**The schematic and the simulation results are for an analog electronic load circuit. The circuit steps through 1mA to 10mA and then starts the cycle again.**

The full circuit has a manual current sink (via a trimpot) and three stepped current sinks (1mA – 10mA, 10mA – 100mA, 100mA – 1A). This problem only relates to the 10mA and 100mA sections.

· The reference voltage is 2V. 2V/10 steps = 200mV per 1mA/10mA/100mA step.
· The clock signal is 10 ms per step (~3 ms high and ~7 ms low), there are ten steps and then the cascaded counters reset and restart the cycle.
· The 0.1A to 1A section is correctly functional. The first step is 100mA on the current sink ammeter, which it should be.
· The 1mA to 10mA and the 10mA to 100mA sections have a glitch on the first step: step 1 is 300uA (or 3mA, respectively) but it should be 1mA (or 10mA).

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The first schematic is the actual schematic. The second schematic here is a (horrible but functional) version showing the signal and power paths when step 1 is high.

In principle I do not think the clock signals are of importance to the problem glitch. I feel the glitch is perhaps more likely related to the NMOS turning off too slowly or something along those lines; perhaps the drop from 2V to 200mV is an unrealistic expectation of the op amp and that clock design will never give it timee to settle after 2V and then rise to 200mV – I have tried a load of different things to pull the NMOS drive op amp inputs to 0V or shorting them together (as in a half-done and unlikely to work chopper/AZA) so as to add step 11 and have a 0V deadtime moment between e.g. 10mA and 1mA.

