MEC-50, MEC-100 and MEC-200

Mini Electronic Chokes
for valve amplifiers
with 50 or 100 or 200 mA current capability

user manual

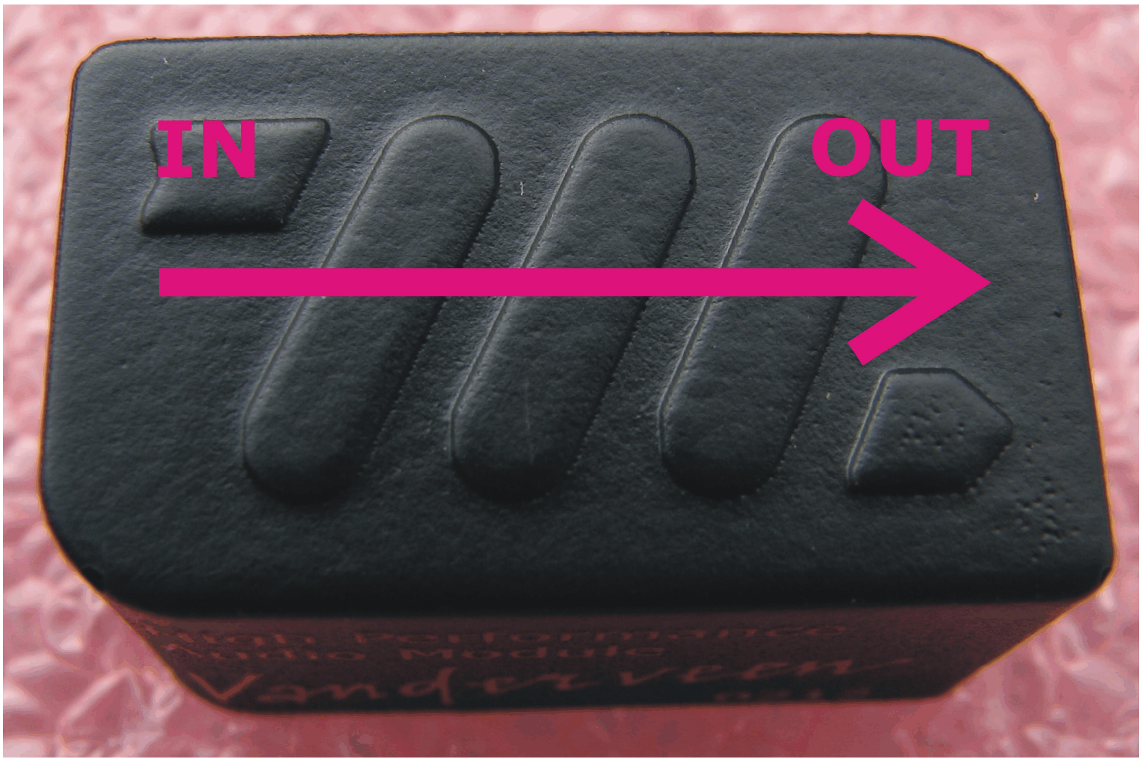
version UK 1-6
date 06-02-2020

See for more info:
www.mennovanderveen.nl
www.tentlabs.com

1- Introduction

In the power supply of valve amplifiers we have noticed that chokes suppress hum and noise better than the standard configuration with capacitors plus resistor. Chokes sound softer and milder, you can hear more details in the sound stage. This observation was the reason why ir. bureau Vanderveen and Tentlabs decided to develop new miniature electronic chokes for valve pre amplifiers and small power amplifiers.

The MEC-50 and MEC-100 and MEC-200 are very small electronic chokes which remove hum and distortions from the high voltage supply lines in valve amplifiers. The MEC-50 can handle 50 mA maximum while the MEC-100 can handle 100 mA and the MEC-200 can handle 200 mA.
The maximum high supply voltage should be below 800 Vdc.



There is an arrow on the MEC's indicating the direction of current flow. Reverse connection does not damage the MEC's; at the output the high voltage will be present. However, without the reduction of hum.

See the schematic below for a standard application.

