HIGH-VOLTAGE STABILIZER WITH A WIDE RANGE OF OUTPUT VOLTAGE REGULATION

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PROJECT

Actually, I am not a fan of publishing all sorts of projects and unverified solutions, but repeated requests from site visitors and the fact that stabilizers with similar circuit solutions work safely in different devices led to this article. About a year ago, I needed such a stabilizer, I designed it and tested some circuit solutions, but due to lack of time I never turned it into a finished product, having got out with improvised means. We will consider the scheme of this stabilizer further, naturally, I cannot guarantee that everything will work well after its assembly, you may have to tinker. I estimate the probability of the absence of all sorts of problems in the operation of the stabilizer at 0.95, but this is far from 1, so I do not advise people who do not have sufficient theoretical training to repeat this scheme.

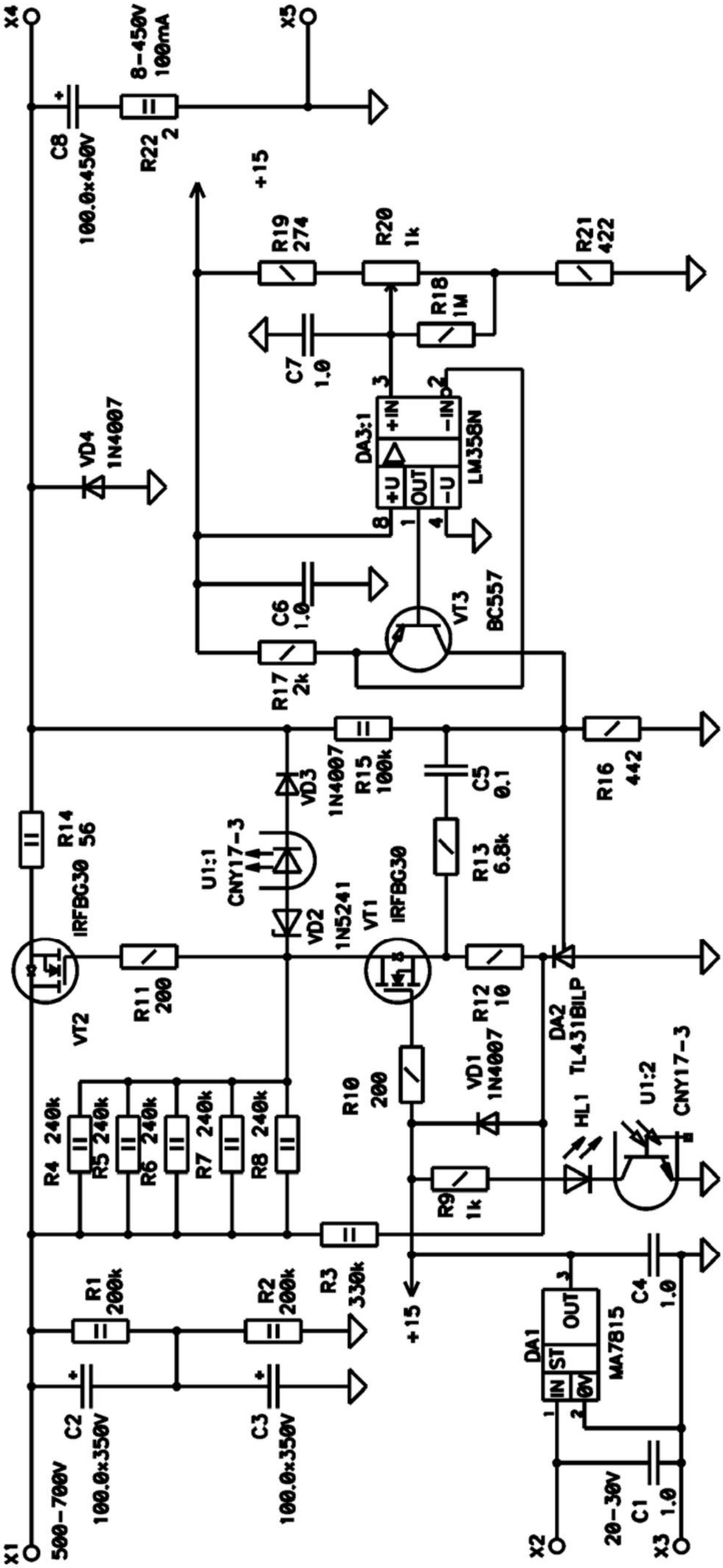
Stabilizer circuit The

expected parameters of the stabilizer are as follows:

Output voltage regulation range	8÷450V
Maximum load current	100mA
Threshold of current protection operation	130÷150mA
Output voltage ripple level	50÷70mV
Main power supply voltage	500÷700V
Auxiliary power supply voltage	18÷30V

The complete circuit of the stabilizer is shown in the figure below, as you can see, its circuit is in many ways similar to the circuit of the stabilizer described in the article [1]. The article described in sufficient detail both the operation of the stabilizer itself and the protection circuit. Therefore, I will not repeat myself, but will dwell in more detail on the differences between the circuits, which appeared due to the need for deep regulation of the output voltage (I will try to use the same terminology as in the article mentioned above).

