



SM3000-series

- **SM 15 - 200 D**
- **SM 30 - 100 D**
- **SM 45 - 70 D**
- **SM 70 - 45 D**
- **SM 120 - 25 D**
- **SM 300 - 10 D**

PRODUCT MANUAL

Contents:

- 1 - Datasheet
- 2 - Safety Instructions
- 3 - Descriptions
- 4 - Operating, Trouble Shooting, Calibration
- 5 - EC Declaration of Conformity

2 SAFETY INSTRUCTIONS - SM3000-series

1 Caution

The following safety precautions must be observed during all phases of operation, service and repair of this equipment. Failure to comply with the safety precautions or warnings in this document violates safety standards of design, manufacture and intended use of this equipment and may impair the built-in protections. Delta Elektronika shall not be liable for user's failure to comply with these requirements.

2 Installation Category

The Delta Elektronika power supplies have been evaluated to installation category II (Over voltage category II).

3 Grounding of Mains Terminals (AC Power Terminals)

This product is a safety Class 1 unit. To minimize shock hazard, the unit must be connected to the AC Power Supply mains through a four conductor power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet.

For units designed to be hard-wired to the mains supply, the protective earth terminal must be connected to the safety electrical ground before another connection is made. Any interruption of the protective ground conductor, or disconnection of the protective earth terminal will cause a potential shock hazard that might cause personal injury.

4 Grounding of DC Power Terminals

If the DC power terminal of a unit is specified to sink or source to a maximum of 60VDC, and either the negative or positive DC power terminal is grounded, the voltage on the DC power terminals and sense connections can be considered safe.

Warning:

When the positive DC power terminal can exceed 60VDC in respect to the negative DC power terminal, additional external measures must be taken to ensure safety isolation of the DC power terminals and sense connections.

Warning:

When the negative power output of the unit can exceed 60Vdc / 42.4Vpk in respect to ground, additional external measures must be taken to ensure safety isolation of the following:

- power outputs and sense connections
- programming/monitor/status-signals, Interlock, Master/Slave-connections, ACF/DCF-relay
- interfaces with operational isolation
- non-isolated interfaces.

Caution 1: If a low voltage unit has both DC power terminals floating, or if the DC terminals are in series with an external high AC or DC voltage, the lower DC power terminal can exceed the safe value in respect to ground as specified in the above warning!

Caution 2: Although a high voltage unit is set to a safe voltage below 60VDC, for safety it must always be considered as a high voltage unit! Wrong operation, a programming error or an external defect can result in an unsafe high DC output voltage.

Caution 3: When programming a high voltage unit directly via a PC or via a network connection, either ground the negative power output or use a safety isolated interface!

For more information and schematics regards Grounding and Safety, see the special application note "*Safe operation of a power supply*" on the Delta Elektronika website.

5 Danger of electrical shock

Touching the contacts of the mains plug or wires directly after disconnecting from the mains can cause an electrical shock. See next paragraph "Connection to the mains supply".

6 Connection to mains supply

Either connect to the mains supply permanently or via an industrial type plug, complying with IEC 60309. "Permanently connected equipment" or "Pluggable equipment type B".

7 Fuses

Fuses must be changed by authorized Delta Elektronika service personnel only, for continued protection against risk of fire.

8 AC Input Ratings

Do not use an AC Supply which exceeds the AC input voltage and frequency rating of this unit. The AC input voltage and frequency rating of the Delta Elektronika power supply series are stated in the accompanying datasheet.

9 Live Circuits

Operating personnel should not remove the unit covers. No internal adjustment or component replacement is allowed by non Delta Elektronika qualified personnel. Never replace components with the power cable connected. To avoid injuries, always disconnect power, remove external voltage sources and discharge circuits before touching components.

10 Parts Substitutions & Modifications

Parts substitutions and modifications are allowed by authorized Delta Elektronika service personnel only. For repairs or modifications the unit must be returned to a Delta Elektronika service facility.

11 Removal of (safety) covers

Safety cover(s) are used to cover potentially hazardous voltages. Observe the following when removing safety cover(s):

- Switch off the unit.
- Disconnect the unit from the mains supply or power outlet.
- Wait for 5 minutes to allow internal capacitors to discharge.
- Unscrew the screws and remove the cover(s).
- Always place the cover(s) back before connecting the unit to the mains supply again.

12 Environmental Conditions

The Delta Elektronika power supplies safety approval applies to the following operating conditions:

- Indoor use
- Ambient temperature : -20 to 50 °C
- Maximum relative humidity : 95%, non condensing, up to 40 °C
: 75%, non condensing, up to 50 °C
- Altitude : up to 2000 m
- Pollution degree : 2



Caution risk of electrical Shock



Instruction manual symbol. The unit will be marked with this symbol when it is necessary for the user to refer to the instruction manual



Protective ground conductor terminal



Off (supply)



On (supply)

WEEE (Waste Electrical & Electronic Equipment)

1 Correct Disposal of this Product

Applicable in the European Union.



This marking shown on the product, its packing or its literature indicates that it should not be disposed with other wastes at the end of its working life, but should be collected separately to recycle it responsibly to promote the sustainable reuse of material resources.

3 DESCRIPTIONS

1) OUTPUT

The SM15-200D, SM30-100D, SM45-70D, SM70-45D, SM120-25D and SM300-10D can either be used as a constant voltage source with current limiting or as a constant current source with voltage limiting.

The change of mode occurs sharply at the crossing of the voltage and current settings (fig. 3 - 1 shows the output ranges).

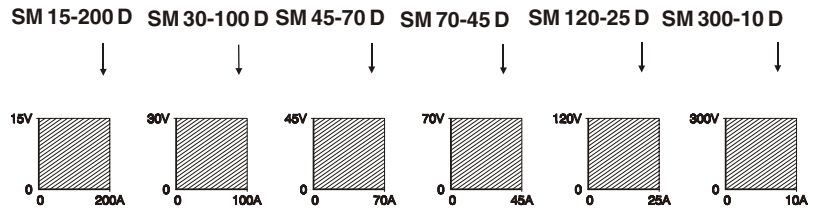


fig. 3 - 1
The output ranges.
every point in hatched area can be used

◦ **DISPLAY CV/CC SETTING FUNCTION**
The setting of the voltage and current control can be observed on the front panel meters by pressing the Display CV/CC Setting button. This allows the current limit to be set when operating in the CV mode without shorting the output terminals, and the voltage limit to be set when operating in the CC mode without opening the load leads.

◦ **OVERLOAD PROTECTION**
The power supply is fully protected against all overload conditions, including short circuit.

2) INPUT VOLTAGE

The power supplies have a wide input voltage range.

- The units need a 3 phase input voltage, but **no neutral connection** is required.
- The units can also operate on one phase but at 90% of the max. output voltage, with a slight increase of the output ripple voltage.
- The units can also be used as a DC/DC converter.
- non-standard line input voltage
The units will still operate at a line input voltage lower than standard, but with a reduction in output power. Figure 3 - 3 shows the max. output current as a function of output voltage with AC or DC line input voltage as a parameter.
Example: Say the required output voltage is 24 V at a line input voltage of 270 V AC. Figure 3 - 2 shows the maximum output current for the SM30-100D to be 59 A.
- **Note:** All AC input curves are measured using 3 phase input.

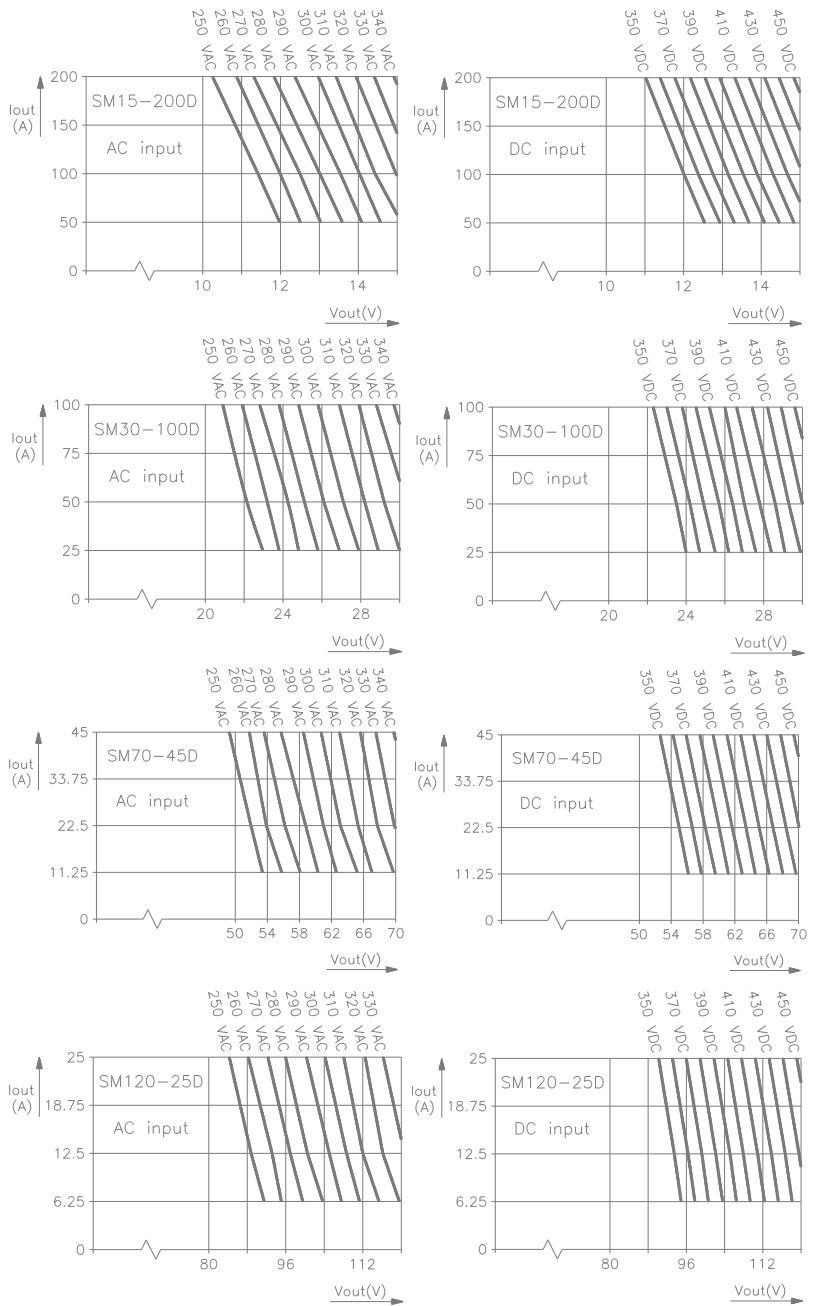


fig. 3 - 3
Max. output current vs output voltage
with AC or DC line input voltage as a parameter

3) INPUT CURRENT

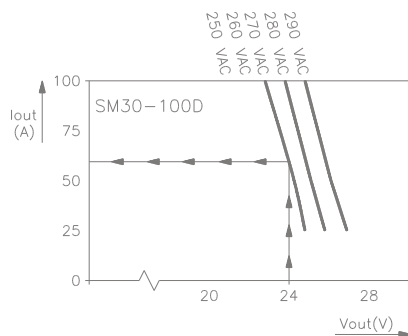


fig. 3 - 2
Example how to use the graph

The input circuit has a large series choke to improve the waveform. The result is: a lower rms input current, less mains distortion and no large peak currents.