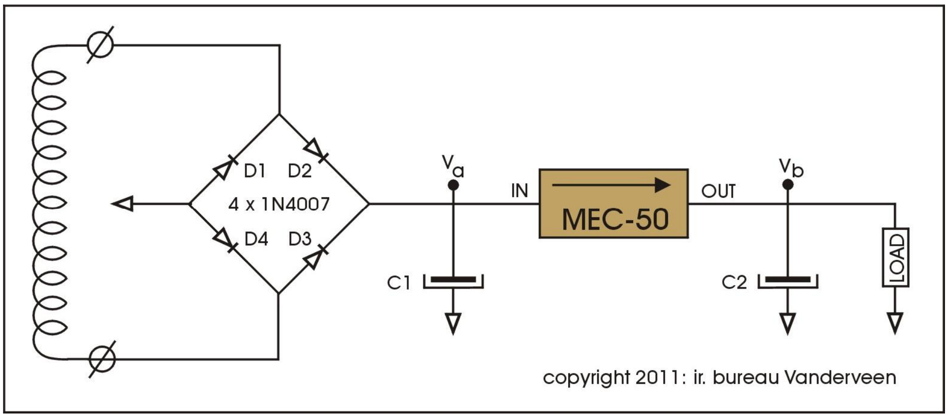


figure 1: connections on the MEC + current direction arrow

The MEC-50 is meant for pre amplifier and driver stages while the MEC-100 is designed for small class A SE amplifiers with the 300B or 2A3 or EL84 power valves as examples. Small push-pull power amplifiers with maximum current demand below 100 mA are also possible, like 2 x EL84 or 2 x ECL86. For currents larger than 100 mA we earlier designed the E-choke and recently added in 2020 the new MEC-200.

The MEC's have only two taps: their input and output. There is no connection to ground. They fit in the standard pi-circuit, where after rectification the supply voltage is buffered in C1, followed by the MEC and next C2. This application is as with standard chokes. However, the MEC's are much smaller than standard transformer core based chokes. They have no magnetic leakage fields and they do not hum or rattle. Besides these important advantages, they reject noise and hum much better than with old fashioned chokes. The hum rejection equals a factor 1000 with the MEC-50 and a factor 250 with the MEC-100 and MEC-200. Read the specs for more detailed information.

In function the MEC's produce little heat. Some air flow cooling is enough to remove this heat.

The effective inductance of the MEC-50 equals 78 H, for the MEC-100 and MEC-200 it is 10 H. These large inductances suppress hum and interference signals with a factor of 1000 (60 dB) and a factor of 250 (48 dB) respectively.

See figure-2 for C1 = C2 = 47 μF and I = 48 mA. The upper curve shows the voltage ripple at C1 while the lower proves the reduction at C2. At higher frequencies the ripple becomes smaller than the noise floor (-140dBV) of the measurement equipment.

