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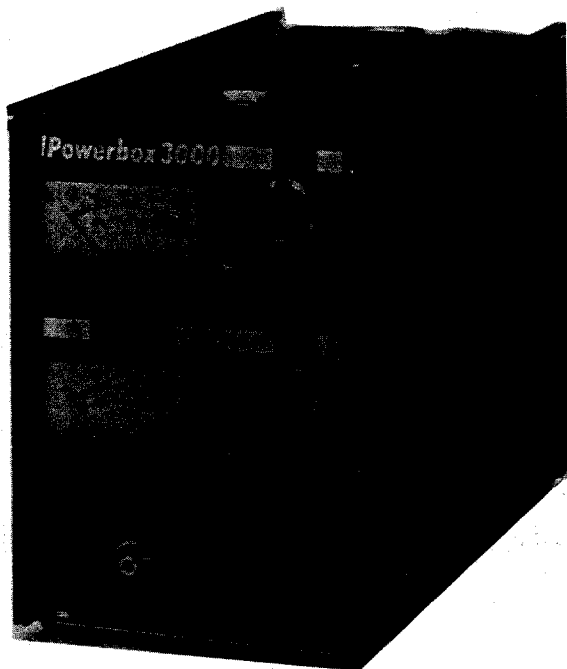
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1. GENERAL DESCRIPTION

1.0 Features

- * Floating output voltages
- * Precision voltage setting
- * Selectable-current mode
- * Panel volt-amp meter
- * LED mode indicators
- * Metal-film or wire-wound resistors
- * Toroidal transformers
- * High isolation between outputs/case
- * Separate regulator PC boards
- * Low MTTR

1.1 Description

Compact, easy to operate, and rugged, the POWERBOX family of laboratory supplies are handy sources of precision regulated power for both digital and linear work. Available in triple-output versions, all types provide a 5V output that is screwdriver adjustable over a 4-to-6V range. Short-circuit current for this output is limited by a semi-foldback circuit, which holds the overrange current to about 30% of the maximum rating as long as the short persists, and resets automatically when the short is cleared.

The Model 3000 series triple-output units offer three combinations of fully adjustable ranges, in addition to the 5V output: two 0-to-40V ranges (Model 3000A), two 0-to-20V ranges (Model 3000B), or a 0-to-40V and a 0-to-20V range (Model 3000), with each range independently adjustable by a lockable precision ten-turn potentiometer having a repeatability within 0.25%.

The current limit for the 20 or 40V ranges in all the models is set with single-turn potentiometers, which select constant-current limits between 0 and 100% of the maximum rating and thereby provide the constant-current output mode for the power supplies, in addition to overload protection.

On top of current-limiting and foldback protection, the supplies have self-resetting thermal-overload switches built into their heat sinks and replaceable fuses mounted inside the cabinets.

Precision 2.5% panel meters, selected by toggle switches, measure the load current or output voltage, and LEDs indicate the operational mode, constant-current (CC) or constant-voltage (CV) output.

All outputs are completely isolated from each other (and from the case), and they may be connected in series in any polarity combination. Also, the 20 or 40V outputs may be paralleled with each other or with the 5V output when set to the same voltage. The voltage between outputs and to the chassis may be a maximum of 500VDC. The input to chassis is tested to withstand 2500VAC. A separate terminal is provided for a chassis (ground) connection.

Regulators for the output voltages are individually mounted on separate PC cards for high isolation and easy replacement of faulty circuits. The mean-time-to-repair (MTTR) of the supplies is very low, approx. 30 minutes. High-quality metal-film resistors, or wire-wound units where needed, are used throughout the power supplies to keep voltage settings stable. Toroidal transformers keep flux leakage and the EMI low. Also, the supplies are not affected by RFI/EMI, and can be used close to radio transmitters.

The housings for the POWERBOX units are assembled from extruded black-anodized aluminum sections and PVC-coated aluminum plates (with a leather-like finish), which are available from POWERBOX's line of FLEXIBOX electronic-enclosure system.

1.2 Specifications

Input voltage: 115/230VAC +10 - -15%, 47-63Hz

Output voltages:

Model 3000	5V/3A, 0-40V/1.25A, 0-20V/2.5A
Model 3000A	5V/3A, 0-40V/1.25A, 0-40V/1.25A
Model 3000B	5V/3A, 0-20V/2.5A, 0-20V/2.5A

Constant-Voltage Mode:

<u>Output voltage</u>	<u>Line regulation</u>	<u>Load regulation</u>	<u>Temp. coef.</u>	<u>Ripple</u>
5 V	+ - 2mV	+ - 10mV	0.01%/°C	10mVpp
20V or 40V	+ - 0.05%	+ - 0.05%	0.005%/°C	1mVpp

Constant-Current Mode:

20V or 40V range only	0.4mA	4mA	0.05%/°C	4mApp
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Output Power:

Duty*

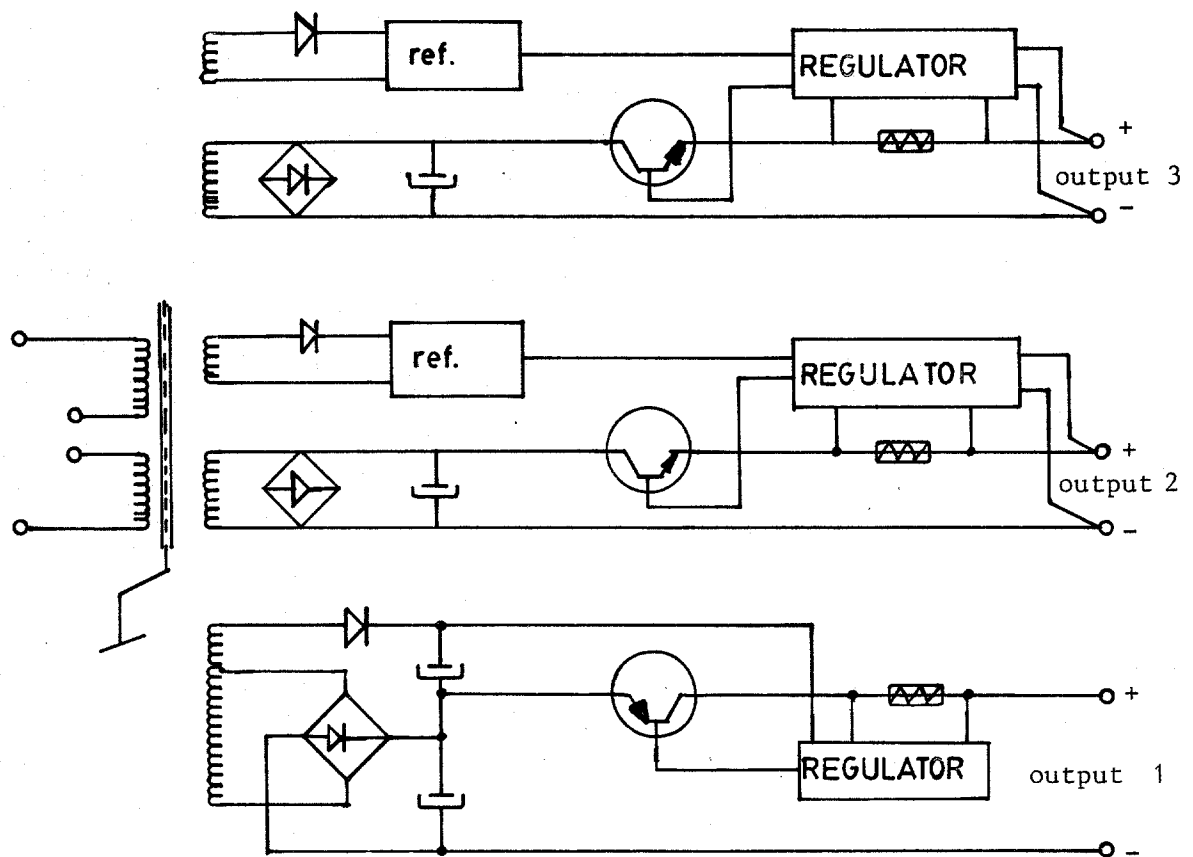
Maximum Continuous	80W
Peak Intermittent	118W

