MPS 850

User's Manual

CAN501996-201

TRIUMF UCN Kicker MPS

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1. Introduction

1.1. Important safety information

This document may contain warnings:

GENERAL HAZARD

Indicates a potentially hazardous general situation. The keyword (DANGER, WARNING, and CAUTION) indicates the hazard level.

ELECTRICITY

Indicates a potentially hazardous electrical situation. The keyword (DANGER, WARNING, and CAUTION) indicates the hazard level.

MAGNETIC FIELD

Indicates a potentially hazardous magnetic field situation. The keyword (DANGER, WARNING, and CAUTION) indicates the hazard level.

1.1.1. General warnings

Please review the following safety precautions and all warning and caution information throughout the manual.

WARNING!

This Magnet Power Supply (MPS) is intended for professional incorporation into complete accelerator systems as a part of a fixed installation. If installed incorrectly it may present a safety hazard. Close attention is required to system design and electrical installation to avoid hazards in either normal operation or in the event of equipment malfunction.

WARNING!

Do not perform any flash test or voltage withstand test on the Magnet Power Supply. Any electrical measurements required must be carried out with power supply disconnected.

CAUTION!

Only qualified electricians are allowed to install and maintain this equipment.

DANGER! ELECTRIC SHOCK HAZARD!

Disconnect power at switch board before attempting to work on the Magnet Power Supply. High voltages are present at the terminals and within the power supply for up to 10 minutes after disconnection of the electrical supply. Always ensure by using a suitable measuring device that no voltage is present prior to commencing work.

CAUTION!

Ensure correct grounding connection. The grounding cable must be selected to be able to carry the maximum supply fault current. This is normally limited by fuses at the switch board. Fuses at the switch board must be selected according to local legislation or code.

1.2. About this document

This document is intended for service engineers responsible for the installation, maintenance and repair of the UCN Kicker Power Supply supplied by Danfysik A/S. External cabling, cooling hoses and the Kicker Magnet are outside the scope of this manual. Regular preventive maintenance is necessary to ensure a high uptime of the installed equipment.

1.2.1. Intended use

The Magnet Power Supply (MPS) is intended for professional incorporation into complete accelerator systems as a part of a fixed installation. It must be installed in an enclosed operating area. The power supplies are built according to industrial standards.

The intended use is to control a magnet by supplying the current for the magnet. The MPS includes an interlock system, which shuts down the power supply in case a number of predefined errors occur.

Only qualified personnel are allowed to install the MPS, and only instructed personnel are allowed to operate it.

In case of failure, the accelerator system must have the means to shut down in a safe manner.

1.3. Warranty and warranty repair

DANFYSIK A/S warrants that the products manufactured by us will be free from defects in material and workmanship that adversely would affect the normal functioning of the unit, for a period of 24 months from the date of shipment. The exceptions to this are:

a) Parts not manufactured by DANFYSIK A/S which are covered by the original equipment manufacturer's warranty.
b) Repair work which is warranted for six (6) months from the date of shipment from DANFYSIK.

DANFYSIK A/S will repair or replace either on site or at the factory, at option and without charge, any equipment which proves to be defective within its warranty period.

In the case of warranty, DANFYSIK A/S will pay or reimburse lowest freight rate (two-way) of any item returned to DANFYSIK or our designated agent/representative, provided that prior written authorization for such return has been given by DANFYSIK A/S.

This warranty shall not apply to any equipment which has become defective or unworkable due to mishandling, improper maintenance, incorrect use, radiation damage or any other circumstance not generally acceptable for equipment of a similar type.

On standard products, DANFYSIK A/S reserves the right to make changes in design without incurring any obligation to modify previously manufactured units.

The foregoing is the full extent of this warranty, and no other warranty is expressed or implied. In no event shall DANFYSIK be liable for special damages arising from the delivery, late delivery or use of the equipment.

If any fault develops, the following steps should be taken:

- All RMA-cases are handled via Danfysik's web based RMA-system. It can be accessed from the official Danfysik web page www.danfysik.com (via the Service & Test tab), where a RMA Quick Guide also can be downloaded. Alternatively the RMA-system can be accessed directly via www.dfservice.dk/rma/
- Notify DANFYSIK A/S, giving full details of the problems, and include Model-Type and Serial number.
  On receipt of this information, DANFYSIK A/S will give you either service information or instructions for shipping.
- All shipments of DANFYSIK equipment should be made according to our instructions and shipped in the original or a similar container.
- Only suitable materials are to be used for shipment.

2. Unpacking and installation

2.1. Receiving the goods

The Shipping container and the Magnet Power Supply should be thoroughly inspected for signs of obvious physical damage immediately upon receipt.

All materials in the container should be checked against the enclosed packing list. DANFYSIK A/S will not be responsible for shortages against the packing list unless notified immediately. The following must be included in the delivery:

- 1 pc of Magnet Power Supply
- CD-ROM with documentation

Contents of the CD-ROM are:

- User's Manual (this document)
- Main schematic
- Specifications sheet
- Scan of Quality Assurance documents – filled out test sheets and reports, obtained during production.
- Programmer's Guide

2.2. Instructions for unpacking

The Magnet Power Supply is shipped on a wooden pallet enclosed in either reinforced cardboard or wood crate.

Remove the packing straps and nails. If packed in a wood crate, the top lid should be removed first. If the equipment is damaged in any way, a claim should be filed with the shipping agent, and a full report of the damage should be forwarded to DANFYSIK A/S or our local agent/representative immediately.

Upon receipt of this report, you will be issued instructions for the repair, replacement or return shipment.

Please include the Model no, Type no, Serial no and Order no for the Magnet Power Supply on any communication with DANFYSIK A/S or our representatives.

2.3. Installation requirements

During installation of the Magnet Power Supply (MPS), local rules and regulations for electric power and water supplies should be respected and the following conditions and installations should be available.

- A normal, dust free room with humidity not above 80 % and a room temperature within 15 to 35 centigrade.
- Three-phase Mains voltage, switched and fused.
- Single-phase Control Power switched and fused. Normally this is supplied internally from the three-phase terminals. Optionally it may be supplied from an external power source. See the specifications sheet for the actual setting in this power supply
- Ground connection according to the local authority regulation and the requirements for the equipment.
- Cooling water supply which meets the following specifications:
  - Temperature within 15 to 35 centigrade.
  - Differential pressure: Min. 3 bar.
  - Max. inlet pressure: 12 bar.

See the specifications sheet for actual figures for this MPS.

Note:
For cooling of DANFYSIK power supplies and magnets, it is recommended to use demineralized water or pure water with an electrical conductivity of less than 10µS/cm. This reduces the electrolytic corrosion to a minimum.

Adding pure ethylene glycol to the cooling water with no other additives should not affect the electrolytic corrosion. However, it will reduce the thermal conductivity of the coolant. A percentage of 40% glycol reduces the conductivity by approx. 30%. It is recommended to use no more than 25% glycol corresponding to a reduction of thermal conductivity by approx. 17%. It may be necessary to increase the water flow in the MPS.

No other additives should be used.

During operation, the conductivity of the coolant should be checked regularly. A few days of operation with water of poor quality can cause more corrosion damage than several years of operation with good quality water.

2.4. Mechanical Installation

2.4.1. Transport to final position

- Preferably, the Magnet Power Supply (MPS) should be transported to the final position by attaching the four top lugs to a winch or a crane.

CAUTION!

Caution is to be taken, when transporting the MPS. The unit weighs several hundred kilograms. Transport with care.

2.4.2. Mechanical Dimensions

- The cabinet HxWxD is: 2100 x 1200 x 800mm
- Weight 600 Kg (1320 lbs)

2.5. Electrical Installation

Please refer to the main schematic for the overall electrical connections in this Magnet Power Supply. The figures below and on the following pages shows all peripheral connections.

