OLTRONIX

OLTRONIX-ELECTRONICS: Regulated Power Supplies - Digital Voltmeters - Oscillators

OPERATING AND SERVICE MANUAL

LABPAC

C15-2D AND C40-08D

Oltronix AB, Jämtlandsgatan 125, S-162 29 Vällingby, Sweden · Tel. 08/87 03 30, Telex 107 38
Oltronix UK, Hunting Gate, Hitchin, Herts, Great Britain · Tel. Hitchin (STD 0462) 52 201, Telex 824 74
Oltronix-Nederland N.V., Euroweg 15, Leek (Gr.), Holland · Tel. 05 945-27 00, Telex 533 01
Oltronix GmbH, 2000 Hamburg 13, Klosterallee 67, Western Germany · Tel. 0411-44 78 74, Telex 137 56

Table of Contents

SECTION 1

GENERAL DESCRIPTION

A. GENERAL

Oltronix LABPAC C40 - 08D and C15 - 2D is a line of low voltage, regulated DC dual power supplies.
The model number, e.g. C40 - 08D is a code for the performance of the power supply. The first letter "C" indicates the approximate stability for ± 10% line voltage change, being 0,03 - 0,1%. The first group of figures in the model number states the maximum output voltage, in this example 40V.
The figure after the dash shows the maximum output current of the power supply at 40 V, which is 0,8 A.
The letter "D" stands for dual range power supply.

B. FEATURES

The power supplies are equipped with combined volt- and ammeter.
An adjustable current limit control for protecting the load and the power supply from excessive current is incorporated. Further facilities are: Resistance programming, constant current programming and constant current with external shunt.
current with external shunt.
Resistance programming and constant current programming give the possiblity to control the output voltage by an external resistor.
The terminals for operating the power supply are accessible from both the binding posts on the front panel and from the connections at the rear.
The terminals for programming are located at the rear.
If higher voltage or current is desired, two or more units can be connected in series or parallel. Then remote sensing and programming with above mentioned instruments are still possible.

C. INCOMING INSPECTION

a. Mechanical check

When the power is received, verify that the package contents are complete and as ordered. Inspect the instrument for any physical damage such as a scratched panel surface, broken knobs or connectors etc. incurred in shipping.
Visually check inside the instrument for loose or damaged components.
To facilitate possible reshipment, keep the original packing. If damage is found, file a claim with the responsible carrier or insurance company and refer to the warranty, last page in this manual.

b. Performance check

The power supply may be checked for electrical operation within the specifications of section 2 by following the procedures of section 5. If the instrument does not operate as specified, refer to the warranty page of this manual.

SECTION 2

SPECIFICATIONS

Model	DC output			Stability 10 % line voltage change %	Stability 100 % load change mV	Noise mV RMS	Recovery time (0–100 % load) μsec	Environmental temperature range °C	Dimensions height x width x depth mm	Weight kg
	Voltage range	Amperes								
		Short circuit current	Max current							
C15-2D	0–15 0–7	1.0 2.0	2.0 3.0	0.005	10	0.3	15	0–45	160x70x220	2.3
C40-08D	0–40 0–20	0.4 0.8	0.8 1.6	0.005	10	0.3	15	0–45	160x70x220	2.3

Input supplies: 220 VAC ± 10%, 50 - 60 Hz.
Storage temperature range for both supplies is - 40°C to + 70°C.
Output totally floating; positive or negative may be grounded.
Output voltage is adjustable from zero.

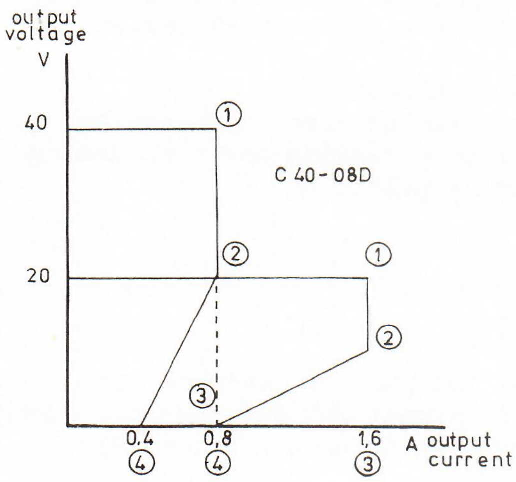


Figure 1

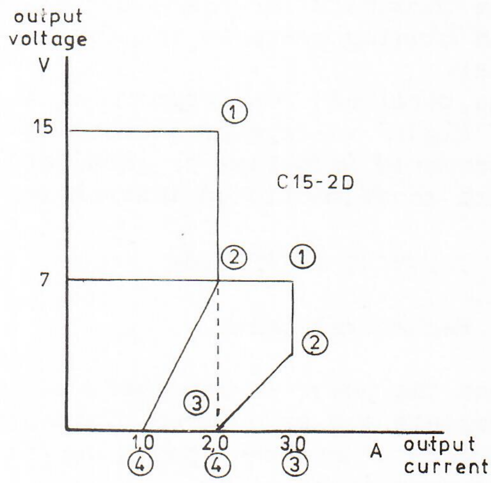


Figure 2

(1) Upper knee current in corresponding curve
(2) Lower knee current in corresponding curve
(3) Upper shoot circuit current corresponding curve
(4) Lower shoot circuit current corresponding curve

SECTION 3

OPERATION

A. GENERAL

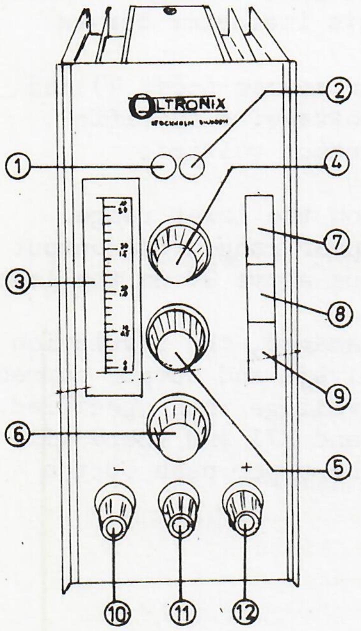


Figure 3

Presentation

Figure 3. Front side of LABPAC C40 - 08D, which is identical to that of C15 - 2D.

1. Output voltage indicator lower range
2. Output voltage indicator upper range
3. Combined volt-ammeter
4. Coarse output voltage control
5. Fine output voltage control
6. Current limit control
7. Volt/ammeter selector
8. Output voltage range selector
9. Line switch, AC only
10. DC power "-" terminal
11. Power supply ground terminal
12. DC power "+" terminal

Line

Unless otherwise specified these models are wired for 220 VAC ± 10%, 50 - 60 Hz operation.

Fuse

The line fuse is mounted inside the power supply under the transformer as shown in figure 4. Use slow blow type.

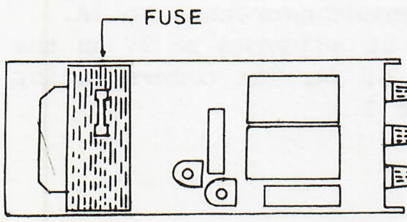


Figure 4. Fuse location.

