DUAL ADJUSTABLE AND STABILIZED DC VOLTAGE-DECK DC2-LAB10

DC2-LAB10 is a conventional lab unit based on low frequency transformation of the supply voltage to a weaker and later stable DC voltage, through a smoothing capacitor and NPN transistor. The advantage of building your own lab units can be helpful to know when there are so many in the trade to choice at. Above all, there are some factors which I think is essential. The price of course, but it depends on how much you have in your home that may be of use here? It may be aluminum plate, transformers, heat sinks, capacitors and components. Most of these elements tend to be able to obtain in a normal metal scrap. Given the high current capacity here, one can compare what the trade has to offer? The work space is an important factor I think and it tends to be quite limited. Since most require significant place in the longitudinal direction, it would be a good fit with one that instead extends vertically. Another factor is in my opinion an extra resource and then one has dual DC outputs. With two galvanically isolated and adjustable outputs increases the flexibility of more advanced exercises.

With DC2-LAB10 is the situation as follows: One DC output ranges up to 40VDC, while the other only can be set to a maximum 20VDC. The 40V can deliver 3A while the output of the 20V can give 10A. Both can sneak down to 0V while the 40 volt outlet is equipped with current limiting. By linking the two with a cord one can do experiments with projects that require dual supply voltage.

A not entirely irrelevant feature is that the voltage can be adjusted down to 0 volts. A requirement one not should circumvent. Observe that this can be achieved with the voltage regulator 723 and without any frills!

DC2-LAB10 is equipped with thermal and short circuit protection and digital display-viewing. For digital display of voltage and current is DC2-LAB10 optimized for VAD. VAD1/2 is another project I've done and offer high flexibility and accuracy.

DC2-LAB10 is thus a tower-shaped lab unit with dual and individual DC jacks. It is very stable, hum-canceling and is able to display all occurring voltages and currents with high accuracy. Voltages down to 0V are possible. The unit has a function of current-limiting and is safe for both short circuit and overheating. It is not only flexible in its design but also allows components of different kinds and types for those who want to build it.

The construction of DC2-LAB10 does not need to follow a precise schedule. Of course one should not change in the circuit that control the voltage, RE (Regulate Electronic) too much, but the other parts can be exchanged and combined as one like; especially the transformer and the design of the apparatus enclosure. The casing should preferably be made of metal such aluminum or steel. Note that the heat sink to cool the power transistors (T3) not shall be in contact with the apparatus. Therefore is the collector in direct contact with the heat sink for maximum cooling effect. The apparatus shall be connected to protective earth!

The heat sink should be attached to the back surface of the deck. Many ventilation holes or openings must exist on the apparatus, particularly in view of the transformer. Fan cooling may be an interesting alternative but is not described here. PCB laminates can be used as insulation between the apparatus and the heat sink. The larger the heat sink is the longer can you run the unit without that the thermal fuse is activated. The effect transistor (T3) is of the 2N377x series and can withstand 390°F on the outside. The heat is recorded with an NTC resistor for each transistor and is placed 3cm above it and at the same heat sink of course. The NTC resistors have to break at approximately 250°F. This corresponds to a temperature close to 390°F on the transistor. Here it break at 250°F and open again at 210°F.

The transformer determines how much voltage and current one can get out. It may not be appropriate to get 10A at 40V. So then one can customize the deck to the modified specification instead of buying a new one. A transformer should be dimensioned so that it not gets hotter than 140°F at maximum load.

The Smoothing-Capacitor (C1/C2) can consist of several parallel-connected capacitors of different types. NOTE that there is the SC that determines the lab-unit data in terms of stability and hum-suppression. The stability of the regulated voltage of the transistor (the emitter) is due to 723, or more precisely; the voltage that is connected to the transistor's base. SC only task is to ensure that the valleys of the rectified AC voltage (before T3) not passes below the voltage level after T3, at maximum current. Of course must SC never be under dimensioned - then fail the whole concept.

The size of SC is then determined of the maximum current output, but also on the voltage difference between the collector and the maximum voltage of the emitter. For example, if the maximum output voltage is 40V and the TRAFO's output voltage (after the rectifier) is 49V, is the voltage different 9V. The valleys on these 9V must not fall to deep when the unit is maximum loaded (here, 5A). Minimum is around 1V over T3 (41V).
It can be difficult to calculate if there is no access to an oscilloscope. Such a instrument, however, simplifies the problem. The size of SC increases the smaller the difference is, but at the same time increases the power losses of the transistor at a high differential. It is therefore important to find a TRAFO whose voltage is approximately 10 volts higher than the maximum output voltage, and that it does not drop too much at maximum output.

The electronics to DC2-LAB10 is quite simple but smart. It is enough with a small one-sided board. As always is it SMD that rules. No holes need be drilled except those you need to attach the board.

The 723 handles the voltage regulation (down to zero volts) and the OP shut off the 723 if there is a power output over the limits, thus is the unit protected in the same way against short circuits. It is the voltage drop on B-E on T3 that governing the outgoing current maximum value. This is controlled by R23 but also the size of the R24 is significant.

An OP turns off at the high temperature at T3. When this occurs will the unit not start until the temperature has dropped to a certain value. This hysteresis is determined by the values of R20, R21 and R22. R19 and R20-R22 gives together the break point and hysteresis. Here's open to their own experiments, but remember that the current of Vref not shall exceed 15mA. Another OP generates a time delay through an RC-link (R5 and C5), which means that it takes a little while before the device is "switched on". A LED (named LED) indicates that the power is off for all of the listed auto-protective effects. This function is activated even after the unit turned off, which may look a little strange.

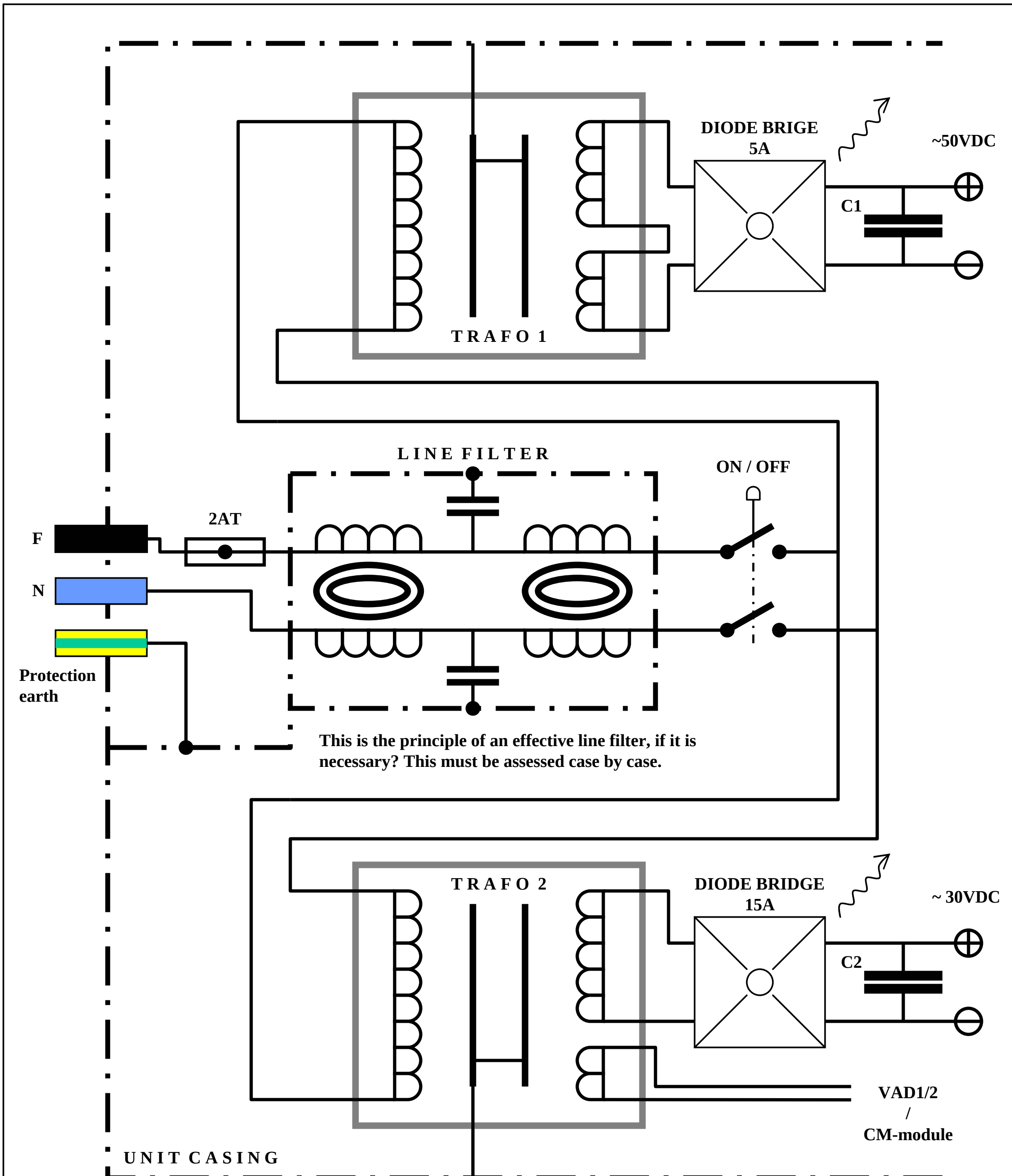
Another optocoupler (4N32) is required when the whole things work in symbiosis with VAD1/2. This applies to the current limiting function. <u>An optocoupler is required when the zero voltage plane (ground) on the various units must be kept separate</u>. All ICs can be soldered directly to the board; you can bend the legs slightly so they are aligned correctly. You may choose whether to cut off your legs, bend them or let them remain unchanged.