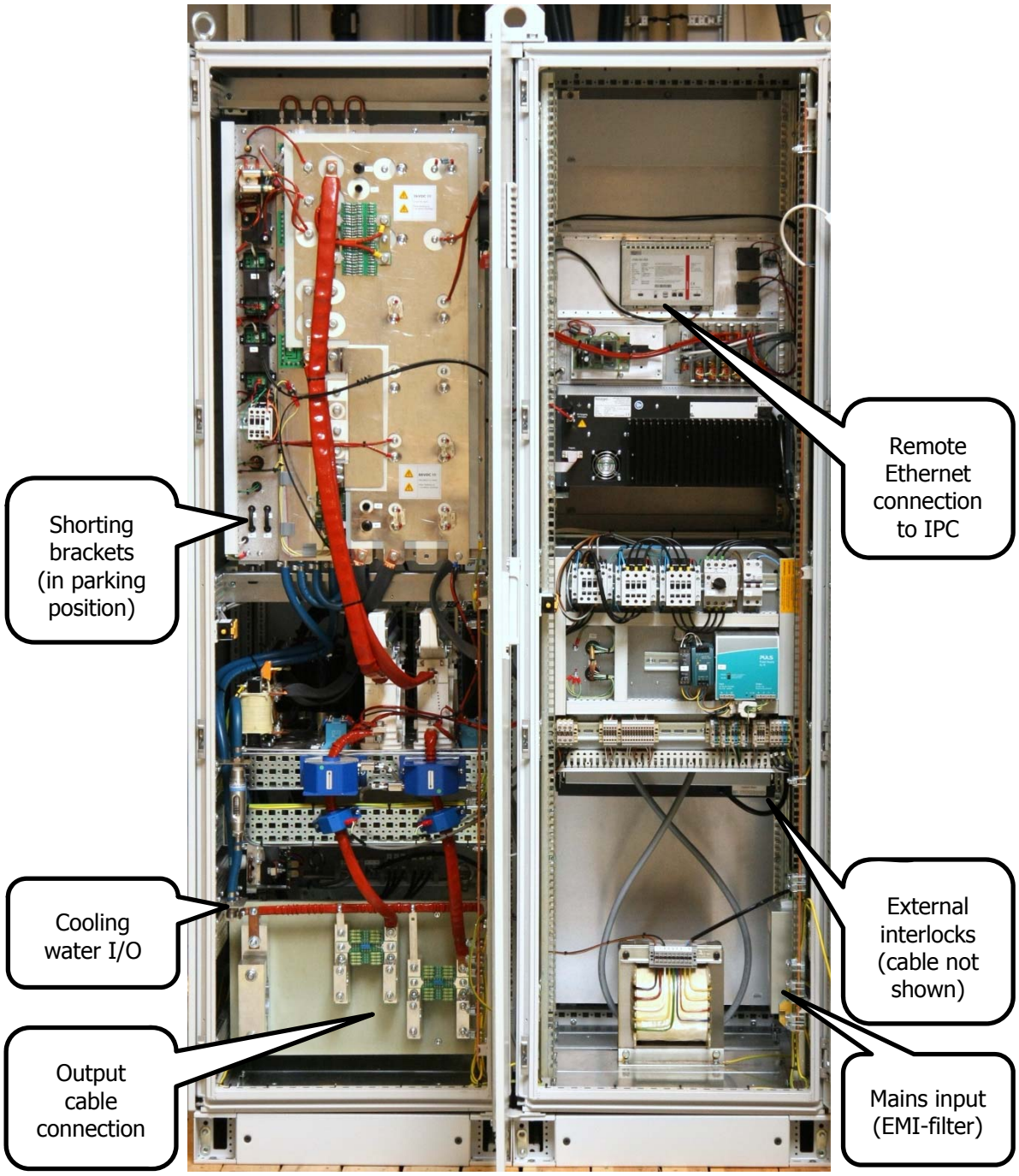


Figure 1: Connections, cabinet rear

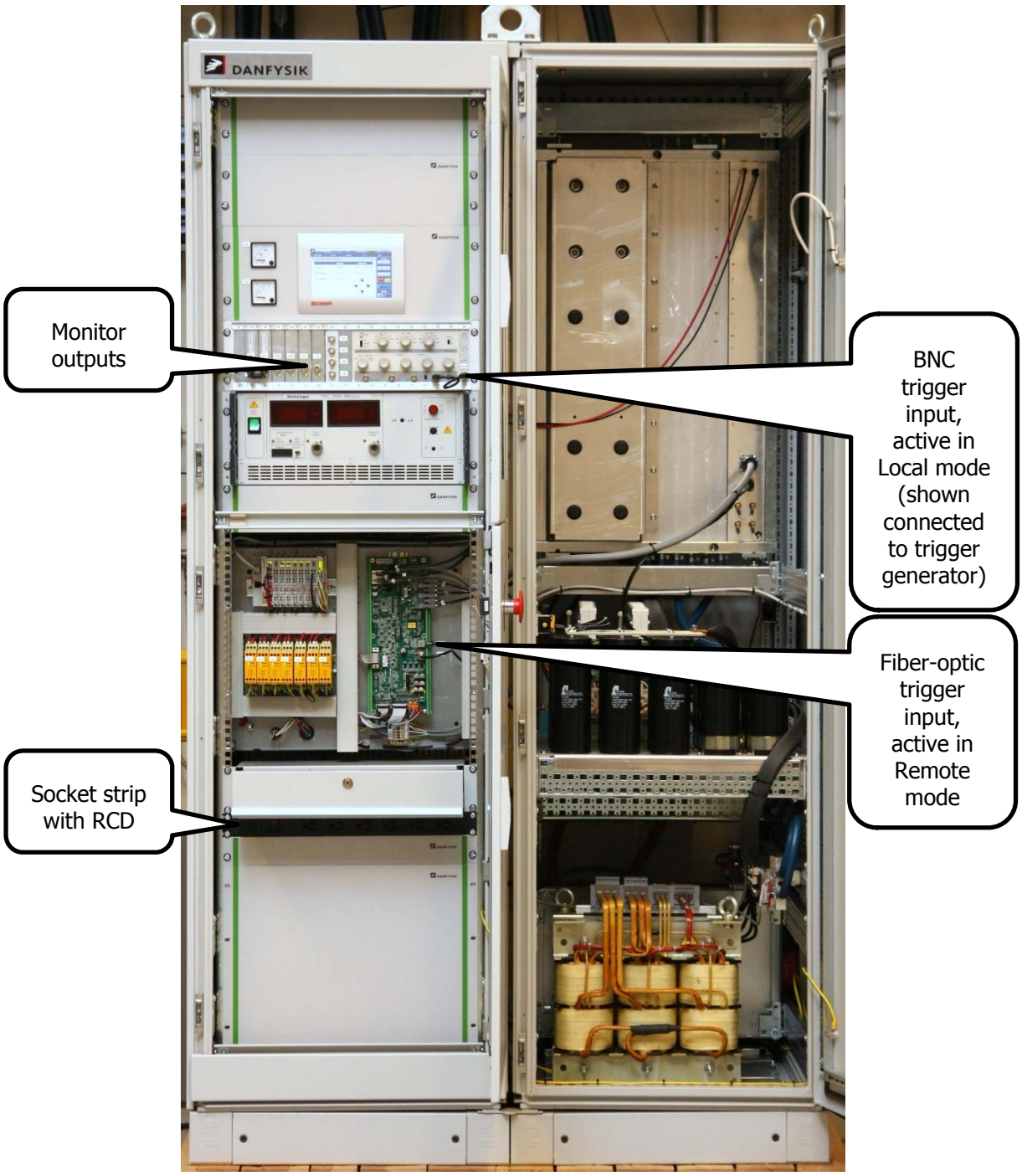


Figure 2: Connections, cabinet front

2.5.1. Connection of Main Power Cable

Warning: Risk of electric shock! Follow the instructions of section 4.1 before working inside the power supply.

- Main power is connected directly to the EMI filter, which is located close to the floor behind the righthand back door (seen from behind).

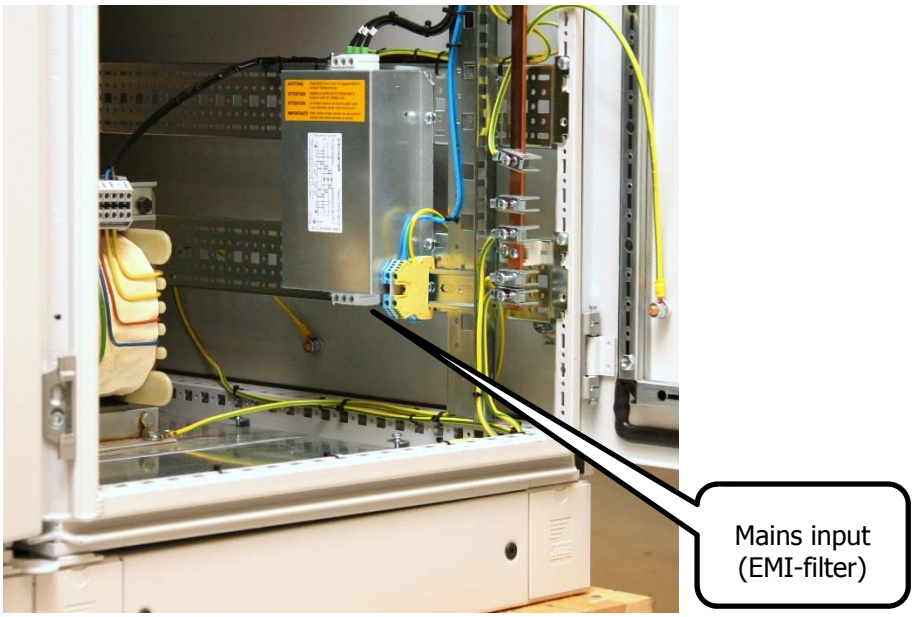


Figure 3: Mains connection to EMI filter

- Minimum cross section to be used for main power on this power supply is 6mm^2.
- Power terminal torque settings must conform to the table below.

Table 1: Table 1. Tightening torque, Power terminals (DS/EN 61010-1:2010)

Thread size [mm]	≤4.0	5.0	6.0	8.0	10.0
Tightening torque [Nm]	1.2	2.0	3.0	6.0	10.0

2.5.2. Connection of Ground Cable

- Building ground must be connected to ground rail inside power supply.
- Ground cable must be ≥ 6 mm^2

2.5.3. Connection of Output Cable

Warning: Risk of electric shock! Follow the instructions of section 4.1 before working inside the power supply.

- Use Okonite CLX, 15kV/500kcmil cable (571-23-3544) prepared for connection to the output terminals:
  - The outer jacket must pass through the cable gland, the cable gland only acting as mechanical relief.
  - The outer jacket of the cable must be removed to allow connection between the corrugated aluminum sheath ("armor") and the major copper clamp (approx. 60mm). (Care must be taken, not to damage the layers under the corrugated aluminum sheath.)
  - Two inner conductors must be trimmed in length to fit the minor connection clamps for positive and negative output, respectively (positive is the longer of the two). The third inner conductor is not used, and should be trimmed down to zero length. Each of the three inner conductors have a phase identification tape under the copper foil; take note of which conductors are used.
  - The inner conductor must be stripped from insulation (approx. 30mm) and fitted with a suitable ferrule to fit the smallest (right-most) copper clamps, without copper cores fraying.
  - The copper foil screen must be removed from the inner insulation, leaving approx. 30mm of exposed orange/red rubber insulation (creepage distance). Hold the copper foil in place using a suitable adhesive tape. **Note**: the orange/red rubber insulation is covered with a black semiconducting rubber screen on its outside (under the copper foil screen). This must be removed to ensure insulation.