Power

The power supply is switched on by pressing the push button, marked "LINE ON". (Fig. 3 pos. 9)

Voltage

LABPAC C15 - 2D and C40 - 08D each have two output voltage ranges. The maximum output power is the same. The desired voltage range is selected with the middle push button (pos. 8). When this push button is released, the power supply operates on its lower voltage range. (7V for model C15 - 2D and 20 V for model C40 - 08D).
By pressing the same button, the power supply is switched for the upper voltage range. (15V for model C15 - 2D and 40V for model C40 - 08D).
To avoid any misunderstanding which range is selected, a range indicator is mounted on the front panel (pos. 1 and 2). This indicator serves also as a "LINE ON" indicator.
There are two single turn potentiometers: one for coarse (pos. 4) and one for fine (pos. 5) adjustment of the output voltage. A specific setting of these potentiometers gives the same output voltage, irrespective of the voltage range selected.
Take for example model C15 - 2D, adjusted to 6V on the lower range.
If the output range push button is pressed for upper range, the output is still 6V. Adjusting the power supply to a value above 7V on the lower range is not recommended.
Though in this case the power supply cannot be damaged, the regulation may get lost for certain combinations of line voltage and output current. The regulator system tries to adjust for higher voltage than specified. Then the base current for T71 flows through R70 and R71 and there will be a current indication on the meter, provided the upper push button is pressed.

Current limit

Set "Current limit" control (pos. 6) at a value well above the expected peak current, but below the value which could damage the load. Read output current from the ammeter on the front panel (pos. 3) after pressing upper push button (pos. 7).
The characteristics of this current limit are shown in figures 1 and 2.
The current limit function is the following:
If the load is increased above the value giving maximum output current (upper knee current) for the actual power supply, both output voltage and output current will decrease. This means for e.g. model C15 - 2D that, if it is adjusted for 15V in the upper range, it maintains a constant voltage as long as the output current is less than 2A. If the load resistance decreases from its value down to zero ohms, the voltage decreases naturally to zero and the output current decreases to 1A.
Figure 2 also shows that, when model C15 - 2D is adjusted to 7V on the lower range, it can deliver a maximum current of 3A. The corresponding values for model C40 - 08D are given in figure 1.

Meter

The panel meter can be used for both output voltage (black scale division) and current indication (red scale division). Either function is chosen by the upper push button (pos. 7). In released position the meter acts as a voltmeter and in "ON"-position the meter indicates the output current.

B. NORMAL OPERATION

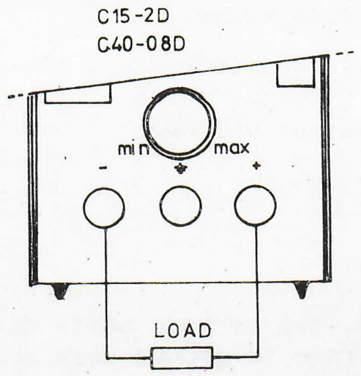


Figure 5.

The output may be positive, negative or floating, depending on how the jumper is connected, i.e. respectively between ground and "-", or between ground and "+", or removed.
The maximum voltage to ground is limited to 500V.

C. RESISTANCE PROGRAMMING

When the resistance programming mode is used, the output voltage is controlled by an external resitor. The connection procedure is as follows:

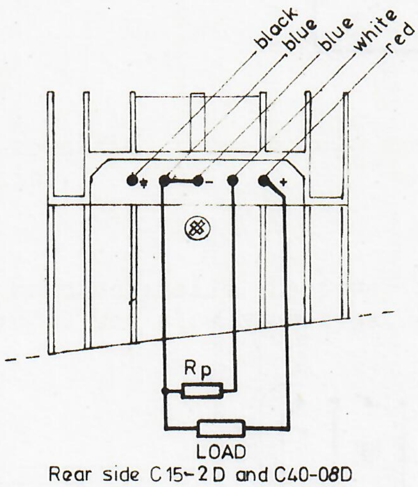


Figure 6

1. Switch off the power.
2. Set voltage control at zero.
3. Connect load and programming resistor Rp according to figure 6.
4. Now the output voltage is controlled by Rp. The relation between R_p and output voltage V is:

$$V = K_p \cdot R_p \quad (R_p \text{ in kOhms}).$$

where : K_p = 3,35 (programming constant 300 Ohms / V)

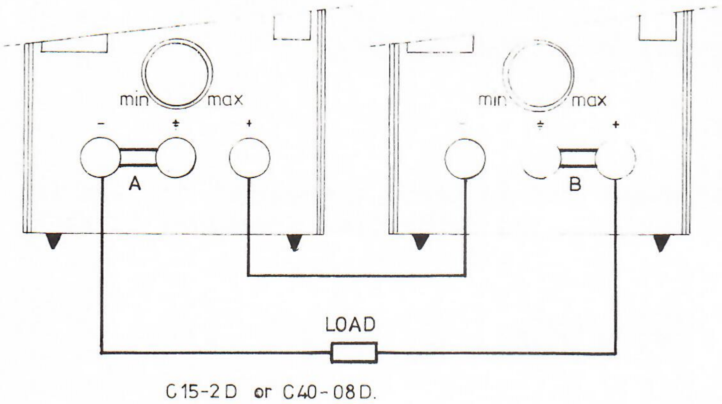
Note 1 : Do not increase R_p over the value that gives maximum specified output voltage.

R_p max. for model C15-- 2D : 4,52 kOhms, and for
model C40 - 08D:11,94 kOhms.

Note 2 : If the programming terminals are left open, the power supply will deliver an unregulated output voltage, which is considerably higher than the specified maximum output voltage.

D. SERIAL OPERATION

If higher output voltage is desired, two or more units can be connected in series, provided the maximum voltage to ground does not exceed 500V. The output may be positive, negative or floating, depending on how jumpers A and B (figure 7) are connected. Jumper A to ground gives positive output; jumper B to ground gives negative output;



Set current limit on all units well above the expected peak output current, but below the value that can damage the load.

Figure 7.

E. SERIAL OPERATION, PROGRAMMING

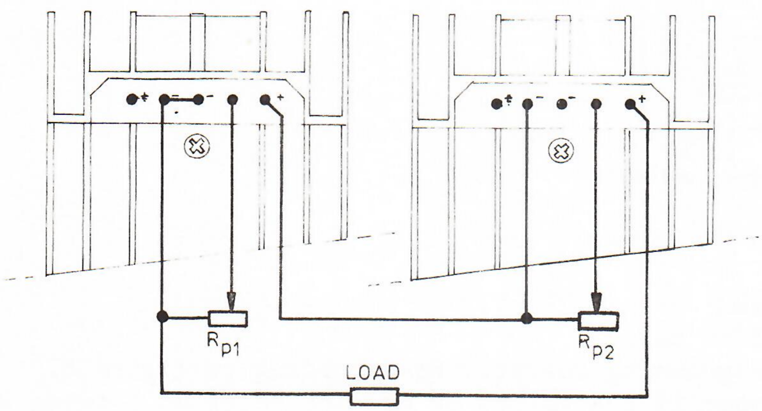


Figure 8. Connection procedure on rear side with LABPAC C15 - 2D and C40 - 08D.

The output voltage is controlled by the resistors Rp_1 and Rp_2. The relation between Rp_1 and Rp_2 and output voltage V is:

$$V = Kp\ (Rp_1 + Rp_2)$$

where: Kp = 3,35 (see section 3C).

If the voltage variation range desired is less than the control range of one of the power supplies, one Rp can be omitted and the corresponding power supply is arranged for serial operation in the usual way. Also refer to "Resistance programming", section 3C and "Serial operation", section 3D.

F. PARALLEL OPERATION

If higher output current is required, two or more units can be connected in parallel.

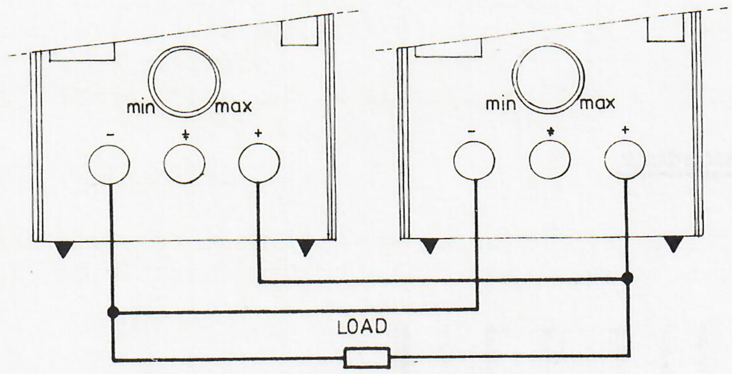


Figure 9. Parallel operation either LABPAC C15 - 2D or C40 - 08D

Adjustment

1. Set all voltage controls at desired voltage.
2. Set all current limit controls to approximately the same percentage of maximum and so that the sum of them is the desired current limit.