There are some cables routing to and fro. First shall the cables be drawn forth and back to the switch through the fuse and the line filter. Use heat shrinks tubing to cover all the points which form a contact hazard. <u>Do not forget the protective ground wire. It shall be attaches to the device enclosure / chassis and also on the transformer iron core</u>. Cables must be drawn between the TRAFO and the rectifier bridge via RE40VNA and a car-fuse to T3, the lab-polarizing plug (+ & -), P1, NTC resistor and the LED. If VAD is used must a supply cable be drawn and lines between VAD and the L-circuit etc. From VAD to RE40VNA, if the current limit function is used and its switches plus the potentiometer on the panel. If one excludes VAD can the visual information be made in the form of regular analog dials.

The Darlington transistor T2 makes the biggest gain job and gets warm at higher discharges. It shall be equipped with a small heat sink above the circuit board. The dimension of R10 depends on the peak voltage across C1/C2. Measure it and calculate R10 from the current through Z1, which should be around 50mA. The result is a power resistor of 1 to 2W.

The maximum current that continuously are able to be charged is determined primarily by the temperature at T3. Thus, the heat sink cooling capability and also on the TRAFO and to some extent the rectifier bridge. But even the size of C1/C2 is equal to the max output current. Depending on how you have designed this deck so can one not say it specifically. <u>What it is going to say specifically, is the size of the temporary current. It is determined by the TRAFO and C1/C2</u>. When the voltage valleys before T3 output voltage approaches the maximum value, should the over current protection stop the unit. This depends of R23 and R24. You can wait to stop until the voltage valleys before T3 drops below the output voltage. The Hum-factor is likely to increase substantially but it is only for high output voltages, not low. This can be remedied by adding to C1/C2 again. DC2-LAB10 is holding a fixed output voltage regardless of the size of the outgoing current. That the voltage drops is due the L-circuit, Ri, wires and measuring cables.

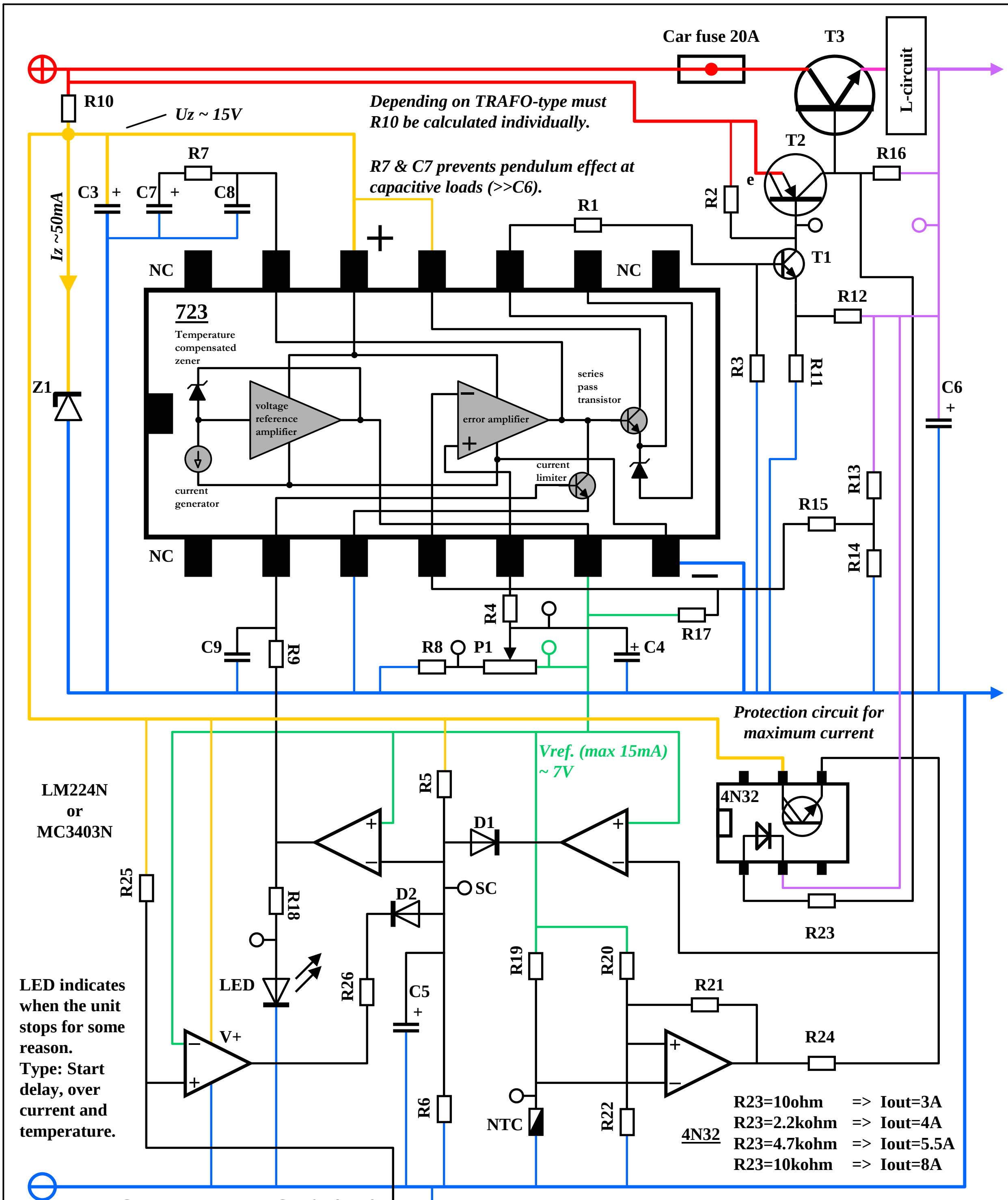
CIRCUIT DIAGRAM



The figure shows two transformers, one for each DC output. One could also use a single transformer but with multiple outputs. It would then be twice as large in order to deliver the same power.