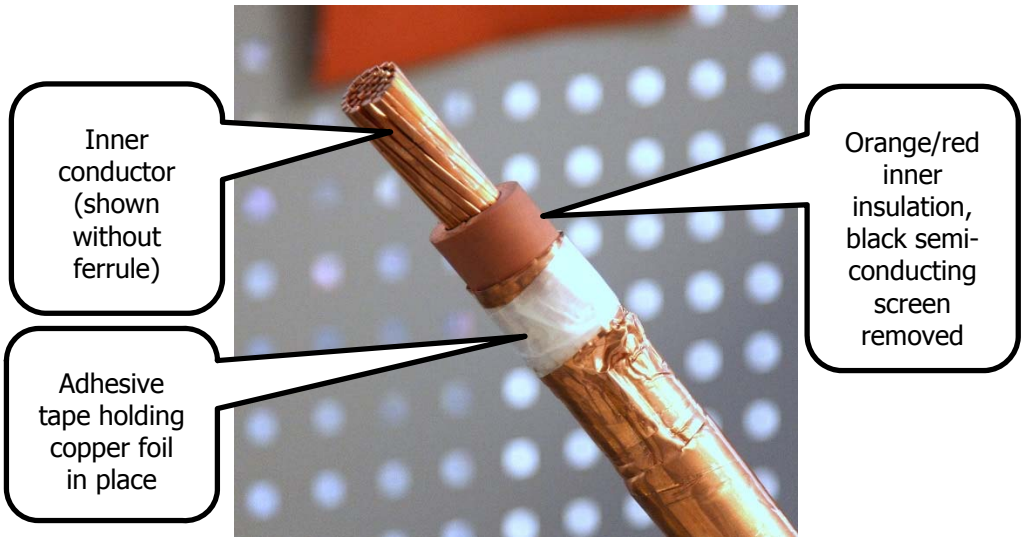


Figure 4: Output cable stripping

- Mount the cable and tighten nuts (M8: 6Nm, M12: 16Nm).
- Cable gland should be tightened to ensure mechanical relief.

2.5.4. Connection of Remote Control Cable

The power supply can be remote controlled via an Ethernet connection. The connection is made directly on the rear of the IPC. Seen from behind, open the right-hand door and make the connection to the rightmost of the two RJ45 connectors.

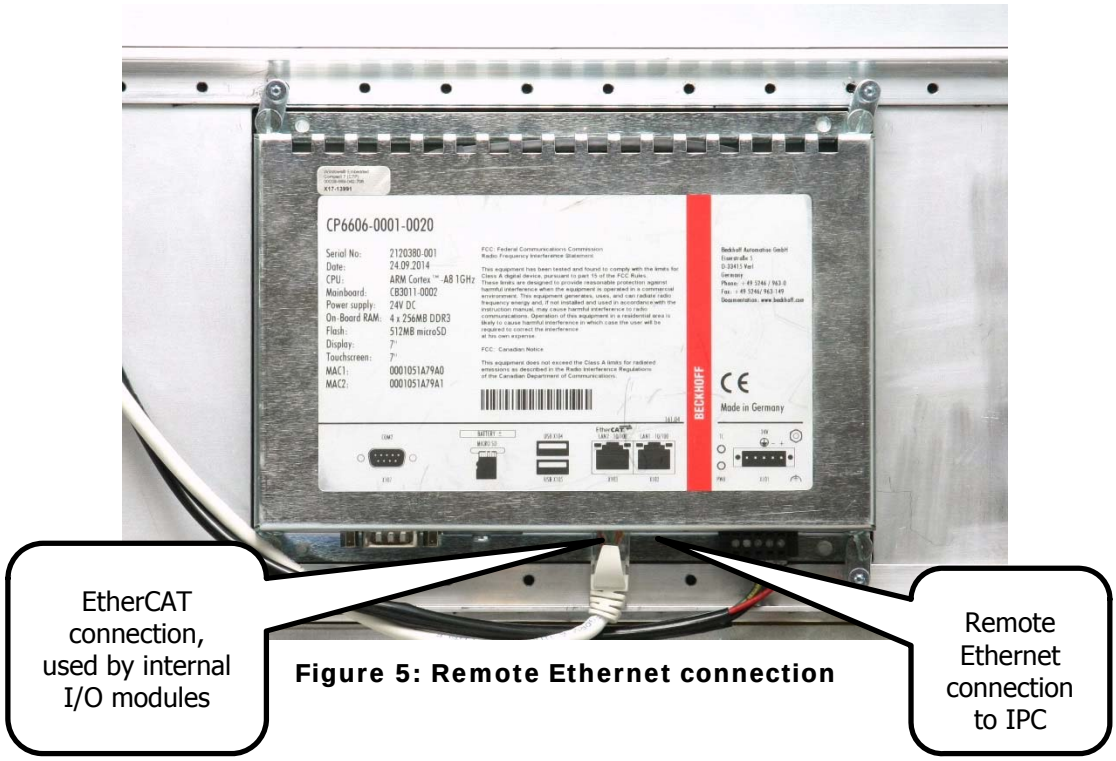


Figure 5: Remote Ethernet connection

Instructions for remote line setup and use are given in chapter 3.4.

2.5.5. Connection of External Interlocks

The external interlock inputs require potential free, closed contacts to satisfy the interlock circuit and allow operation.

The potential free contacts must be isolated, and have a contact rating of 250mA @ up to 36VDC.

The five external interlocks are wired to a SOURIAU UTG01412S, female circular connector, available on the rear of the control electronics section.

A preassembled cable with matching counterpart and approx. 2m of loose cable is supplied.

Please refer to Control Section Schematic 8200092857 for pinout.

2.5.6. Connection of Timing / Trigger Signals

2.5.6.1. Remote / Normal Timing

Timing/trigger signal for remote (normal) operation must be connected to fiber optic receiver S700 on the "Hysteresis Control Module" (PCB module, p/n: 8100092962), which is located in the control electronics section. (Remove 19" front plate above drawer to gain access.)

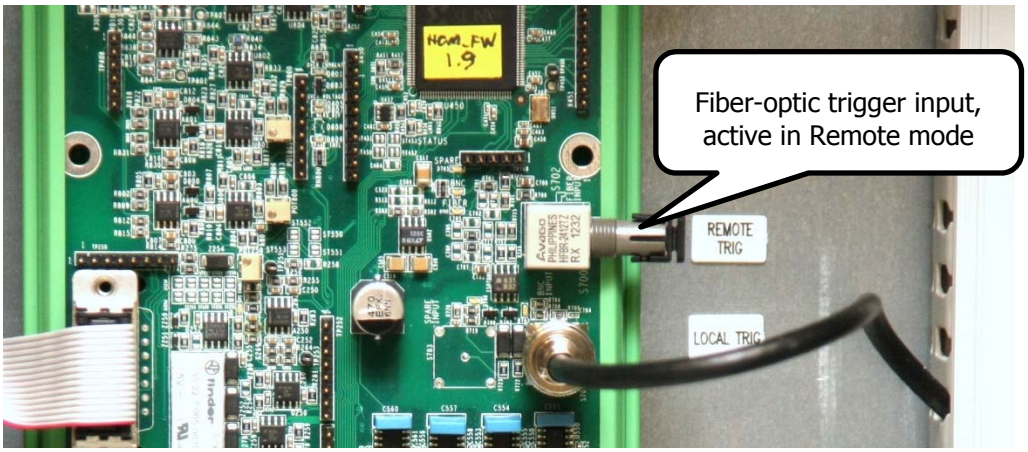


Figure 6: Remote (normal) trigger input

S700 is a HFBR-2412TZ from Avago, with ST connection accepting 820nm signals.

2.5.6.2. Local / Test Timing

Timing/trigger signal for local (test) operation must be connected to the "Local/Test Timing Input", which is located on the front panel of the control electronics section.

Figure 7: Local (test) trigger input

The "Local/Test Timing Input" is provided as a BNC connector, and the source should provide 0-5V square waves in 50Ω.

The source can be external or the built-in pulse generator (TTi TGP110) as selected by wiring. Please refer to separate manual for the setup and use of the pulse generator.

In any case, the cycle frequency should be kept ≤350Hz (the power supply will interlock at approx. 400Hz).

