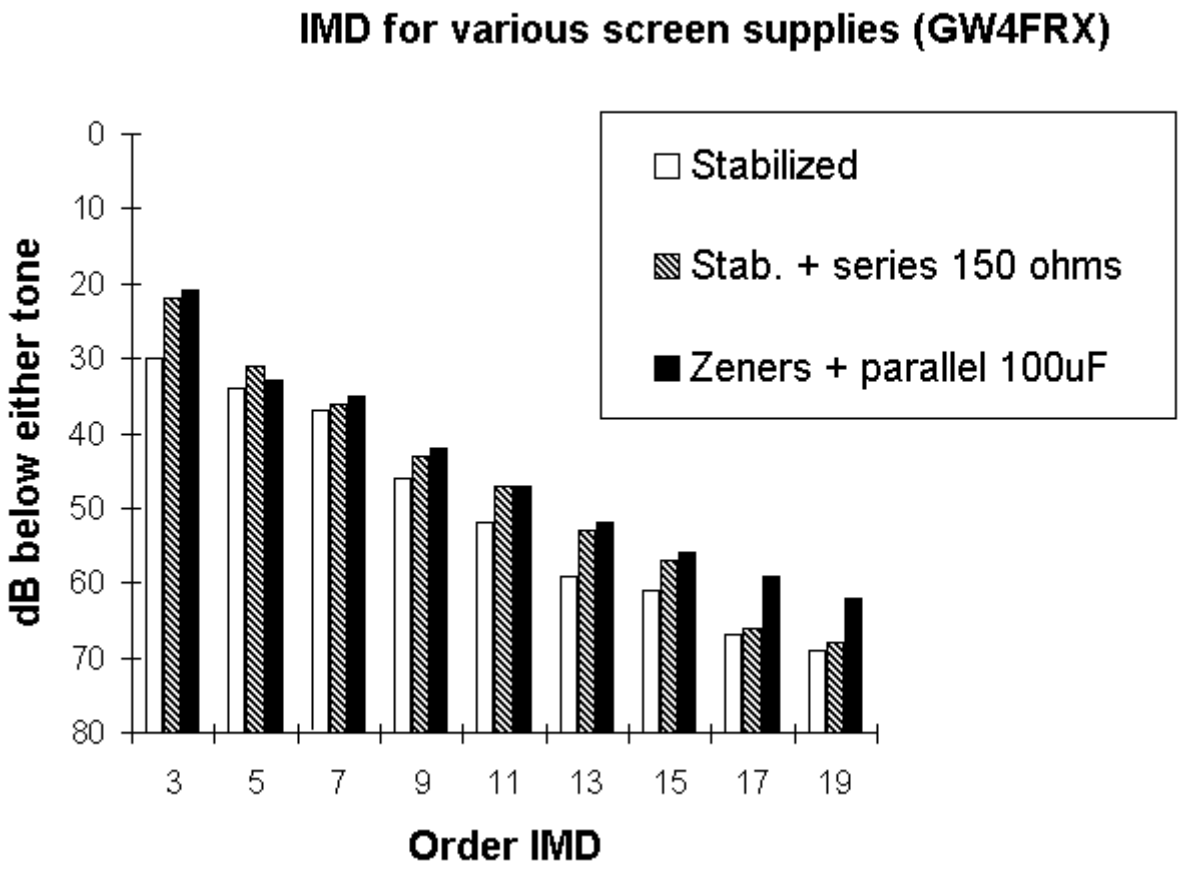
Lower IMD from Tetrode Power Amplifiers

John Nelson, GW4FRX has been a constant campaigner for cleaner signals, and has been responsible for many key developments in tetrode power supplies (see Chapters 6 and 11 of The VHF/UHF DX Book). This bar-chart shows his measurements of two-tone IMD performance of a pair of 4CX250Rs in class AB1 at 500W PEP output, with three different types of screen supply.



Test conditions

- Two Eimac 4CX250Rs, operating (heater) time 4500hrs
- Va 2000V
- Vg2 350V
- Zero-signal anode current 100mA per tube
- Two-tone test signal, 1kHz spacing, class-AB1 drive conditions (no g1 current).

1. Amplifier tuned and loaded initially for -30dB 3rd-order IMD at 500W output, using GW4FRX stabilized screen supply (350V). IMD measured.
2. 150 ohms series resistance added to screen supply to simulate poorer regulation. IMD re-measured.
3. Screen supply replaced by 350V zeners with 100uF in parallel to improve audio-frequency regulation. IMD re-measured.