The units also have an inrush current limiter and a soft start circuit, for smooth switch on.

° FUSES 16 A Slow blow.

4) **STANDBY INPUT POWER**

The unit consumes very little power when in standby. This makes it possible to leave the input power on and use the Remote ShutDown input (pin 5 on prog. connector rear panel) to disable the output.

5) **EFFICIENCY**

The efficiency is very high and constant over a wide output current range (see fig. 3 - 4). High efficiency also means low power loss and low heat generation.

6) **REGULATION**

The load regulation should be measured directly on the output terminals. A few cm of cable can have a voltage drop of several mV (at high current!).

7) **RIPPLE & NOISE**

The output ripple is very low with almost no spikes.

The ripple voltage has to be measured directly on the output terminals using a probe with very short connections (to avoid pick up of magnetic fields) (see fig. 3 - 5 and fig. 3 - 6).

At low temperatures like -20°C the ripple increases. By using high quality electrolytic capacitors the increase is relatively low.

8) **PROGRAMMING INPUTS**

The output voltage and current can be programmed by an external analog voltage. This programming is very accurate and linear, (non-linearity <0.15%). The levels are all standardized on 5V. Always use a **shielded cable** for programming.

The inputs have a protection circuit formed by a series resistor and a parallel zener (see fig. 3 - 7). The capacitor limits the speed to a safe value. Note that the analog inputs (and outputs) are **not floating, but the common is connected to the negative output terminal**. Wrong connection of Ø can cause earth loops which can trip the fuse. After removing the fault, the fuse will reset (PTC-fuse). To prevent earth loops, use isolated programming with the **ISO AMP CARD internal interface option P145(δ-product)**.

The programming mode (program and manual) can be selected by means of the prog. switches which are situated below the programming connector (see fig. 3- 9).

9) **IEEE488 / RS232 PROGRAMMING**

For programming use the external interface **PSC-488 module** or internal interface **PSC-232 (both δ-products)**.

Voltage and current can easily be programmed and read back. Also the CC and OVP status can be read by the computer. Always use a **shielded cable** for programming.

10) **MONITORING OUTPUTS**

The monitor outputs give a voltage 0 - 5 V proportional to the output current or voltage. The output current can easily be measured without an external shunt using the I-monitor (see fig. 3 - 8). The monitor outputs are buffered by op-amp's and protected by series resistors and parallel zeners (see fig. 3 - 10). The table 3 - 1 shows the impedance levels of the monitoring outputs.

For using Imon on a pulsating load, see paragraph 17) of this chapter.

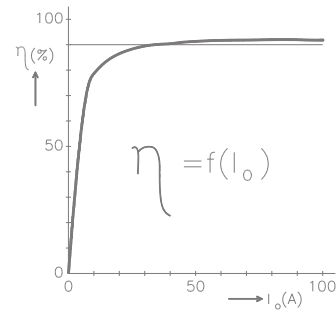


fig. 3 - 4
Efficiency vs output current, SM30-100D
DC input , $V_{out} = 30 V$

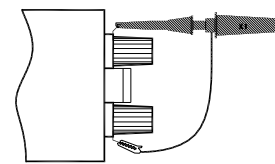


fig. 3 - 5
Measuring ripple voltage
WRONG !

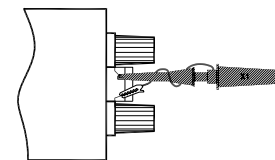


fig. 3 - 6
Measuring ripple voltage
RIGHT !

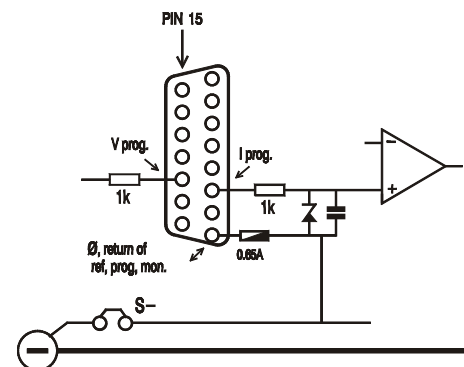


fig. 3 - 7
Programming inputs
(internal circuit)

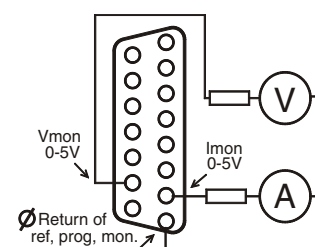


fig. 3 - 8
External meters
using monitor outputs

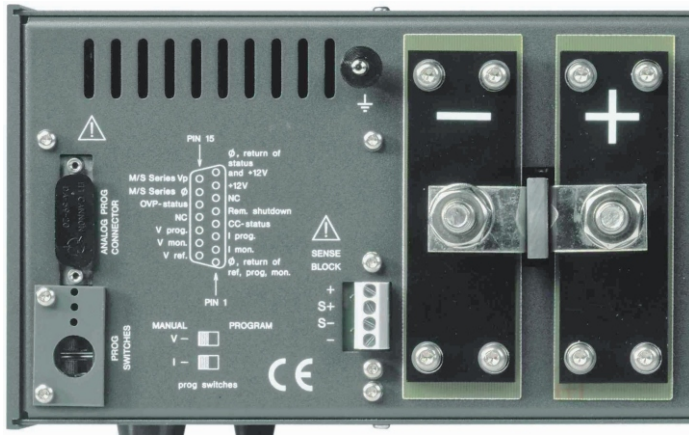


fig. 3 - 9

Location of output terminals and analog prog. connector on rear panel

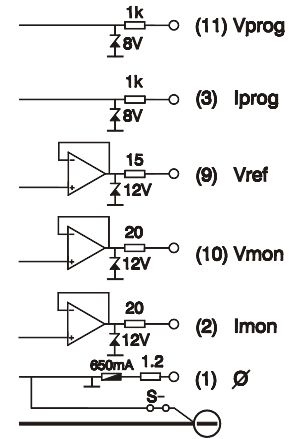


fig. 3 - 10

Buffered monitor outputs (internal circuit)

Output	pin	Ro	Io max
Vref	9	15 Ohm	10 mA
Vmon	10	20 Ohm	10 mA
Imon	2	20 Ohm	10 mA
+12V	7	500 Ohm	25 mA
∅	1	1.2 Ohm	

table 3 - 1

Outputs on programming connector

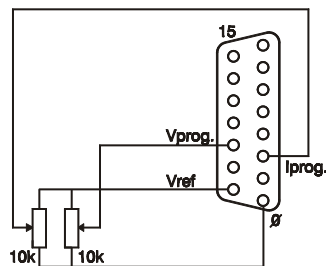
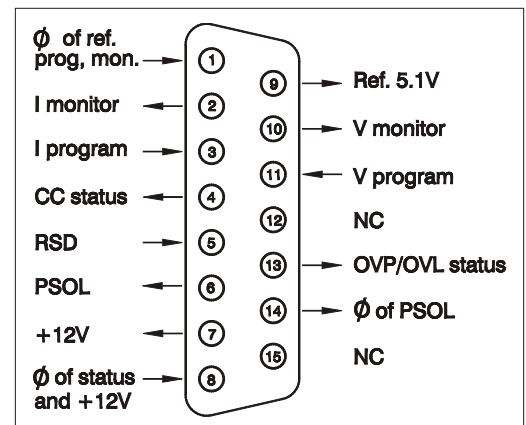


fig. 3 - 11

External potmeters



pin	description
1	∅, return of reference, prog. inputs and monitor outputs.
2	current monitor output (0 - 5V)
3	current programming input (0 - 5V)
4	CC status output, logic 1 = CC mode (5 V / 10 mA)
5	Remote ShutDown
6	PSOL status output (optional)
7	+12 V output (Ri = 500 Ohm)
8	∅, return of status outputs, +12 V and remote ShutDown
9	reference voltage 5.1 V
10	voltage monitor output (0 - 5V)
11	voltage programming input (0 - 5V)
12	NC
13	OVP status output, logic 1 = OVP mode (5 V / 10 mA)
14	∅, return of PSOL (optional)
15	NC

fig. 3 - 12

Connections ANALOG PROG. CONN.

11) STATUS OUTPUTS

The status outputs have an open output voltage of 5 V and a short circuit current of 10 mA. This makes it possible to drive directly: an opto-coupler, a TTL gate or a CMOS gate (put leakage resistor to ∅).

12) REMOTE SHUTDOWN

A voltage of +5V on the Remote ShutDown input on the programming connector will switch off the power circuit of the unit. In standby mode the power supply consumes very little power.

It is also possible to use a relay contact or a switch to shut down the unit: connect a switch between Vref and Rem. ShutDown (pin 9 and 5).

Note: The Remote ShutDown will also cause the OVP-led to burn and the OVP-status will be high.

13) PROGRAMMING SPEED

The response time is measured with a step waveform at the CV prog. input. Programming from a low to a high output voltage is nearly load independent, but programming down to a low voltage takes more time on lighter loads. This is caused by the output capacitors, which can only be discharged by the load because the power supply cannot sink current.

When having a supply with a **fast programming option**, the response is 5 to 25 times faster (see datasheet). When using fast programming it is generally not recommended to use remote sensing or serial / parallel operation. Consult factory for advice. Also the output ripple is higher.