2.6. Monitor outputs

The following monitoring signals are provided on BNC outputs for analog, real-time monitoring:

Table 2: Monitor Signals

Signal	Label	Attenuation (no load)	Max. nominal signal
Output Voltage, Forward lead	V_OUT_P	1:500 V/V	4V @ 2000V
Output Voltage, Return lead	V_OUT_N	1:500 V/V	4V @ 2000V
HV Capacitor Voltage	V_HV	1:500 V/V	4V @ 2000V
LV Capacitor Voltage	L_LV	1:500 V/V	100mV @ 50V
Output Return Current	I_RTN	1:100 V/A	2.5V @250A
Output Forward Current	I_OUT	1:100 V/A	2.5V @250A
(no connection)	N/U	-	-
(no connection)	N/U	-	-

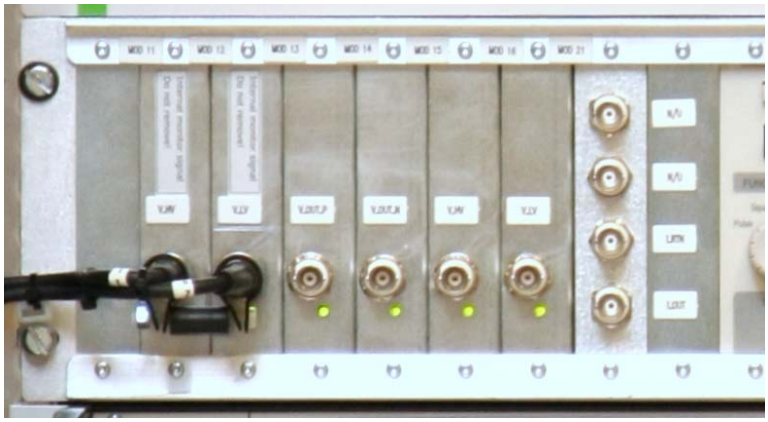


Figure 8: Monitor outputs

OBS: The two left-most modules are used for internal monitoring and interlock. **Do not disconnect**.

3. Operating instructions

3.1. Setup and configuration

3.1.1. Charge Power Supply Setup

Figure 9: Charge Power Supply front panel

The Charge Power Supply (CPS) delivers the high voltage used for ramping the current up and down.

For test purpose, the CPS can be controlled using the internal (front-panel) potentiometers, but in normal operation, the CPS is controlled by an external analog set-signal from the Hysteresis Control Module, and the front panel controls must be set up as follows:

- Power mains switch (Gerät Power) must be set to ON (I).
- Programming source switch must be set to "Ext." to enable external control from the HCM.

For further details on the CPS, please refer to the Heinzinger PNC User Manual.

3.1.2. Hysteresis control Module

Jumpers on the Hysteresis Control Module (HCM) allow the following configuration:

Table 3: Hysteresis Control Module, jumper settings

J450	Name	Description
Pos. 1-2	Local DC-mode	DC operation in Local mode, independent of trigger input.
Pos. 3-4	Not Ready Intl.	Invokes "Not Ready" on the Sum interlock signal, tripping the power supply to the OFF state, if it does not perform within specification.
Pos. 5-6	HV Not Ready at trig Intl.	Invokes "HV not Ready at trig" on the Sum interlock signal, tripping the power supply to the OFF state, if it is triggered before the HV is at the programmed level.
Pos. 7-8	TRIG	Permanent trig independent of Rem/Loc state. In parallel with moment switch SW450 (can be used as manual push-button test trigger).

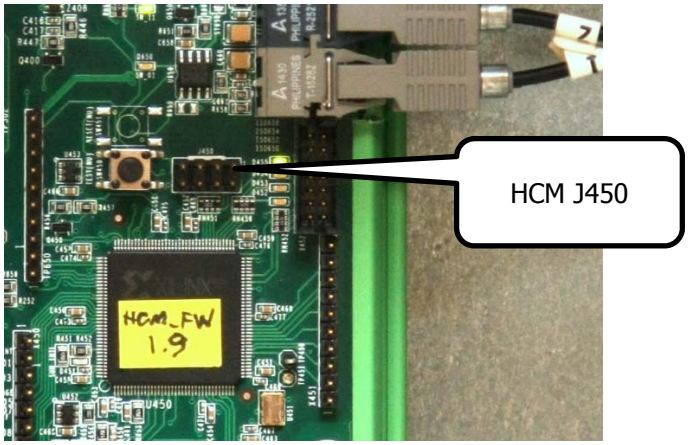


Figure 10: Hysteresis Control Module, jumper J450

By factory default, no jumpers are mounted on J450.

3.2. Powering up the Power Supply, Emergency Stop reset

The Emergency Stop switch on the front of the power supply is wired to an under-voltage release function on the main circuit breaker Q1 on the contactor plate (see Figure 11).

To reset the Emergency Stop and apply power to the power supply;

1) Twist and pull the red Emergency Stop push button on the front of the power supply.
2) Open back door (right door seen from behind), reset Q1 and switch it to the ON position.

Note: If power is not supplied to the power supply, the under-voltage release function will prevent Q1 from latching in the ON position. Q1 will therefore also have to be reset manually in the event of a power outage.

Warning: Risk of electric shock! Mains voltage remains present on the Emergency Stop switch even if it is pushed.

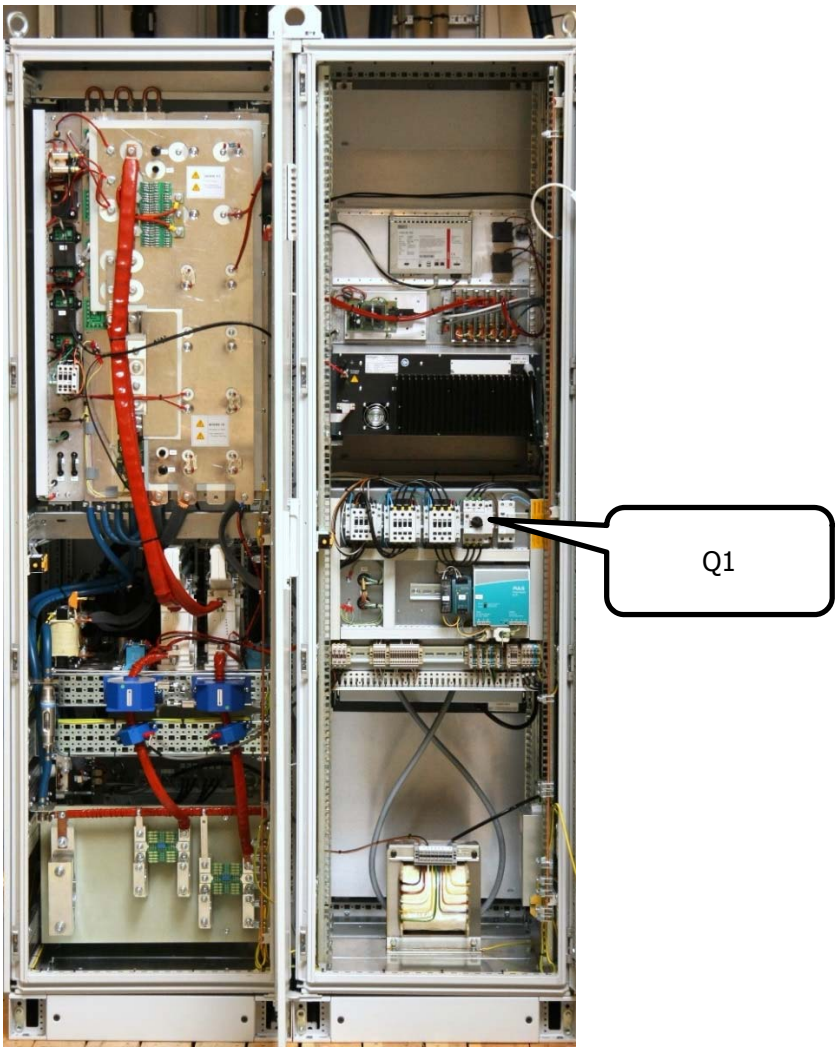


Figure 11: Circuit Breaker Q1 location (seen from behind)

3.3. Local control interface

The local interface is a Beckhoff CP6606 Industrial PC with a touch sensitive monitor on which the HMI of the control system is displayed.

The control system can be in two command modes: Local and Remote.

When the system is in Local mode, the MPS can be controlled only from the local interface. It is possible to ask about status on the remote line but it is not possible to set values on the remote line. It is possible to switch to Remote mode from the local interface and also set it in Local mode if it is Remote mode.

When the system is in Remote mode it is possible to set values over the remote line and the values will be displayed on the local interface but it is not possible set values from the local interface. It is possible to set the system in local mode over the remote line but if the system is in Local mode it is not possible to set the system in remote mode over the remote line, this must be done from the local interface for safety reasons.

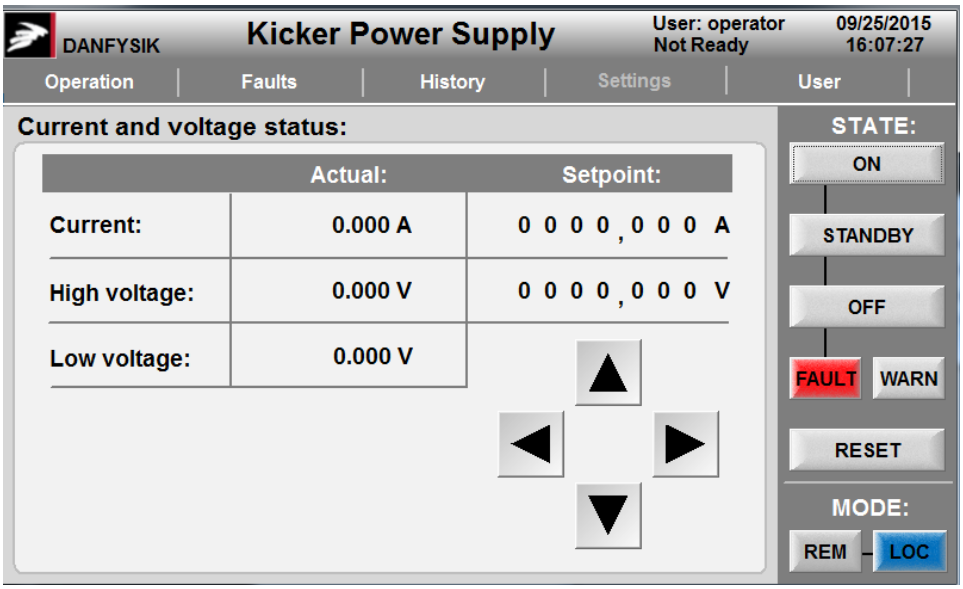


Figure 12: The main "Operation" screen

3.3.1. Turning the power supply on

The power supply has 3 states: Off, Standby and On. The power supply must first be in Standby state before it can be turned On.