See comments below

Comments

- **The best IMD performance** (white bars) came from GW4FRX's own extremely well regulated supply.
  This has excellent DC stability and a very low dynamic impedance at all audio frequencies, from 3kHz down to syllabic frequencies of a few hertz.
- **Second best** (checkered bars) was the highly stabilized supply with a 150-ohm series resistor added to artificially increase the output

impedance.
- **A poor third** (black bars) – especially for higher-order IMD – is the traditional 'chain of zeners' stabilizer with a 100uF parallel reservoir capacitor.

Conclusions

1. A screen voltage regulator with low dynamic impedance at all audio frequencies from 3kHz down to syllabic frequencies of a few hertz will produce significantly better IMD performance, especially for the higher-order products that make your signal 'wide'.
2. Improved screen stabilization can give IMD performance that is notably better than stated in the Eimac data sheets.
3. **Zener stabilizers are no longer state-of-the-art.**

On the air, these conclusions have been verified by many British and European stations. Tight screen voltage regulation really does make a difference to your reputation!

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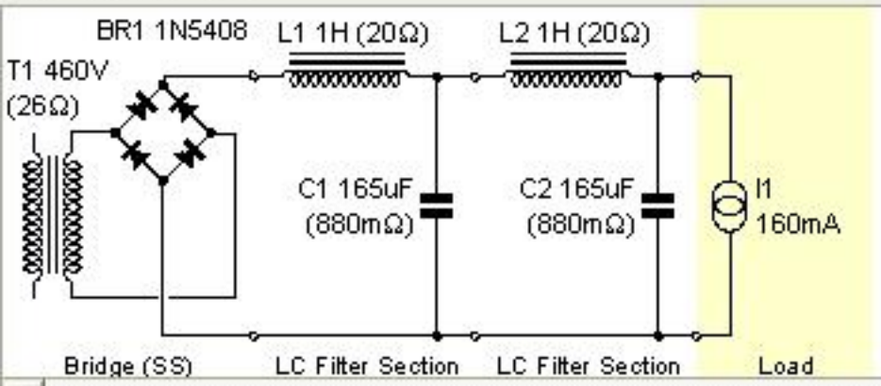
Updated 15 July 2005

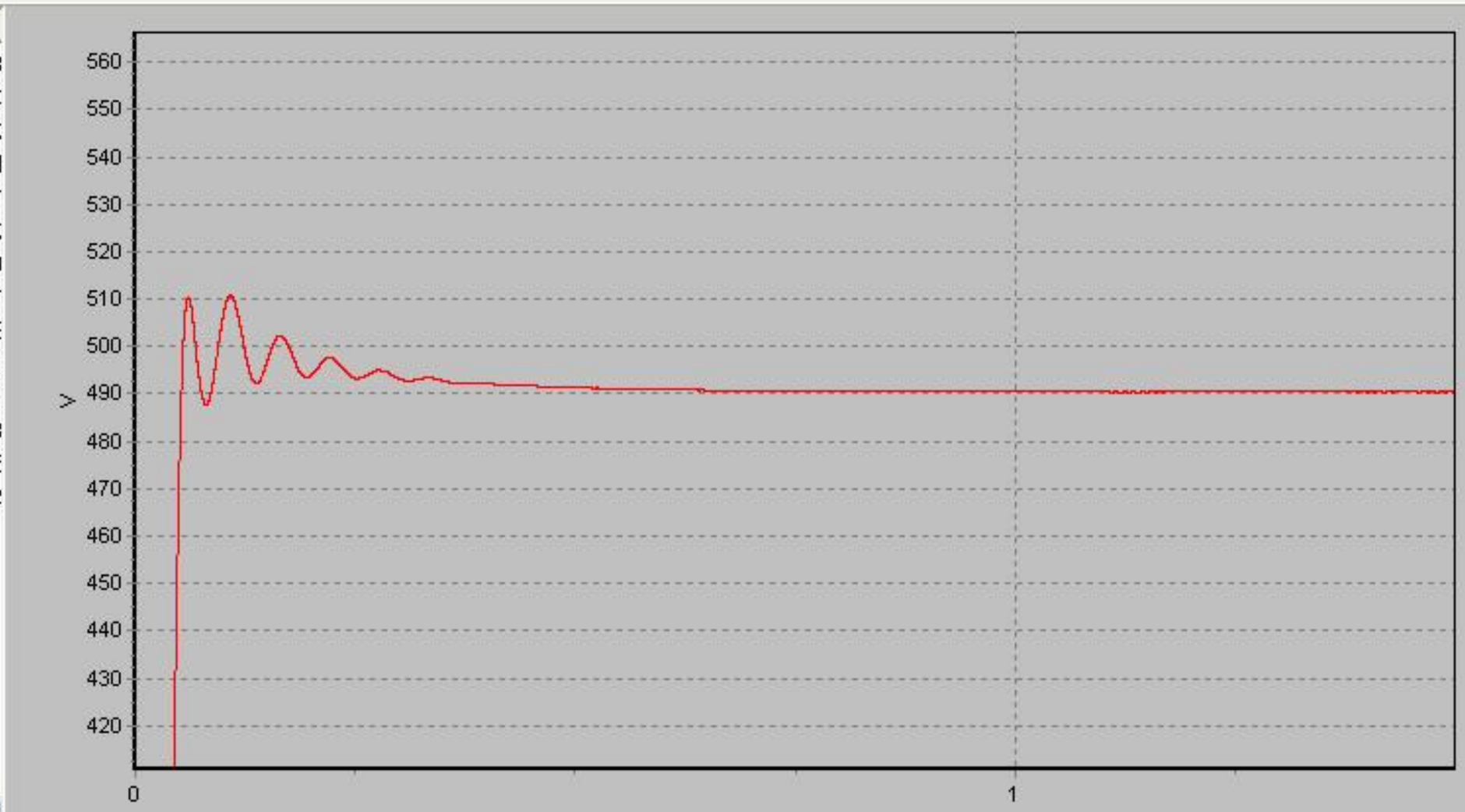
PSU Designer II [D:\SIMULATIONS\Power Supplies\Alim G2 F1FRV Low Ripple.psu]