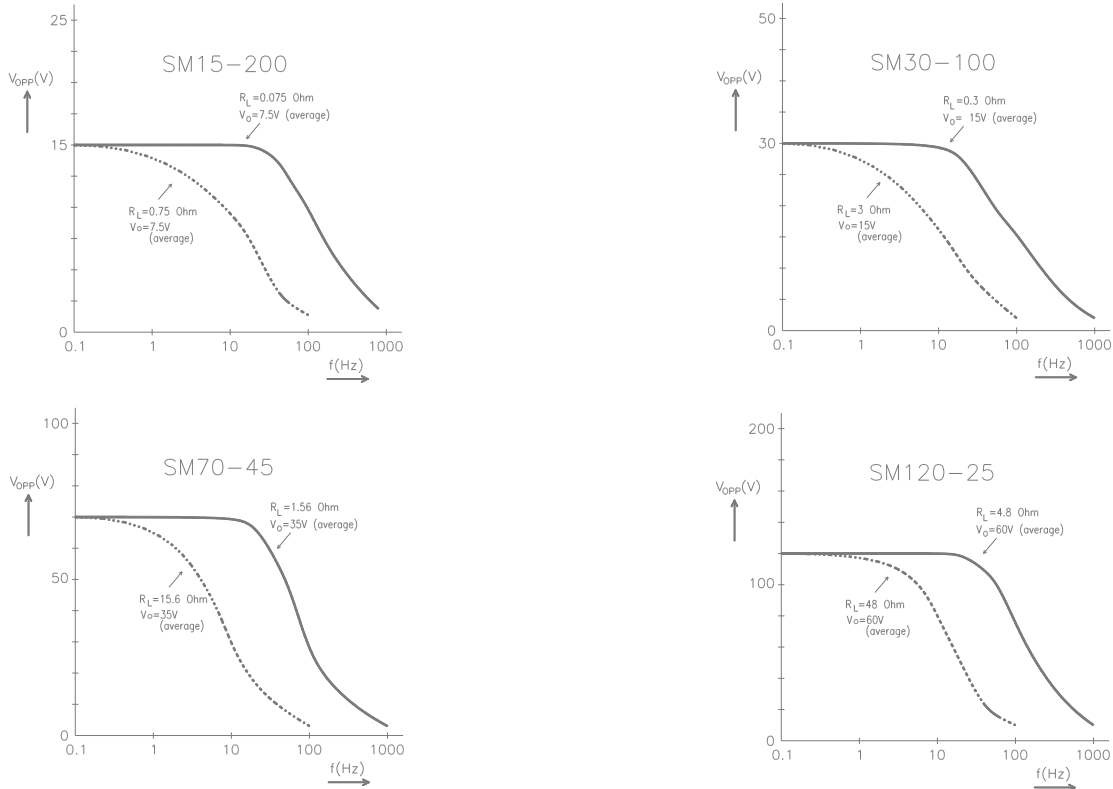


fig. 3 - 13
Max. peak to peak output voltage swing vs frequency

14) **PROGRAMMING BANDWIDTH**

For small signals the bandwidth is 50 Hz, but for large signals there is a limitation in the maximum amplitude of the output waveform. The output capacitors limit the max. slew rate. Figure 3 - 13 shows the maximum peak to peak output voltage swing as a function of frequency, with the load as a parameter. The higher the load resistance the lower the max. amplitude. The measurements were carried out using a sine wave. The DC level of the output is 50 % of the max. output voltage.

15) **RECOVERY TIME**

Figure 3 - 14 shows the recovery time for the SM30-100D at 25 °C, set at 30 V output voltage, with a 50 – 100% load step.

16) **NOISE SUPPRESSION (input / output)**

The input / output noise suppression is measured with a pulse generator (a) in series with the line input or (b) between input and case (earth). The generator should produce a high energy pulse of about 300 V. If there is an electrical connection between the output and the input through the oscilloscope, you will get a false reading. The suppression for the SM120-25D is lower, but the relative disturbance on the output is comparable to the SM30-100D.

17) **PULSATING LOAD**

To avoid overheating the output capacitors, the AC component of the load current should be limited (see fig. 3 - 15).

One method of decreasing the AC current through the output capacitor is by using a large external electrolytic capacitor in parallel with the load. Care must be taken so that the capacitor in combination with the lead inductance will not form a series resonant circuit!

When using **remote sensing** on a pulsating load (for instance a DC-motor), use a capacitor in series with a resistor over the load (see fig. 3 - 16). Like this the AC-component caused by the pulsating of the load is filtered.

With pulsating loads the **I-monitor output** should not be used.

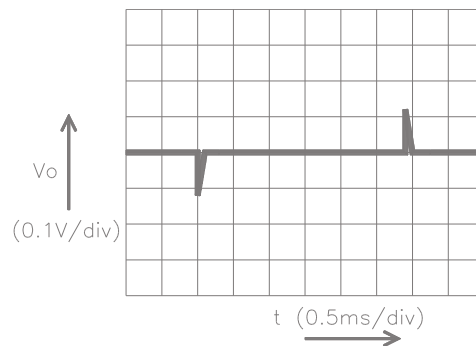


fig. 3 - 14
Recovery time SM30-100D
50 - 100 % load step, $V_o = 30 \text{ V}$

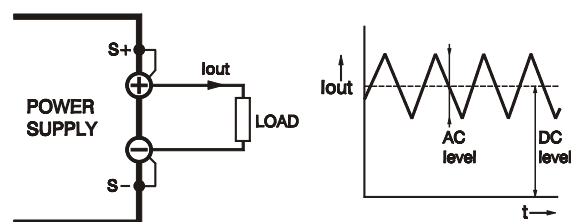


fig. 3 - 15
Pulsating load current

18) INSULATION

For safety the insulation of the separating components (transformers) between input and output is tested at 3750 Vrms during 1 minute. This is tested before assembling.

Warning! The 3750 Vrms cannot be tested afterwards on the assembled unit because the insulation between the components on the input side to the case (like the bridge rectifier) is specified at 2500 Vrms. Since the insulation output - case is low (only 600 V DC) the insulation of the primary components to case will break down when 3750 Vrms is applied between input and output (2500 Vrms + 600 V DC < 3750 Vrms) (see also fig. 3 - 17).

Note: when testing the insulation, take care to charge and discharge the capacitors between input - case and output - case slowly (e.g. in one second). This to prevent high peak currents, which could destroy the power supply. Make sure to have discharged the capacitors completely before using it again.

19) RFI SUPPRESSION

Both the input and output have RFI filters, resulting in very low conducted RFI to the line and load. Due to the output filter the output voltage is very clean, having almost no spikes.

20) OPERATING TEMP

At full power the operating temperature range is -20 to $+50$ °C. From 50 to 60 °C the output current has to be derated linearly to 75 % at 60 °C (see fig. 3 - 18). These temperatures hold for normal use, i.e. the ventilation openings on the left and right side must be free.

21) THERMAL PROTECTION

A thermal switch shuts down the output in case of insufficient cooling. After cooling down the unit will start working again.

The thermal protection circuit protects 2 parts separately in the unit: the switching transistors on the primary side and the output circuit.

A tripped thermal protection can have the following effects:

- 1) When the protection on the switching transistors has tripped, no led indicator or digital meter will burn on the front panel.
- 2) When the protection on the output circuit has tripped, the OVP led on the front panel will burn, and the OVP status output will be high.

22) HOLD - UP TIME

The hold - up time depends on the load, output voltage and line input voltage. A lighter load, a lower output voltage or a higher line input voltage all result in a longer hold - up time (see fig. 3 - 19).

23) TURN ON DELAY

The output voltage is available 0.5 sec after mains switch on.

24) INRUSH CURRENT

The inrush current is limited by a 90 Ohm resistor, resulting in a very low current during switch on. The input current during switch on will be lower than during operation at full load.

25) PHASE LOSS

Phase loss means that there is only one phase available instead of three.

The unit will continue to operate on one phase but at 90% of the max. output voltage. Ex.: a SM30-100D on one phase 380 V can deliver $90\% \times 30 = 27$ V @ 100 A. So if the output voltage is not set higher than 27 V no drop in the output voltage will be noted during phase loss. However the output ripple voltage will be slightly higher when the input is on one phase.

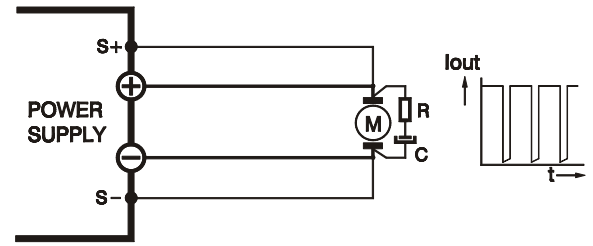


fig. 3 - 16

Remote sensing on a pulsating load

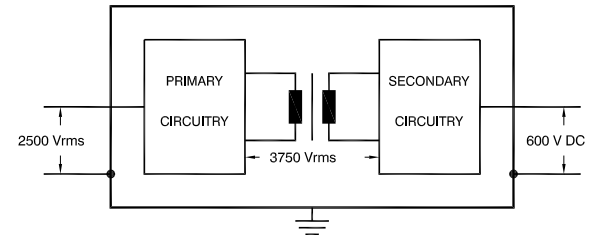


fig. 3 - 17

Insulation test voltages

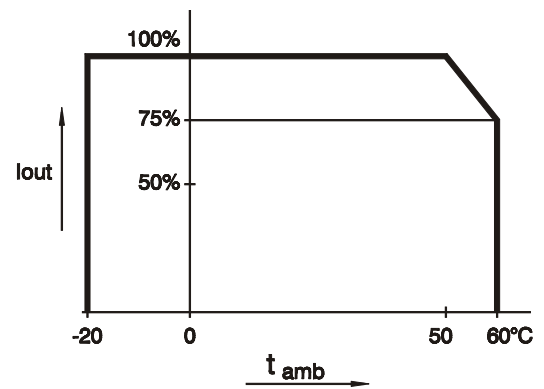


fig. 3 - 18

Operating temperature ranges

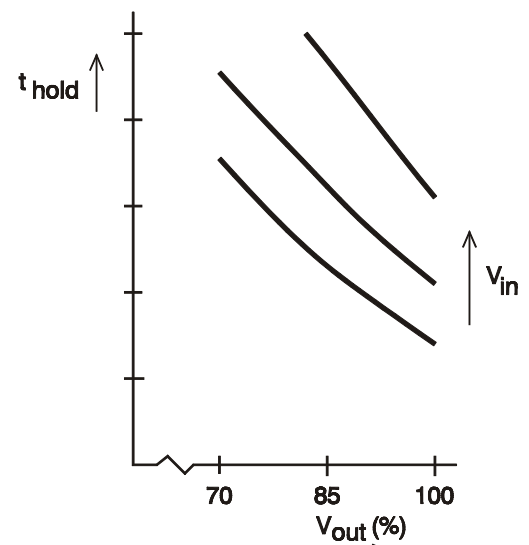


fig. 3 - 19

Hold-up time vs V_{out} with V_{in} as a parameter

26) **SERIES OPERATION**

Series operation is allowed up to 600 V total voltage. The power supplies can be connected in series without special precautions.
 For easier control, Master / Slave operation is recommended (see fig. 3 - 20). By using the Master / Slave Series feature a **dual tracking** power supply can be made with one unit as master and one as slave.
 For series operation in combination with Power Sink option, all units must have a Power Sink built inside otherwise no power can be absorbed.