In order to turn the power supply On from the local panel, the following sequence must be executed:

1. Set the system in Local mode by pressing the LOC button in the right panel.
2. Make sure that there are no faults. Faults are indicated with a red "FAULT" button in the right panel. Press the "Faults" tab or the red "FAULT" button to view the faults in the Faults screen. Press the RESET button to reset them.
3. Press the STANDBY button
4. Press the ON button

3.3.2. Turn the Power supply Off

To turn the power supply Off, press the OFF button (it is not necessary to go through the Standby state).

3.3.3. Setting a current or voltage

From the Operation screen, the Current and High voltage set point can be set (Low voltage can not be set). Press the desired parameter, navigate with the left and right arrows to the digit to set and change the value of that digit with the up and down arrows.

When a Current set point is given, the High voltage set point is calculated and set automatically. The calculated High voltage setpoint is directly proportional to the Current setpoint, the relation based on the operating range given under Settings.

If a different High voltage set point is desired, it must be set manually after each change of Current set point.

The Actual value, the read value, is also displayed for the Current, High voltage and Low voltage.

3.3.4. Faults and warnings

All faults and warnings are displayed on the Faults page. All faults are latched, meaning they will only be reset and disappear from the list after a RESET command has been issued. Warnings are not latched and are therefore only displayed while they are active. Faults are displayed in red text, and warnings are displayed in yellow text.

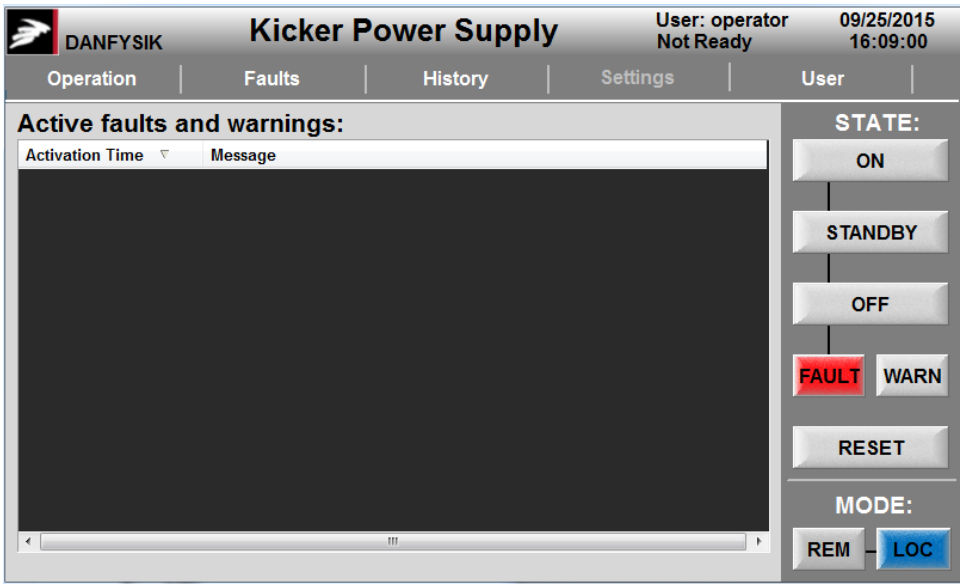


Figure 13: Faults screen

3.3.5. The history log

The History page displays the history of all occurred faults and warnings, stamped with the recorded time of occurrence.

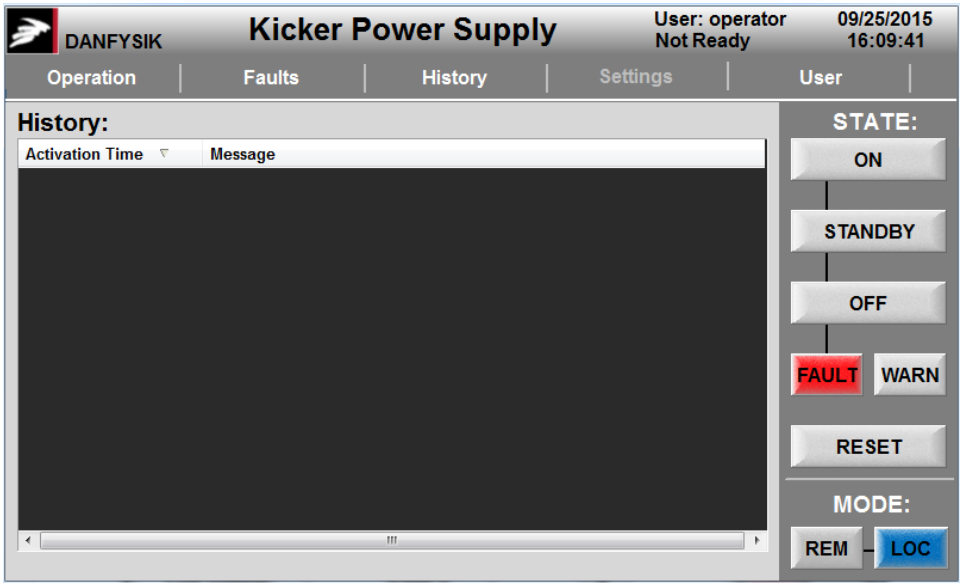


Figure 14: The History screen

3.3.6. Settings

In order to get access to the settings page the administrator login must be used. To login, click on the User tab and from here select Log On, see Figure 15, and a login prompt will appear.

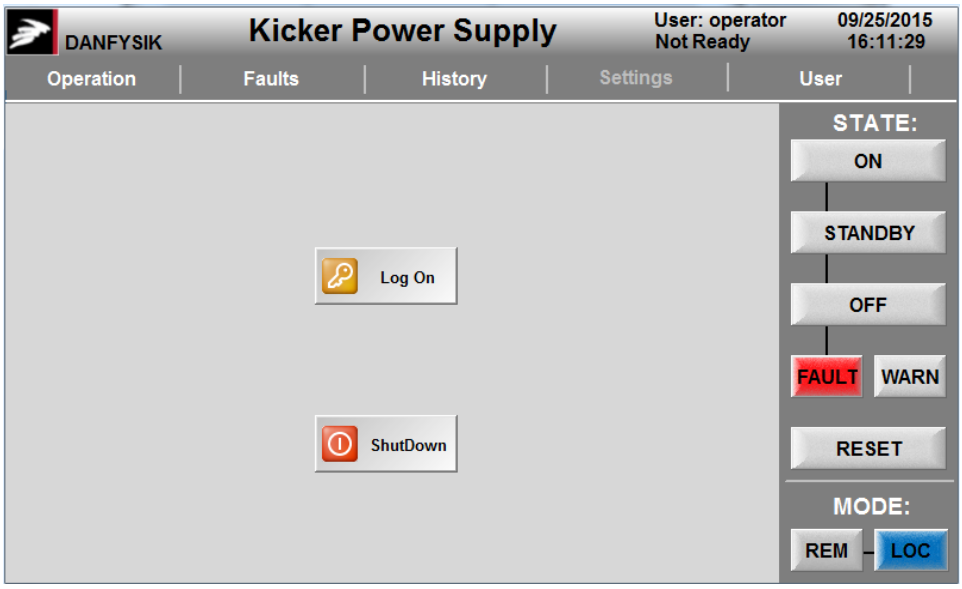


Figure 15: The login window

The administrator credentials are:

Username: admin

Password: Danfysik

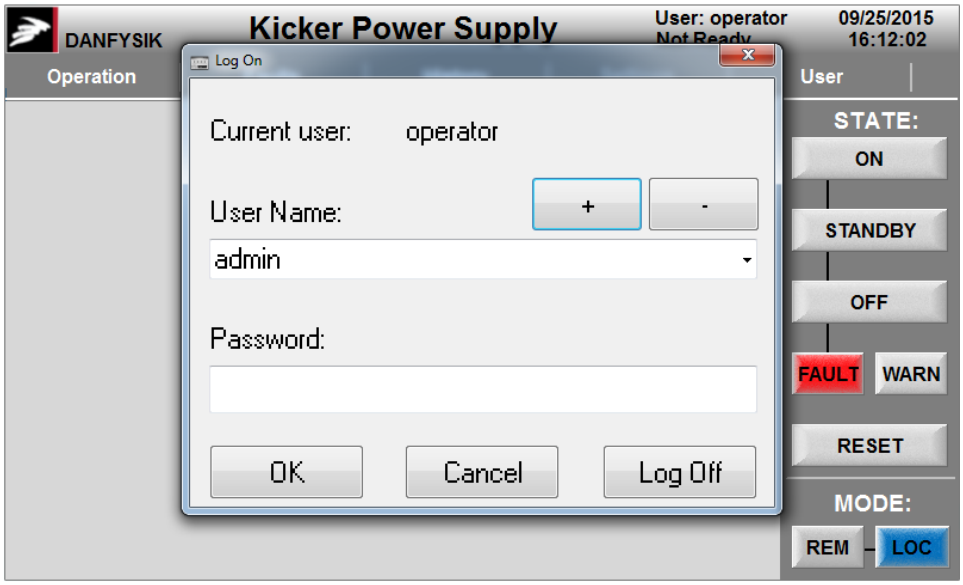


Figure 16: The login prompt

From the Uset tab, the HMI can also be shut down and this will then give access to the Windows CE operating system where e.g. IP addresse can be set up.