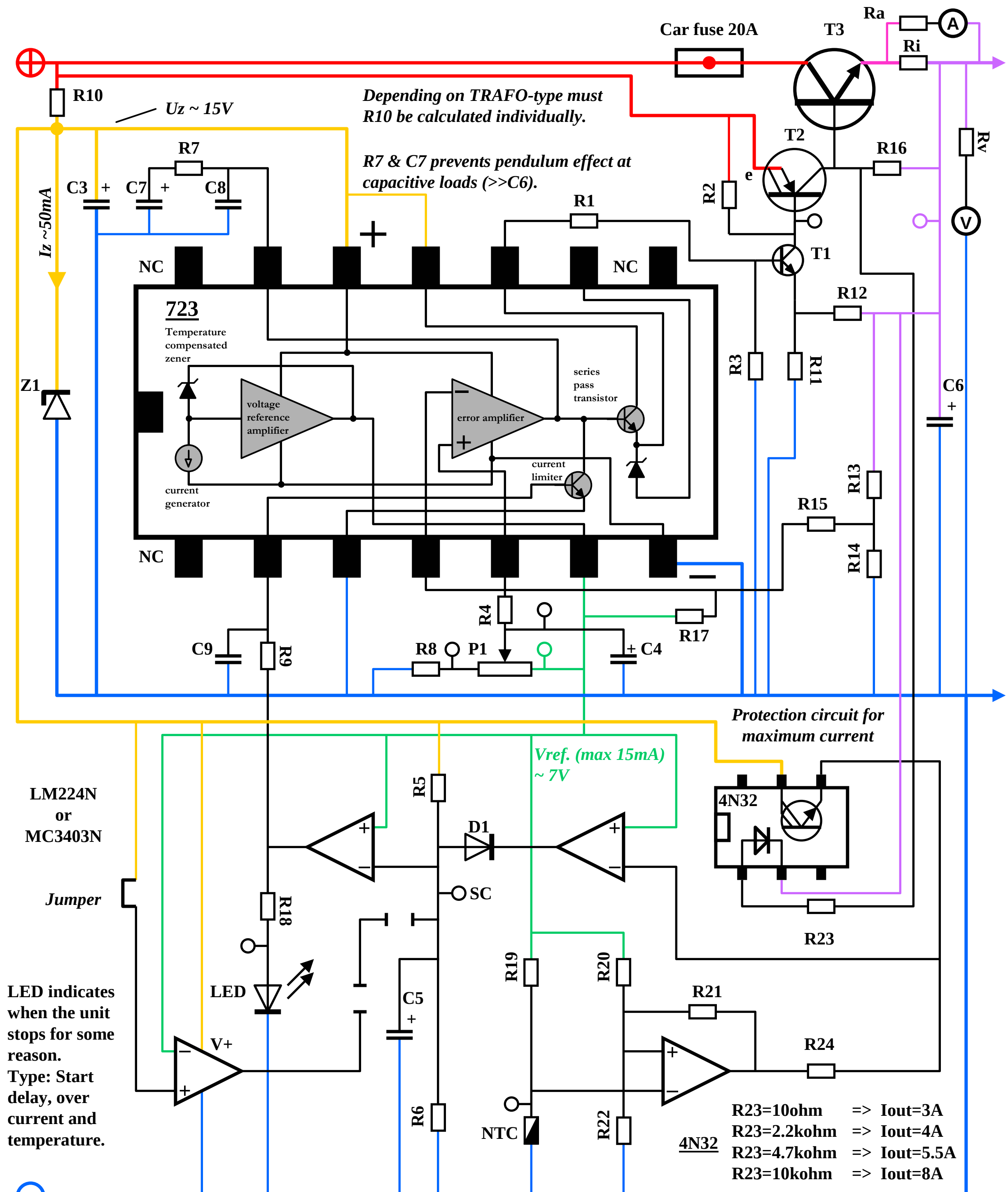
PROJECT	*Dual DC lab unit*	
MODULE		
MODEL	**DC2-LAB10**	**-**
AUDIT	A-1	**DRAWING: 1 of 1**
SUPPLY	~ 230VAC	
CURRENT	Max 2A	
OTHER	Mains wiring, trafo& rectification	
B. Lindqvist		*2005-07*

CIRCUIT DIAGRAM



PROJECT	Dual DC lab unit	
MODULE	RE40VNA	
MODEL	DC2-LAB10	
AUDIT	A-1	DRAWING: 1 of 1
SUPPLY	≥ +18 VDC	
CURRENT	Type 50 mA	
OTHER	For connection to VAD1/2	
B. Lindqvist		2005-07

CIRCUIT DIAGRAM

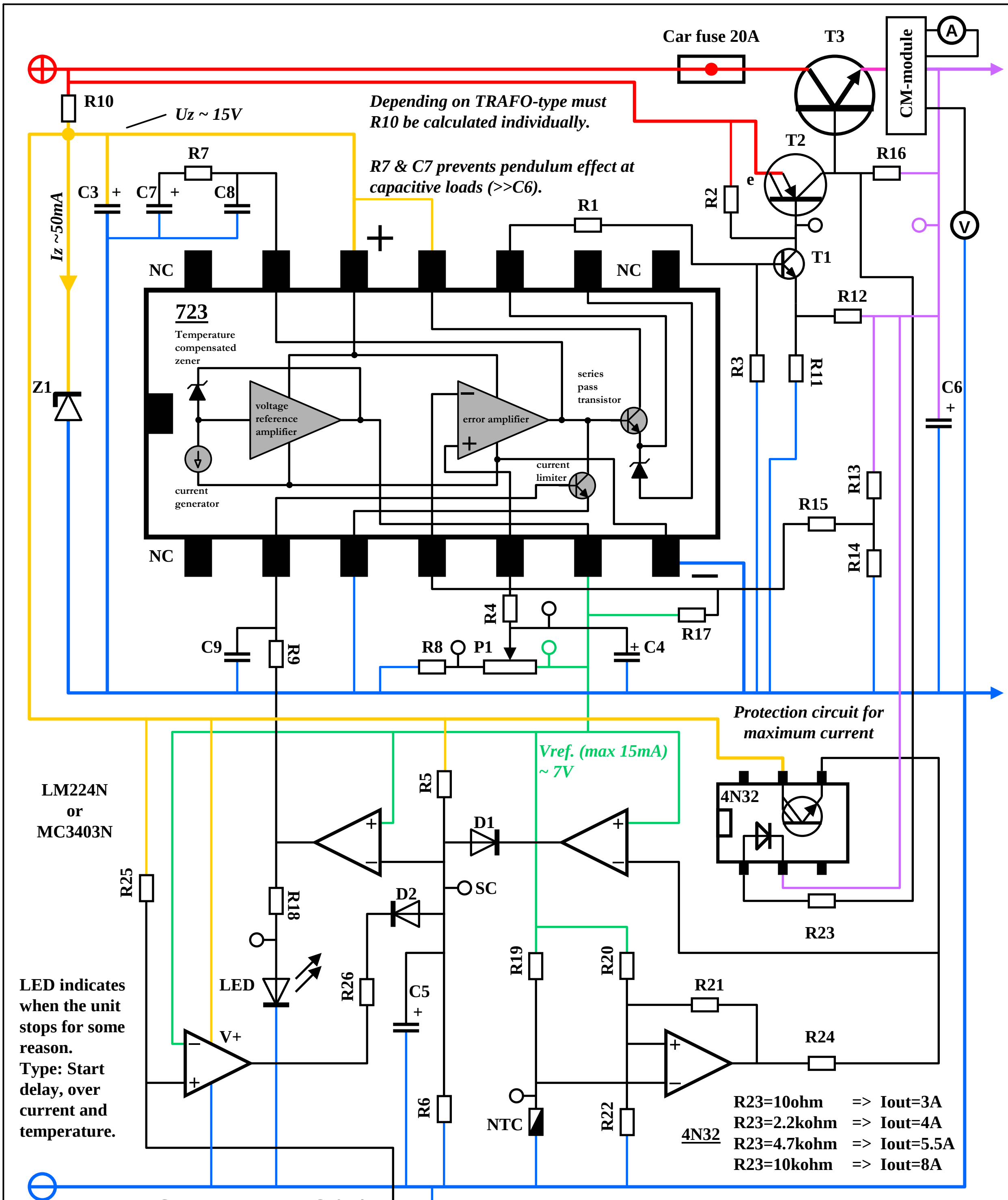


NO CURRENT LIMITING
(except the protection against max current)

If one wishes to use current limiting but do not want to use VAD, then you can use the CM module that is connected to an available secondary winding on the TRAFO.