* Ambient operating temperature: - 20°C to + 50°C

Dimensions: W = 5.2 in. 132 mm
H = 6.9 in. 185 mm
D = 10.6 in. 270 mm

Weight: 10.0 lbs 4.7 kg

1.3 Overall Block Diagram

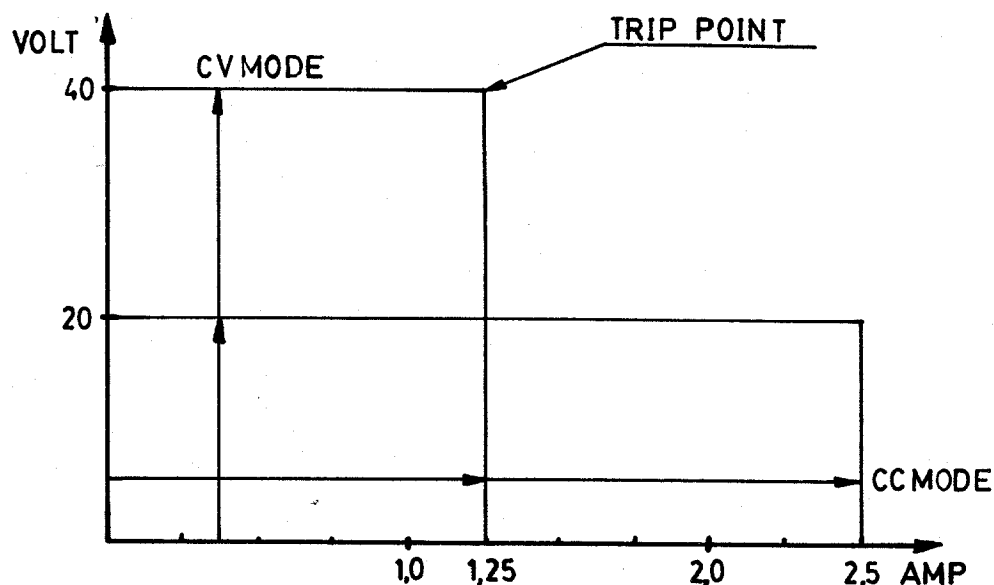


1.4 Modes of Operation

Voltage and current output can be independently set for the two main outputs by precision front-panel controls. The 5V output can be set over a limited voltage range of 4-6V and has a fixed current limit with a semifoldback characteristic.

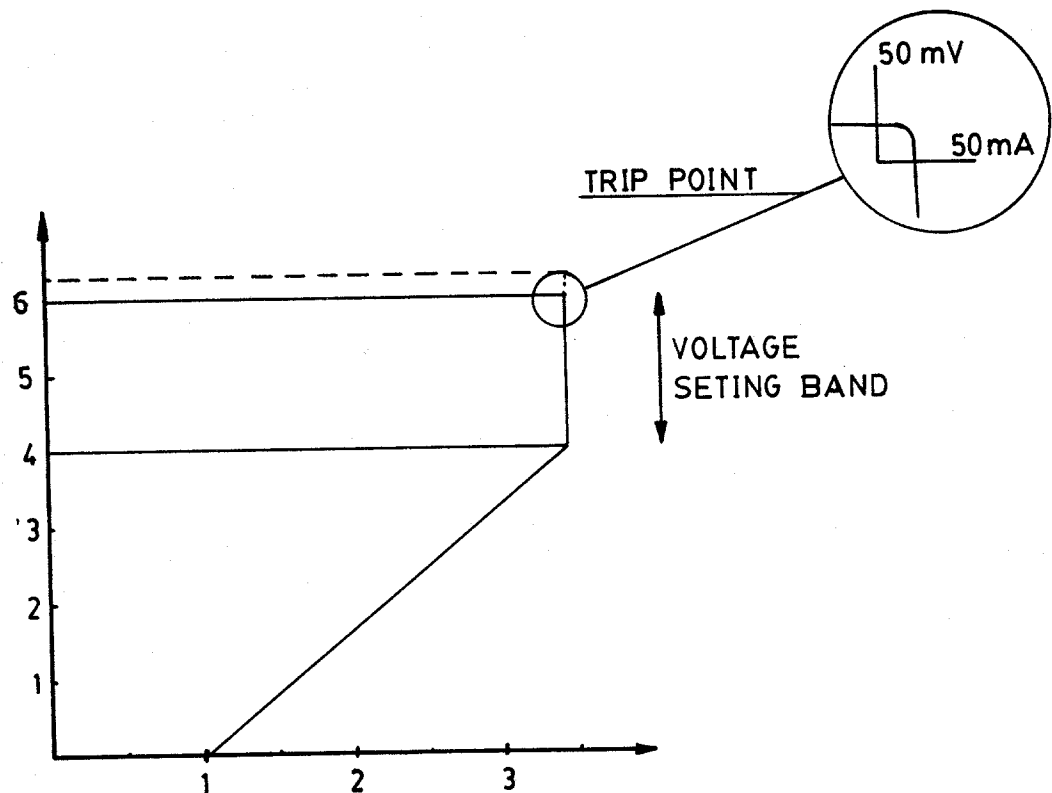
1.4.1 Constant-voltage, constant-current modes

Two LED diodes mounted on the front panel, indicate mode of operation -- constant voltage (CV) or constant current (CC). When the load current is increased to the constant-current trip point (see graph), the unit automatically transfers to the constant-current mode and the CC LED lights. Below the CC trip point the unit is in the CV mode and the CV LED lights. The CC mode also acts as a protective circuits to limit load current on an overload or short circuit.