As can be seen from all the shunt ammeter waveforms, 1A is correct at step 1, the other two are incorrect at step 1. The reference voltages are correct throughout the cycle, so they may not be the problem.

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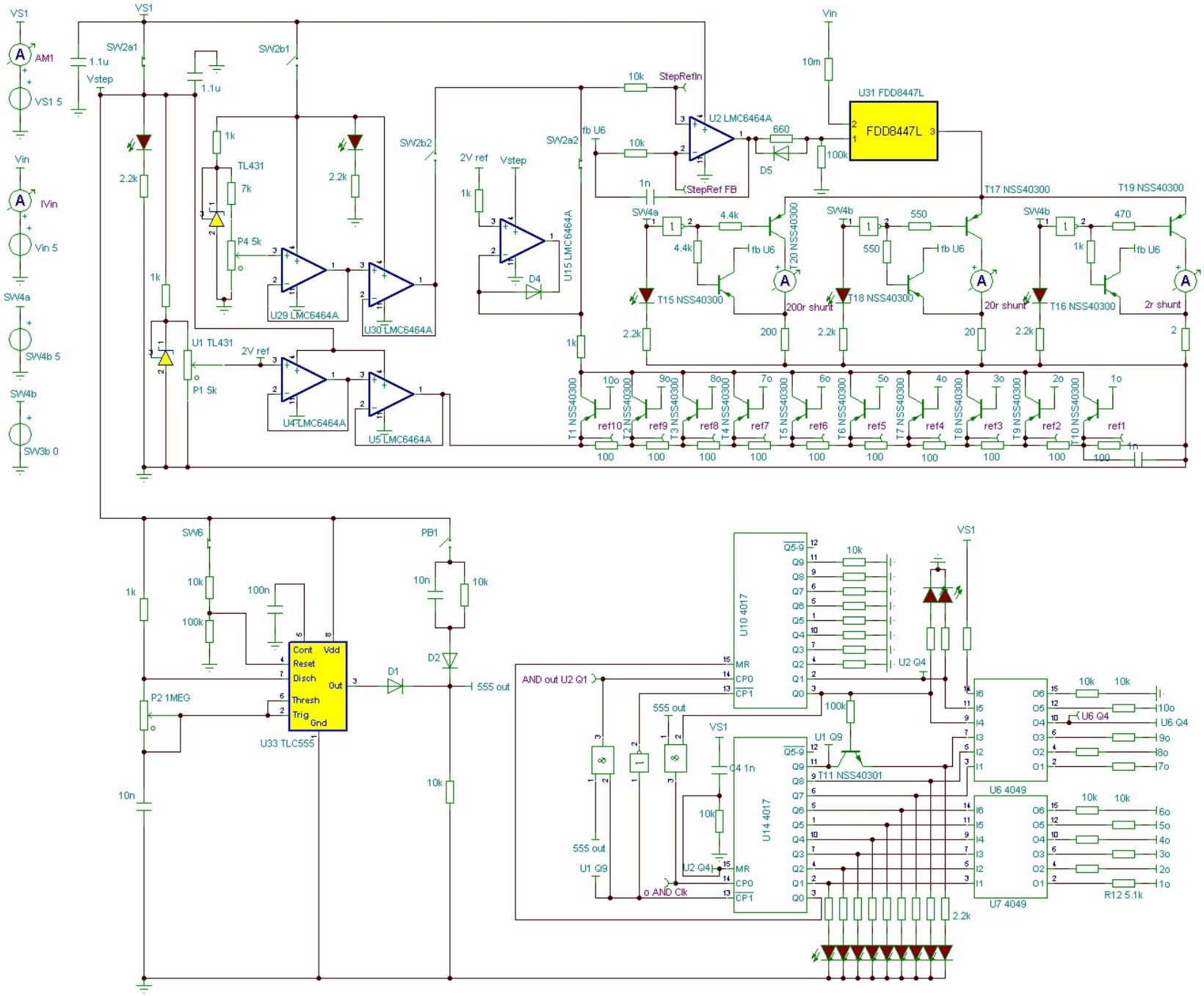
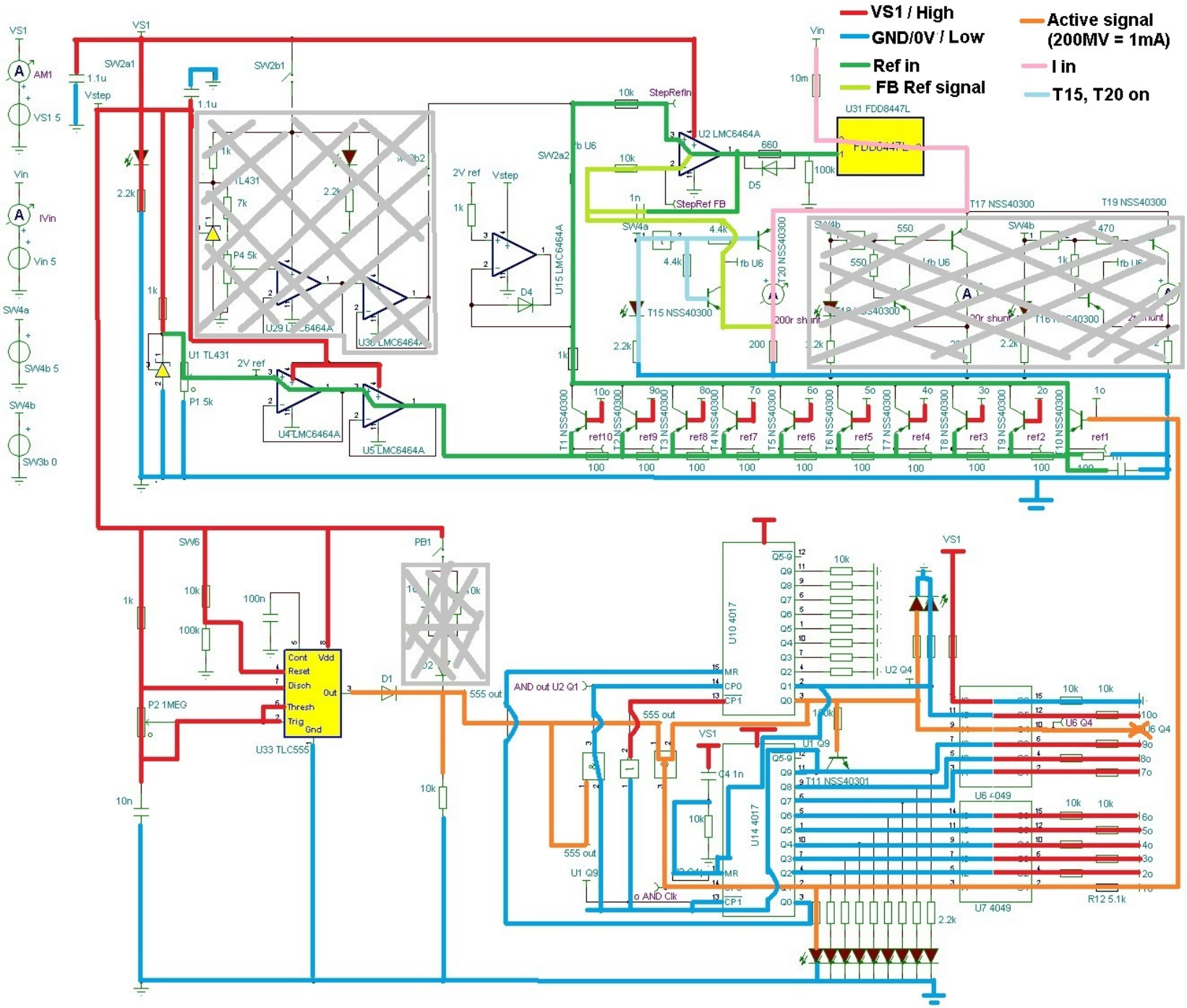
**Pictures:**



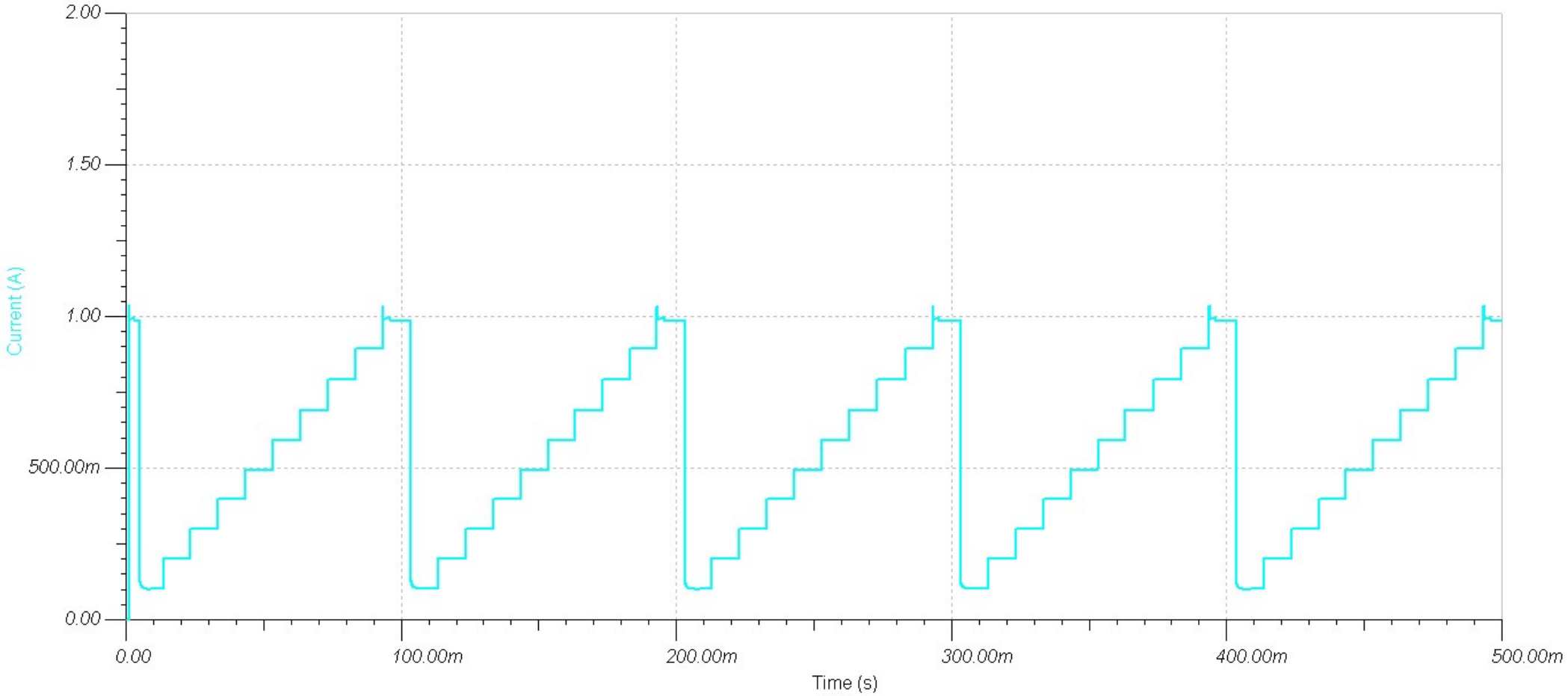
On the simulation results that include reference voltages:
The horizontal lines are the 200mV, 400mV, etc. to 2V reference voltages on the PNP/100R junctions. The (pink) steps are the voltage steps and feedback signals seen at the U2 op amp input(s).