27) **PARALLEL OPERATION**

Paralleling of the units has no limitations. The power supplies can be connected in parallel without special precautions. For easier control, Master / Slave operation is recommended (see fig. 3 - 20 and fig. 3 - 21).
 Normal parallel operation of **Fast Programming** units can give problems, each combination has to be tested first, in combination with the load !
 For parallel operation in combination with **Power Sink** option, only one unit can have a Power Sink. Refer to Power Sink manual for details and restrictions.

28) **MASTER / SLAVE OPERATION**

The Master / Slave feature makes it possible to use the power supplies as building blocks to form one large unit (see fig. 3 - 21).
 The resulting combination of units behaves like one power supply and can be programmed on the master. Figure 3 - 23 shows a computer controlled M/S parallel combination.
 Mixed parallel - series operation is also possible (see fig. 3 - 22), to a maximum of 600 V. Here the **MASTER/SLAVE SERIES ADAPTER** (δ-product) must be used. For parallel operation connections can easily be made on the analog programming connector.
 In series mode the master controls one slave, which in turn controls the second slave and so on. In parallel mode the master controls all the slaves.
 The result is true **current or voltage sharing** in the parallel or series mode respectively.
Note: Master / Slave parallel operation is not recommended for more than 3 units or in combination with Fast Programming option. Consult factory for a solution.

29) **REMOTE SENSING**

The voltage at the load can be kept constant by remote sensing. This feature is not recommended for normal use but only when the load voltage is not allowed to vary a few millivolts. Always use a **shielded cable** for sensing.
 In order to compensate for the voltage drop across the load leads, the unit will have to supply a higher voltage: $U_{out} = (\text{voltage drop across each lead}) + (\text{voltage across the load})$ (see fig. 3 - 24). The **OVP** reads the voltage directly at the output and the setting must be increased by the total voltage drop across the load leads.
 The voltmeter is connected to the sense leads and therefore reads the voltage across the load and **not** the voltage on the output terminals.
 The sense leads are protected for **accidental interruption**, in which case the output voltage will go to a max. of 115% of the set value.
Warning: Do not interrupt the minus lead while the S- lead is still connected to the load, during operation.
 For sensing on a **pulsating load**, see previous paragraph 17).

30) **OVP**

The Over Voltage Protector will protect your circuit from unwanted high voltages.
 A high output voltage could be caused by accidental interruption of leads, accidentally turning up the voltage potmeter or a defect in the power supply. The OVP circuit uses a separate voltage divider connected directly to the output terminals.
 The OVP limits the output voltage to a value which can be set by the OVP potmeter on the front panel. While doing this, press the DISPLAY OVP SETTING button to read the limit value in the left display. The led on the front panel will indicate whether the OVP has reached the limit. The OVP status output will give a logic 1 (+5 V).
 Note: The Thermal ShutDown and Remote ShutDown will also cause the OVP-led to burn and the OVP-status will be high.

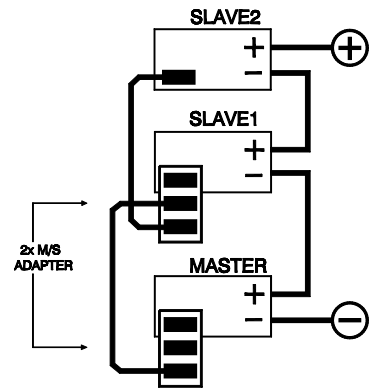


fig. 3 - 20
 Master / Slave series operation

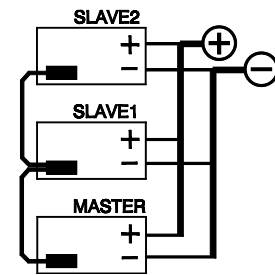


fig. 3 - 21
 Master / Slave parallel operation

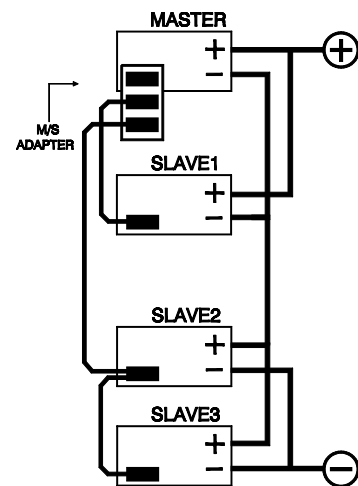


fig. 3 - 22
 Master / Slave mixed series-parallel

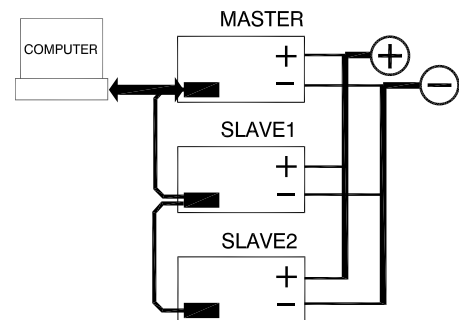


fig. 3 - 23
 The Master / Slave combination can also be programmed with the interfaces PSC-488 or the PSC-232

When the OVP status output is used as an indication for accidental interruption of leads, a defect in the power supply etc., it is recommended to set the limit well above the working output voltage to avoid accidental limiting. The recommended OVP set voltages can be read from the following table:

	SM 15-200 D	SM 30-100 D	SM 45-70 D	SM 70-45 D	SM 120-25 D	SM 300-10 D
V _{ovp} set	V _{out} + 2 V	V _{out} + 3 V	V _{out} + 5 V	V _{out} + 5 V	V _{out} + 10 V	V _{out} + 25 V

Example: For a SM30-100D set at 24 V output voltage it is recommended to set the OVP on 24 + 3 = 27 V.

31) **POTENTIOMETERS**

- Standard: - CV and CC potentiometers with knobs at front panel, OVP potentiometer with screwdriver adjustment at the front panel.
- Option P001: - Screwdriver adjustment for CV, CC and OVP at the front panel (see fig. 3 - 25).
- Option P002: - Screwdriver adjustment for CV, CC and OVP at the rear panel (no potentiometers at front panel), (see fig. 3 - 26).

32) **COOLING**

A low noise blower cools the unit. The speed of the fan depends on the temperature of the internal heatsink. At room temperature and full load the fan will run at a very low speed. The fan does not operate on no load. Normally at 50 °C ambient and full load the fan will not work at full speed. Since the fan is over-rated it will still have enough capacity to cool the unit when dust partially obstructs the fins of the heatsinks.

A special feature is that the fan blows through a tunnel where the heatsinks are situated, the delicate control circuitry is separated and will not be in the airflow path (see fig. 3 - 27).

Because the air enters at the left and exits at the right side it is possible to stack the power supplies, no distance between the units is required. Only the ventilation openings at the left and right side should be free.

For long life the temperature of the air entering on the left side, should be below 35 °C under normal conditions. Under extreme conditions it should be below 50 °C.

Note: The control circuit makes the fan start in a pulsating mode, during which period it normally produces a high pitched sound. This is normal.

33) **DIMENSIONS**

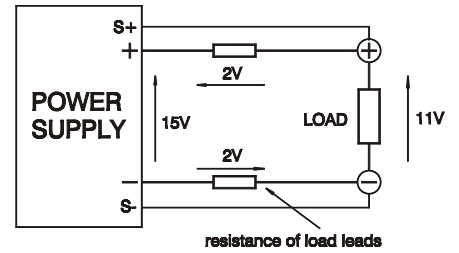
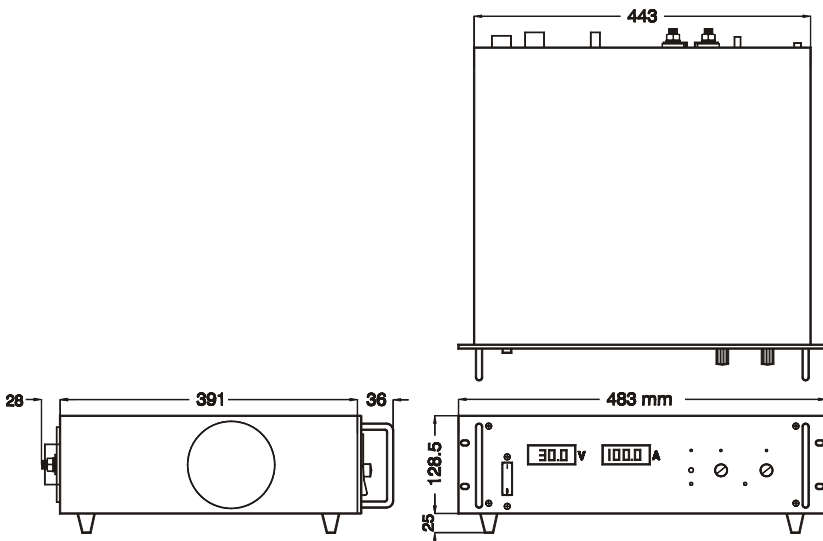


fig. 3 - 24

Remote sensing, voltage drop in load leads subtracts from max. output

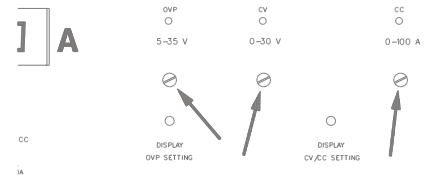


fig. 3 - 25

Screwdriver adjustment at front panel

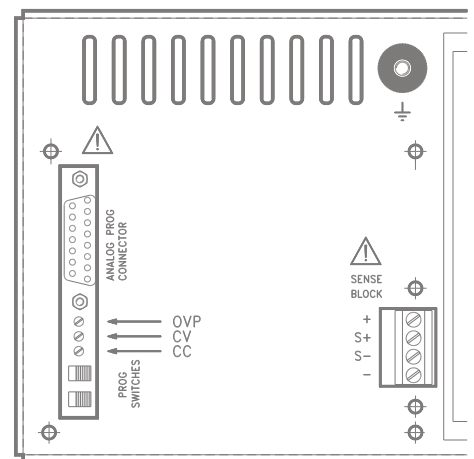


fig. 3 - 26

Screwdriver adjustment at rear panel

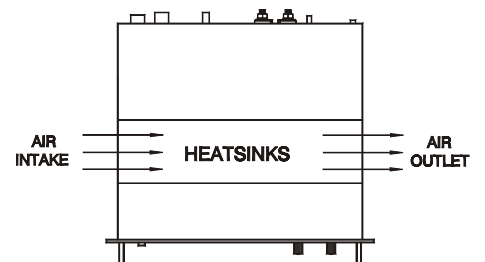


fig. 3 - 27

The fan blows through a tunnel, where the heatsinks are situated

CIRCUIT DESCRIPTION

The 380 V AC line voltage is rectified by a bridge rectifier and smoothed by a large electrolytic capacitor. The 50 Hz choke in the input circuit improves the waveform of the input, so that no low frequency distortion is produced on the line voltage.