1.4.2 Semifoldback output

The 5V output is set by a screwdriver front-panel control on the front panel over a range of 4-6V. The current limit is fixed to 3 Amp and has a current trip point approx. 120-130% above. The current has a semifoldback characteristic and regulates down to approx. 30% of specified current in a short circuit.



1.5 Parallel Operation

The outputs of the POWERBOX 3000 are fully isolated and independent of each other and may be connected in parallel operation with each other or with any other power supply. However, the voltage of each unit in the CV mode must be carefully set to the same value otherwise unsymmetrical loading will occur.

1.6 Serial Operation

Two or more fully isolated outputs from POWERBOX 3000, 3000A and 3000B, may be connected in serial operation. But do not exceed the maximum chassis isolation voltage of 500VDC.

2. INSTALLATION

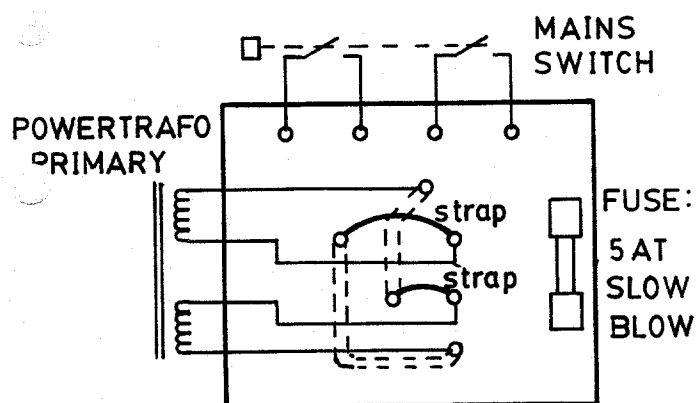
2.1 Unpacking and Inspection

After carefully unpacking the instrument, inspect the external parts for damage to knobs, dials, indicators, surface areas etc. If there is damage file a claim with the carrier who transported the instrument. Retain the shipping container and packing material for use in case reshipment is required.

2.2 Power Requirements

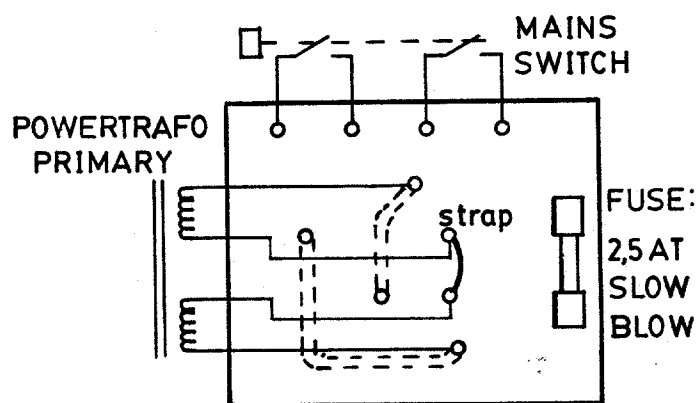
Before connecting the instrument to the line power, be sure that the 115/230 Volt strap is set in the right position for your mains (see below). Also, change the line fuse in accordance with the table below. Be sure that the plug on the power cord is the proper mate for the line receptacle.

95-125 VAC.



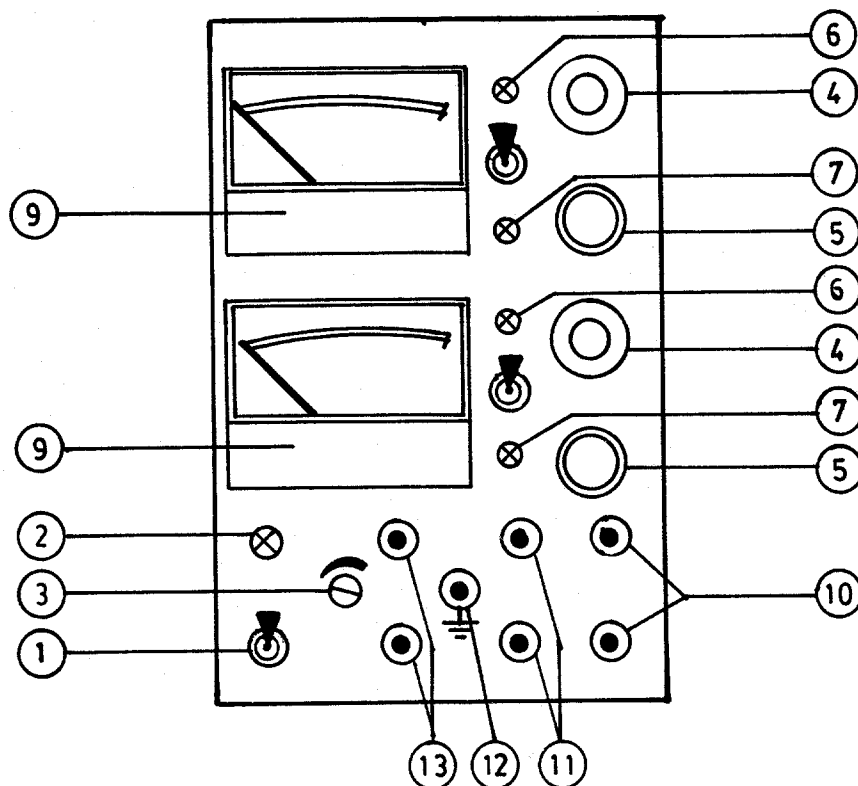
Trafo windings connected in parallel for 115 V operation

195-250 VAC



Trafo windings connected in series for 230 V operation

2.3 Controls and Connectors



1. Line-voltage switch
2. Line-voltage indicator
3. Voltage control for 5V output: adjustable 4-6V
4. Voltage control: outputs 2 and 3
5. Current control: outputs 2 and 3
6. Constant-voltage indicator: outputs 2 and 3
7. Constant-current indicator: outputs 2 and 3
8. Voltage/current toggle-switch selector
9. Output voltage-and-current meter: outputs 2 and 3
10. Output terminals for output 2
11. Output terminals for output 3
12. Ground connection
13. Output terminals for 5V output

3. CIRCUIT DESCRIPTION

3.1 General

The power main input is connected to a 115/230 V input selector, which connects the transformer windings in series for 230V-50Hz and in parallel for 115V-60Hz input. The power transformer, a toroid type, converts the 230V/115V to secondary voltages suitable for the three completely separated and independent regulation systems.

The power supplies are fully protected against overheating by a self-resetting thermal overload switch built into the supplies' heat-sink extrusion. If, for any reason, the unit runs too hot, the thermostat will switch off both sides of the mains simultaneously.

Snubbers and other protection circuits protect the units from breakdown resulting from working near transmitters and from inductive loads. Diodes across transistors and the inputs of operational amplifiers, also prevent breakdowns from voltage spikes.