As there will likely be a small difference between the adjusted voltages the power supplies are adjusted to, the following will happen: as long as the load current is less than the capability of the power supply adjusted to the highest output voltage, this unit will carry the whole load current.
When the current limit of this power supply is reached, the next highest adjusted power supply takes over the part of the load current, which power supply no 1 cannot carry. When switching from power supply no 1 to no 2 the output voltage will drop by an amount corresponding to the voltage difference between the settings of these two power supplies. The same thing happens when the third, fourth and so on power supply takes over. Thus a slightly stepwise output voltage will result from any difference between the output voltages of the parallel connected power supplies. It is thus necessary to adjust the power supplies sufficiently accurate so that the incremental voltage steps become negligible.

G. CONSTANT CURRENT WITH EXTERNAL SHUNT

When using the power supply as a constant current source, an external shunt resistor is required, across which a voltage proportional to the output current is produced.
The instrument senses the voltage across this resistor and regulates the output voltage so that the voltage across the shunt is constant.
The relative current stability achieved with this method is in the same order as the relative voltage stability in the voltage stabilizing mode, measured at an output voltage equal to the voltage across the shunt. In this case it is necessary that the shunt resistance is a high stability, low temperature coefficient type, as the stability of the constant current is directly affected by the stability of the shunt resistance.
Choose the resistance of the shunt so that it takes 10% of the maximum output voltage. If it takes too great part of the available output voltage, it can be reduced to 5% with little sacrifice in performance.

Operation procedure

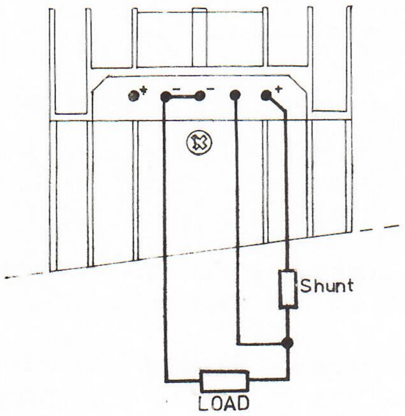


Figure 10.

Models C15 - 2D and C40 - 08D with external shunt

1. Connect shunt resistor according to figure 10.
2. Set the voltage control to zero, and choose proper voltage range for either model C15 - 2D or C40 -08D.
3. Switch on and set the current with the voltage control.

The resolution with the current adjustment is sometimes not high enough, as just a small part of the voltage control adjustment range will give full current. In such a case constant current programming (section 3H) is recommended.

H. CONSTANT CURRENT PROGRAMMING

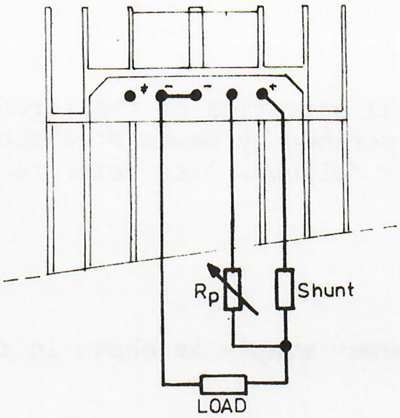


Figure 11. Connection procedure models C15 - 2D and C40 - 08D

Choose the value of Rp (in kOhms) according to:

$$Rp = \frac{Vs}{Kp} \qquad Kp = 3{,}35 \text{ (Section 3C)}$$

where V_s is the maximum expected voltage across the shunt. The adjustment procedure is as above, but set the constant current with Rp.

The current limit protects the instruments against overload also in constant current operation. The maximum output voltage that the constant current circuit can supply is considerably higher than the maximum specified voltage for the actual model and voltage range for certain combinations of line voltage and load current. Approximate figures are given in the table in section 6 "T71 collector to output".

The panel meter will show the output current or the voltage across the load and the shunt.

SECTION 4

CIRCUIT DESCRIPTION

A. GENERAL

This section describes the electrical operation of the circuit.
First the principal operation is described by means of a block diagram.
A detailed description of the blocks follows. Also refer to the complete diagram, section 9 in this manual.

B. BLOCK DIAGRAM

The complete block diagram of the power supply is shown in figure 12.

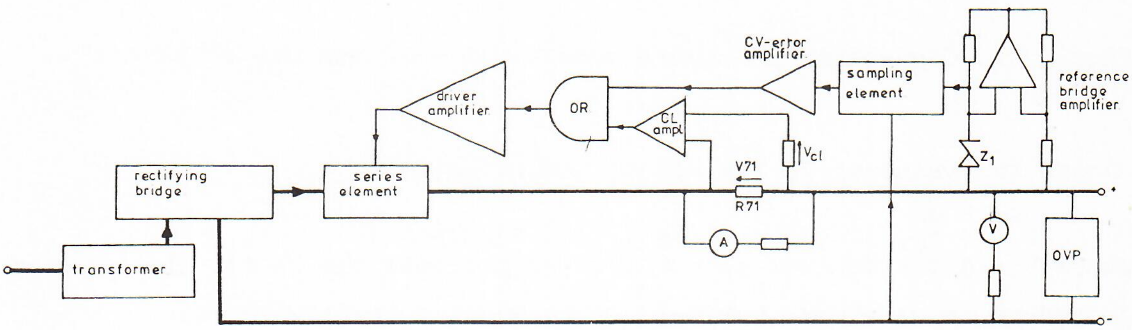


Figure 12. Block Diagram

The line delivers power to the transformer, where it is transformed to a suitable voltage. In the block "Rectifying bridge" the voltage from the transformer is rectified. The "Sampling element" is designed so, that the input voltage to the "CV error amplifier" is zero if the output voltage is correct.
If for example the output voltage is lower, the error is amplified in the"CV error amplifier", the "OR-gate" and the "Driver amplifier".
The phase angle of this chain is such that the "Series element" is controlled to decrease the voltage across itself. As this happens, the output voltage returns to its correct value.

To make sure that the output current will never be excessive, the instrument is equipped with a current limit system. The output current is monitored through the resistor R 70. (see also circuit diagram, section 7)
When the voltage across R 70 is higher than the voltage at the wiper arm of R90, the "CL amplifier" comes in through the "OR-gate" and the "Driver amplifier" and controls the "Series element" in such a way that the voltage across R70 does not exceed a predetermined value.
The "Reference bridge" together with the "Reference bridge amplifier" supplies an extremely constant reference voltage across Z1. This circuit also supplies voltages for the other amplifiers in the instrument.

C. RECTIFYING CIRCUIT

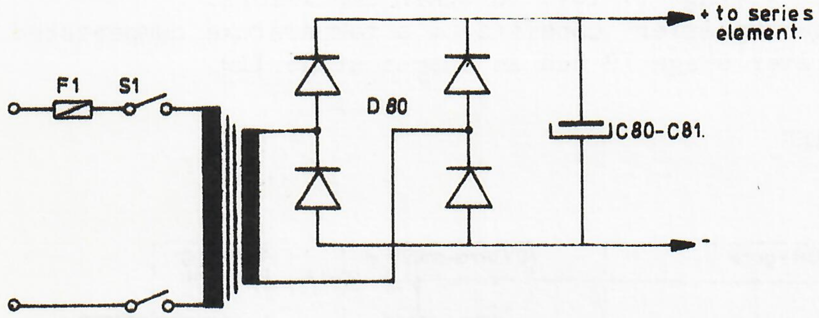


Figure 13

The rectifying circuit supplies a rectified voltage to the series regulator.