Carefully designed RFI filters protect the line and the load from the high frequency interference produced inside the power supply.

When the unit is switched on, the electrolytic capacitor is charged via the resistor of the INRUSH CURRENT LIMITER circuit, so no large inrush current will flow. As soon as the voltage is sufficiently high the power supply starts working and the series resistor is bypassed by a relay contact.

The operating switching frequency of 200 kHz has many advantages like small size, reduced weight, low ripple and fast regulation.

The rectified 380 V (500 V DC) is chopped by the transistors and transformed to a lower voltage. This 200 kHz power converter is of the feed forward type. The regulation is achieved by pulse width modulation.

Careful design, over-rating of vital components, several built-in protections and cool operation (because of the very high efficiency) make the SM-series very reliable power supplies which can be used continuously at maximum rating.

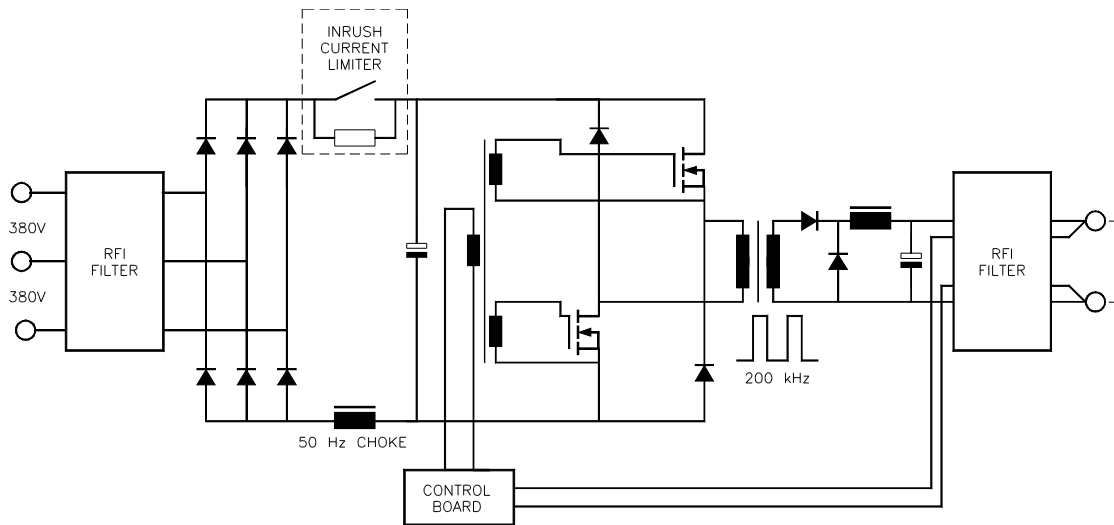


fig. 3 - 28
Simplified functional diagram

4 OPERATING MANUAL

1) OPERATING THE UNIT FOR THE FIRST TIME

- Check that there is no condensation on the unit. If there is, allow some time to dry.
- Set the program switches on the rear panel on MANUAL.
- Check that there is a link between + and S+ and between – and S– on the SENSE BLOCK (on rear panel)
- Set OVP potentiometer (on front panel) to maximum (fully clockwise), Use a screwdriver to set the OVP voltage.
- With **high output current** make sure to use low resistive connections between the power supply and the load:
 - Mount the cable lugs **directly** on the tinned output strips followed by a washer and a nut (see fig. 4 - 1). Always in this order!
 - Never place extra washers between the lugs and the strips!
 - Only use nuts and washers supplied with the unit.
- Switch on unit.
- Turn both the CV and CC potentiometer a few turns clock wise. A voltage should now be present on the output.
- By pressing the DISPLAY CV/CC SETTING button the meters will show the setting of the CV and CC potentiometer.
- By pressing the DISPLAY OVP SETTING button the volt meter will show the setting of the OVP potentiometer.
- When the power supply is used on a fixed output voltage it is highly recommended to set the Over Voltage Protector. As set out in the following table:

SM15-200D	SM30-100D	SM45-70D	SM70-45D	SM120-25D	SM300-10D
Vout + 2 V	Vout + 3 V	Vout + 5 V	Vout + 5 V	Vout + 10 V	Vout + 25 V

Example: For a SM30-100D set at 24 V output voltage it is recommended to set the OVP on $24 + 3 = 27$ V.

- Check that the cooling of the unit is not obstructed.

2) ANALOG PROGRAMMING

- Put the appropriate switch(es) in the position PROGRAM.
- Connect the programming voltage source(s) (0 - 5 V) to the ANALOG PROG. CONNECTOR on the rear panel (see fig. 4 - 2 and fig. 4 - 3). Always use a **shielded cable** for programming.
- If only the voltage is programmed, the maximum current can still be set with the CC potentiometer and vice versa. If this is not desirable the CC or CV can be set with an external potentiometer, in order to have a fixed setting.
- **CAUTION:** The analog inputs are not isolated from the output. The \emptyset of the prog. input (pin 1) is internally connected to the S–, the S– is connected to the negative output. To protect the internal wiring a 650 mA self-resetting fuse is connected in series (F600 on P432) (see fig. 3 - 10).
- For isolated analog programming the **ISO AMP CARD** (δ -product) is recommended to avoid earth loops.
- To avoid hum or noise, the programming cable may have to be twisted in some cases.
- To program the unit by current instead of voltage, simply use a parallel resistor as a current to voltage converter.

3) IEEE488 / RS232 PROGRAMMING

- Set both prog. switches to the position program.
- Both CV and CC can be programmed and read back. The CC and OVP status can also be read by the computer.

4) MONITORING OUTPUTS

- The 5 V level is compatible with most interfaces.
- The monitoring outputs can drive a meter directly (see fig. 4 - 4).



fig. 4 - 1

Low resistive cable connection by mounting the cables directly on the tinned output strips

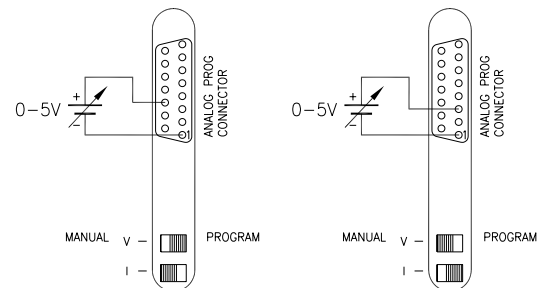


fig. 4 - 2

Programming by voltage: left voltage -, right current programming

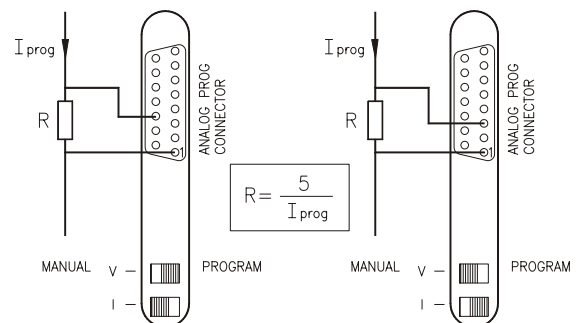


fig. 4 - 3

Programming by current: left voltage -, right current programming

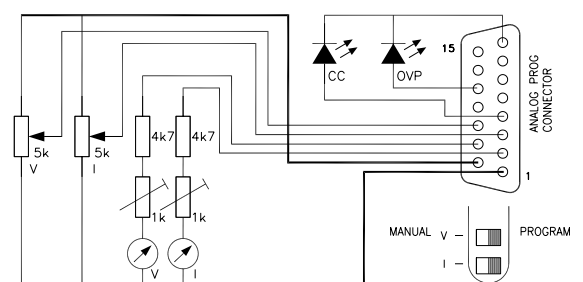


fig. 4 - 4

Remote control

5) **STATUS OUTPUTS**

- The status outputs have a separate Ø connection (pin 8) to avoid unwanted offsets in the programming. This pin is protected with a 650 mA fuse (F601 on P432).

6) **REMOTE SENSING**

- Remove the links on the SENSE BLOCK (on rear panel) and connect sense leads (thin **shielded** measuring wires) to S+ and S- (see fig 4 - 5 and fig. 4 - 6).
- With remote sensing the voltage on the load can be kept constant. The voltage drop in the load leads will be compensated. This feature is not recommended for normal use, because it can easily give problems.
- Max. 2 V per load lead can be compensated. Note that the voltage drop in the leads decreases the max. output voltage rating. In fig. 4 - 7 can be seen that on a 15 V power supply only 11 V will be available on the load when 2x 2 V compensation is used.
- In order to prevent interference it is advisable to twist the sense leads. To minimize the inductance in the load leads keep the leads close to each other. The inductance of the loads leads could give a problem with pulsating loads. In this case a large electrolytic capacitor (Cd) in series with a damping resistor (Rd) both in parallel with the load will help (see fig. 4 - 6). Check that the capacitor Cd in combination with the load leads and resistor Rd forms a well damped circuit.
- Since the **voltmeter** is internally connected to the sensing terminals, it will automatically indicate the **voltage on the load**. Note that the voltage measured on the load will be lower than on the output terminals.
- The Over Voltage Protector measures the voltage on the output terminals, so the OVP setting should be increased by the total voltage drop in the load leads.

7) **BATTERY CHARGER**

- The CV / CC regulated power supplies are ideal battery chargers. Once the output is set at the correct voltage the battery will charge constantly without overcharging. This can be useful for emergency power systems.
- **Protective measures**
Use a **CIRCUIT BREAKER** in series in order to protect the power supply from **accidental reverse connection** (see fig. 4 - 8). The circuit breaker should have a DC voltage rating 2x the battery voltage. Use the very fast type (Z), a type meant for protecting semiconductors.
The unit has a reverse diode in parallel with the output, this diode and the wiring cannot withstand the thousands of amperes supplied by a wrongly connected battery.

