Circuit suggestions for T-Reg

T-Reg ('A High-voltage Regulator for Valve Amps'), Elektor March 2009, article # 081089-I)

Dear Editor -- I read the T-Reg article with considerable interest, and I tried out the circuit right away. However, I replaced the two SC2910s and the two SA1208s with BF422s and BC327s, since the specified types are difficult to obtain in my country.
The basic principle of this regulator is certainly clever, and the stabilisation characteristics of the circuit are very good. However, I simply could not manage to make the circuit work with a normal MOSFET (such as the BUZ42 or BUZ90) instead of a valve as the pass regulator. There was absolutely nothing to be seen at the output of the circuit.
I found this rather puzzling, but a bit of study of the theory clarified the situation. A valve is controlled by a grid voltage that is negative relative to the cathode, but a normal MOSFET only responds to a gate voltage that is positive relative to the source (which takes the place of the cathode).
The T-Reg circuit is designed such that the voltage on the grid (or gate) can never be positive relative to the voltage on the cathode (or source). Accordingly, I began to have some slight doubt that the author actually managed to get the circuit to operate properly with a MOSFET. Perhaps the type of MOSFET used in the author's design (a DN2540) actually has control characteristics similar to those of a valve. If that is so, it would be a service to the reader to point this out, since many readers are inclined to use better known or commonly available components in place of rare or uncommon components.

A second criticism is the complexity of the circuit relative to what it does. I spent a bit of time developing a simplified circuit design based on the operating principle of the control amplifier (differential amplifier) used in the T-Reg, with the reference voltage provided by a pair of Zener diodes. The results of this effort are enclosed. The specified component values are chosen for an output voltage of 300 V.
This design has the following advantages relative to the T-Reg design:

1. Reduced circuit complexity and component count
2. No need for a second supply voltage
3. Comparable regulation performance, and in some regards even better (such as dynamic load regulation)
4. Use of commonly available components

It is actually possible to use any desired type of component with any desired power rating as the pass regulator. In addition to being quite amenable in this regard, the circuit can be built reliably by others.
However, there is also a significant disadvantage. With the T-Reg design, the stabilised output voltage can be adjusted relatively easily by changing the value of resistor R3. It can thus be used without overly much effort to build a bench supply for a hobby lab with an adjustable output voltage, which is admirable. By contrast, my proposed design has a fixed output voltage, although the actual the output voltage can be set over a wide range by selecting Zener diodes with suitable values.
If I have aroused your interest in this circuit, on your request I would be pleased to provide a detailed circuit description and a table of component values for some commonly used voltages (200 V, 250 V, and 300 V).

Please allow me to make two additional remarks.
In my opinion, the question as to whether delayed switch-on of the anode voltage (as suggested by the author of the T-Reg article) is worthwhile with a valve amplifier is more of an academic question than a matter of practical benefit. I am not aware of any scientific or engineering treatise according to which it can be concluded that there are any significant disadvantages associated with applying the anode voltage without delay while the filaments are warming up.
I am not aware of any circuit from the golden era of valves that has delayed anode voltage switch-on.
The article in question also brings up another issue. To the dismay of users, authors often make use of unusual ('rare') components that cannot be found in regional electronics shops or in the stock lists of the usual postal order merchants. For future issues of Elektor, I would like to see authors mention alternative components (substitutes) in cases where they feel compelled to use uncommon components.

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We regard your comments as sufficiently interesting to publish them here. On request, we would be pleased to post the table of component values on the web page for the Mailbox section of this issue (www.elektor.com/090919).
The T-Reg circuit does indeed work as described; after all, it was replicated and tested in the Elektor labs. The DN2540 MOSFET is what is called a depletion-mode MOSFET, which conducts with zero gate voltage. A negative gate voltage must be applied to this type of MOSFET to cut off the current, in which regard it does in fact behave the same way as a valve. It would have been a good idea to mention this in the article.
However, this is a good example of the fact that in most cases designers use special or unusual components due to their specific characteristics. Consequently, it is often not possible to specify other components as alternatives or substitutes, since other components do not have these specific characteristics. Also, not everyone lives in the same country and may disagree with you on what's an 'unusual' component or a 'common' one.
Delayed switch-on of the anode voltage unquestionably has the advantage that the anode current can flow immediately after the voltage is applied. This direct application of the load to the power supply prevents the voltage on the filter or smoothing capacitors from rising to the much higher no-load value. As the anode voltage is usually not regulated, this would otherwise occur while the filaments were warming up. You may have missed that practically all equipment from the 'golden era of valves' as you call it does have delayed switch-on of the HT rail — simply through the use of a valve rectifier.
Another advantage of delayed HT is that the

voltage stress on the electrolytic capacitors is reduced. Of course, this is only true if the switch contact for delayed switch-on of the anode voltage is located ahead of these capacitors. This is not the case with the T-Reg circuit, so it is not a consideration here.

A short literature study and some digging in the Philips Technical Review archive gives evidence that valves benefit from a reduced load on the cathodes during the warm-up phase (for example) by the fact that anode voltage switch-on is delayed during the warm-up phase in lots of Philips' professional valve circuits. However, we are confident that some of our readers will have more to say about this and may be able to provide references. As usual, knowledgeable information is always welcome.

R1,R2,R3 component values		
	Valve	***MOSFET***
U_E	*350 V*	*250 V*
R1	*100 kΩ*	*10 kΩ*
R2	*1 kΩ*	*100 Ω*
R3	*1 MΩ*	*180 kΩ*