3.2 The 5V output

The 5V supply employs a conventional uA723 voltage regulator. To avoid a large voltage drop, the regulator has a separate voltage supply connected from the power transformer. For a low powerloss at short circuit and at the same time maximum power over the full voltage-setting range, a current-limit system called semi-foldback is used where the current falls to 30% of specified maximum current at short circuit.

The semi-foldback action is obtained by connecting a reference voltage to the input of the current amplifier (see schematic). The regulator series element consists of a Darlington transistor.

3.3 The 20 and 40V outputs

The two main outputs (20 and 40V) use a quadruple operational amplifier for reference, voltage and current control.

In the CV mode, the operational amplifier senses the reference voltage through R13-R12 and receives a feedback signal via pot P5 and resistance R15. The operational amplifier attempts to keep the input voltage near zero across pins 9 and 10 by sinking current to the serial element T2-T3 which in turn adjust the output voltage to keep the system in balance and the supply's output voltage constant. If pot P5 is adjusted counter-clockwise, the output to and from the operational amplifier will decrease, and vice versa.

In the CC mode, the regulation system works similarly to the CV mode, but a voltage drop across a current shunt R23 is sensed. The reference is sensed through R7-R5 and feedback received via P4 (R10). The operational amplifier works at constant current only, but then pin 5 and 6 are kept near zero by adjusting the current to T2, T3 and the output current. Potentiometer P4 can set a value between 0-100% of the output current.

The LED diodes indicate a CV or CC mode of operation and are connected in series with the CV or CC operational amplifiers.

Output voltage and current can be monitored with the two panel meters. Voltage or current scales are selectable by a toggle switch.

4. CALIBRATION AND MAINTENANCE

4.1 General

The power supply is burned-in and calibrated prior to shipment. Calibration should remain valid for a minimum of 1 year. A complete set of factory test-data sheets shipped with each instrument establishes when recalibration is needed.

4.2 Factory Repair, Field Service

Although the supplies are designed for easy diagnosis and repair with just basic test equipments, Powerbox maintains both factory and field-repair services for those customers not possessing the necessary capability. When returned for calibration or repair, the unit should be accompanied with a detailed description of the specific problems to help minimize turn-around time.

4.3 Required Test Equipment

- A. Oscilloscope.
100MHz bandwidth sensitivity. Minimum 50mV per division. (HP Type No. 1740 A, or equivalent).
- B. DMM.
4-1/2 digit, AC-DC voltage and current ranges. Min. 5A DC. (Fluke Type No. 8060 A, or equivalent).
- C. Isolated and adjustable transformer.
0-125 or 0-250 VAC. (1000 W, Variac, or equivalent).
- D. Dynamic load.
A dynamic load rated 50 W min. having the voltage and current range of the unit under test.
- E. DMM.
3-1/2 digit with AC-DC volt and current ranges. (Fluke Type No. 8020 A, or equivalent).

WARNING: High voltage is present inside cover. Service and calibration by authorized personnel only.

4.4 Calibration Procedure

Take off the wrap-around bottom cover plate by unscrewing the 4 self-tapping screws in the bottom of the unit.

- A. Adjust all trimmers to the middle positions.
- B. Disconnect all regulator PC cards - A, B and C.
- C. Adjust all potentiometers on the front panel to the zero position,, counter clockwise.
- D. Connect power plug to the adjustable transformer and set to 50VAC.
 1. The power-on LED should light
 2. The power input current should be a max. of 10mA at 50VAC input; a max. of 15mA at 110VAC input; and a max. of 30mA at 220VAC input.
 3. Turn power off.
- E. Connect the 5V regulator card, a DMM and a scope to the 5V output terminals.
 1. Turn power on.
 2. Adjust the voltage and current. The adjustment range should be 4-6V at maximum 3 Amp and max. ripple 10mV p-p at full current with a power input voltage of 99VAC (or 198, depending on line connection).
 3. Short the 5V output terminals with the current meter and measure voltage and current. The measurements should be 60mV max. at 0.8 Amp.

Control of line and load regulation.

1. Vary the power input voltage over the range 198-242VAC (230V input) or 99-125VAC (115V input). The maximum deviation from 5V should be 4mV with a load of 3 Amp.
2. Vary the load from 0 to 3 Amp with an input voltage of 115 or 230VAC. The max. deviation from 5V should be 20mV.
3. Turn the power off.

F. Connect one of the 20 or 40V PC boards to the mother board.

1. Turn the power on.
2. CC LED should light.
3. Connect DMM and oscilloscope to output.
4. Connect a DMM to TP1 and + out (pin 2 at connector). Adjust trimmer P1 to 8.5VDC
5. Adjust current control 1/8-turn clockwise (one scale marking). The CV indication now should light and the CC should go out.
6. Set the instrument toggle switch to the volt position, adjust output voltage to half of maximum scale, a 10.00 or 20.00V reading with DMM. Adjust trimmer P7 marked V trim on mother board for correct voltage reading with the analog meter on the front panel.
7. Adjust output voltage control to maximum. Carefully and slowly vary output voltage with trimmer P2 to get the correct output reading, 20.00 or 40.00V at max. scale. (Adjust trimmer P2 very carefully). Maximum deviation from 20 or 40V should be no more than 100mV.
8. Set the current potentiometer to half scale. Connect the dynamic load and current meter to the output. Then adjust the load so that the current limit is reached and the CC indicator lights.
9. Calibrate the analog front-panel meter carefully with trimmer P6 (on mother board) so that the meter reads half the specified maximum current.
10. Adjust front-panel current potentiometer carefully towards max. output. Vary the current with the load and simultaneously adjust trimmer P3 for the correct max. output current, 2.5 or 1.25 Amp. with the DMM. (Adjust trimmer P3 very carefully). Check the calibration of the analog meter and readjust trimmer P6 if needed.
11. Vary current potentiometer over full range of 0-100% and at the same time measure current and check CC indication.

- G. Calibrate second 20 or 40 V output with exactly the same procedure.
- H. Fix the trimmer positions with drops of Glyptol or other suitable sealing material.

4.5 Maintenance

Maintenance: Only by authorized personnel. High voltage is present inside cover.

4.6 Trouble shooting

1. No output from any output:

- A. Unit overheated.
Thermostat has disconnected line voltage: Disconnect power and load, wait 5 minutes and unit should reset and be ready for normal operation.
- B. Check mains fuse.
If blown use slow-blow 5 Amp for 115VAC input and 2.5 Amp for 230VAC input.
- C. Check transformer winding connections. They must be in series for 230VAC operation and in parallel for 115VAC operation see section 2.2.

2. No output from 5V terminals:

- A. Measure voltage at pin 12 IC1 (uA 723): should be 20-22VDC, if not, check diode D3C.
- B. Measure voltage at TP1: should be 10-12VDC, if not, check bridge rectifier D4.
- C. Measure reference voltage, at pin 6 IC1 (uA 723): should be approx. 7V, if not, change IC.
- D. Measure voltage between emitter and base on transistor T1, if 10-12V change transistor T1, if less than 1.4V change IC1.
- E. Check C6 and D5 for short circuit.