Suggested circuit breakers for protection power supply			
Model	Type number circuit breaker	Brand	Remarks
SM 15-200 D	HT1102 B 100	GE	2 poles parallel
SM 30-100 D	HT1102 B 100	GE	
SM 45-70 D	HT1102 B 100	GE	
SM 70-45 D	S281 UC-Z 50	ABB	
SM 120-25 D	S281 UC-Z 25	ABB	
SM 300-10 D	S282 UC-Z 10	ABB	2 poles in series, extra parallel diode on output needed =OPTION P023

- **Remote sensing** cannot be recommended, because it easily causes defects inside the power supply in case of wrong connection. If you really need remote sensing, please use the circuit (see fig. 4 - 9). The internal circuit can be protected by relatively small anti-parallel diodes. To protect the anti-parallel diodes, please connect the fuses in series as indicated in fig. 3 - 9. A practical choice for the fuses is 250 mA, the diodes can be any normal 3 or 5 A type.

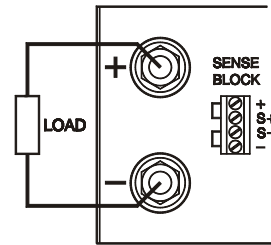


fig. 4 - 5
Local sensing

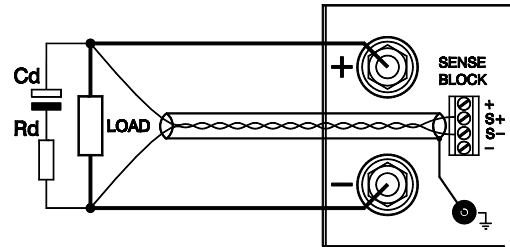


fig. 4 - 6
Remote sensing with shielded wires

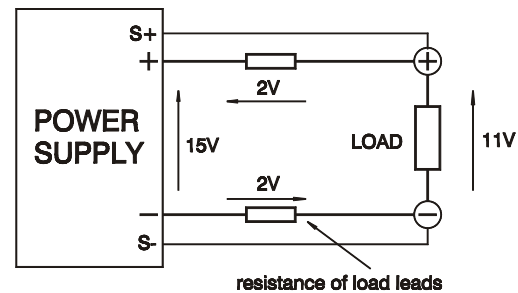


fig. 4 - 7
Remote sensing, voltage drop in load leads subtracts from max. output

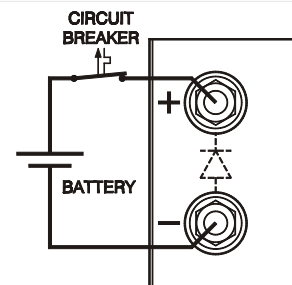


fig. 4 - 8
Charging battery with a circuit breaker in series

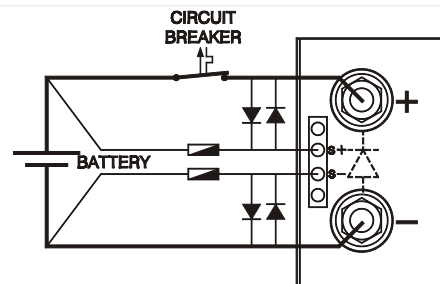


fig. 4 - 9
Protecting sense wires with diodes

- Note: The **SM300-10D** needs an extra parallel diode on the output, without this diode the internal diode will still blow. For this diode 2 paralleled BYT261-PIV-400 from ST can be used. The SM300-10D with option P023 has an extra diode built-in.

8) **REMOTE SHUTDOWN / OVER CURRENT TRIP**

- The Remote ShutDown can be operated with +5 V or a relay contact (see fig. 4 - 10).
- Using the Remote ShutDown input, an **Over Current Trip** could be made (see fig. 4 - 10).

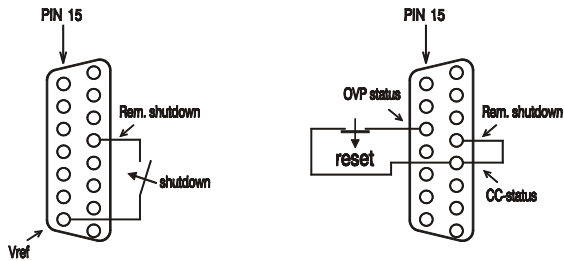


fig. 4 - 10

Left: Remote ShutDown with switch.
Right: Over Current Trip

9) **MASTER / SLAVE SERIES OPERATION**

- For series operation the **MASTER / SLAVE SERIES ADAPTER** (δ-product) must be used (see fig. 4 - 11).
- First, connect output terminals and test system in **normal series** operation. Ensure that all (output) power leads connections are reliable. An interruption of one of the power leads can cause a fuse to blow in the unit, see "trouble shooting".
- The voltage drop in the connecting leads between the units should be kept < 10 mV.
- Second, switch off all units. Connect units as shown in fig. 4 - 12. Use standard 15 pole (1:1) **shielded cables**.
- The max. number of slaves is only limited by the max. total voltage of 600 V.

10) **MASTER / SLAVE PARALLEL OPERATION**

- **Note: Master / Slave parallel is not recommended for more than 4 units, consult factory for using more than 4 power supplies in parallel.**
- First connect output terminals and test system in **normal parallel** operation. Ensure that all power connections are reliable. An interruption of one of the (output) power leads can cause a fuse to blow in the unit, see "trouble shooting".
- Second, switch off all units. Plug in prog. connectors with the connections according to fig. 4 - 13 (buss bar topology). Always use a **shielded cable**. The shielding must be connected to the case of the supply.
Disconnect the links between the S- and - of the slaves only. If not removed the current sharing will not be proportional. Both prog. switches of the slaves should be in the position PROGRAM.
- The purpose of the link between pin 9 and 11 is to set the voltage limit of the slaves at maximum.
- Keep the load close to the master. Keep wiring between master and slaves short. The voltage drop between a unit and the buss bar should be kept < 10 mV.
- Accidental interruption of a negative load lead of a unit during operation will cause fuse F600 to blow, see section 'trouble shooting'.
- The S- and S+ could be connected to the load if desired, but this is not recommended because of the complexity.

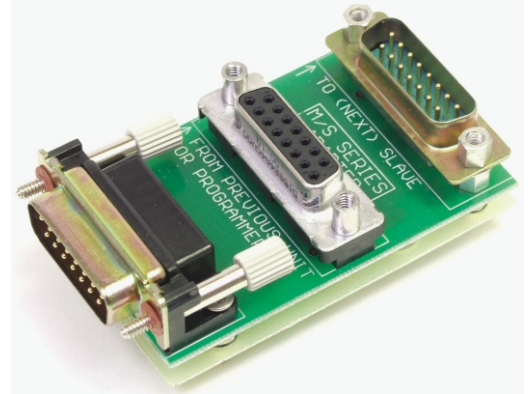


fig 4 - 11

The Master / Slave Series Adapter, supplied by Delta Elektronika

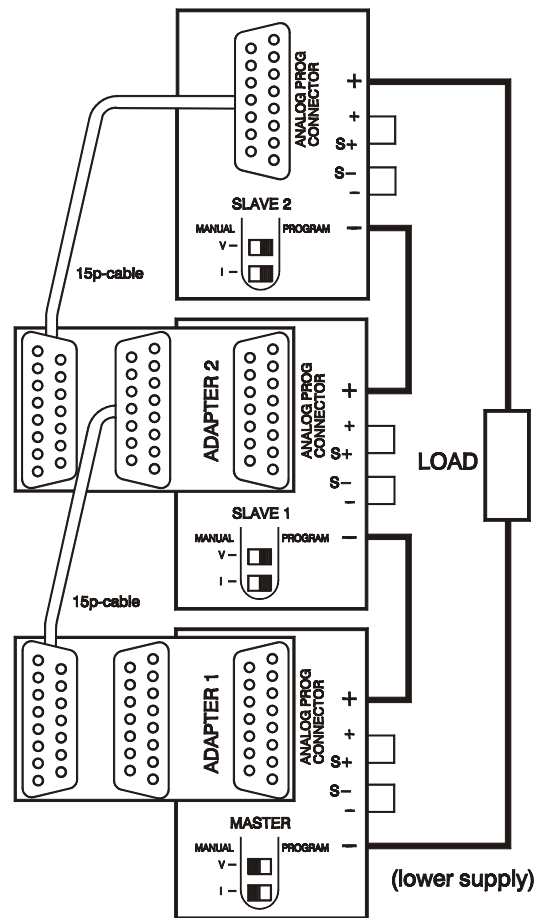


fig. 4 - 12

Master / Slave Series Connection with two **MASTER / SLAVE SERIES ADAPTERS**

11) **PARALLEL OPERATION OF FAST PROGRAMMING VERSIONS:**

- Master / Slave operation is not recommended.
- Normal parallel operation can give problems, each combination has to be tested first in combination with the load.

12) **MASTER / SLAVE MIXED SERIES / PARALLEL OPERATION**

- For complex combinations as mixed series - parallel always use the **MASTER / SLAVE SERIES ADAPTER** (δ -product).
- See fig. 4 - 14 for an example of how to connect 2 units in series in parallel with 2 units in series, controlled by 1 master.
- On the parallel slave1, fully open the CV-potmeter.
- Note: A Master / Slave combination can always be programmed, also with the **IEEE488 / RS232 controller (PSC-488 module / PSC-232 (both δ -products))**.