The windows OS can also be accessed by connecting a USB keyboard to the computer (see Figure 19), and pressing the "Windows key".

After login the Settings tab becomes active, please see Figure 17:

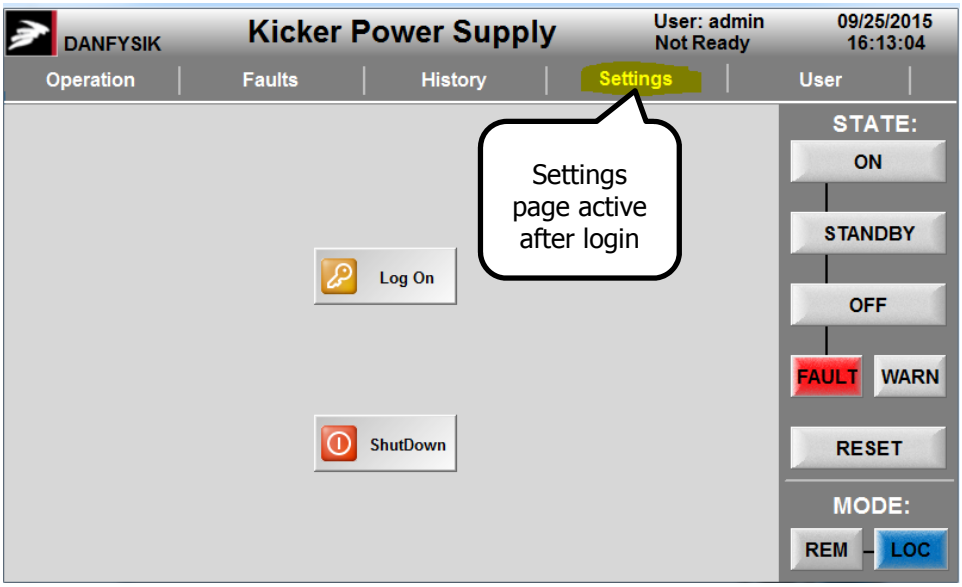


Figure 17: Settings page active after login

On the settings pages, the different signals can be set to either error or warning and this will affect whether they are latched or not.

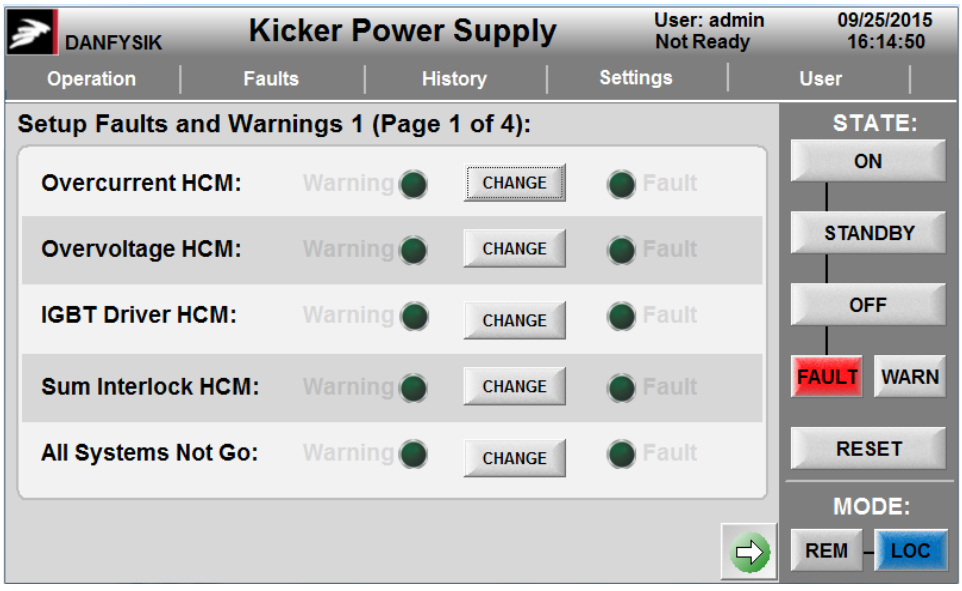


Figure 18: The settings page

Operating ranges of output current and voltages are set up on Settings page 4.

Please note that all DA and AD channels relating to a parameter must be recalibrated if the range is changed.

3.4. Remote control interface

The remote communication interface is TCP/IP, via the RJ45 connector marked LAN at the bottom of the Beckhoff 6606 IPC (Industrial PC), please see Figure 19. Please note that there are two RJ45 connectors on the IPC, the one already in use (marked "EtherCAT" in Figure 19) is for the communication to the I/O modules.

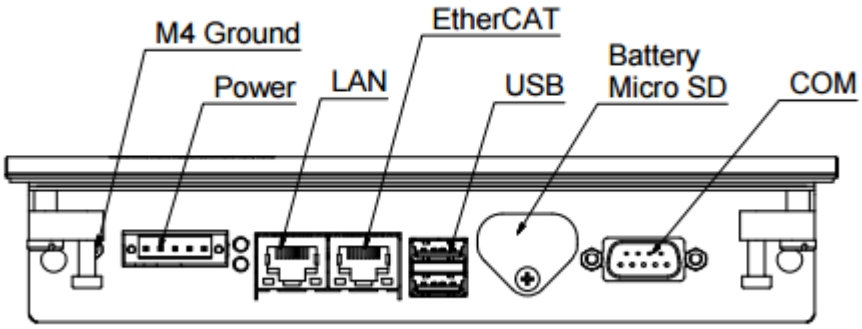


Figure 19: The connections on the Beckhoff 6606 IPC

The communication protocol is based on the IEEE standard "Standard Commands for Programmable Instruments" (SCPI) but only a subset of commands are implemented. The definition of the standard can be found here http://www.ivifoundation.org/docs/scpi-99.pdf but it is rather lengthy and an easier to read example of how it can be implemented can be found here http://www.us.tdk-lambda.com/hp/pdfs/product_manuals/83034100.pdf, please see page 35-45.

In short, SCPI is a standard set of commands implemented by many of the major instrument companies, making it much easier to implement different instruments in software.

Most SCPI commands, but not all, have "set" version and an "ask" version. Example:

- The command "OUTP:CURR 22.56" sets the current to 22.56 amps.
- The command "OUTP:CURR?" asks for the current set value and will return "22.56".

The computer uses port 8003 for the SCPI communication.

The implemented commands are listed in Table 4.

3.4.1. Remote control commands

Table 4: Implemented SCPI commands

Command	Description
SYST:ERR?	Returns error text for latest processed command
SYST:SET?	Returns the active system control mode, 0=Local, 1=Remote
SYST:SET 0	Set system control mode to LOCAL
SYST:SET LOC	Set system control mode to LOCAL
SYST:SET 1	Illegal command, attempt to set system control mode to REMOTE while system is in LOCAL. It is only allowed to set the system in REMOTE mode from the local control.
SYST:SET REM	Illegal command, attempt to set system control mode to REMOTE while system is in LOCAL. It is only allowed to set the system in REMOTE mode from the local control.
OUTP:CURR?	Returns active current setpoint
OUTP:CURR XXX.XXX	Set new value for setpoint for current in Amps
OUTP:VOLT?	Returns active voltage setpoint
OUTP:VOLT XXX.XXX	Set new value for setpoint for high voltage in Volts
OUTP:STAT?	Returns active state, 0=OFF, 1=ON, 2=STB
OUTP:STAT 0	Change system state to state OFF
OUTP:STAT OFF	Change system state to state OFF
OUTP:STAT 1	Change system state to state ON
OUTP:STAT ON	Change system state to state ON
OUTP:STAT 2	Change system state to state STANDBY
OUTP:STAT STB	Change system state to state STANDBY
*CLS	Clears all status data structures in a device incl. Error/Event queue, OPERation, QUEStionable
*RST	Reset command, Active alarms are reset
CONF:PPUL?	[sec] Returns active value for PPUL
CONF:PPUL X.XXX	[sec] Set new value for feedback signal from contactors when state machine switches to state standby
CONF:CURR:AD <gain, offset> @1	Sets gain and offset for scaling of MEASUREMENT of primary current (Note: Secondary current measurement is scaled as primary)
CONF:CURR:AD? @1	Returns the gain and offset
CONF:VOLT:AD <gain, offset> @1	Sets gain and offset for scaling of MEASUREMENT of high voltage
CONF:VOLT:AD <gain, offset> @2	Sets gain and offset for scaling of MEASUREMENT of low voltage
CONF:CURR:DA <gain, offset> @1	Sets gain and offset for scaling of SETPOINT current
CONF:VOLT:DA <gain, offset> @1	Sets gain and offset for scaling of SETPOINT voltage
STAT:QUES:STAT?	Returns bitwise MPS status for STATus:QUEStionalble:STATus represented in X binary digits
STAT:QUES:WARN?	Returns bitwise MPS status for STATus:QUEStionalble:WARNings represented in X binary digits
STAT:QUES:ERR?	Returns bitwise MPS status for STATus:QUEStionalble:ERRor in X binary digits
STAT:QUES:EXT?	Returns bitwise MPS status for STATus:QUEStionalble:EXTernal represented in X binary digits
STAT:QUES?	Returns bitwise MPS status for STATus:QUEStionalble represented in X binary digits

3.4.2. Status reporting

The status reporting is done via the QUEStionable status register with the command STATus:QUEStionable. The different status, warnings and errors are split up in separate arrays, see below. The array is summed up on the level above with an "or" so that if one or more bits are set in an array, the bit on the level above will also be set. New sub commands have been constructed to get the individual sub arrays e.g. to read the warnings, the command STATus:QUEStionable:WARNings is used.