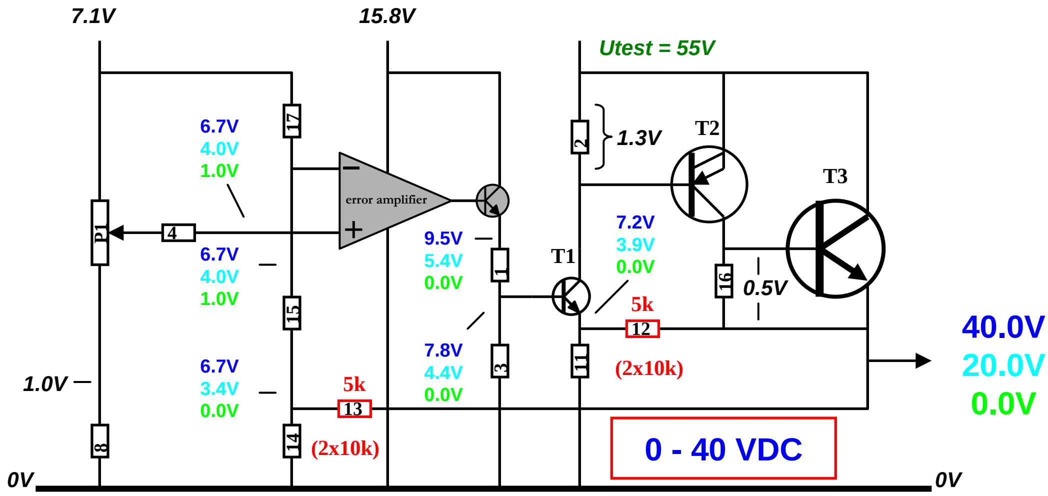
PROJECT	*Dual DC lab unit*
MODULE	*RE40VNA*
MODEL	**DC2-LAB10**
AUDIT	A-1 — **DRAWING: 1 of 1**
SUPPLY	≥ +18 VDC
CURRENT	Type 50 mA
OTHER	For connection to VAD1/2
B. Lindqvist	*2005-07*

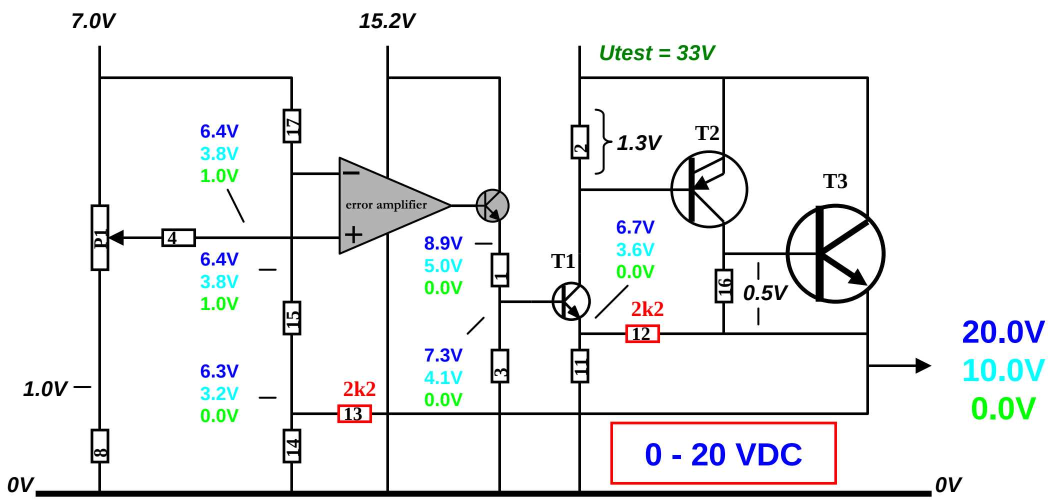
CIRCUIT DIAGRAM

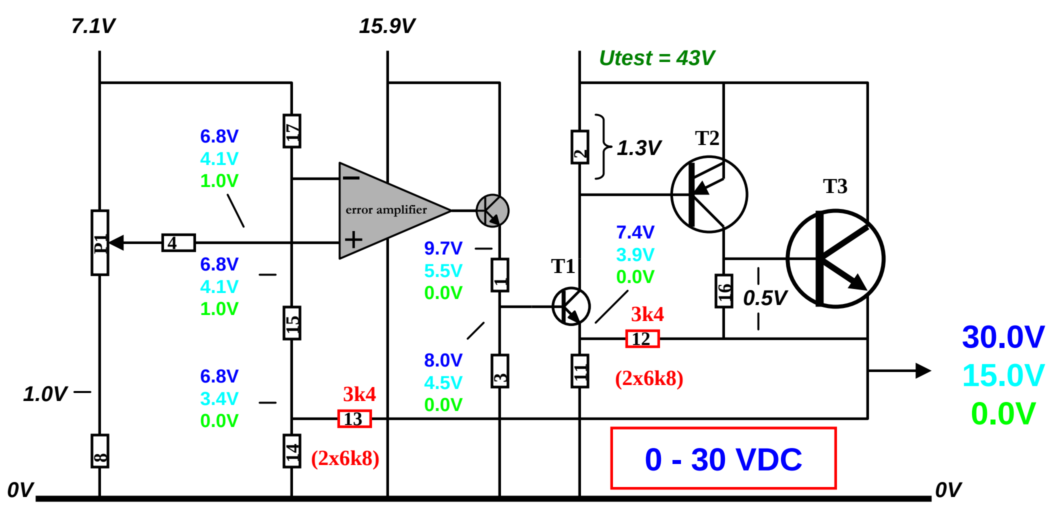


PROJECT	Dual DC lab unit	
MODULE	RE40VNA	
MODEL	DC2-LAB10	
AUDIT	A-1	DRAWING: 1 of 1
SUPPLY	≥ +18 VDC	
CURRENT	Type 50 mA	
OTHER	For connection to CM-module	
B. Lindqvist	2005-07	