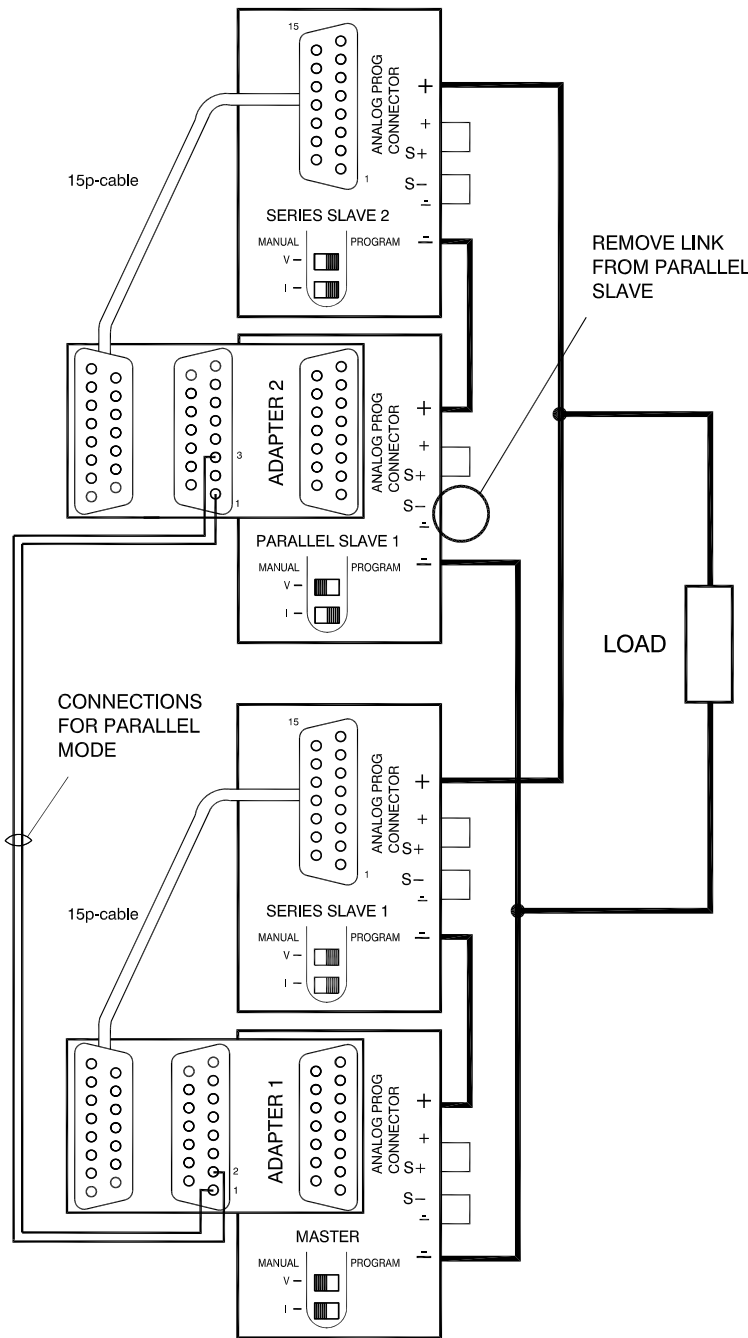


fig. 4 - 14

Master / Slave mixed series - parallel connections with two **MASTER / SLAVE SERIES ADAPTERS**

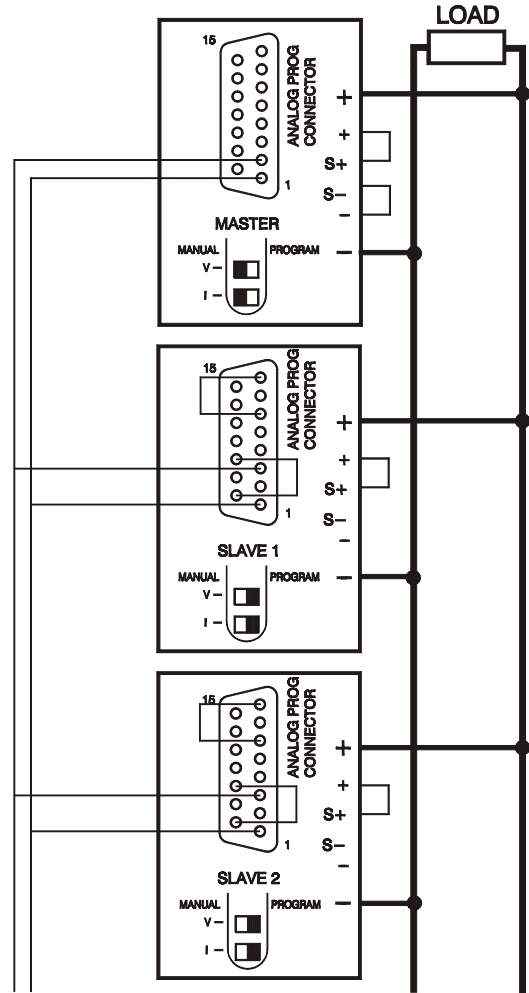


fig. 4 - 13

Master / Slave parallel connections

OPERATING AND STORAGE CONDITIONS

1) TEMPERATURE

- The operating temperature range at full load is -20 to $+50$ °C. But this temperature range only holds when the AIR-INTAKE and AIR-OUTLET are unobstructed and the temperature of the AIR-INTAKE is not higher than $+50$ °C.
- **Please note: a lower temperature extends the life of the power supply.**
- When the power supply is **mounted in a cabinet** please note that the temperature of the AIR-INTAKE should be kept low and avoid a short circuit in the airflow i.e. the hot air leaving the AIR-OUTLET entering the AIR-INTAKE again.
- The storage temperature range is -40 to $+85$ °C.

2) HUMIDITY

- During normal operation humidity will not harm the power supply, provided the air is not aggressive. The heat normally produced in the power supply will keep it dry.
- **Condensation.**
Avoid condensation inside the power supply, break-down could be the result.
Condensation can occur during a period the power supply is switched off (or operating at no load) and the ambient temperature is increasing .
Always allow the power supply to dry before switching it on again.

3) GALVANIC INDUSTRY

- For using the power supplies in the galvanic industry it is strongly recommended to take precautions against an aggressive environment.
- An aggressive environment with acid, salt, etc. can harm the electronic components. Sometimes even the copper traces of the pc-boards dissolve.
- To avoid problems the power supplies should be mounted in a relative clean room, or mounted in a cabinet receiving clean air with over pressure. Or a cabinet with a heat exchanger.

MAINTENANCE

1) GENERAL

- The SM-series power supplies normally need no maintenance or calibration. Only care must be taken that the cooling of the unit is not obstructed.

2) COOLING FAN

- The built up of dust on the impeller of the fan and the heat sink fins depends on the environment. Since the fan has over-capacity dust will not present a problem very quickly.
- The internal construction of the power supply is such that no dust will reach the sensitive control circuitry, only the heat sinks in a tunnel will be cooled by forced air (see fig. 4 - 15).
- The thermal protection will shut down the output in case of over-heating, so no damage will be done to the power supply.
- It is advisable to inspect the fan and the heat sinks regularly.

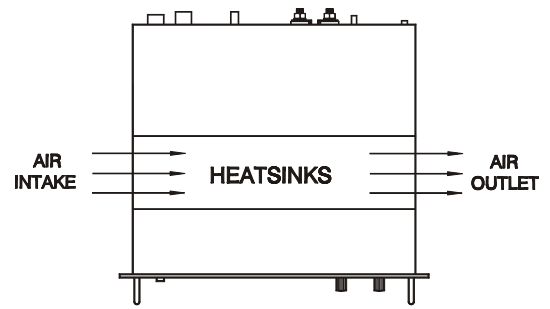


fig. 4 - 15

The fan blows through an internal tunnel, where the heatsinks are situated

TROUBLE SHOOTING

1) GENERAL

- In case you need assistance for repairing a unit, please contact our engineers using the address "Support@Delta-Elektronika.nl".
- In case you want us to repair the unit, please first fill out the RMA-form before sending the unit to us. Adding a detailed fault description will help us to repair the unit as soon as possible. On our website www.DeltaPowerSupplies.com the RMA-form can be found under 'Support'.

2) NO OUTPUT (normal operation)

- Check input fuses.
- Check position of prog. switches at the rear panel, they should be on MANUAL.
- Check the connections on the SENSE BLOCK (at rear panel), there should be a link between + and S+ and between – and S–.
- Set OVP potentiometer (at front panel) at maximum (fully clock wise).
- Switch on unit.
- Turn both the CV and CC potentiometer a few turns clock-wise. A voltage should be present on the output.

3) PROGRAMMING DOES NOT WORK OK

- Check position of prog. switches at rear panel.
- **The unit works OK in manual control**, but in programming mode the output voltage / current has a large error. Probably the fuse in series with Ø (pin 1) of prog. connector tripped, the fuse (F600 = 650 mA) is a self-resetting type (see fig. 4 - 16).
- To check the fuse (F600) measure the voltage between Ø and the minus output, during the fault condition. The voltage should only be a few mV, a high voltage means that an unwanted current is flowing through pin 1 of the prog. connector. Please check why current is flowing through pin 1 (see also next paragraph 4) and fig. 4 - 17).

4) PROGRAMMING OFFSETS

- **Unwanted offsets in the programming can be caused by earth loops.**
Figure 4 - 17 shows a typical earthing problem. In case the load has a connection to earth and the programming source as well, problems could occur. Improper choice of the earthing point of the load can give a voltage drop of $\Delta V1$. Connecting the minus or zero to a separate earth connection can give a voltage drop of $\Delta V2$. Because the internal wires of the programming input are thin, the voltage drops $\Delta V1$ and $\Delta V2$ will be across the internal wiring as well. Resulting in a error voltage in series with the programming voltage.
- The best **solution** for this is using a floating programming source with the help of the **ISO AMP CARD**(δ -product) or a floating load.

5) STATUS OUTPUTS FAIL

- Check fuse F601 in series with Ø (pin 8) (see fig. 4 - 16). To check the fuse (F601) measure the resistance between Ø and the minus output, an open circuit means a blown fuse. F601 = 650 mA.

6) MASTER / SLAVE PARALLEL PROBLEMS

- Accidental interruption of a minus lead of a unit during operation will cause fuse F600 to blow (see fig. 4 - 16). To check the fuse (F600) measure the resistance between Ø (pin 1 of prog. conn.) and the minus output, the fuse is a self resetting type. F600 = 650 mA
- Check link between pin 9 and 11 on the prog. connector of the **slaves**
- Current sharing is not ok. Probably the links between S– and – of the **slaves** are not removed.

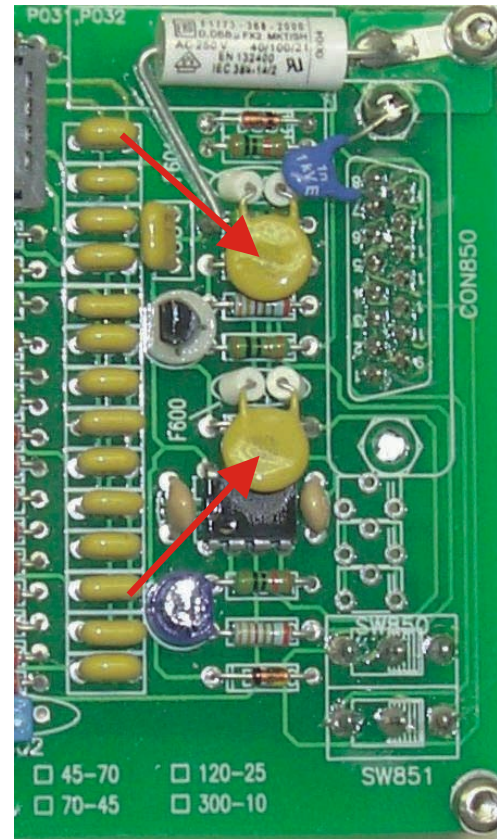


fig. 4 - 16

Location of programming fuses on P432
P432 is situated on the rear panel

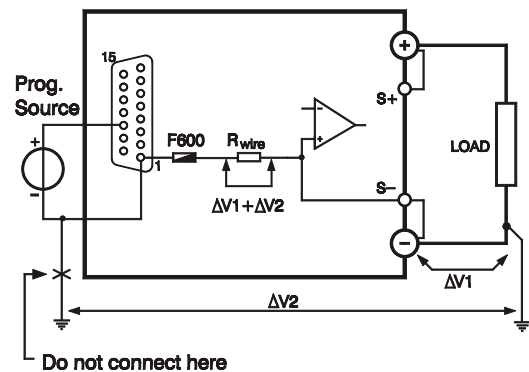


fig. 4 - 17

Unwanted programming offsets

7) OUTPUT VOLTAGE IS HIGHER THAN SET VALUE

- Check connections on SENSE BLOCK (on rear panel), For normal operation there should be a link between + and S+ and between – and S– (see also fig. 4 - 18). When remote sensing is used, check the wires of the sensing.