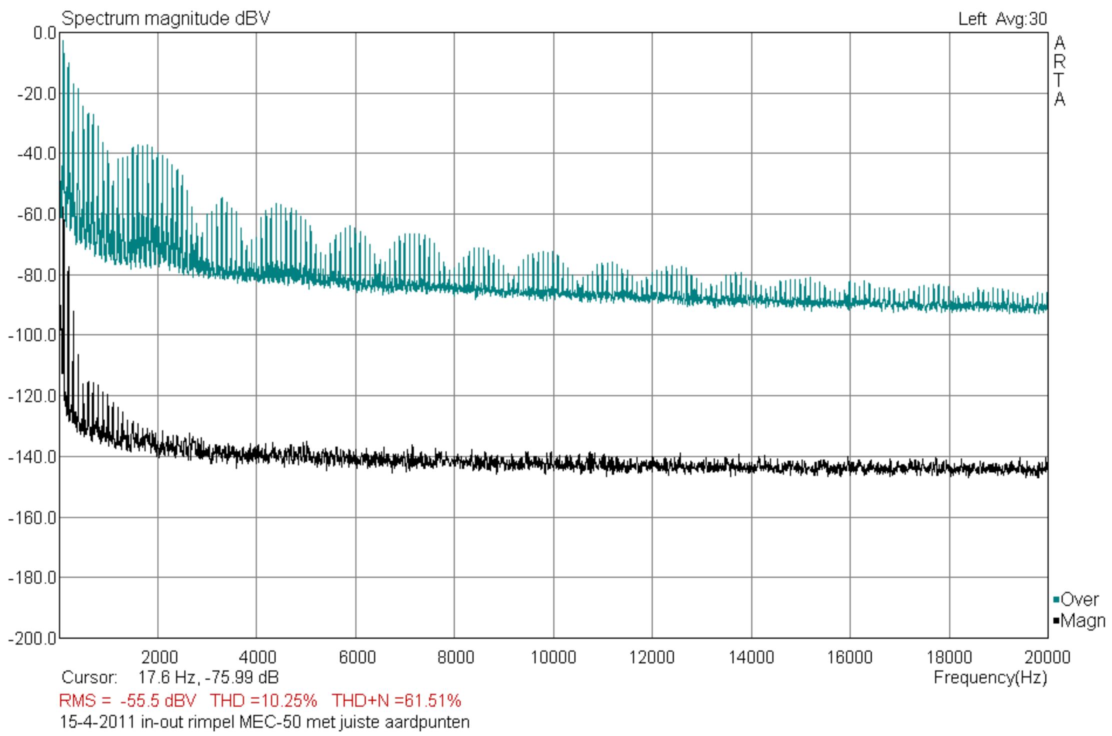


figure 2: input (upper curve) and output (lower curve) ripple voltages.
The reduction is at least a factor 1000 for the MEC-50

The MEC's are designed for so called C-L-C supplies and not for L-C supplies. Neither they are meant for transformer anode load applications.

2- Application

Figure 3 shows the first application of the E-choke plus MEC's in the Vanderveen UL40-S2 valve amplifier.

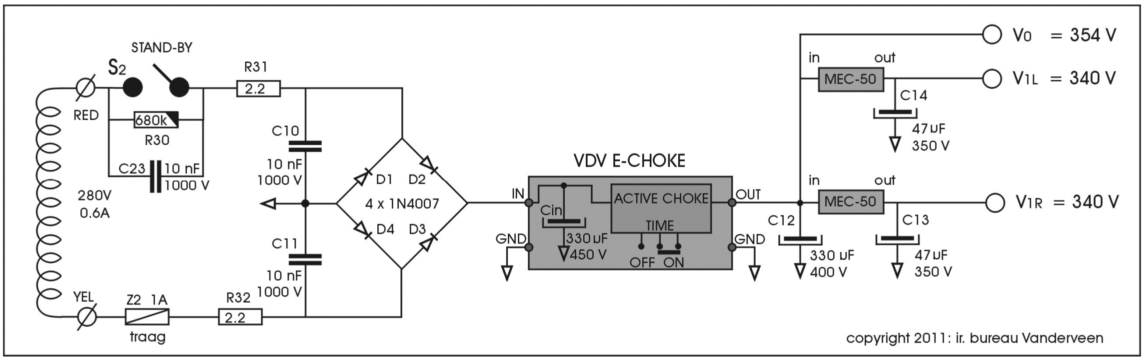


figure 3: E-choke and MEC in the UL40-S2 amplifier.

Figure 4 explains how to apply the MEC-50 in the Vanderveen MVML05 pre amplifier.