3.4.2.1. Status, bit 9

Command: STATus

Bit	Signal	GUI name	Interpretation
0	IS_ON	ON	Power supply is ON and can be operated.
1	IS_STB	STANDBY	The entire power converter is powered, but in STANDBY mode (trigger is inhibited).
2	/IS_OFF	OFF	Converter is OFF and can not be operated.
3	REM/LOC	REM / LOC	High: Power supply is in Remote mode. Low: Power supply is in Local Mode.
4	ALL_SYS_GO	All systems not go	High: Power Supply is ON **and** HV is charged (or discharged) to the programmed level.
5	READY	Ready / Not Ready	High: Output current is within ±2% wrt. the programmed output current. (60µs of transition time is allowed pr. transition.)
6	HV_RDY@TRIG	HV not Ready at trig	High: HV was ready (at the programmed level), when a trigger was received (leading edge). Low: HV was too low (or too high), when a trigger was received. Held low min. 1s.

3.4.2.2. Warnings, bit 10

Command: WARNings

Bit	Signal	GUI name	Interpretation
0	/OF WARNING	Over freq. warning	High: SW3 running >7kHz **or** trigger received >370Hz.

3.4.2.3. Errors, bit 11

Command: ERRor.

Bit	Signal	GUI name	Interpretation
0	/OCP	Overcurrent HCM	High: Over-current (>120%) **or** current unbalance (>2% difference between output and return current) **or** DCCT failure.
1	/OVP	Overvoltage HCM	High: Over-voltage (>120%) measured on the HCM.
2	/IGBT_FAULT	IGBT-Driver HCM	High: IGBT driver failure (missing feedback on fiber retun) **or** SW3 running >8kHz **or** trigger received >400Hz.
3	/SUM_INTL	Sum interlock HCM	High: All HCM interlocks OR'ed.
4	DOOR SW PRIM	Door switch, Primary	High: Door open **or** output converter grounding bracket out of "Parking position".
5	DOOR SW REDU	Door switch, Redundant	High: Door open
6	OVER VOLTAGE	Over voltage	High: Over voltage detected by voltage monitor module (1 of 6).
7	MPS FLOW	MPS water flow	High: Insufficient cooling water flow
8	MPS TEMP	MPS temperature	High: Over-temperature in; output converter (cooling plate) **or** softstart resistors **or** LV transformer **or** LV rectifier **or** LV filter chokes.
9	CTRL TEMP	Control rack temperature	N/U
10	-	Failed to close main contactor	High: Failed to close main contactor in the time specified by CONF:PPUL. (Safety relay K7 monitors the safe (off) state of main contactors (K1-3), output contactors (K4-5) and dump switches (DC1-2), and prevents turning on the power supply if one fails to perform its safety function. Check signal chain.)

3.4.2.4. External, bit 12

Command: EXTernal.

Bit	Signal	GUI name	Interpretation
0	-	Not used	
1	EXT INTL1	External interlock 1	High: External interlock 1 (X8 A-B) open
2	EXT INTL2	External interlock 2	High: External interlock 2 (X8 C-D) open
3	EXT INTL3	External interlock 3	High: External interlock 3 (X8 E-F) open
4	EXT INTL4	External interlock 4	High: External interlock 4 (X8 G-H) open
5	EXT INTL5	External interlock 5	High: External interlock 5 (X8 J-K) open

Exampel:

If e.g. there is insufficient water flow, the command;

```
STAT:QUES?
```

will return a bit array where bit 11 is high as there is at least one error signal active.
The command;

```
STAT:QUES:ERR?
```

will return a bit array where bit 7 is high because the error signal "MPS FLOW" is active.

3.4.3. Example: Simple SCPI client

This is a very simple SCPI client for the power supply written in C#.

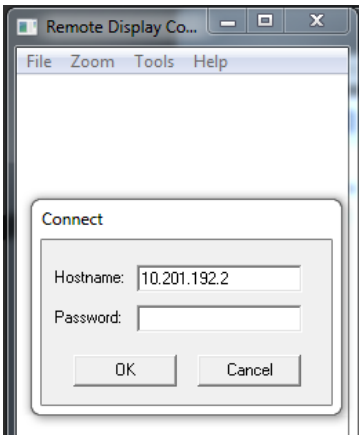
```
using System;
using System.Net;
using System.Net.Sockets;
using System.Text;
using System.Threading;

public class SynchronousSocketClient
{
   public static void SendCommand(String command, String Label,  Socket sender, Boolean wait)
   {
      byte[] bytes = new byte[1024];
      byte[] msg = Encoding.ASCII.GetBytes(command);
      sender.ReceiveTimeout = 10000;
      try
      {
         // Send the data through the socket.
         int bytesSent = sender.Send(msg);
         Console.Write(Label);
         if (wait)
         {
            // Receive the response from the remote device.
            int bytesRec = sender.Receive(bytes);
            Console.WriteLine(": = {0}",
            Encoding.ASCII.GetString(bytes, 0, bytesRec));
         }
      }
      catch (SocketException e)
      {
         Console.WriteLine("{0} Error code: {1}.", e.Message, e.ErrorCode);
         SendCommand("SYST:ERR?\n", "Error", sender, true);
      }
   }

   public static void StartClient()
   {
      // Data buffer for incoming data.
      byte[] bytes = new byte[1024];
      byte[] IpAdr = { 10, 0, 0, 3 };
      int port = 8003;
      string DUT = "MPS";

      // Connect to a remote device.
      try
      {
         // Establish the remote endpoint for the socket.
         // This example uses port 11000 on the local computer.
         IPAddress ipAddress = new IPAddress(IpAdr);
         IPEndPoint remoteEP = new IPEndPoint(ipAddress, port);

         // Create a TCP/IP  socket.
         Socket sender = new Socket(AddressFamily.InterNetwork,
         SocketType.Stream, ProtocolType.Tcp);
         // Connect the socket to the remote endpoint. Catch any errors.
```

```
            try
            {
                sender.Connect(remoteEP);
                Console.WriteLine("Socket connected to {0}", sender.RemoteEndPoint.ToString());
                // Send the data through the socket.
                SendCommand("OUTP:STAT ON\n", "Turning current On", sender, false);

                Double current = 1;

                while (true)
                {
                    Console.WriteLine("Time: "+System.DateTime.Now);

                    if (DUT == "MPS")
                    {
                        SendCommand("OUTPUT:CURR " + current + "\n", "Setting current to " + current +" ", sender, false);
                        Thread.Sleep(2);
                        SendCommand("STAT:QUES?\n", "Interlocks", sender, true);
                        Thread.Sleep(2);
                        SendCommand("MEAS:CURR?\n", "Reading current", sender, true);
                        Thread.Sleep(2);
                        SendCommand("STAT:QUES?\n", "Interlocks", sender, true);
                        Thread.Sleep(2);
                    }
                    current = current +1;
                    if (current >= 90)
                    {
                        current = 1;
                    }
                }
            }

            catch (ArgumentNullException ane)
            {
                Console.WriteLine("ArgumentNullException : {0}", ane.ToString());
            }
            catch (SocketException se)
            {
                Console.WriteLine("SocketException : {0}", se.ToString());
            }
            catch (Exception e)
            {
                Console.WriteLine("Unexpected exception : {0}", e.ToString());
            }

        }
        catch (Exception e)
        {
            Console.WriteLine(e.ToString());
        }
        Console.WriteLine("Press any key to continue...");
        Console.ReadKey();
    }

    public static int Main(String[] args)
    {
        StartClient();
        return 0;
    }
}
```

3.5. Other

3.5.1. Remote Desktop

The normal Remote Desktop is not supported on Windows CE. Instead a special remote desktop program must be used, called Microsoft Remote Display or Cerhost. Please see: http://infosys.beckhoff.com/english.php?content=../content/1033/sw_os/html/cx1000_os_ce_remotedisplay.htm&id= for further information and download of Cerhost.



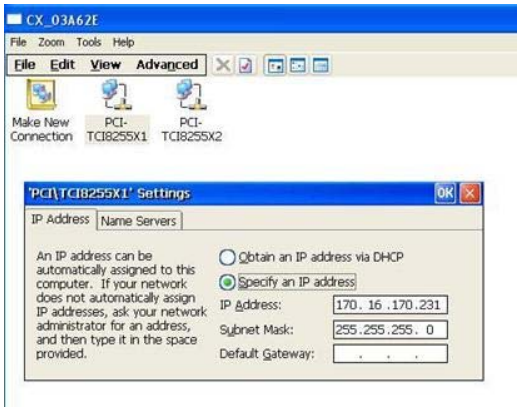
When connecting, enter the IP address of the power supply, the default is 10.201.192.2, and leave the password field empty.

3.5.2. Setting IP

The setup of the power supply's IP address can be done on the local control or via Cerhost. Either way, follow the instructions in section 3.3.6 to get to the OS if the HMI is running.

Click on Start button and select Control Panel.

Select the Network and Dial-up Connections.



Open the network properties for the network card and enter the IP address or select DHCP. End the setup by clicking the OK button.

3.6. Testing remote communication

An easy way to test the remote communication is via a TCP client where the commands from Table 4 can be entered. A client found to work well is the Hercules tool from HW Group, please see Figure 20.

In Hercules, the line feed character "$0A" must be used as stop character, please see Figure 20.