- An auxiliary power supply (DA1) has been introduced to ensure the normal operation of the auxiliary circuits.
- The second input of our conditional cascode amplifier (gate VT1) has lost connection with the input voltage and is receiving a fixed bias from the auxiliary source. This is due to the fact that it is difficult to obtain a transfer coefficient close to the optimal direct connection in our case.
- To reduce the power dissipation on VT1, R4÷R8 and ensure the regime current of the DA2 microcircuit, a resistor R3 is introduced. The fact is that with a deep adjustment of the output voltage, the current through VT1 varies over a wide range. If you choose the value of R4÷R8, based on obtaining the minimum operating current at the maximum output voltage, then at low output voltages, an unreasonably large power will be dissipated on the elements. An additional boost current avoids this. This current does not affect the operation of the stabilizer, since, compared with the dynamic resistance of the microcircuit, the resistor R3 is very large. In fact, it can be regarded as the ideal current source.
- To regulate the output voltage, the method of injecting additional current into the output voltage divider circuit (R15, R16) was used. A simple change in the ratio of the divider with such a wide range of regulation leads both to the problems of implementing the voltage divider itself, and to problems with the stability of the stabilizer. An additional current is injected into the divider circuit using a current source implemented on the DA3 chip and the VT3 transistor. With this method of regulation, the loop gain of the stabilizer and its frequency characteristics do not change. The output voltage is set by resistor R20, which sets the output current of the current source.
- A circuit (U1, HL1) has been added to the stabilizer protection circuit, indicating the fact of stabilizer overload.


X4
X5
8-450V
100mA
C8
100.0x450V
R22
2
+15
R19
274
R20
1k
R21
422
R18
1M
C7
1.0
VD4
1N4007
DA3:1
+IN
-IN
+U
OUT
-U
LM358N
C6
1.0
VT3
BC557
R17
2k
R15
100k
R16
442
C5
0.1
VD3
1N4007
R14
56
U1:1
CNY17-3
R13
6.8k
IRFBG30
VD2
1N5241
VT1
IRFBG30
VT2
R11
200
R12
10
DA2
TL431BILP
VD1
1N4007
R10
200
U1:2
CNY17-3
HL1
R4 240k
R5 240k
R6 240k
R7 240k
R8 240k
R9
1k
R1
200k
R2
200k
R3
330k
+15
C4
1.0
DA1
IN
ST
OUT
0V
MA7815
C2
100.0x350V
C3
100.0x350V
X1
500-700V
X2
20-30V
C1
1.0
X3

What you need to pay attention to and what to think about First of all, I want to remind readers that there are quite high voltages in the stabilizer, and a source with a voltage of 600 ÷ 700 volts and a maximum current of several hundred milliamps is no longer a joke. Be extremely careful. Accordingly, this must be taken into account when installing and selecting components (including wires). It is necessary to ensure efficient heat removal from

transistors VT1, VT2 (both transistors can be installed on one heat sink). On the transistor VT2 in the short circuit mode or low output voltage, power of the order of 120 watts can be dissipated. A good solution would be to use a heat sink from modern processors (complete with a fan) Mounting the stabilizer should be compact, resistors R10, R11 should be in

close proximity to transistors.

Resistors R15÷R17, R19÷R22 must be accurate and stable. Finding a precision resistor for high voltage and high power (R15) can be problematic, it makes sense to compose this resistor from several low-power precision resistors, including them sequentially.

The variable resistor R20 must have a high electrical resolution; it will not be possible to obtain an acceptable smoothness of output voltage adjustment with a single-turn resistor. Resistors of types SP5-35, SP5-39, SP5-40, SP5-44 are well suited. Zener diodes of the KS2xx type cannot be used as a VD2 zener diode. With

these zener diodes, the protection circuit will not work normally. Consideration should be given to improving the stabilizer protection system. First of all, it is

designed to protect the stabilizer itself, and its operation in the current source mode is very conditional. Therefore, from the point of view of protecting the load, it is of little use. Perhaps it makes sense, by changing the value of the resistor R14, to introduce several current limiting thresholds, and also to supplement the stabilizer with a device for forced shutdown in case of overload (with a delay of 0.3 ÷ 0.5 seconds).

Particular attention should be paid to the stability of the stabilizer, it may be necessary to change the parameters of the corrective chain (R13, C5). It is difficult to give any specific recommendations in case of excitation of the scheme; here you must rely solely on your knowledge and experience. A good help for solving such problems is circuit simulation in the Micro-Cap environment. The stability of the stabilizer should be checked over the entire range of output voltages and at several load values.

Conclusion

Well, I'll wait for the final conclusions from the daredevils who dared to implement this scheme and bring it to mind. And with pleasure I will give them the opportunity to express their views on the pages of the site.

Literature

1. Karpov E. V. A simple high-voltage stabilizer, Internet edition, 2003.