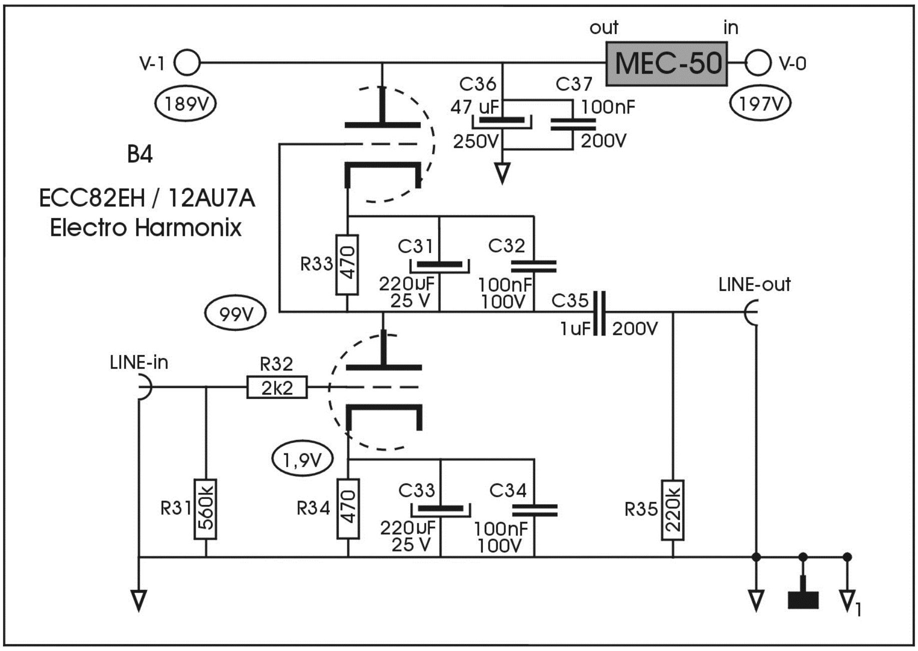
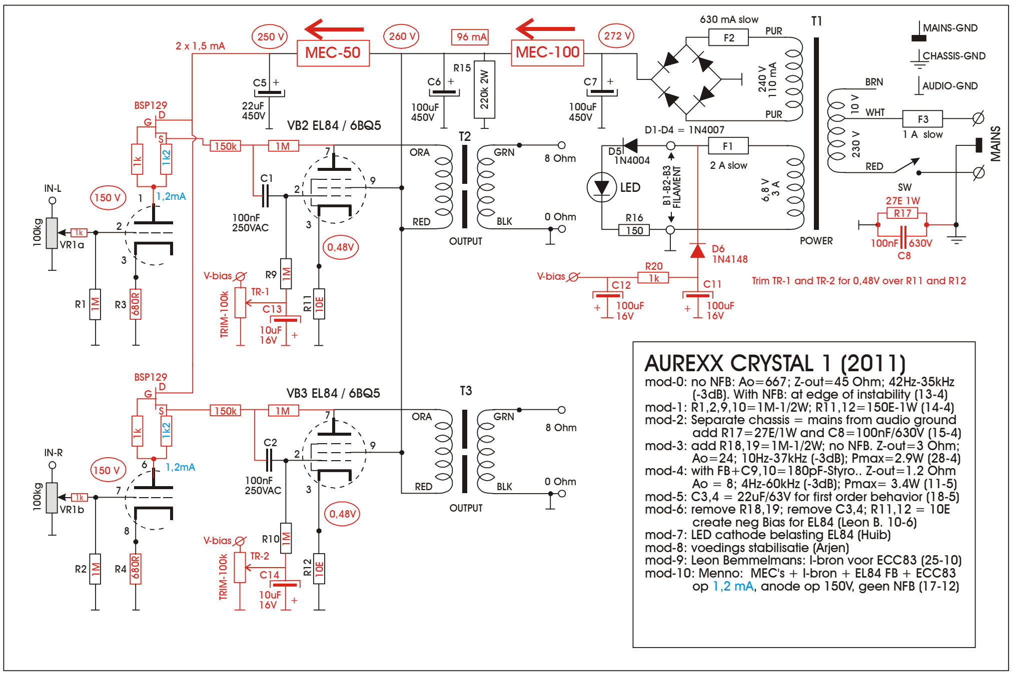


figure 4: MEC-50 in the MCML05 pre amplifier

All that changed is that the C-R-C network has been replaced by a far more effective C-MEC-C pi-filter network with much larger hum suppression.



Application of the MEC's in the Aurexx Crystal 1 TubeSociety 2011 project.

3- Maximum Specifications

The table below shows the important specifications and limits.

Item	MEC-50	MEC-100	MEC-200	Unit
maximum current	50	100	200	mA
maximum Vdc	800	800	800	V
internal limit for I larger than	68	no	no	mA
inductance	78	10	10	H
maximum voltage drop @ Imax	12	9	15	V
short circuit protection	no	no	no	(1)
protected for inverse connection	yes	yes	yes	
maximum heat production	0,7	0,9	4,2	W (3)
minimum capacity C1	27	47	100	μF (2)
optimal capacity C1 = C2	47	100	220	μF
dimensions (l-d-h)	27-16-15	27-16-15	27-16-15	mm
pin distance	14.2/.56"	14.2/.56"	14.2/.56″	mm/"
pin length	9	9	9	mm
pin diameter	1.0	1.0	1.0	mm
mass	12	12	12	gram

(1): Charging C2 too fast can be interpreted as short circuiting the output of the MEC. Therefore guarantee slow charging of C2 to prefend such a condition.
(2): See chapter 4 for detailed information.
(3): MEC-200 maximum temperature is 52 ^{o}C; air cooling is sufficient.