D. REFERENCE CIRCUIT

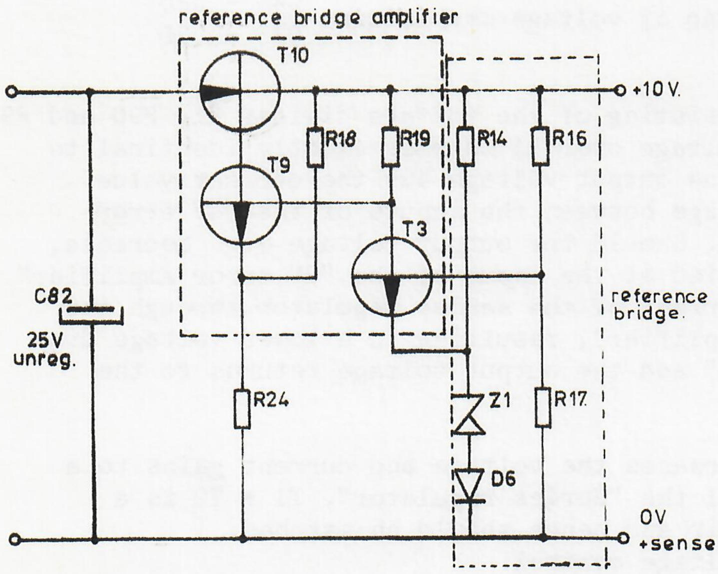


Figure 14

Stabilizer for reference and internal supply voltages

Z1 is a zener diode, which supplies a highly stable reference voltage for the instrument. The "Reference bridge" is stabilized by the "Reference bridge amplifier". This serves two purposes:

1. To supply a stable current to the reference zener diode Z1 + D6.
2. To supply a stable voltage (+ 10V) to other amplifiers.

The "Reference bridge amplifier" consists of a temperature compensated input stage T3, a driver stage T9 and an output stage T10.

E. VOLTAGE STABILIZING

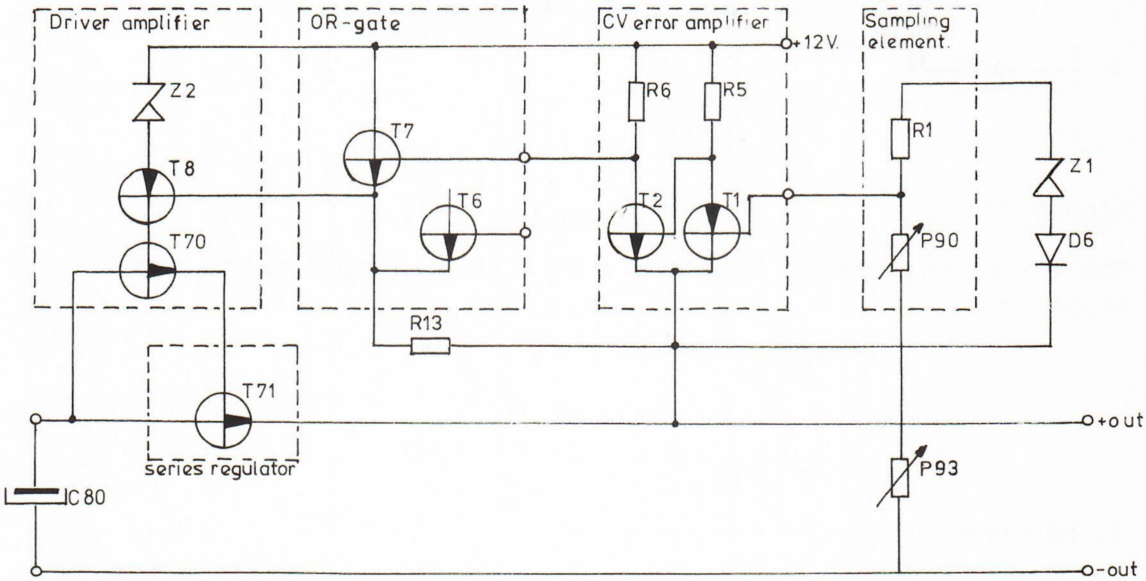


Figure 15. Principle drawing of voltage stabilizing C40 - 08D
C15 - 2D

The "Sampling element" consisting of the voltage divider R1, P90 and P93 is designed so that the voltage over R1 becomes exactly identical to the reference voltage if the output voltage has the correct value. This implies that the voltage between the inputs of the "CV error amplifier" T1 + T2 is zero. Should the output voltage e.g. decrease, a positive voltage is applied at the input of the "CV error amplifier". This increases the base current of the series regulator through the "OR - gate" and "Driver amplifier", resulting in a lower voltage drop over the "Series regulator" and the output voltage returns to the correct value.

The "Driver amplifier" increases the voltage and current gains to a sufficient level to control the "Series regulator". T1 + T2 is a temperature compensated pair and hence should be matched.
P90 + P93 is the output voltage control.
Refer to the circuit diagram, section 7:
D1, D2 and R2 form a protection circuit for the "CV error amplifier".
C91 is an AC feedback, reducing ripple and noise.
T6 together with T7 form the "OR - gate" where T7 is the CV input.
Under CV conditions the CL input of the "OR - gate" is not active as the base of T6 is reverse biased.

F. CURRENT LIMITING

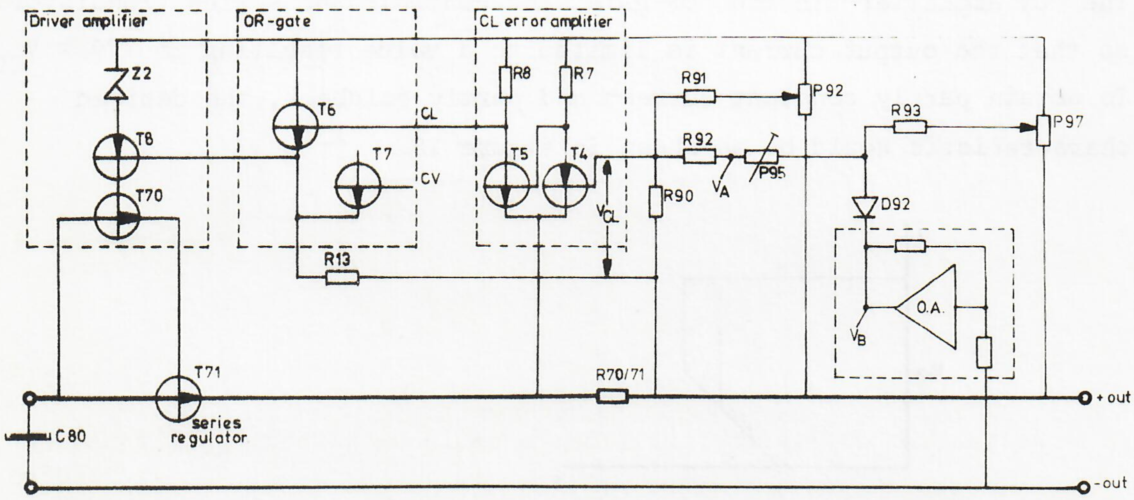


Figure 16. Principle drawing current limiting

The output current passes through the emittor resistors of T71, where they give voltages proportional to the current through the transistor. R70 and R71 are changed with the output range so that 100% current corresponds to an average of 0,5V over R70 and R71.