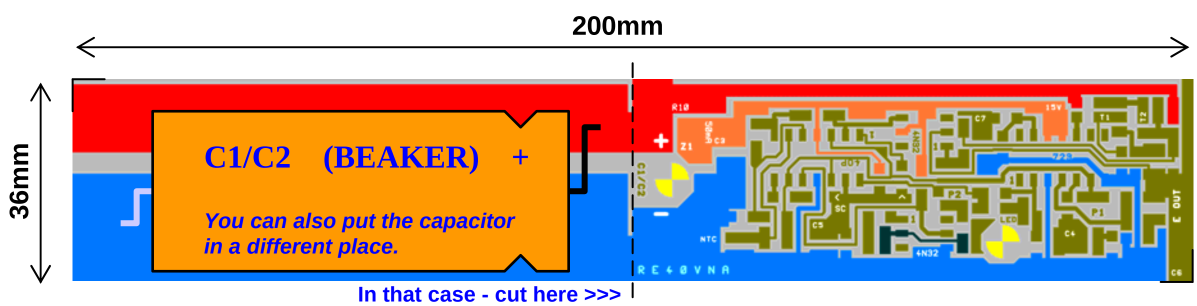
VOLTAGE POINTS AND INTERVALS

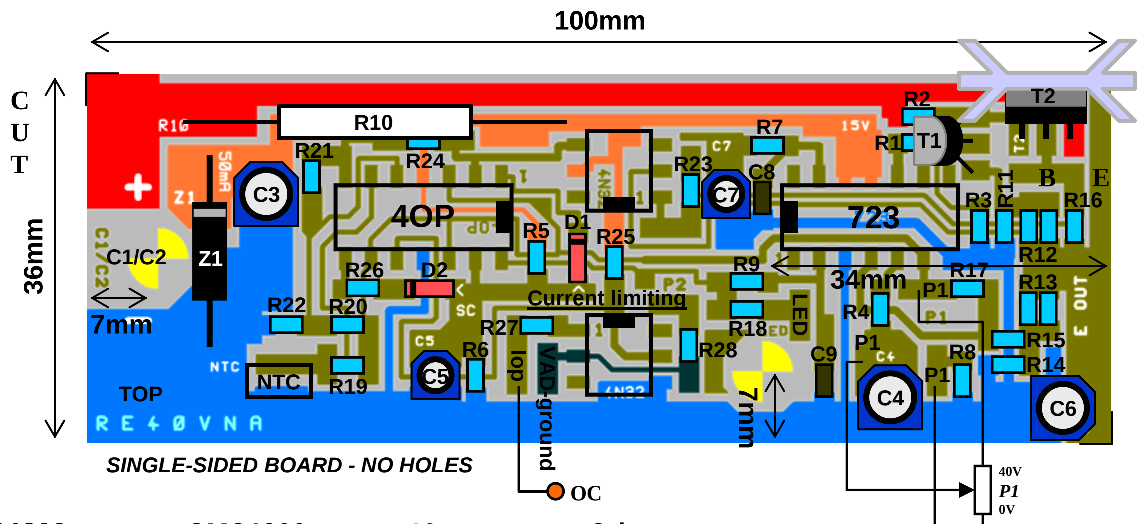






PLACING OF COMPONENTS





SMR1206:
R1 = 4k7
R2 = 2k2
R3 = 22k
R4 = 22k
R5 = 1M
R6 = 1M
R7 = 470Ω
R8 = 820Ω
R9 = 22k
R11 = 1k
R12 = 2 x 10k
R13 = 2 x 10k
R14 = 1k
R15 = 22k
R16 = 47Ω
R17 = 100k
R18 = 820Ω
R19 = 2k7
R20 = 100k
R21 = 1M
R22 = 100k
R23 = 10k
R24 = 100k
R25 = 100k
R26 = 100k
R27 = 470Ω
R28 = 2k2

0-40VDC (R12, R13)

≤8A (R23, R24)

(10A => R23 = 10k & R24 = 68k)

SMC1206:
C8 = 47n
C9 = 100n

IC:
723
LM224N
4N32

*NTC**	*R19*
15k	1k1
22k	1k6
33k	1k9
47k	2k7

** At 75°F*

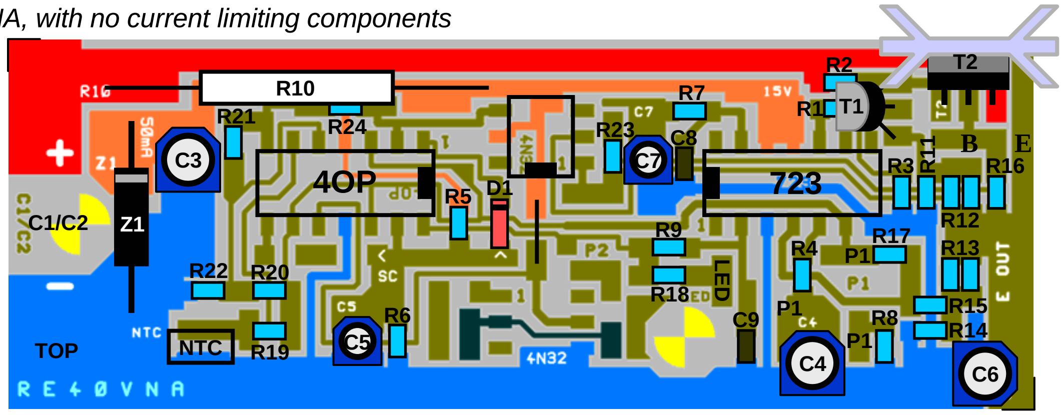
Other components:
R10 = Power resistor. See text!
Z1 = 1N5352B , 15V/5W , Hole mount
C1/C2 depends on TRAFO. See text!
C3 ≈ 220u/25V , E-lytic , SMD or h-mount
C4 ≈ 47u/25V , E-lytic , SMD or h-mount
C5 ≈ 2u2/25V , E-lytic , SMD or h-mount
C6 ≈ 47u/50V , E-lytic , SMD or h-mount
C7 ≈ 2u2/25V , E-lytic , SMD or h-mount
D1 & D2 = BAS32L/1N4148 , hole mount
T1 = BC546B , NPN , Hole mount
T2 = BDX34B , PNP , Power Darlington
T3 = 2N3773 , NPN , Power transistor
P1 = 4k7 , Linear , Panel mounted
P2 = 10k , Linear , Panel mounted
NTC-resistor = 47k at 75°F , Hole mount
LED = Red , 20mA

If there is an interruption from the NTC resistor will not the temp-protection work. At a high temperature on T3 will the car-fuse blown out.

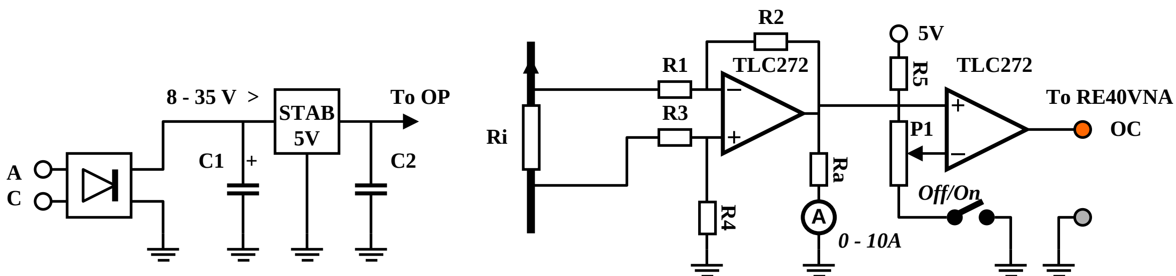
PROJECT	*Dual DC lab unit*	
MODULE	*RE40VNA*	
MODEL	**DC2-LAB10**	
AUDIT	A-1	**DRAWING: 1 of 1**
OTHER	*For VAD1/2 with current limiting*	
B. Lindqvist		*2005-07*

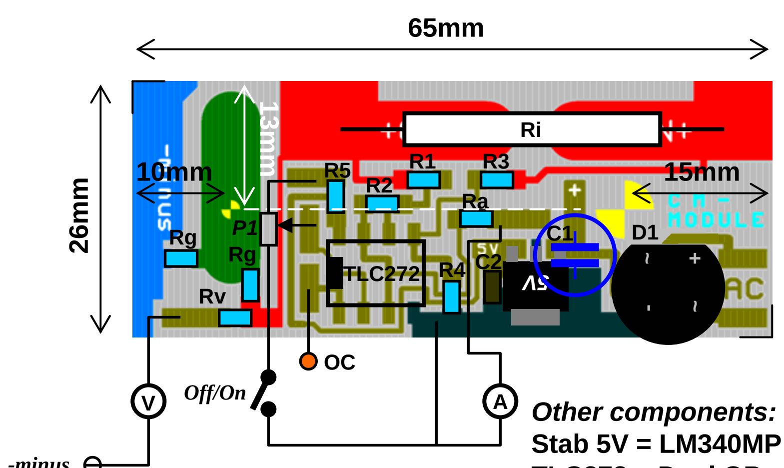
PLACING OF COMPONENTS AND CIRCUIT DIAGRAM