4- Selecting C1 and C2

After rectification the high voltage is buffered in C1 to bring the ripple voltage magnitude in the working area of the MEC.

The best choice is to make C1 and C2 equally large. For a current of 50 mA C1 = C2 = 47 μF is the optimal capacity. For currents I smaller than 50 mA you can select C1 = C2 = I (C1=C2 in μF, with I in [mA]). Example: I = 10 mA, then C1 = C2 = 10 μF.

The MEC-100 behaves equally with C1 = C2 = 100 μF and for I smaller than 100 mA: C1 = C2 = I (C1=C2 in μF, with I in [mA])

The MEC-200 behaves equally with C1 = C2 = 200 μF and for I smaller than 200 mA: C1 = C2 = I (C1=C2 in μF, with I in [mA])

Under certain current demand and values of C1 and C2, a kind of switching on resonance might occur, as shown in figure 5.

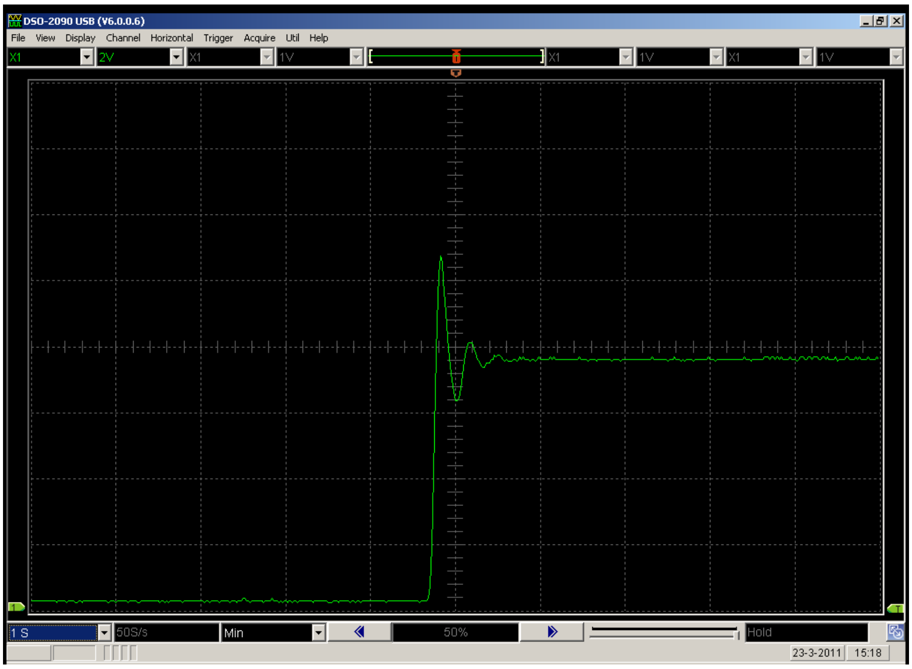


figure 5: time behavior MEC is not optimal tuned.

To compensate for this, apply an extra resistor at the input or output of the MEC. This resistance of the extra damping resistor easily can be determined by experiment. Try 10, 47, 100 or 220 Ohm to determine with the oscilloscope the right damping effect.

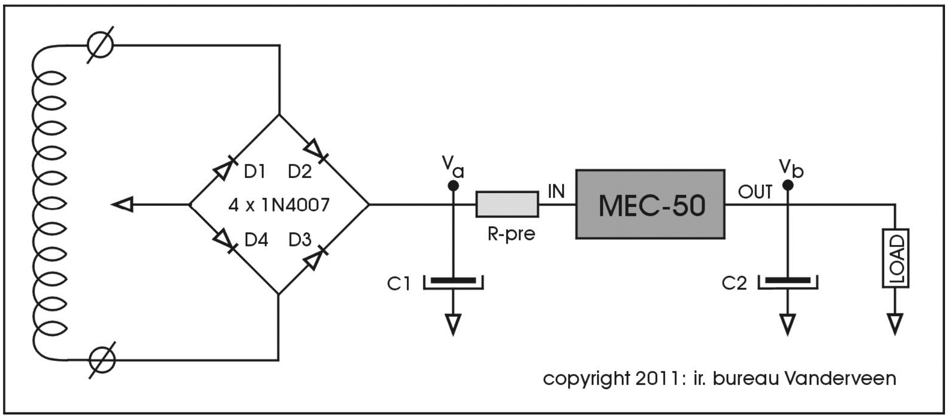


figure 6: how to connect a damping resistor (can also be at the MEC output).