File Options Help



Simulate For 6 000 ms after a reporting delay of 0 S

Result	Min	Max	
I(BR1)	-3,1557m	3,8576	3,
I(C1)	-427,93m	2,9259	3,
I(C2)	-305,20m	2,9910	3,
I(I1)	0	160m	1
I(L1)	-3,1657m	4,1553	4,
I(L2)	-145,20m	3,1510	3,
I(T1)	-4,1553	3,8576	8,
V(BR1)	-2,6635k	48,025	2,7
V(C1)	0	522,83	52
V(C2)	-152,92m	510,72	51
V(I1)	-152,92m	510,72	51
V(L1)	-522,51	2,1581k	2,6
V(L2)	-109,17	245,25	35
V(T1)	-646,09	645,98	1,2



Simulation complete, elapsed time 1,47 seconds

PSU Designer II [D:\SIMULATIONS\Power Supplies\Alim G2 F1FRV Medium Ripple.psu]

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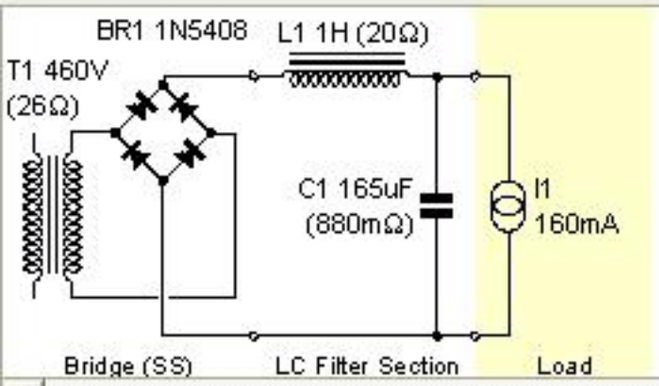
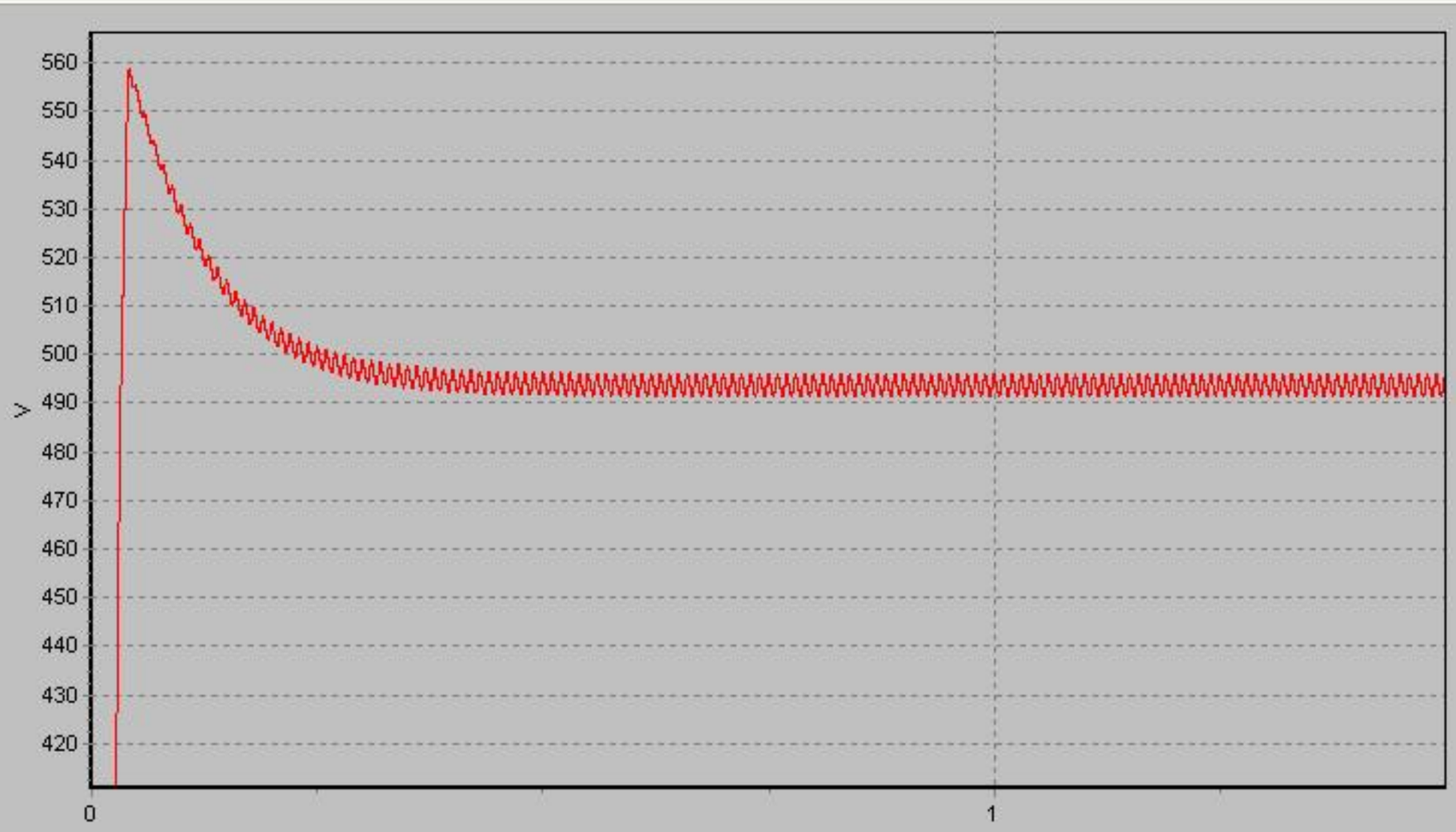


Simulate For 6 000 ms after a reporting delay of 0 S

Result	Min	Max	
I(BR1)	-3,1617m	3,5667	3,!
I(C1)	-163,16m	3,9585	4,'
I(I1)	0	160m	1
I(L1)	-3,1626m	4,1185	4,'
I(T1)	-4,1185	3,5667	7,!
V(BR1)	-2,7060k	47,198	2,7!
V(C1)	-152,64m	558,72	5!
V(I1)	-152,64m	558,72	5!
V(L1)	-563,05	2,1599k	2,7:
V(T1)	-647,51	647,80	1,2!