RE40VNA, with no current limiting components



<u>Current measurement and current limiting module</u>. **Can be used instead of the VAD which allows one to choose a low Ri. However, requires the CM-module an individual power supply from an available transformer output.**





SINGLE-SIDED BOARD - NO HOLES

Other components:

Stab 5V = LM340MP
TLC272 = Dual OP , Hole mount
C1 ≈ 100u , E-lytic , Hole mount
D1 = Capsulated rectifier bridge , h-mount
P1 = 1k , Linear , Panel mounted

SMR1206:
R1 = 47k
R2 = 1M
R3 = 47k
R4 = 1M
R5 = 10k
Rg ≥ 10M
Ra ~ 5k

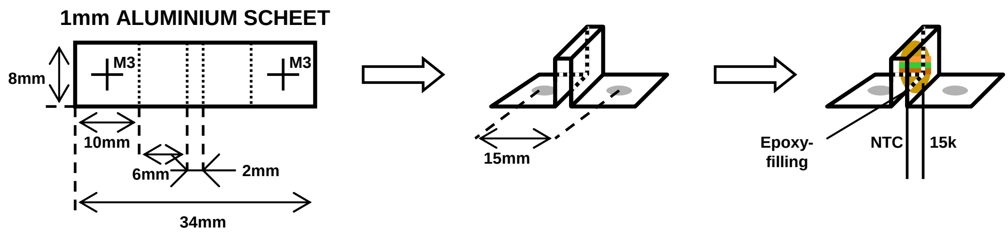
SMC1206:
C2 = 100n

IC:
TLC272

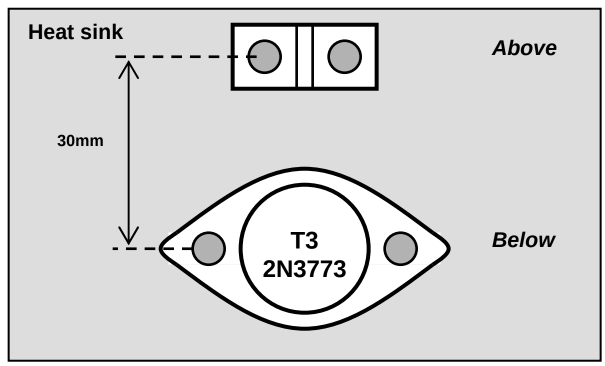
PROJECT	*Dual DC lab unit*	
MODULE	*CM*	
MODEL	**DC2-LAB10**	
AUDIT	A-1	**DRAWING: 1 of 1**
SUPPLY	≥ +5 VAC	
CURRENT	Type <10 mA	
OTHER	Diff.amplifier Current measure	
B. Lindqvist		*2005-07*

NTC-CAPSULE AND LINE FILTER

Temperature sensor



Mounting

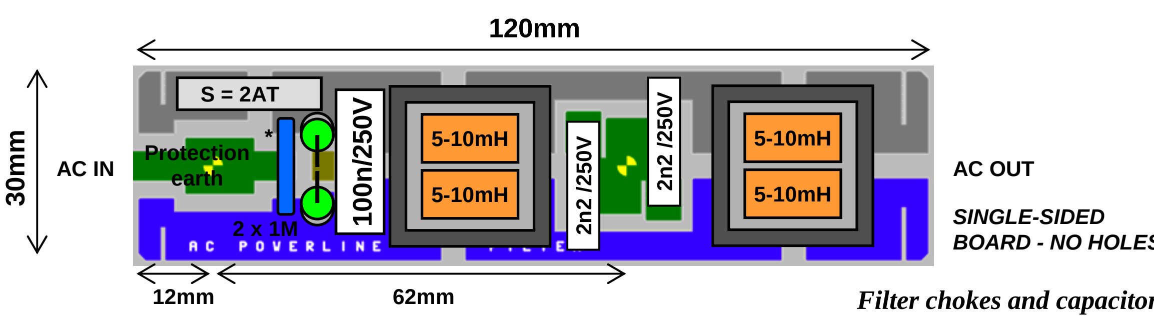


It is important that there is a smooth metal surface under the transistor. silicon grease/paste is a must! Add plenty, but wipe away the rest after the screws are tightened.

NOTE.
Tighten the screws firmly.

Line filter

Type 1:
According to previous schema plus some additional components.



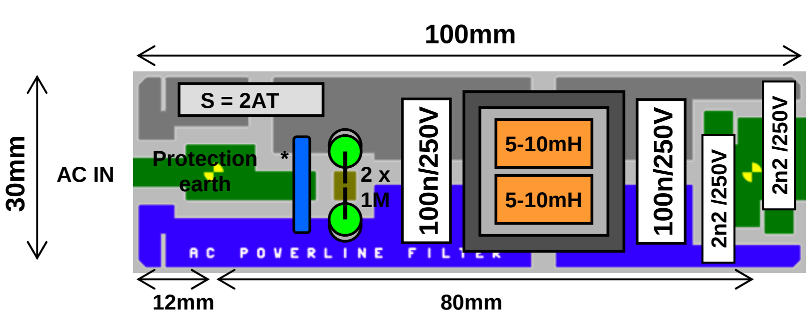
****Over voltage protection (VDR resistance), optional.***

Filter chokes and capacitors can be found in scrapped hi-fi or old TV sets. The component values are approximated guideline value.

Type 2:
A simpler version.

NOTE. The 1 M ohm resistors may not be of SMD-type

You can also wrap two of the coils on a ring core of ferrite or… acquire a brand new line filter.



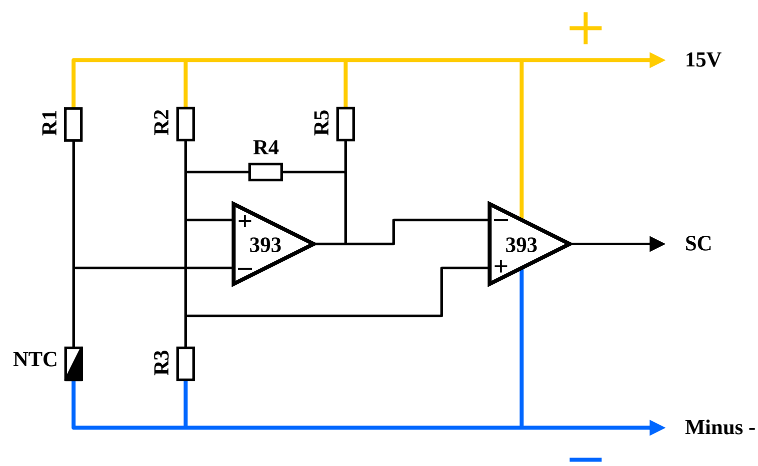
AC OUT

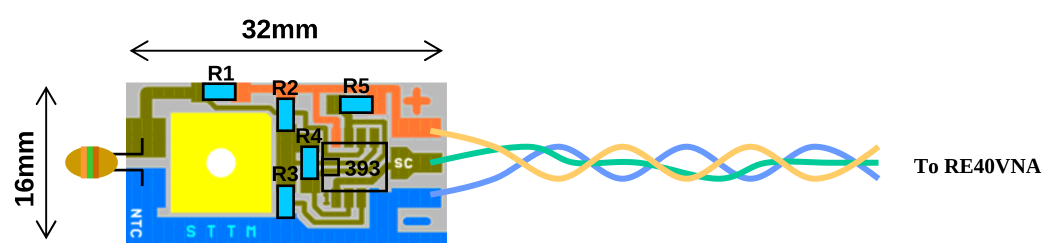
Single-sided board. The component assembly is done on the pattern side. Holes are drilled for ground screws. Spacers are unnecessary.