3. Obtain 12V at 5V output terminals:

- A. Check for short circuit in transistor T1.
- B. Change IC1 (uA 723).
- C. Check the feedback circuit from output to pin 3 on IC1.

4. No output from 20 or 40V outputs:

- A. Check unregulated voltage across C8. It should be approx. 30V for the 20V and 60V for the 40V ranges. Check bridge rectifier D13 and the AC to it if voltage is too low or missing.
- B. Check voltage across capacitor C7. It should be approx. 20V. Check diode D5 and AC to it if voltage is too low or missing.
- C. Check reference voltage from + C3 to - C2. It should be 8.5V. Check transistor T1.
- D. Change operational amplifier.
- E. Measure voltage between the base of T2 and the base of T3. It should equal the value preset at the output, less the base - to - emitter voltage of T3.
- F. Check current sensing action through R5 resistance.

5. Obtain unregulated 30 or 60V at 20 or 40V output terminals:

- A. Check transistors T2 and T3 for short circuits.
- B. Check diode D9, D10 and LED 1 and 2 for open circuits.
- C. Change operational amplifier IC1.
- D. Check the sensing leads for open circuit and also the P5 control.
- E. Check the following components carefully: P2, R15, R16, and in particular R12.

Note: After repair use the calibration procedure explained under item 4.4 to recalibrate the unit.

5. PARTS AND SCHEMATICS

See enclosures

6. LIMITED WARRANTY

Each instrument manufactured and sold by POWERBOX, or its authorized agents, is warranted to be free from defects in material and workmanship and to perform within applicable specifications for a period of five years after the original shipment date. POWERBOX's obligations under this guarantee is limited to repairing or replacing any instruments or parts thereof, which within five years after delivery to the original purchaser shall be returned to POWERBOX with transportation charges prepaid, and shall be proved after POWERBOX's examination to be defective, and to have been operated within specified limits.

We reserve the right to discontinue instruments without notice, and to make modifications at any time without incurring any obligations to make such modifications to instruments previously sold.

PARTS LIST for Powerbox 3000 series:

Output 1 5-V 3-A

All resistors 1% metal-film types unless otherwise stated.

R1c	10k	R7c	1.0k		
2c	820	8c	470		
3c	1.0	9c	0.22	5W	wire-wound
4c	6.8k	10c	220	Sk4	
5c	8.2k				
6c	3.3k				

P1c	500	trimmer	wire-wound
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C1c	2.2uF	35V	ETP
2c	10nF	cer.	
3c	47uF	25V	
4c	10nF	cer.	
5c	10000uF	16V	
6c	220uF	16V	

D1c	5.1V	Zener	500mW
2c	1N4148		
3c	1N4002		
4c	PK 10F		
5c	1N5401		

T1c	2N6649
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IC1c	UA 723 PC
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PARTS LIST for Powerbox 3000 series:

Output 2, 3 40-V 1.25-A

All resistors 1% metal-film types unless otherwise stated.

R1a	130	R15a	130	
3a	470	16a	1.6k	
4a	3.9k	17a	220	CW-2B-13
5a	120	18a	1.2k	Mk4
6a	1.6k	19a	680k	Mk4
7a	1.0 M	20a	47	Mk4
8a	220	21a	1.5k	5W 208
9a	470	22a	220k	Mk4
R10a	470	23a	1.0	CW-2B-13
11a	2.7k	24a	1.0k	Mk4
12a	100	25a	39k	Mk4
13a	100k	26a		
14a	470			

P1a	2.0k	trimmer	3386P
2a	50k	"	"
3a	50k	"	"
4a	5.0k	1 turn	Cermet
5a	5.0k	10 turn	
6a	2.0k	trimmer	3386P
7a	2.0k	"	"

C1a	10uF	25V	
2a	2.2uF	35V	ETP
3a	2.2uF	35V	ETP
4a	47nF	63V	polyester
5a	3.3nF	400V	polyester
6a	10uF	25V	
7a	470uF	40V	EGS
8a	2200uF	100V	EYB
9a	10uF	63V	
C10a	10uF	63V	
11a	100uF	63V	

D1a	6.2V	Zener	500mW
2a	1N825A		
3a	1N4148		
4a	"		
5a	1N4002		
6a	LED		
7a	"		
8a	"		
9a	BZ102/2V8		

PARTS LIST for Powerbox 3000 series:

D10a BZ102/2V8
11a 1N4002
12a 1N5401
13a KBPC608

T1a BC141-16
2a "
3a 2N3772

IC1a 3403 ADB

Instrument A R45

PARTS LIST for Powerbox 3000 series:

Output 2, 3 20-V 2.5-A

All resistors 1% metal-film types unless otherwise stated.

R1b	130	R15b	130	
3b	470	16b	2.2k	
4b	3.9k	17b	220	CW-2B-13
5b	120	19b	1.0 M	Mk4
6b	1.8k	20b	47	Mk4
7b	1.0 M	21b	1.5k	5W
8b	220	22b	220k	Mk4
9b	470	23b	0.5	CW-2B-13
R10b	470	24b	1.0k	Mk4
11b	2.7k	25b	27k	Mk4
12b	100	26b	75k	Mk4
13b	100k			
14b	470			

P1b	2.0k	trimmer	3386P
2b	50k	"	"
3b	50k	"	"
4b	5.0k	1 turn	Cermet
5b	5.0k	10 turn	
6b	2.0k	trimmer	3386P
7b	2.0k	"	"

C1b	10uF	25V	
2b	2.2uF	35V	ETP
3b	2.2uF	35V	ETP
4b	47nF	63V	polyester
5b	3.3nF	400V	polyester
6b	10uF	25V	
7b	470uF	40V	EGS
8b	4700uF	40V	EYB
9b	10uF	63V	
C10b	10uF	63V	
11b	47uF	100V	

D1b	6.2V	Zener	500mW
2b	1N825		
3b	1N4148		
4b	1N4148		
5b	1N4002		
7b	LED		
8b	LED		
9b	BZ102/2V8		

