu *Function selection* and turn off the midpoint measuring and temperature measuring. But then you must not forget to restore these settings again later!

When the repaired rectifier arrives you restore all settings in the rectifier that temporarily has been master.

A less practical but more correct solution is the following:

1. Dismount the disabled rectifier.
2. Move the last slave rectifier to the place of the disabled master rectifier.
3. Enter the moved rectifier and set “Number of rectifiers” to one less than before, If midpoint voltage measuring is used, you must enter the menu *Function selection, Umid* and set the parameter in position “Yes”.
4. Now all should be OK again

When the repaired rectifier arrives it is easiest to leave the existing rectifier in its new position continuing to be master, while the repaired rectifier is given the next available slave address. Check that the parameter for midpoint voltage measuring is OK in the repaired rectifier. Should normally be “No” in all slave rectifiers. In the master rectifier you restore “Number of rectifiers” to its original value. Then all should be ready for operation.

If the master rectifier has an externally mounted display panel, i e the rectifier unit is equipped with an empty panel, both the temporarily moved rectifier and the repaired master rectifier has to be placed by their ordinary places. Restore all changed settings in the temporarily moved rectifier and check that “Number of rectifiers” and other parameters are correctly set in the master.

**Appendix A**
**TYPE DIAGRAM**