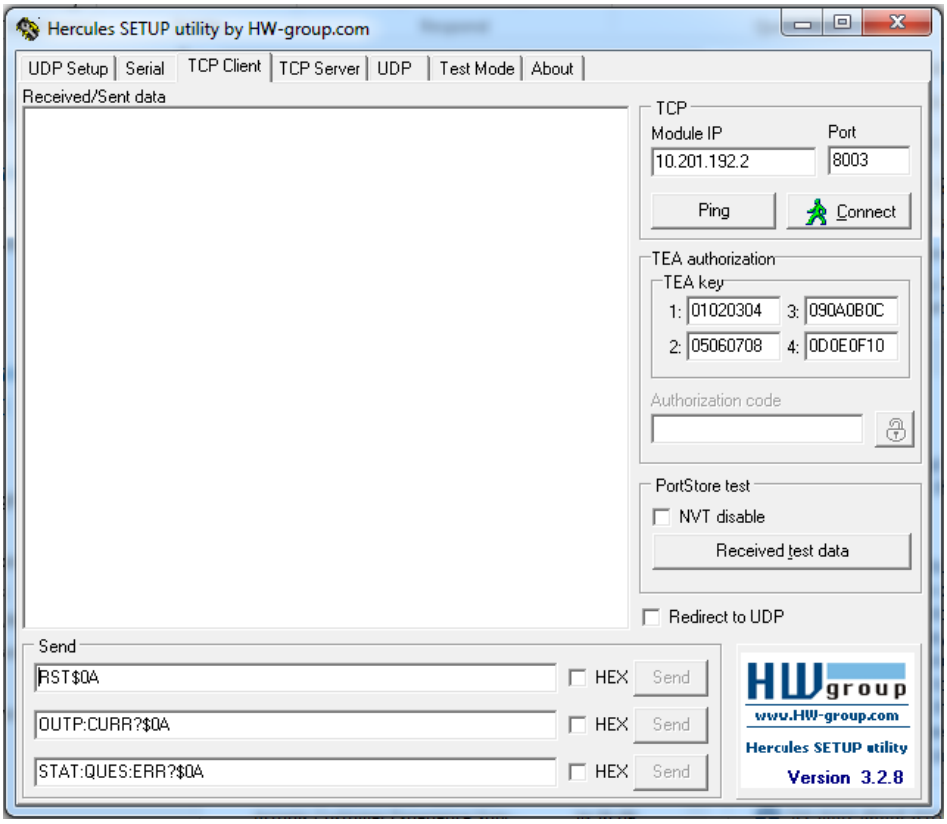


Figure 20: The Hercules utility from HW Group.

Further information on Hercules and a download link can be found here: http://www.hw-group.com/products/hercules/index_en.html

4. Maintenance

4.1. Warning before servicing / working on the power supply

- Turn off the power supply on the local control panel.
- Press the Emergency Stop switch located at the front door.
- Inspect the voltmeters, and verify that the voltage is less than 5V (LV) and 50V (HV).
- Open the right rear door and verify that Q1 (main breaker) is in the OFF position.
- Open F4 on contactor plate (to remove voltage from the emergency stop circuit).
- Open the left rear door and verify that the voltage is less than 0.1V (across C_LV) and less than 0.1V (across C_HV).
- Move the "Grounding Brackets" from their "Parking Docks" to the Grounding Points on C_HV and C_LV (GP1-2 and GP3-4 respectively, see Figure 21 below.

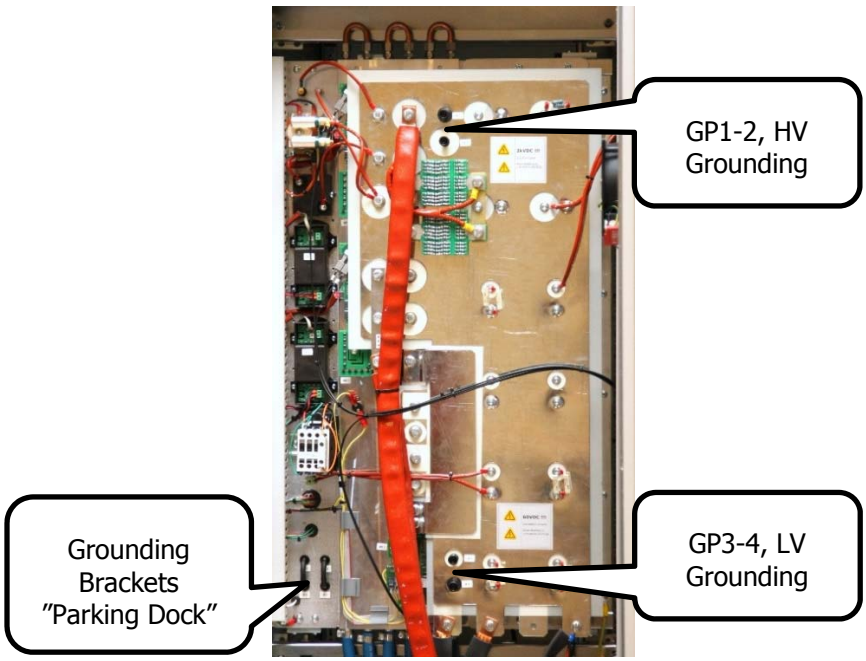


Figure 21: Grounding Points for HV and LV capacitor banks

Power supply is now safe for maintenance.

Note: The Grounding Bracket "Parking Docks" are wired in series with the primary door-switch circuit, preventing the power supply from being operated until the Grounding Brackets are back in "Parking" position.

Until main power is disconnected externally, dangerous voltages may is still be present on the input terminals, EMI filter, Q1 input side and F4 input side!

4.2. Introduction

Servicing DANFYSIK Magnet Power Supplies is only allowed by trained and qualified personal.

DANGER!

Dangerous voltages capable of causing loss of life are present inside this Magnet Power Supply. Use extreme caution when accessing, handling, testing and adjusting.

CAUTION!

Only qualified personnel are allowed to maintain this equipment.

DANGER! ELECTRIC SHOCK HAZARD!

Disconnect power at switch board before attempting to work on the Magnet Power Supply. High voltages are present at the terminals and within the Magnet Power Supply for up to 10 minutes after disconnection of the electrical supply. Always ensure by using a suitable measuring device that no voltage is present prior to commencing work.

4.3. Preventive maintenance

In a normal operating environment, perform the following tasks at one year intervals:

- Clean all fan protection grills.
- Vacuum clean the openings in the cabinet and all heat sinks mounted on printed circuit boards to ensure a normal flow of cooling air.
- Check that all screw connections to the primary and from the secondary of the transformer are tightened.
- Check that connections from the secondary of the transformer to the output terminals are tightened. (I.e. cable and bus bars carrying heavy current).
- Check that the water-flow switch works correct.
- Check that external interlocks are functioning.
- Check function of door interlocks.

In dusty or dirty environments the above-mentioned points should be performed more often.

- Visually inspect the power supply for overheated components or other suspicious signs.

4.4. Adjustment and calibration

The following adjustments are available on the Hysteresis Control Module:

- Abs. calibration: POT300 (factory calibrated against high precision measurement system).
- Pre-peak detect: POT301, may require adjustment if cable length or rise-time is changed.
- Over current: POT800 (factory adjusted to 120%)
- Over voltage: POT801 (factory adjusted to 120%)

5. Spare Parts, Ordering of

The available spare parts may vary from supply to supply. As a rule of thumb, circuit boards and major components can be ordered individually from Danfysik A/S.

All RMA-cases are handled via Danfysik's web based RMA-system. It can be accessed from the official Danfysik web page www.danfysik.com (via the Service & Test tab), where a RMA Quick Guide also can be downloaded. Alternatively the RMA-system can be accessed directly via www.dfservice.dk/rma/

Please include the following information in your request:

- Magnet Power Supply type (e.g. MPS 854).
- The serial number of the unit. See the data label on the front door.
- The module or component part no, you wish to order (e.g. 8100084741).

5.1. Handling ESD-sensitive Components

CAUTION!

Observe precautions, when handling ESD-sensitive components. Electrostatic discharge can damage ESD-sensitive components such as the PCB's installed in this Magnet Power Supply.

Use a grounding armband or similar whenever working with these components.

Keep ESD-sensitive components in antistatic material during storage, transport or packing for shipment.

6. Specification

6.1. Input power rating

Voltage :	3 x 208V
Wiring configuration:	3PH + N + PE (min. 6mm^2)
Frequency:	50/60 Hz
Full Load Current:	<20 Arms (excluding power drawn from the integral socket strip)
Power:	<7.2 kVA (excluding power drawn from the integral socket strip)
Main Breaker rating:	30 A
Interrupt current:	65 kA I.C. (@ 240V)

6.2. Pulsed output

Voltage:	2000 V
Current:	250 A
Pulse shape:	≤50 µs linear rise/fall, ±2% flattop
Repetition rate:	Up to 350Hz, controlled by external trigger
Load:	360µH + ≤50mΩ (UCN Kicker Magnet, DF#: 7505019961) + cable
Cable:	20-30m, 2 of 3 wires of a 15kV/500kcmil cable, Okonite#: 571-23-3544

6.3. Main cooling system

Cooling water:	
Min. differential pressure	3 bar
Max. absolute pressure	12 bar
Test pressure	16 bar / 5 min.
Flow	≤5 l/min @ 3 bar
Fitting	½" BSP

6.4. Dimensions and weight

Dimensions (HxWxD)	2100 x 1200 x 800mm
Weight	600 Kg (1320 lbs)