STT-MODULE - PLACING OF COMPONENTS AND CIRCUIT DIAGRAM

STT is a small module for to superintend a transformers temperature. In addition to the monitoring provide the module protection against overheating if the temperature rises above around 140-180°F. The module is compatible with RE40VNA but should be attached to the transformer near the top of the windings or onto the iron core. Then link totally, three twisted wires from RE40VNA to STT module. To STT is an NTC resistor (SMD or hole mounted).

STT stops the DC unit if the transformer's temperature becomes too high, but resets itself when the temperature has dropped again.





SINGLE-SIDED BOARD - NO HOLES

The NTC resistor can either be a hole mounted or SMD. The value can be chosen quite arbitrarily, between 10 - 100 kilo.

**** At 75°F***

*NTC**	*R1*
10k	2k7
15k	3k9
22k	5k6
33k	8k2
47k	10k
68k	15k
100k	22k
150k	33k

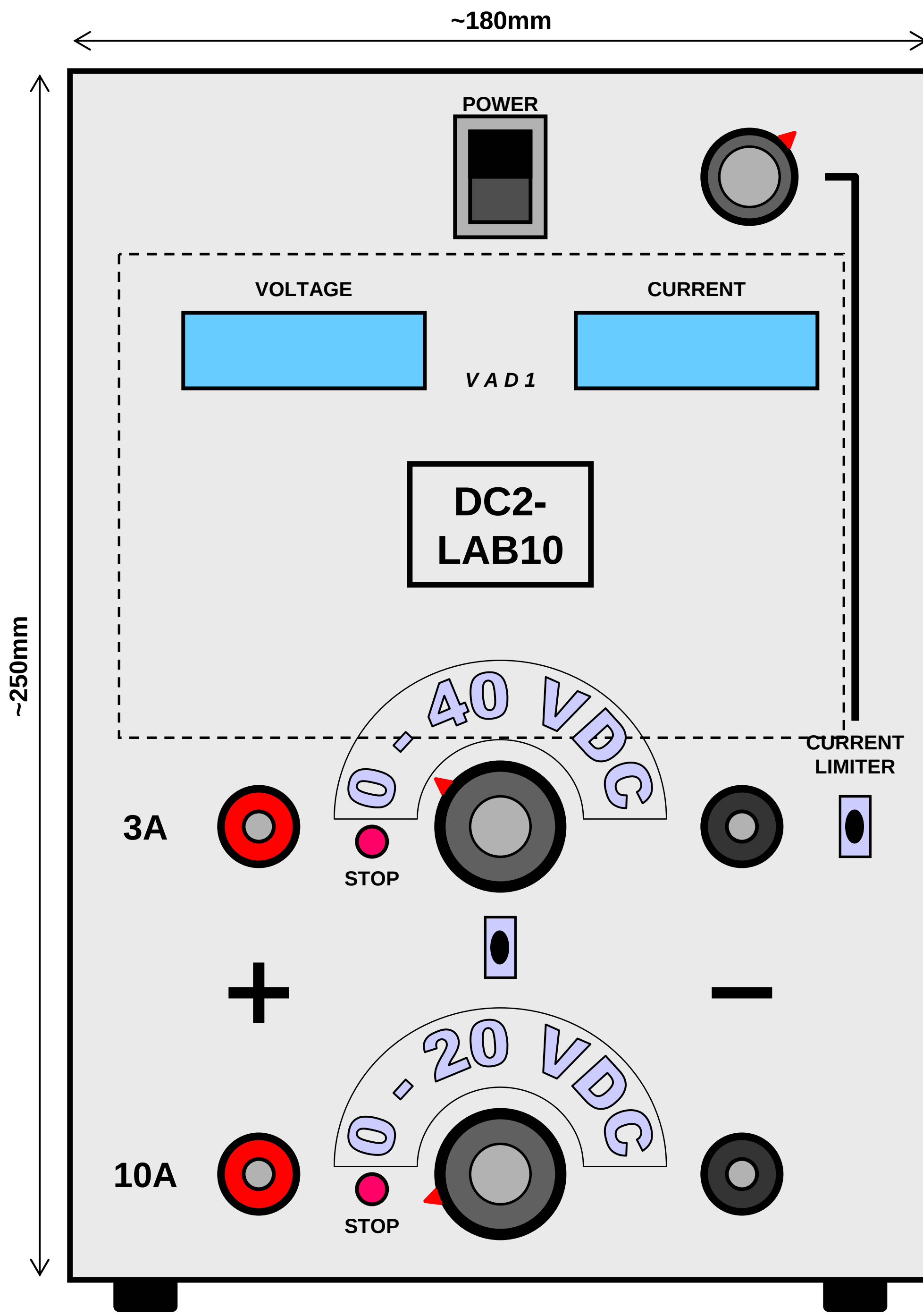
SMR1206:
R1 = 10k for NTC=47k
R2 = 100k
R3 = 100k
R4 = 1M
R5 = 10k

IC:
LM393 , SMD

PROJECT	*Dual DC lab unit*	
MODULE	*STT*	
MODEL	**DC2-LAB10**	
AUDIT	A-1	**DRAWING: 1 of 1**
SUPPLY	5 - 36 VDC	
CURRENT	Type 5 mA	
OTHER	Superintend of transformer	
B. Lindqvist		*2011-12*

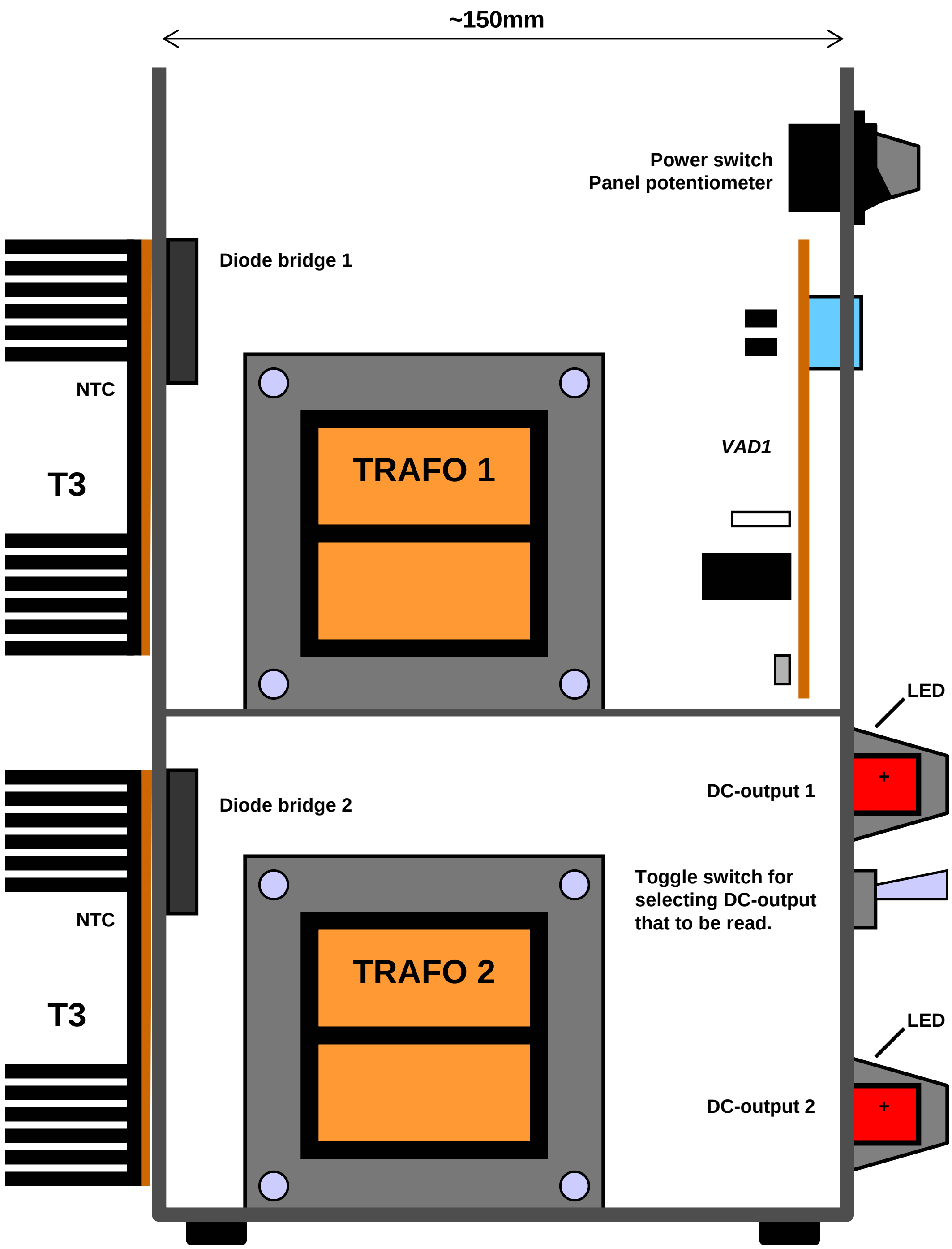
FRONT (PRINCIPLE)