PARTS LIST Powerbox 3000 series

D10b BZ102/2V8

11b 1N4002

12b 1N5401

13b KBPC608

T1b BC141-16

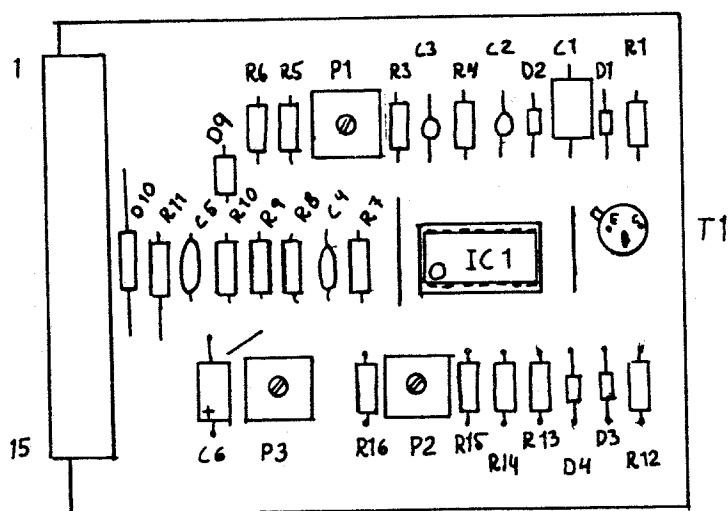
2b BC141-16

3b 2N3772

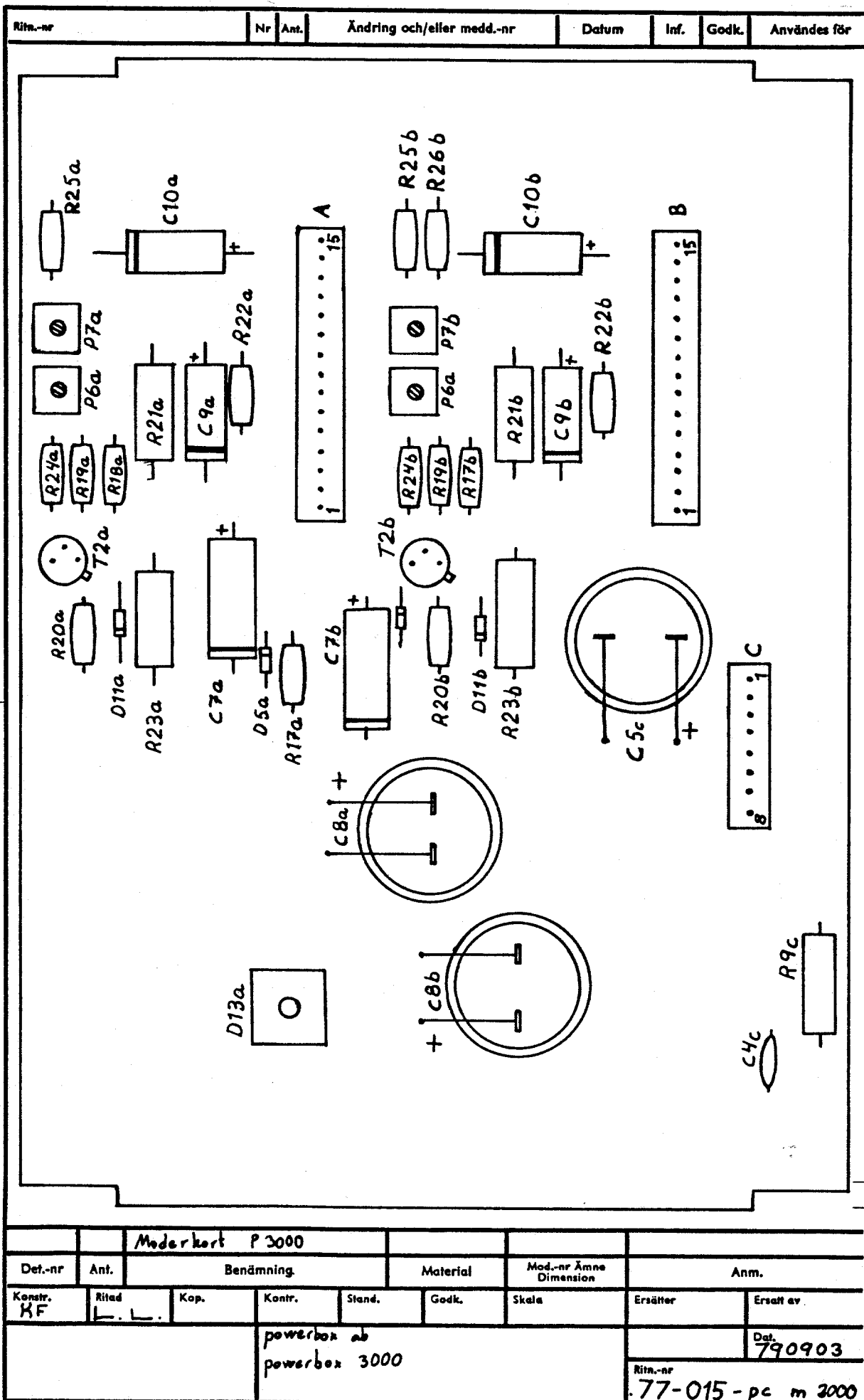
IC1b 3403 ADB

Instrument B R45

Ritn.-nr	Nr	Ant.	Ändring och/eller medd.-nr	Datum	Inf.	Godk.	Användes för
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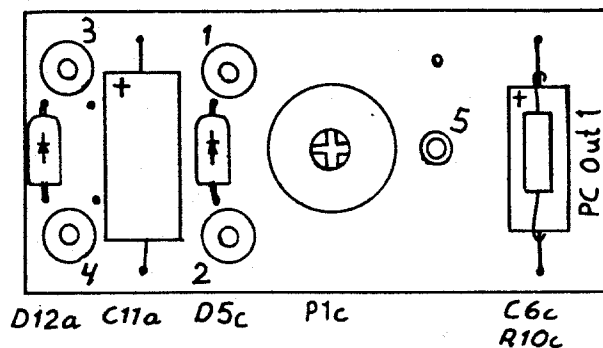


		Räglerskretskort utgång 1, 2							
Det.-nr	Ant.	Benämning			Material	Mod.-nr Ämne Dimension	Anm.		
Konstr.	Ritad	Kop.	Kont.	Stand.	Godk.	Skala	Ersätter	Ersatt av	
KF	LL								
powerbox ab			power box 2000, 3000					Det. 790619	
20-volten märks med 'b' efter komponentnamnet			pc ab				Ritn.-nr 77-015-015-pc ab		
40-volten märks med 'a'									