5- Safety and helpful application remarks

a) Hum reduction (measured up to 1 kHz) a factor of 1000 (MEC-50) and a factor of 250 (MEC-100 and MEC-200)
b) Voltage drop 12 V (Mec-50) and 9 V (MEC-100) and 15 V (MEC-200)
c) Use C1=C2=47 μF as optimal capacitors for the MEC-50
Use C1=C2=100 μF as optimal capacitors for the MEC-100
Use C1=C2=220 μF as optimal capacitors for the MEC-200
d) For smaller I, apply C1=C2=I (C1=C2 in μF, I in [mA], MEC-50)
e) For smaller I, apply C1=C2=I (C1=C2 in μF, I in [mA], MEC-100).
f) For smaller I, apply C1=C2= I (C1=C2 in μF, I in [mA], MEC-200).
g) The MEC's are designed for class A amplifiers with constant current demand. C-L-C oscillations as calculated with "PSU designer II) occur, however, they dampen much faster than calculated. If problematic, apply a series resistor.
h) $V_{in,max}$ + ripple <= 800 V_{DC}. Charge C1,2 slowly at such high voltages, for instance by means of a valve rectifier.
i) The MEC's are <u>not protected for shortcut outputs</u>
j) The MEC's are protected for inversed connection. However, then the hum reduction does not function.
k) The MEC's are not designed as inductive anode load, nor for so called L-C application without C1, because the input voltage ripple should be rather small (< 10 Vpp) to stay inside the SOA of the MEC's.

6- Subjective observations

Applying the MEC's has a profound influence. Hum is absent, even with your ears close to the loudspeakers. The measurements show an impressive hum reduction over a wide frequency range. This largely reduces mains intermodulation interference with audio signals, and consequently the sound character is much friendlier. As an example, in the piano you now can hear and follow the sounds much longer and deeper. Without the MEC you were not able to hear down to such a micro detail level, as if a curtain was between you and the piano. The higher harmonic components of instrument tones are separately recognizable. Much more details can be heard, even the CD starts to sound mild, because no digital disturbance is found on the mains high voltage supply lines. The music sounds more dynamic with the MEC, even low tones sound stronger and better controlled.

In summary: the sounds are cleaner and clearer, with much more natural warmth.

The producers: Guido Tent (L) and Menno van der Veen (R)

For more information:

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7- Appendix: Comparing the MEC-50 with C-R-C filters

Suppose the mains frequency f = 50 [Hz] and a current demand equals I [A]. Then the voltage ripple V_a (see figure 1, peak to peak value) is given by:

$$V_a = \frac{I}{(2 \cdot n \cdot f \cdot C_1)}$$

where n=1 for single and n-2 for double sided rectification (like in figure 1).

Suppose the inductance of the MEC equals **L**, then the peak to peak ripple voltage V_b over C2 is given by the next formula:

$$V_b = \left(\frac{0.7}{4 \cdot \pi^2}\right) \cdot \frac{I}{(2^3 \cdot f^3 \cdot L \cdot C_1 \cdot C_2)}$$

Our measurements showed that V_b is a factor 1000 smaller than V_a. When we calculate V_a/V_b, we find (for n=2):

$$\frac{V_a}{V_b} = \frac{(4 \cdot \pi^2 \cdot 2 \cdot f^2 \cdot C_2 \cdot L)}{0.7}$$

Using $C_1 = C_2 = 47\ \mu F$ and f = 50Hz, we find L = 78 H.

Now imagine, we remove our MEC and replace it by a standard resistor **R**, and we wish the same ripple rejection as in the example above. How large should R be, how much heat in R and how much voltage drop would occur? Now we use a so called C-R-C network, and there the ripple ratio is given by:

$$\frac{V_a}{V_{b,R}} = \frac{(2 \cdot \pi^2 \cdot f \cdot R \cdot C_2)}{0.7}$$

Lets apply $V_a/V_{b,R}$ = 1000, then we find R = 15,1 kOhm. At 50 mA the voltage drop over R equals 755 V and the heat inside R is 38 Watt.

Must we say more? The MEC loses 9 to 15 V maximum with little internal heat; far more better than the C-R-C solution as discussed above, which proves our case.