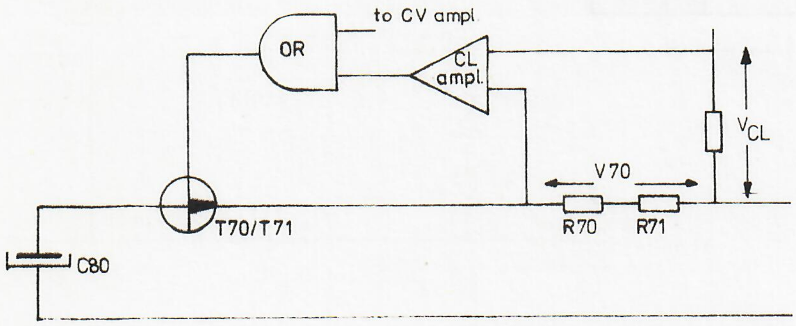


Figure 17

When the output current is low, V_{CL} is greater than V70. Then the "CL amplifier" is disconnected by the "OR-gate". If the output current increases, V70 becomes greater than V_{CL}, causing the input to the "CL amplifier" to change polarity. The "CL amplifier" then overpowers the "CV amplifier" in the "OR-gate" and controls the series transistors so that the output current is limited to a value resulting in V70 = V_{CL}. To obtain partly constant current and partly foldback, the desired characteristic would be as shown in figure 18.

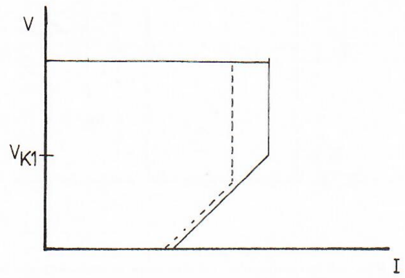
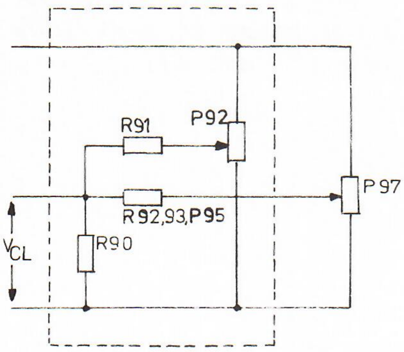


Figure 18.

V_{CL} will be proportional to the output voltage below V_{K1} and constant above it. When the CL control is set below 100% the dotted characteristic is followed.



V_{CL} is composed by the fixed voltage controlled by P92, and the variable component controlled by P97 on the frontpanel.

Figure 19.

For output voltages below V_{K1} the variable component must be limited so that the output current cannot exceed the desired characteristic. This is done with an "Operational amplifier" type circuit with feedback in inverting configuration.

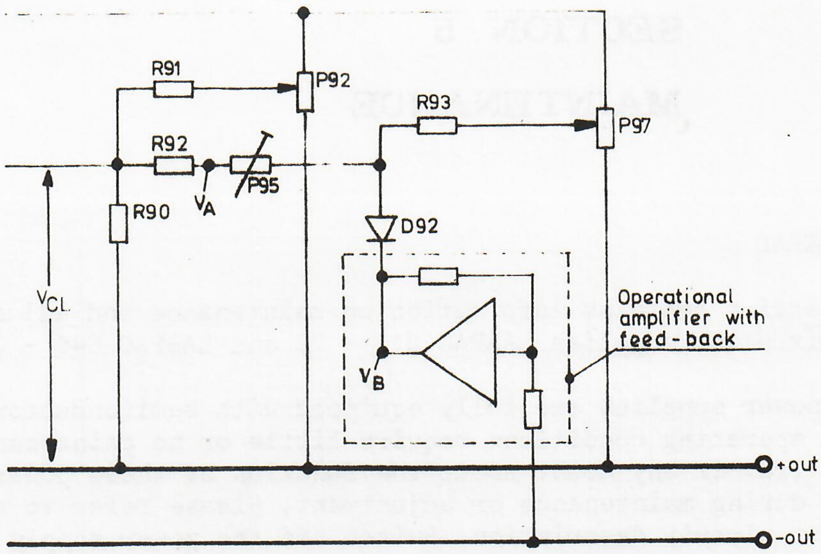


Figure 20

For high output voltages the "FB amplifier" is overcontrolled so that the output is in positive saturation. Then the "FB amplifier" is disconnected by D92.
At an output voltage above V_{K1} (figure 18) V_A and V_B have the same voltage, if the CL potentiometer P97 is set to maximum. At voltages below V_{K1} the component to V_{CL} from the CL control P97 is limited by the "FB amplifier" to lower values as is shown in figure 18.
The "Operational amplifier" consists of T90, R95, P101, R103, P70 and R74a.

SECTION 5

MAINTENANCE

A. GENERAL

This section contains information on maintenance and adjustment of the Oltronix power supplies LABPAC C15 - 2D and LABPAC C40 - 08D.

These power supplies are fully equipped with semiconductors and under normal operating conditions require little or no maintenance throughout their life. If any doubt about the function of these power supplies arises during maintenance or adjustment, please refer to section 4 for complete circuit description. Switch off the power supply before any component replacement is made.

B. COVER REMOVAL

The cover of these power supplies is removed as follows:

1. Turn the instrument upside down.
2. Unscrew the M4 screw located in the middle of the power supply bottom.
3. Pull the cover upwards.

C. VISUAL INSPECTION

Inspect the power supply once a year for possible circuit defects. These defects may include loose or broken connections, broken PC-board, or burned components. The cure for most of these faults is obvious but special care must be taken when a burned component is found. This kind of fault often indicates that there is another fault in the circuit as well. It is therefore essential to find out what has caused the actual component to overheat before it is replaced.

D. ALIGNMENT PROCEDURE

All power supplies are completely aligned when delivered from the factory. Though it is unlikely that the power supply will fall out of trim when used under normal operating conditions, the power supplies may need readjustment in case of component replacement. Information on these tests is given in the following paragraphs a - c.
Always perform the alignment in this order. For "Identification of components" see section 6.