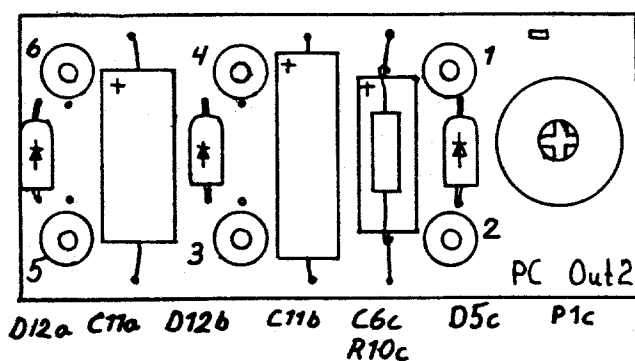


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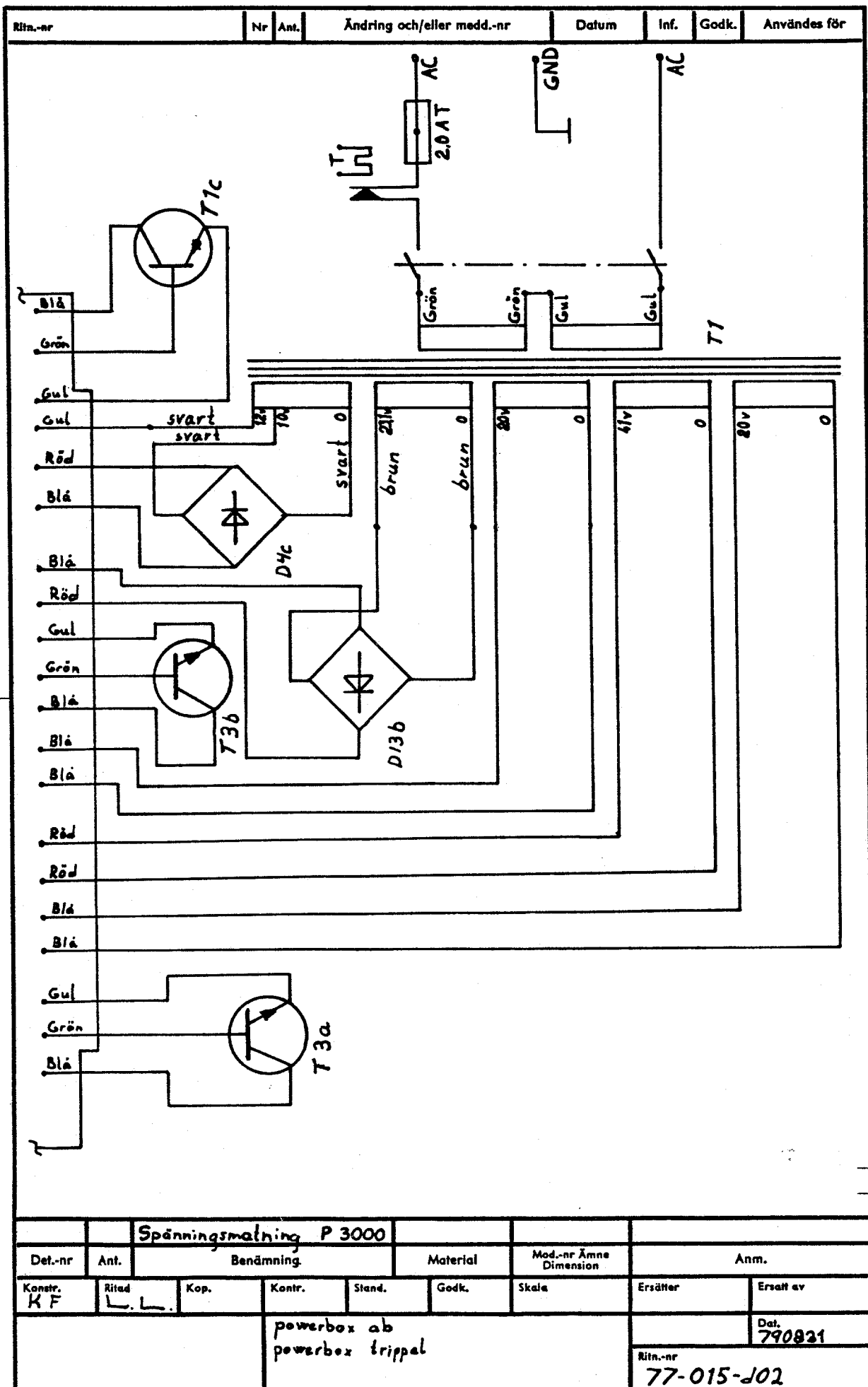
2000