N.B. The current and voltage waveform ammeter diagrams read 1R, 10R, 100R – those are actually 2R, 20R, 200R – the schematic values are true/real (i.e. I'm not simulating one thing and then showing another in the schematic).

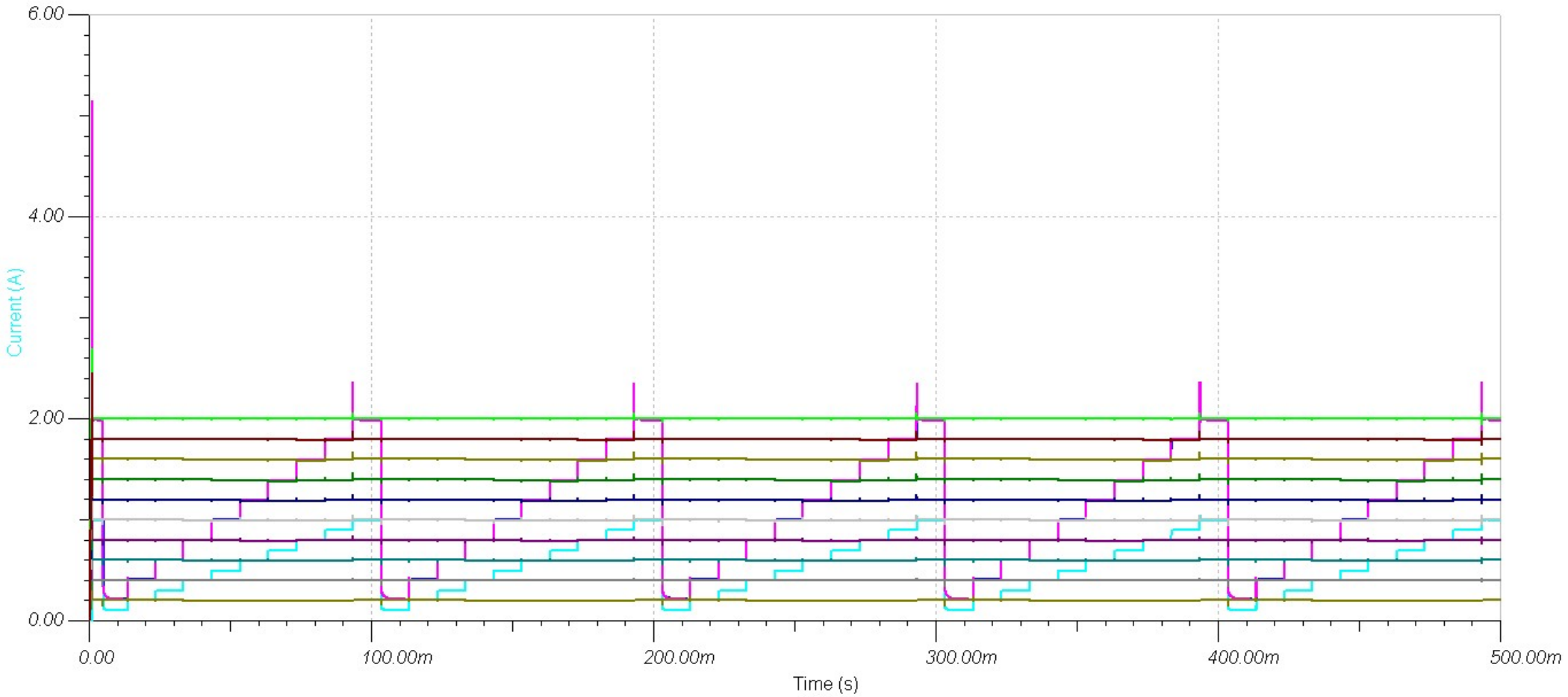

VS1
AM1
VS1 5
Vin
IVin
Vin 5
SW4a
SW4b 5
SW4b
SW3b 0
SW2a1
SW2b1
1.1u
Vstep
2.2k
1k
TL431
7k
P4 5k
U29 LMC6464A
U30 LMC6464A
U1 TL431
P1 5k
2V ref
U4 LMC6464A
U5 LMC6464A
SW2b2
SW2a2
fb U6
10k
StepRefIn
U2 LMC6464A
660