a. Meter calibration

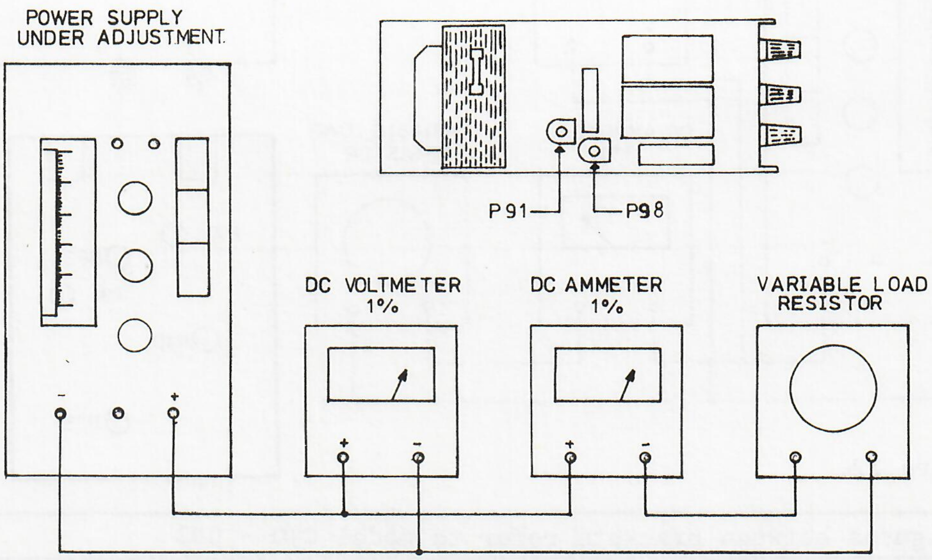


Figure 21

1. Connect the power supply as shown.

2. Select the upper output voltage range. Switch on.

3. Disconnect the load (no output current).

4. Set the "Voltage control" for maximum nominal output voltage according to the external voltmeter.

5. Meter function push button in released position (voltmeter).

6. Adjust P98 for correct meter reading.

7. Select lower output voltage range.

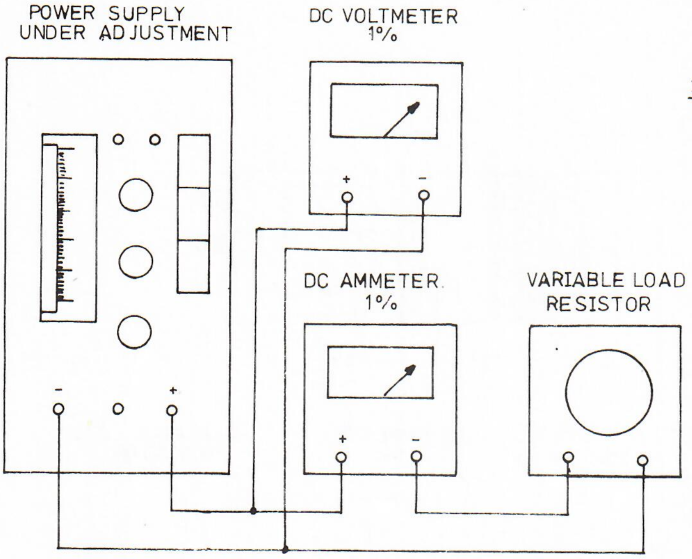
8. Set the "Voltage control" for maximum nominal voltage of this range. Disconnect the external voltmeter.

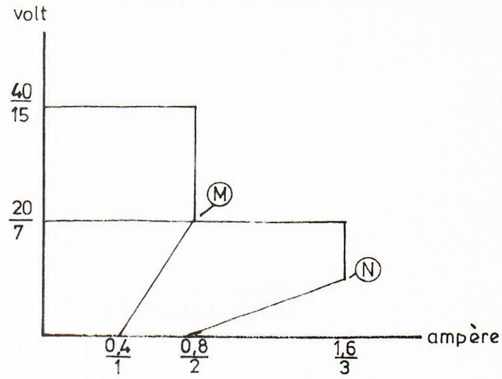
9. Press "meter function" push button (Ammeter position).

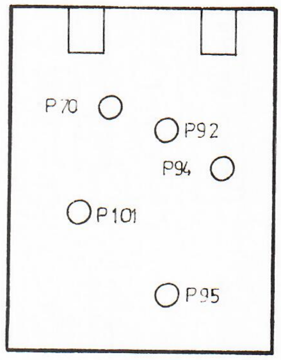
10. Connect the load and adjust it for maximum nominal current, according to the external ammeter.

11. Adjust P91 for correct meter reading.

b. Current limit adjustment







PC board
B9-5

Figure 22.

Figures between brackets refer to model C40 - 08D

Voltage range	Adjustment
1. 15V (40V)	Set P70 and P101 (PC-board) to min. position
2. 15V (40V)	Current limit potentiometer P97 -front panel- in min. position. Adjust P92 -PC board- to 100mA (80mA).
3. 15V (40V)	Current limit potentiometer P97 in max. position; adjust P95 -PC board- to 2,2A (0,9A).
4. 15V (40V)	Adjust short-circuit current 1,0A (0,4A) with P94 -PC board.
5. 15V (40V)	Set output voltage to 6,5V (18V) P70 min, output current 2,1A (0,85A). Increase P70 until output current decreases somewhat, i.e. 2,05A (0,80A).
6. 15V (40V)	Increase adjusted voltage to approx. 10V (30V). Check that point M 7V 2,1-2,2A (20V 0,85-0,90A) -above drawing- is achieved.
7. 7V (20V)	Adjust 3V (9V), P101 in min. position and output current 3,3A (1,65A). Decrease P101 until the current falls to 3,2A (1,6A).
8. 7V (20V)	Increase the voltage to approx. 6V (15V). Check point N 3,5V 3,1-3,3A (10V 1,7A-1,75A).
9. 20V	Max. current 1,7-1,75A.

c. Performance check

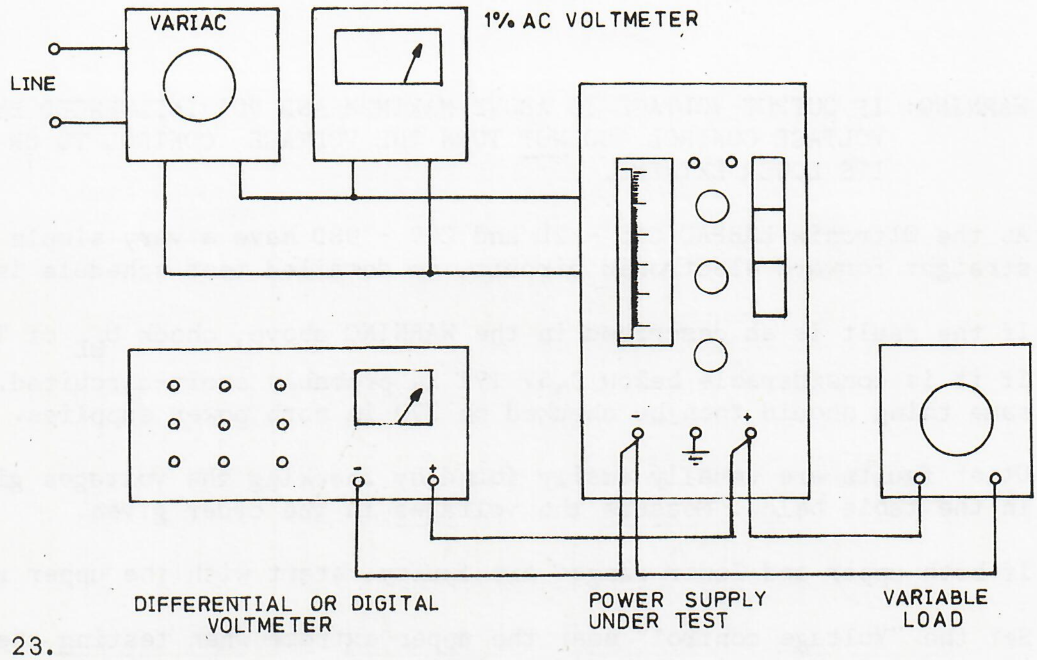


Figure 23.

Prior to all short term performance checks

1. Connect the power supply as shown.

2. Adjust the variac for 220 V power. Switch on.

3. Adjust the power supply for a 100% output voltage in the upper voltage range and the load for maximum current of this range.

Line voltage regulation

1. Adjust the variac for 240 V power input. Read the differential voltmeter.

2. Adjust the variac for 200 V power input. Read the differential voltmeter.

3. The difference between these two readings, divided by a factor 1,8 is the power supply regulation for 10% line voltage variation. (The factor 1,8 is because 200-240V is an 18% voltage variation.)

Load regulation

1. Adjust the variac for 220 V power. Read the differential voltmeter.

2. Disconnect the load. Read the differential voltmeter.

3. The difference between these two readings is the load regulation.

Ripple

1. Connect the load resistor for 100% output current.

2. Measure the output ripple by means of an AC RMS voltmeter connected across the output.

Perform above checks for both output voltage ranges.

SECTION 6

TROUBLESHOOTING

WARNING: IF OUTPUT VOLTAGE IS ABOVE MAXIMUM AND NOT INFLUENCED BY THE VOLTAGE CONTROL DO NOT TURN THE VOLTAGE CONTROL TO OR NEAR ITS LOWER EXTREME.

As the Oltronix LABPAC C15 - 2D and C40 - 08D have a very simple and straight forward electronic circuit, no detailed test schedule is necessary.

If the fault is as described in the WARNING above, check U_{BE} of T71.

If it is considerable below 0,5V T71 is probably short-circuited. The same thing should then be checked on T70 in both power supplies.