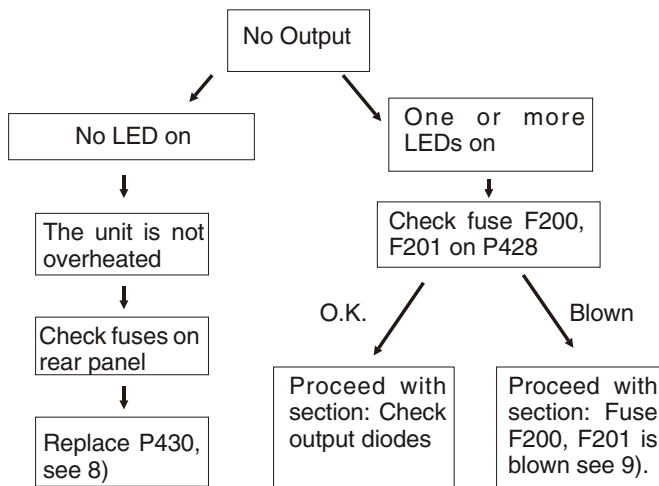
8) OVP LED on.

- Check OVP setting.
- Overheating also causes the OVP led to be on, cooling down will reset the thermal protection.
- You are using Remote Sensing.
Even a short voltage pulse $>3V$ between – and S – causes the OVP circuit to limit the output voltage.
- Remote ShutDown voltage is applied to the prog. connector.

9) NO LEDS on.

- Overheating can be the cause, cooling down will reset the thermal protection.
- Check input power and input fuses (on rear panel)
- Check fuses F400 and F401 on P430, a blown fuse can be caused by a defective rectifier bridge D400 or D401. Note: The fuses are of a special 500 V type.
- The auxiliary power supply (board P430) is defect. Do not try to repair P430 (except for D400, D401, F400 and F401), but send P430 for repair or ask for replacement.

10) CHECK POINTS IN CASE OF A SERIOUS FAILURE



- Check output diodes.
Defective diodes give a short.
SM 15-200 D Check diodes D300 - D315
SM 30-100 D Check diodes D300 - D309
SM 70-45 D Check diodes D300 - D303 on P457
SM 120-25 D Check diodes D300 - D303 on P458
Replace defective parts.
- Fuse F200 and / or F201 on P428 are blown.

Probably there is a defect on one of the two boards P433.
First check output diodes, see above.

WARNING: Do not replace F200 or F201 until the unit is repaired.
Replacing fuse F200 and F201 while P433 is still defect will cause R104 till R109 to blow, this will damage the board P428.

Note: Do not try to repair P433, but send the subunit with 2x P433 for repair or ask for replacement.
Preferably consult factory when you discover a defect in P433.

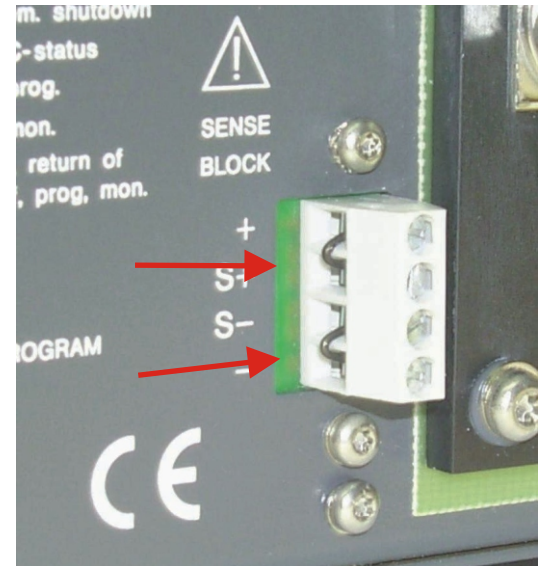


fig. 4 - 18

For normal operation links should be connected between S+ and + and between S– and –

CALIBRATION

1) GENERAL

- The power supplies are factory calibrated and normally need no further calibration.

2) METER CALIBRATION

- **DIGITAL METERS**
The zero indication can be calibrated with R712 and R716, the full scale indication can be calibrated with R706 and R708 on P388 (see fig. 4 - 19).

3) SPECIAL CALIBRATIONS

- The following calibrations must be done by qualified personnel only. Wrong calibration causes malfunction. These calibrations are only needed after special repairs. **Warning!** Damage caused by wrong calibration is not warranted.

- **CALIBRATING MAX. CURRENT RANGE or CALIBRATING CC MONITOR FULL SCALE.**

The max. output current can be calibrated with R686. R686 is located on P432 (see fig. 4 - 20).

Program CC input with exactly 5.00 V. Set output voltage to a low value, ensuring the power supply is in CC mode. Measure the output current with an accurate shunt. Calibrate the current with R686 exactly on the rated max. current.

Warning! Wrong calibration can damage the unit.

- **CALIBRATING THE CC MONITOR OFFSET.**

With R652 on P384 the offset of the CC monitor voltage can be calibrated (see fig. 4 - 21). The unit has to be unloaded, the output voltage set on a low value. Measure the offset voltage of the CC monitor on the prog. connector. Calibrate the offset on a negative value between -10 mV and zero mV.

Warning! wrong calibration can damage the unit.

4) SPARE PARTS

- When ordering spare parts please state: Model, Serial number, Component number and Component description.

Example:

- ModelSM 30-100 D
- Serial no.Sn821701900017
- BSU no.....Bs816802900036
- Component.....D300
- Description.BYV52-PI-200

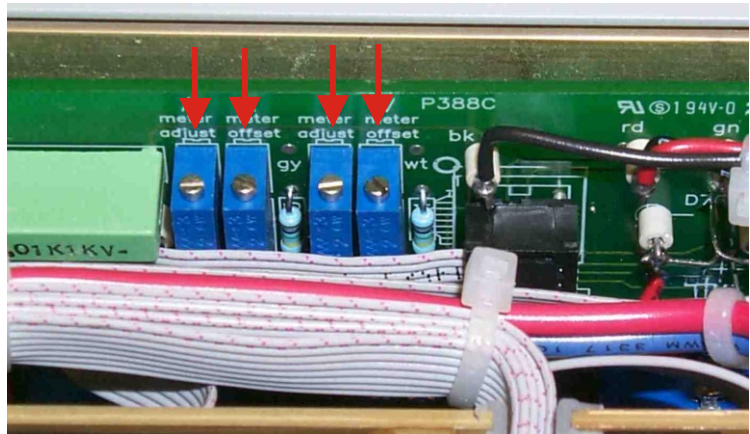


fig. 4 - 19 Meter calibration with 25-turn potmeters on P388

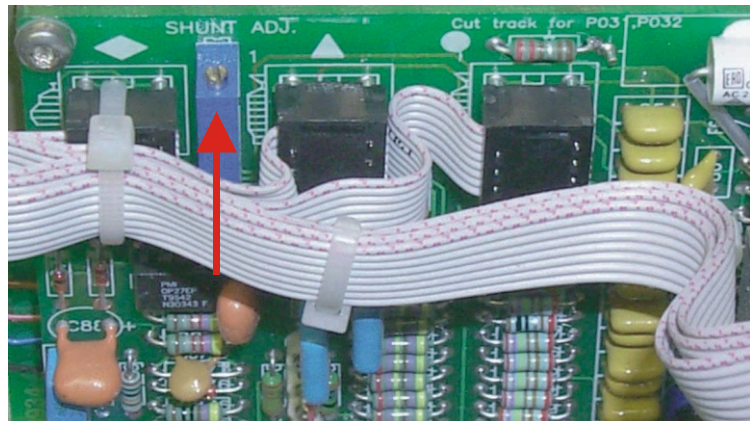


fig. 4 - 20 Calibrating max. current on P432

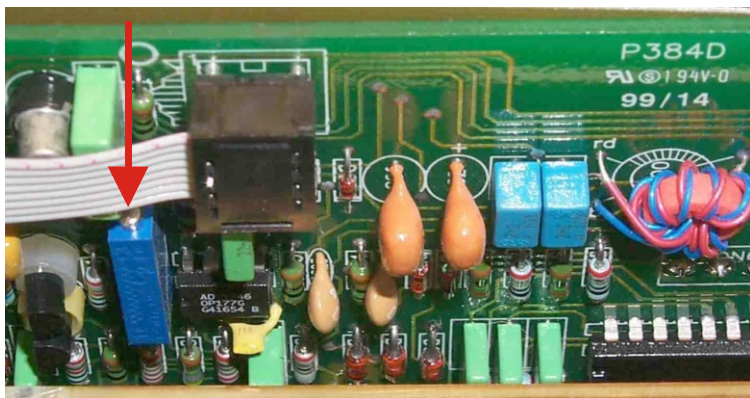


fig. 4 - 21 On P384, CC monitor can be calibrated



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Compliance was demonstrated to the following specification as listed in the official Journal of the European Communities:

EN 61000-6-3 Generic Emissions: (residential, light industrial)

EN 55022 Radiated and conducted, Class **B**
EN 61000-3-3 Voltage fluctuation and flicker

EN 61000-6-1 Generic Immunity: (residential, light industrial)

EN 61000-6-2 Generic Immunity: (industrial environment)

EN 61000-4-2 Electrostatic Discharge
EN 61000-4-3 Radiated electromagnetic fields
EN 61000-4-4 Electrical Fast Transients / Bursts
EN 61000-4-5 Surge on DC output
EN 61000-4-5 Surge on line input
EN 61000-4-6 RF common mode, conducted
EN 61000-4-11 Voltage variations and dips

EN 60950 Safety of IT equipment

EN 61010 Safety of electrical equipment for measurement, control and laboratory use

Managing director
Zierikzee, February 2018