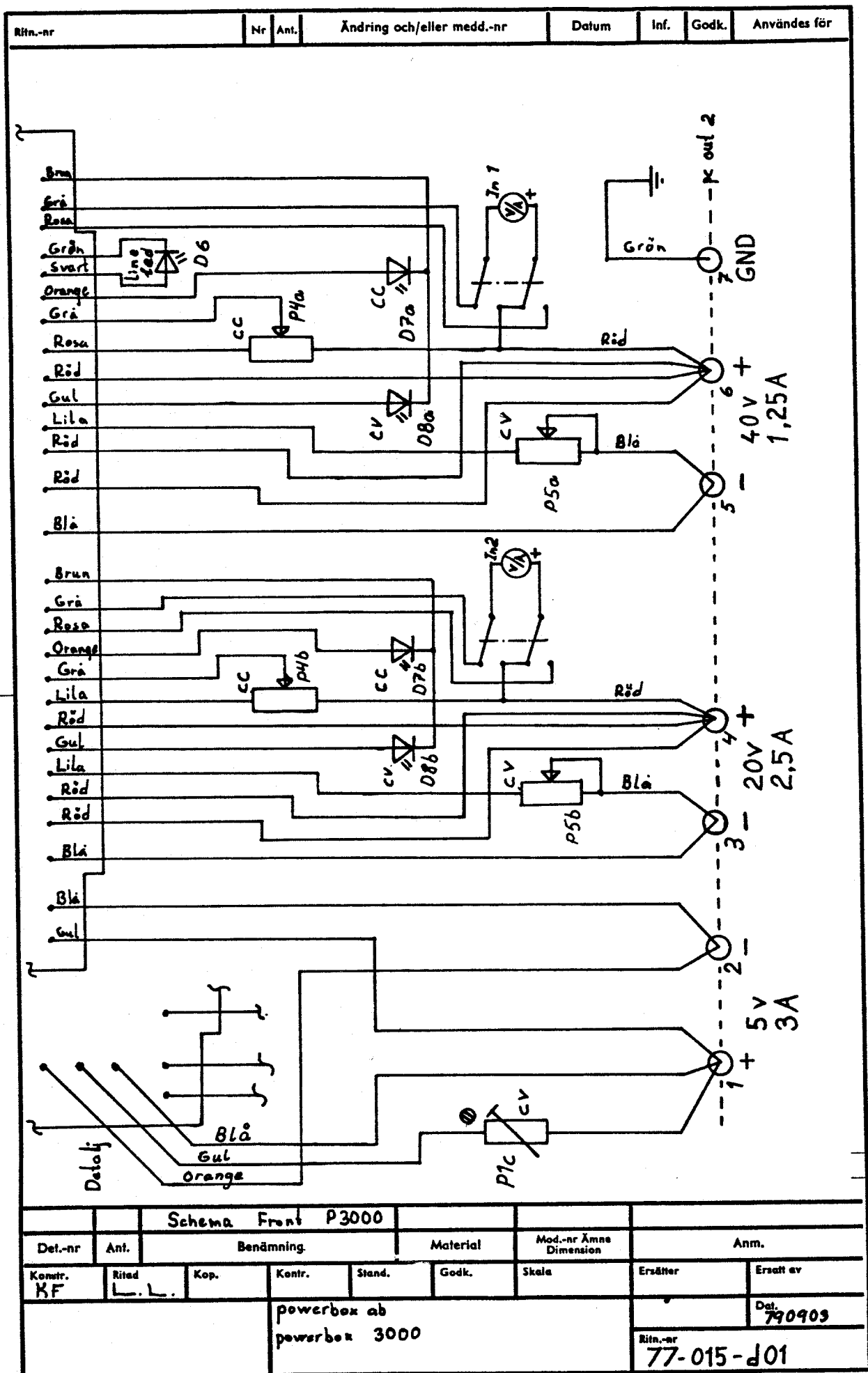


3000

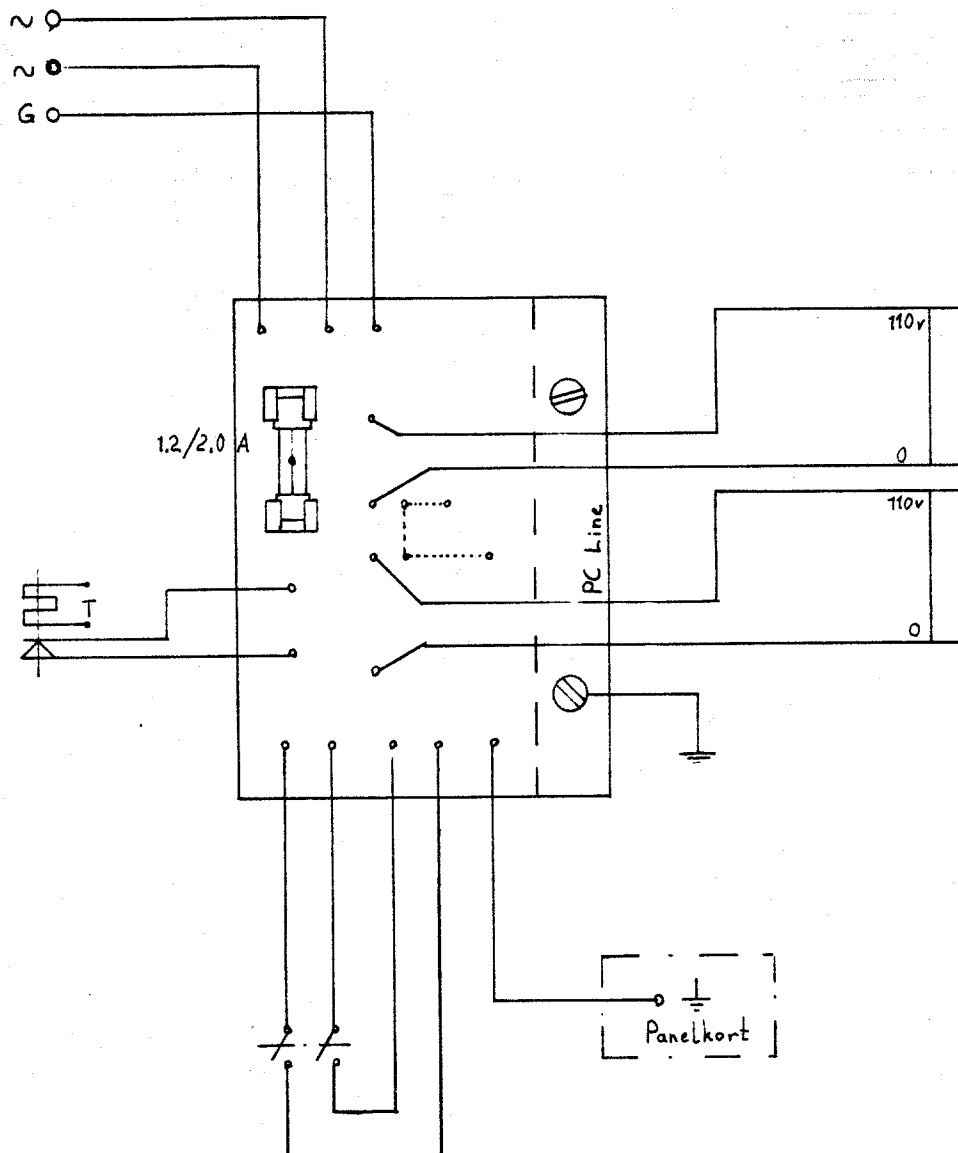


Panelkort												
Det.-nr		Ant.	Benämning			Material		Mod.-nr Ämne Dimension		Anm.		
Konstr. KF		Ritad LL	Kop.		Konstr.	Stand.	Godk.	Skala		Ersätter		Ersatt av
Powerbox ab					Powerbox 2000, 3000 Panelkort						Det. 790618	
										Ritn.-nr	77-015-015 PC Out 1,2	





Ritn.-nr	Nr	Ant.	Ändring och/eller medd.-nr	Datum	Inf.	Godk.	Användes för
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		PC Line						
Det.-nr	Ant.	Benämning			Material	Mod.-nr	Ämne	Anm.
Konstr	Ritad	Kop.	Kontr.	Stand	Godk	Skala	Ersätter	Ersatt av
KF	LL							
powerbox ab		Powerbox 2000, 3000				Dat		
--- bygel för 220 v insp.		PC Line				790618		
.... byglar för 110 v insp.						Ritn.-nr		
						77-015-015- PC Line		

SPECIFICATIONS

Input Voltage: 115/230 VAC + 10–15% ; 47–400 Hz

Output Voltages: Settability – within 10 mV for the 5-V range; (with DVM)
50 and 100 mV for the 20 and 40 V.

Model 3000 4–6V/3 A; 0–40 V/1.25 A; 0–20 V/2.5 A
Model 3000 A 4–6V/3 A; 0–40 V/1.25 A; 0–40 V/1.25 A
Model 3000 B 4–6V/3 A; 0–20 V/2.5 A; 0–20 V/2.5 A
Model 3000 C 4–6V/3 A; 0–30 V/1.8 A; 0–60 V/0.9 A

Constant-voltage mode:

Output voltage range	Line regulation ($\pm 10\%$)	Load regulation (0–100%)	Ripple output (pk–pk)	Temp. coef. (per °C)	Drift (8 hr, after 1/2 hr warm.)	Response (100% step @ 5A/ μ s)
5 V	± 2 mV	± 10 mV	10 mV	0.01%	0.1%	50 μ s
20, 30, 40 or 60 V	–0.05%	–0.05%	3 mV	0.005%	0.05%	0.2 V p-p overshoot

Output impedance is 4 m Ω to 1 kHz, increasing to 1 Ω at 10 MHz.

Constant-current mode:

20, 30, 40 or 60 V	0.4 mA	4 mA	4 mA	0.05%
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Output impedance is very high.

Output-Power:

Duty*	
Maximum Continuous	80 W
Peak Intermittent –	118 W

* Ambient operating temperature: –20°C to +50°C; storage: –40° to +85° C