Simulation complete, elapsed time 1,01 seconds

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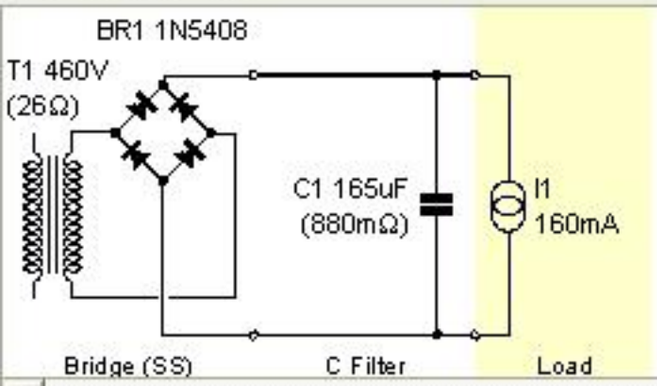
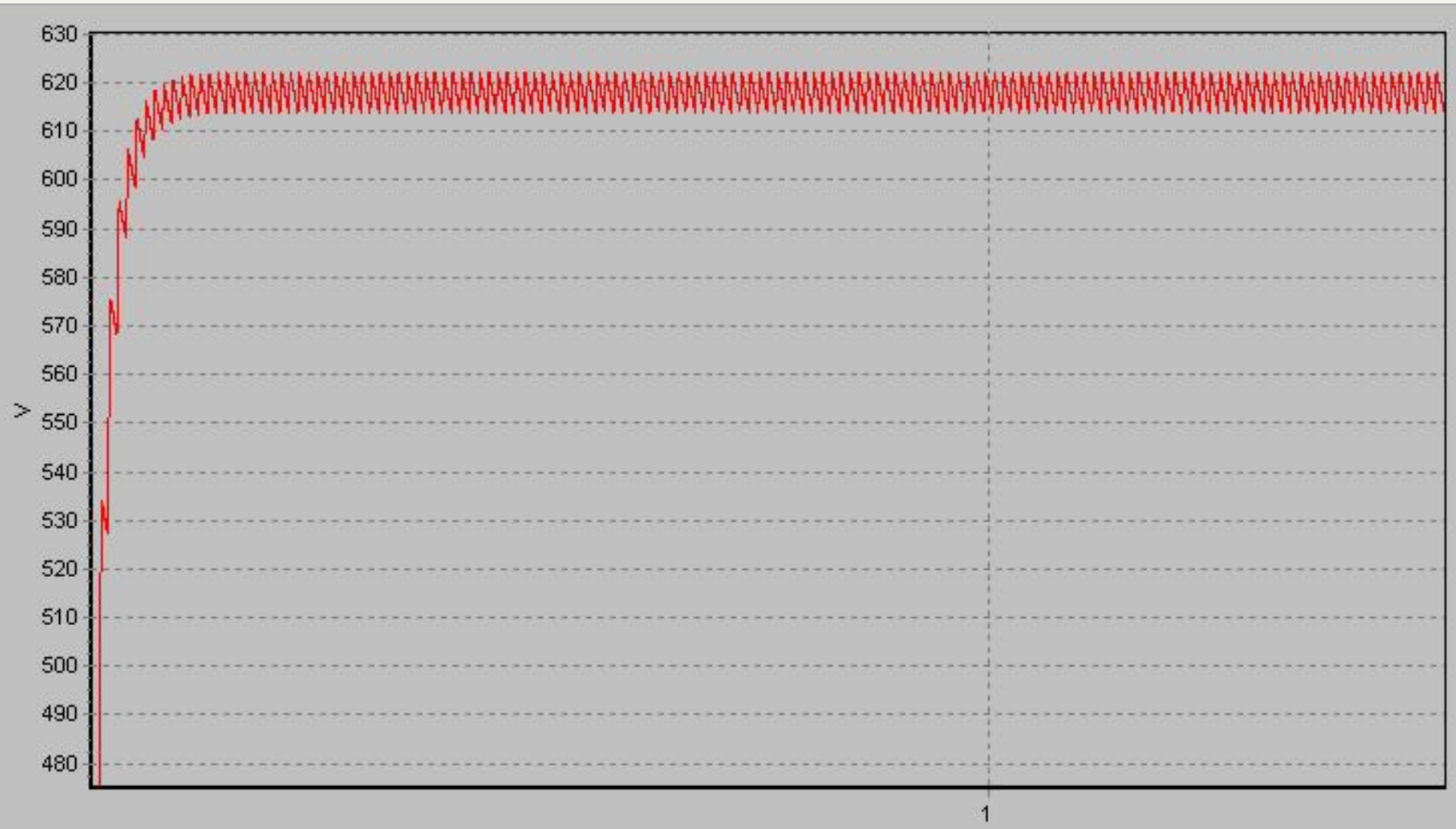


Simulate For 6 000 ms after a reporting delay of 0 S

Result	Min	Max	
I(BR1)	-309,00u	14,335	14,
I(C1)	-160,30m	14,175	14,
I(I1)	0	160m	16
I(T1)	-6,1145	14,335	20,
V(BR1)	-621,96	1,1262	623
V(C1)	90,532m	622,12	622
V(I1)	90,532m	622,12	622
V(T1)	-623,16	623,16	1,24



Simulation complete, elapsed time 0,56 seconds