D5
100k
10m
U31 FDD8447L
FDD8447L
1n
(StepRef FB
U15 LMC6464A
D4
T17 NSS40300
T19 NSS40300
T20 NSS40300
T15 NSS40300
T18 NSS40300
T16 NSS40300
4.4k
550
470
200r shunt
20r shunt
2r shunt
200
20
2
T1 NSS40300
T2 NSS40300
T3 NSS40300
T4 NSS40300
T5 NSS40300
T6 NSS40300
T7 NSS40300
T8 NSS40300
T9 NSS40300
T10 NSS40300
ref10
ref9
ref8
ref7
ref6
ref5
ref4
ref3
ref2
ref1
100
SW6
PB1
100n
10n
Cont
Reset
Disch
Thresh
Trig
Vdd
Out
Gnd
U33 TLC555
P2 1MEG
D1
D2
555 out
U10 4017
U14 4017
AND out U2 Q1
U1 Q9
U2 Q4
T11 NSS40301
Q4 1n
o AND Clk
U6 4049
U7 4049
R12 5.1k


VS1 / High
GND/0V / Low
Ref in
FB Ref signal
Active signal (200MV = 1mA)
I in
T15, T20 on
VS1
AM1
VS1 5
Vin
IVin
Vin 5
SW4a
SW4b 5
SW4b
SW3b 0
SW2a1
SW2b1
1.1u
Vstep
2.2k
1k
TL431
7k
P4 5k
U29 LMC6464A
U30 LMC6464A
U1 TL431
2V ref
P1 5k
U4 LMC6464A
U5 LMC6464A
10k
StepRefIn
U2 LMC6464A
SW2a2
fb U6
1n
(StepRef FB
660
D5
100k
10m
U31 FDD8447L
2V ref
Vstep
U15 LMC6464A
D4
SW4a
4.4k
T15 NSS40300
T20 NSS40300
200r shunt
200
T17 NSS40300
T19 NSS40300
SW4b
550
470
T1 NSS40300
T2 NSS40300
T3 NSS40300
T4 NSS40300
T5 NSS40300
T6 NSS40300
T7 NSS40300
T8 NSS40300
T9 NSS40300