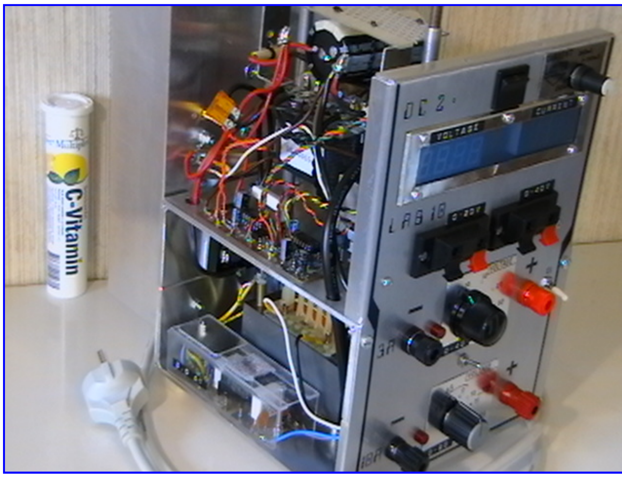
This is the basic design for the front of DC2-LAB10. Here are VAD1 selected along with other panel details. The dimensions should be interpreted as guidelines. You can certainly arrange it all in a different way.

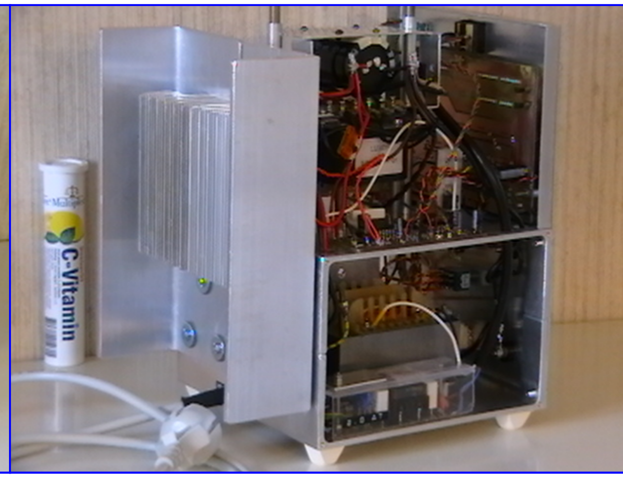


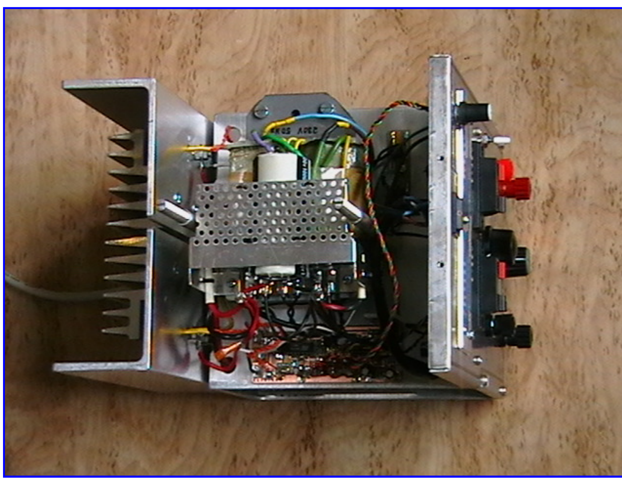
FROM THE SIDE (PRINCIPLE)

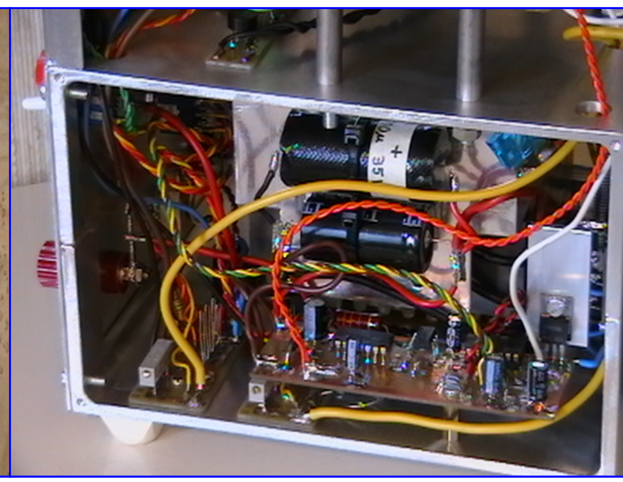
This side view shows that one can use a U-shaped plate as a basic frame. The two DC units are located on different floors. Note that there is much that is missing in the picture. Line filter (1), RE (2), L-circuit (2), Smoothing capacitors (≥2), STAB8V for VAD plus a lot of wiring. The toggle switch (one must have) to select which DC output that is visually active, must be a three-pole type. It is thus the wiring to the L-circuit that need to pass this switch. The heat sinks shall not be located as shown. They shall be rotated 90° for for optimum air flow! One can also place the heat sink next to each other, instead of above and below.

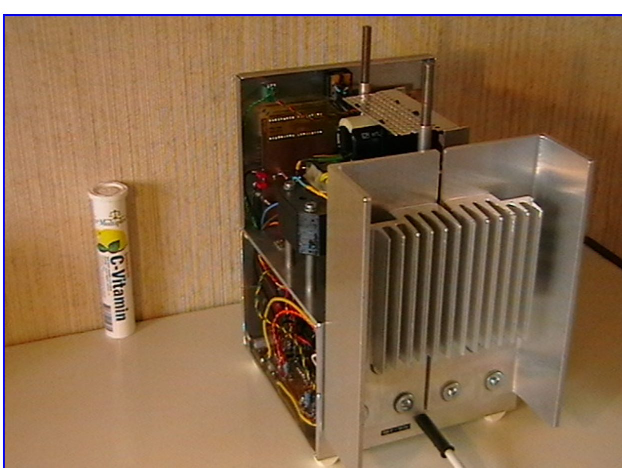



C-Vitamin
LAB 18


C-Vitamin






C-Vitamin


DC 2
VOLTAGE
CURRENT
12.0
00.0
LAB 18
C-Vitamin