Other faults are usually easily found by checking the voltages given in the table below. Measure the voltages in the order given.

If both upper and lower ranges are faulty, start with the upper range.

Set the "Voltage control" near the upper extreme when testing the upper range and to approximately mid position when measuring the lower one.
Check that the line voltage is not too far off its nominal value.
All the voltages given in the table are nominal and can vary slightly from instrument to instrument. Some voltages are also depending on the output current and should be measured without load unless otherwise stated.

Test point	Correct value		Remark	
Across C82	± 16V		both models	
Across Z1	6,8V ± 5%			
T71 collector to output "-"	upper range	lower range		
	68V	34V	C40 - 08D	no load
	55V	26V	C40 - 08D	full load
	29V	19V	C15 - 2D	no load
	21V	13V	C15 - 2D	full load
T1 collector to output "+"	0V			
T3 U_{CE}	0,6V			
T3 U_{BE}	$<$0,4V		check P91	(figure 21)

SECTION 7

SPARE PARTS AND CIRCUIT DIAGRAM

A. GENERAL

Replacement parts are available from the Oltronix factory. All standard parts can also be ordered through most well-equipped component distributors. Note that some transistors have a letter-number combination e.g. H75 in the spare parts list in addition to the part number and value. This combination indicates the quality of the transistor expressed in current gain and maximum voltage. This description should always accompany the transistor when a replacement is ordered. For further information on classification refer to the "Oltronix transistor identification code" which is found after the spare parts list.
When a pair of matched transistors is needed, add "Matched" to the description. When ordering parts listed below, state the following information for each part:
a. Model and serial number of the instrument
b. Circuit reference
c. Type and value
For parts not listed below state:
a. Model and serial number of the instrument
b. Complete description of the part
c. Function and location of the part

B. ABBREVIATIONS

Cer = ceramic
EMC = electrolytic metal case
K = kilo or 10^3
M = mega or 10^6
MF = metal film
MP = metalized paper
pF = pico Farad or 10^{-12} Farad
Pos = position
Rect = rectifier
Si = silicon
Tan = tantalum
Trim = trimpotentiometer
uF = micro Farad or 10^{-6}
V = Volt
W = Watt
WW = wire wound

C. SPARE PARTS model C15 - 2D.
Figures between brackets refer to model C40 - 08D.

Pos	Value			Part no	Type
Capacitors					
C1,C2	4,7	uF	20 - 25V	1415	Tan
C3	2200	pF	350V	1426	Cer
C4,C6	0,02	uF	100V	1398	MP
C80,C81	1000	uF	35V	1519	EMC
C82	160	uF	25V	1483	EMC
C90	470	uF	25V	1512	EMC
	(200	uF	64V)	(1494)	
C91	0,68	uF	250V	1405	MP

Pos	Value			Part no	Type
Diodes					
D1,D2,D3,D4,D5, D6,D91,D92	1S 921			1667	Si
D80	B80 C3200/2200			1713	Rect.
D81	B30 C250/100			1704	Rect.
D90	1N 4003			1668	Si
Potentiometers					
P70	10K (25K)	0,05W		1350 (1351)	Trim
P90	5K (14,5K)	0,5W	10%	1373 (1374)	WW
P91	1K (250)	0,05W		1348 (2633)	Trim
P92	25K	0,05W		1351	Trim
P93	500	1,5W	10%	1320	WW
P94	1K	0,05W		1348	Trim
P95	25K	0,05W		1351	Trim
P97	5K	0,5W	10%	1373	WW
P98	25K	0,05W		1351	Trim
P101	10K (25K)	0,05W		1350 (1351)	Trim

Resistors

Unless otherwise specified, all resistors are carbon 0,25W and 10%

R1	2K	0,13W	1%	1287	MF
R2	1K			1016	
R5	220K			1044	
R6	100K			1040	
R7	330K			1046	
R8	100K			1040	
R9	12K			1029	
R10	1,5K			1018	
R11	100			1004	
R12	1K			1016	
R13	10K			1028	
R14	470			1012	
R16	3,3K			1022	
R17	6,8K			1026	
R18	1,5K			1018	
R19	39K			1035	
R21	1K			1016	
R22	3,3K			1022	
R23	1M			1052	
R24	4,7K			1024	
R26	47			1002	
R27	47			1002	
R70	0,22 (0,28)	1W	2%	1264 (1265)	WW
R71	0,28 (0,22)	1W	2%	1265 (1264)	WW
R72	100			1004	
R73	1,5K			1018	
R74a	12K (27K)			1029 (1033)	

Pos	Value	Part no	Type
R90	1,5K (1K)	1018 (1016)	
R91	100K	1040	
R92	3,9K (4,7K)	1023 (1024)	
R93	10K	1028	
R94	2,2K	1020	
R95	8,2K	1027	
R97	150	1006	
R98	15K (27K)	1030 (1033)	
R103	5,6K (18K)	1025 (1031)	

Transistors

T1,T4,T8,T10	BC 178B	2862	Si
T2,T3,T5,T6, T7,T9	BC 108B	2861	Si
T70	40347 (2N 3053)	3080 (1566)	Si (L75)
T71	2N 3055	1532	H75
T90	2N 3710 (2N 3710)	1591 (1595)	L25 (H75)

Zener Diodes

Z1	ZF 6,2	2758	unclass.
Z2	ZF 5,6	1686	unclass.

D. OLTRONIX TRANSISTOR IDENTIFICATION CODE

To assure that the transistors in the Oltronix power supplies have good enough data for their actual application, all transistors are tested with a Tektronix Curve Tracer before they are mounted in any instrument. Certain transistors e.g. power transistors and transistors for high voltage use pass a more complete test after which a classification mark is applied. This mark is a letter-number combination on the power transistors and a colour dot on the smaller transistors.
The letter indicates high "H" or low "L" current gain. The number shows the maximum working voltage.
The test conditions are:

Test	Power transistors TO-3 and TO-36	Other transistors TO-5 and similar
Current gain	$I_c = 2A$ $V_{CE} = 10V$ High if $h_{FE} \geqslant 50$ Low if $h_{FE} < 50$	$I_c = 1$ mA $V_{CE} = 10V$ High if $h_{FE} \geqslant 50$ Low if $h_{FE} < 50$
	Transistors with extremely high or extremely low h_{FE} are rejected.	
Voltage	$I_c = 400$ mA $R_{BE} = 100$ ohms	$I_c = 1$ mA $R_{BE} = 1,5k$

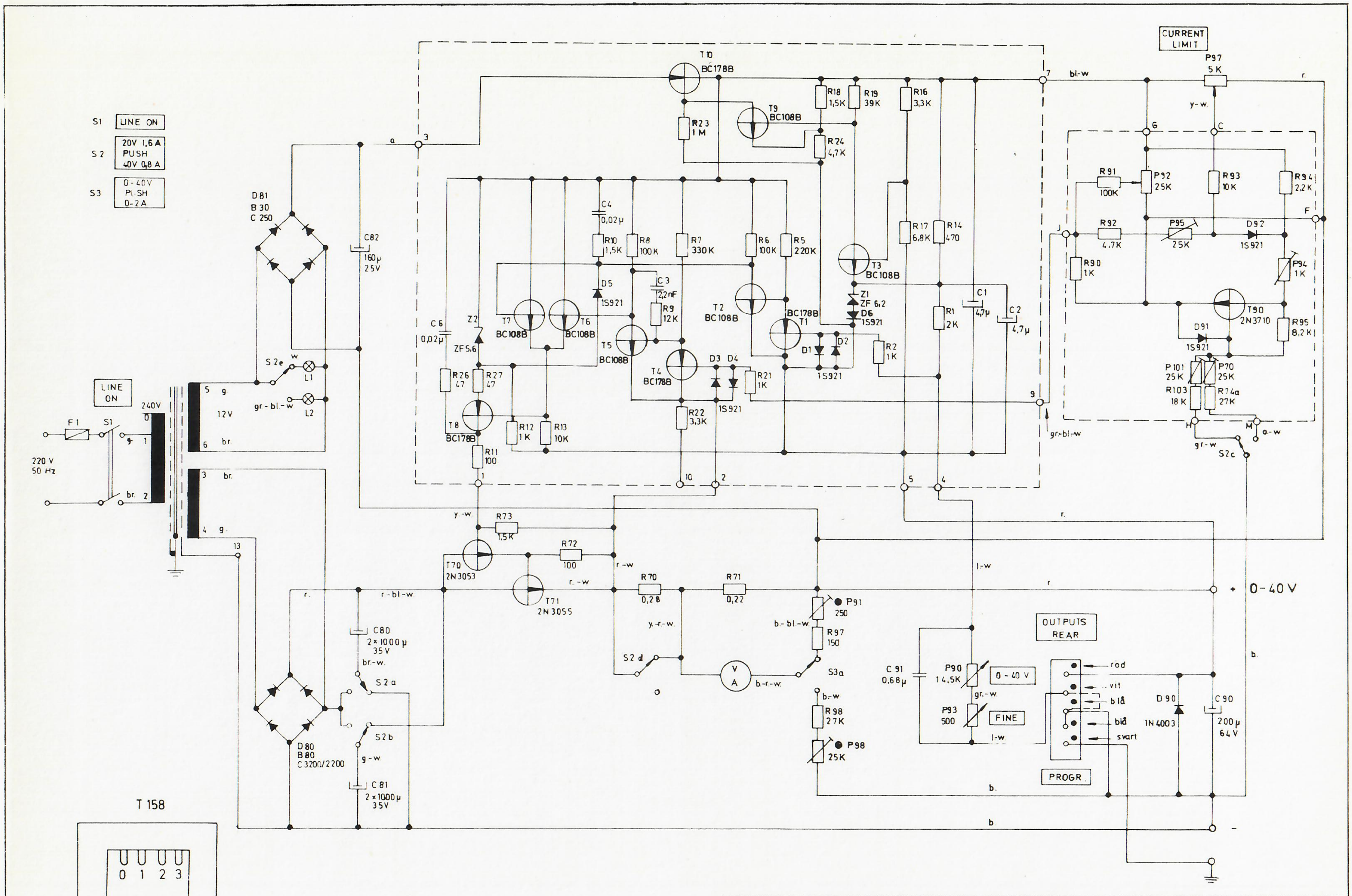
The colour code is:

Class	Colour	Class	Colour
L25	Brown	L100	Silver
H25	Red	H100	Black
L50	Yellow	L125	Silver and brown
H50	Green	H125	Black and red
H65	Blue	L150	Silver and yellow
L75	White	H150	Black and green
H75	Violet	L175	Silver and white
		H175	Black and violet

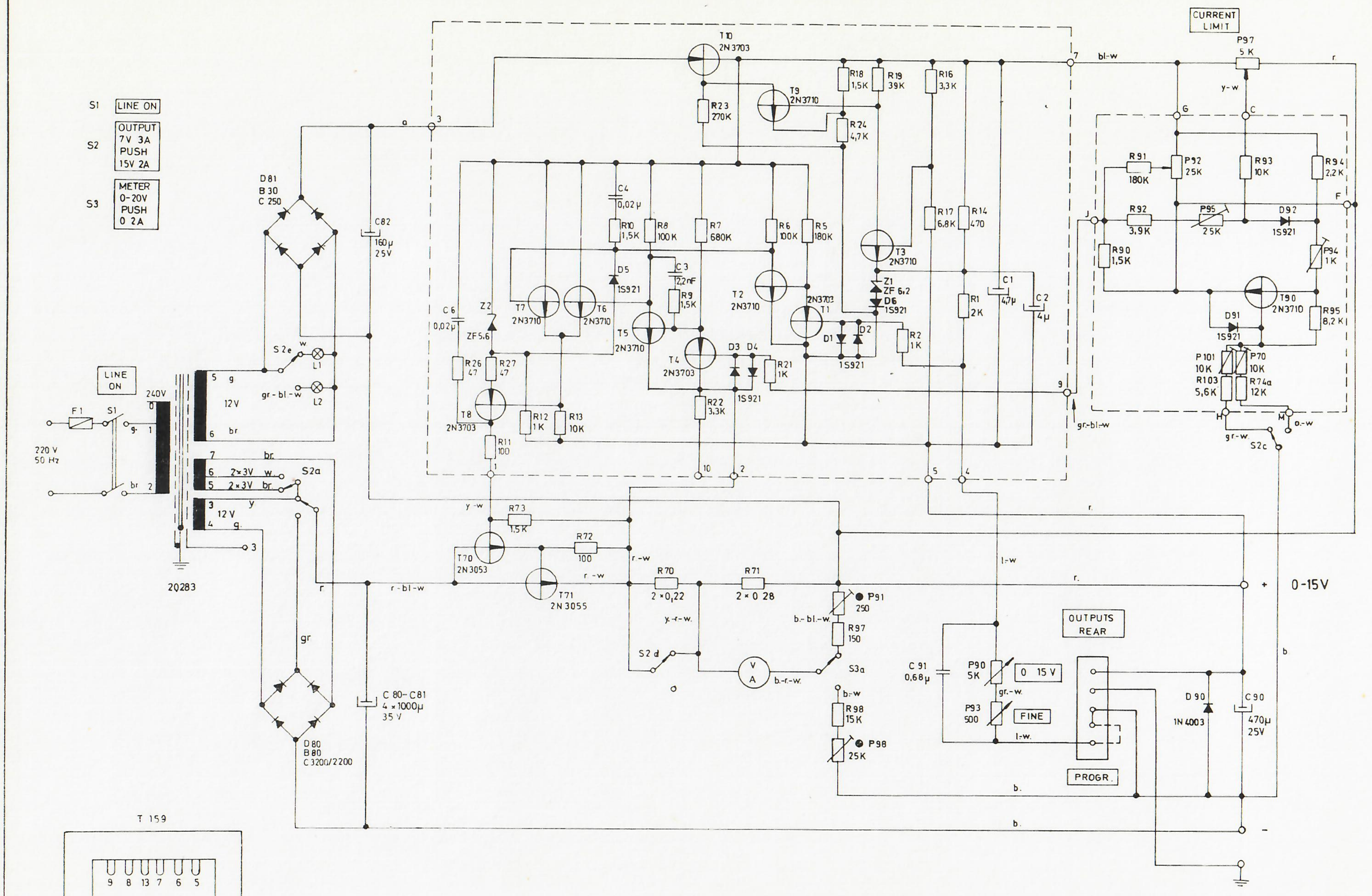
Colour code for wiring is:

b = blue	l = violet
bl = black	o = orange
br = brown	r = red
g = green	w = white
gr = grey	y = yellow

E.g. an orange-black wire is indicated as o-bl.



OLTRONIX	REGULATED POWER SUPPLY C40-08D	05 12 68	PG
		191-73-1B	



OLTRONIX	REGULATED POWER SUPPLY C15-2D	05 12 68	PG
		192 - 73 - 1	

5-year quarantee

We warrant each instrument manufactured by us, and sold by us or our authorized agents, to be free from defect in material and workmanship and that it will perform within applicable specifications for a period of five years after original shipment. Our obligations under this guarantee are limited to repairing or replacing any instruments or parts thereof, which shall, within 5 years after delivery to the original purchaser, be returned to us with transportation charges prepaid, prove after our examination to be thus defective. Excluded are semiconductors, fuses, multiturn potentiometers used in resistance divider units or those components, which are not covered by a corresponding manufacturers guarantee or have been misused or accidentally damaged.

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.