T10 NSS40300
ref10
ref9
ref8
ref7
ref6
ref5
ref4
ref3
ref2
ref1
100
SW6
100n
100k
P2 1MEG
10n
Cont
Reset
Disch
Thresh
Trig
Vdd
Out
Gnd
U33 TLC555
PB1
D1
555 out
AND out U2 Q1
U10 4017
MR
CP0
CP1
Q5-9
Q0
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q9
U2 Q4
U1 Q9
T11 NSS40301
C4 1n
U14 4017
o AND Clk
U6 4049
U7 4049
R12 5.1k
2.2k

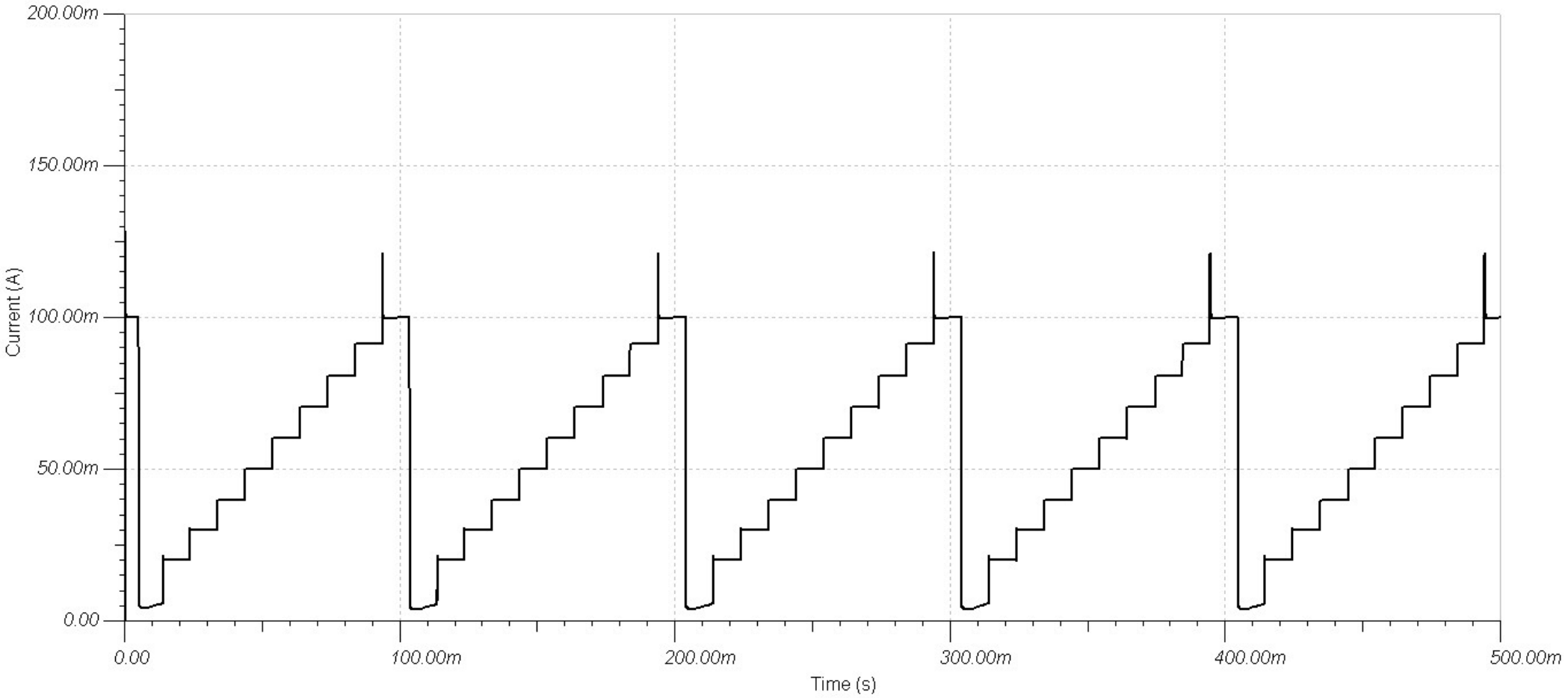
1A/2R ammeter waveforms:



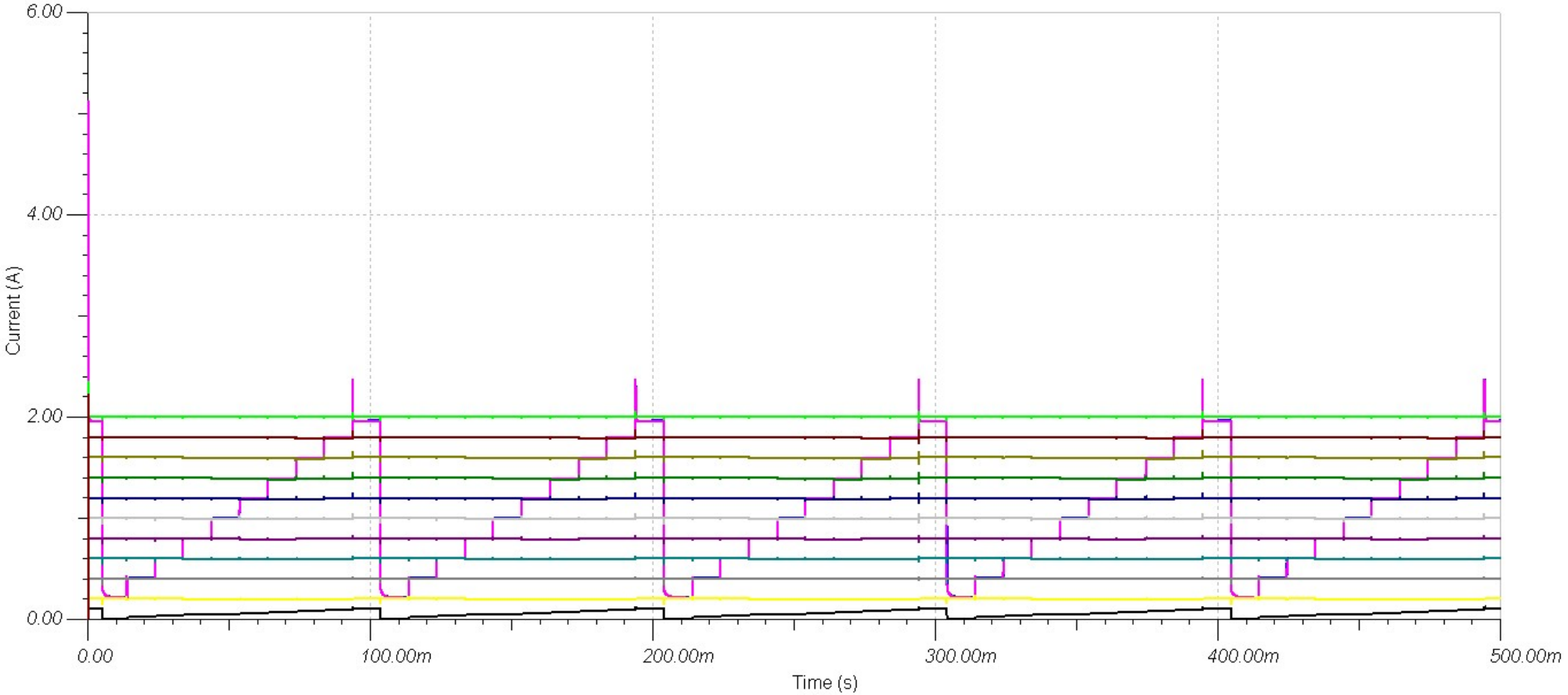
1A/2R reference voltage waveforms:



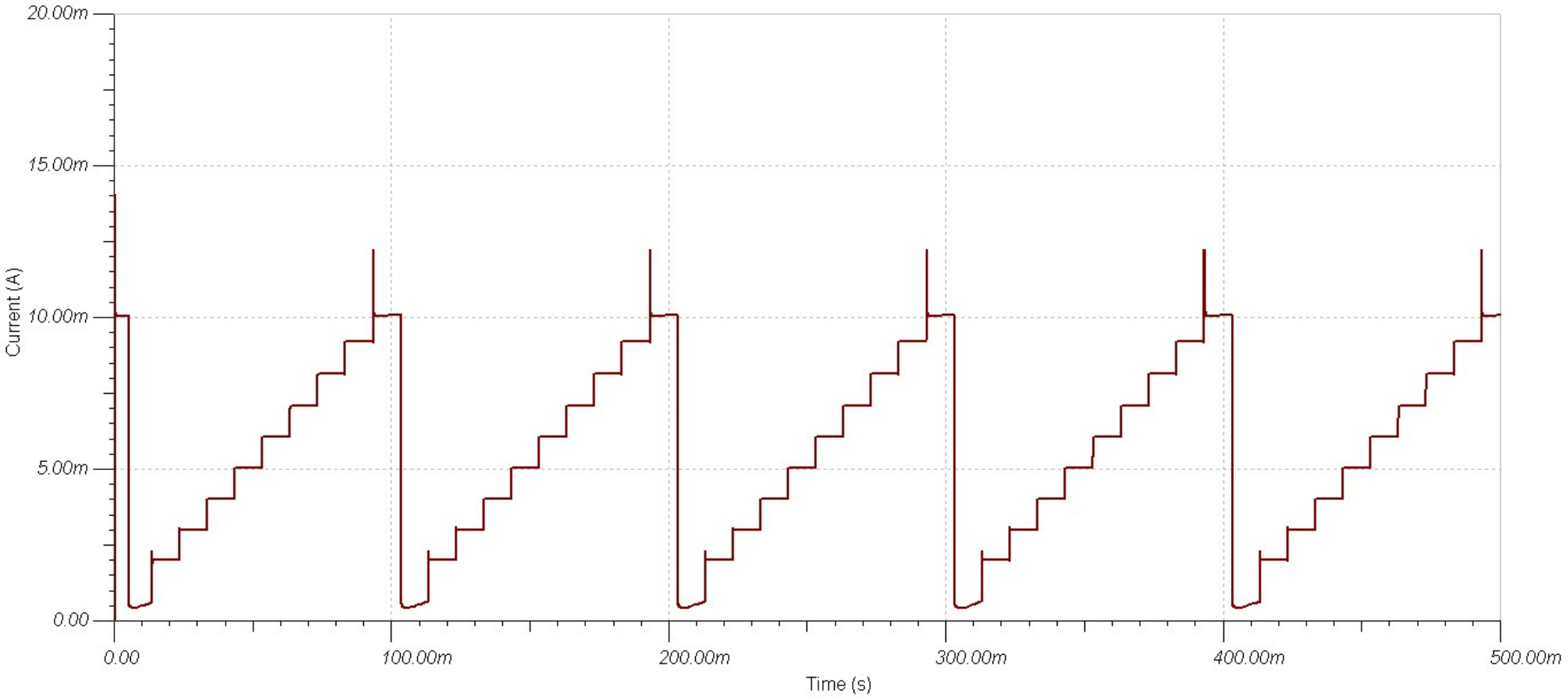
0.1A/20R ammeter waveforms:



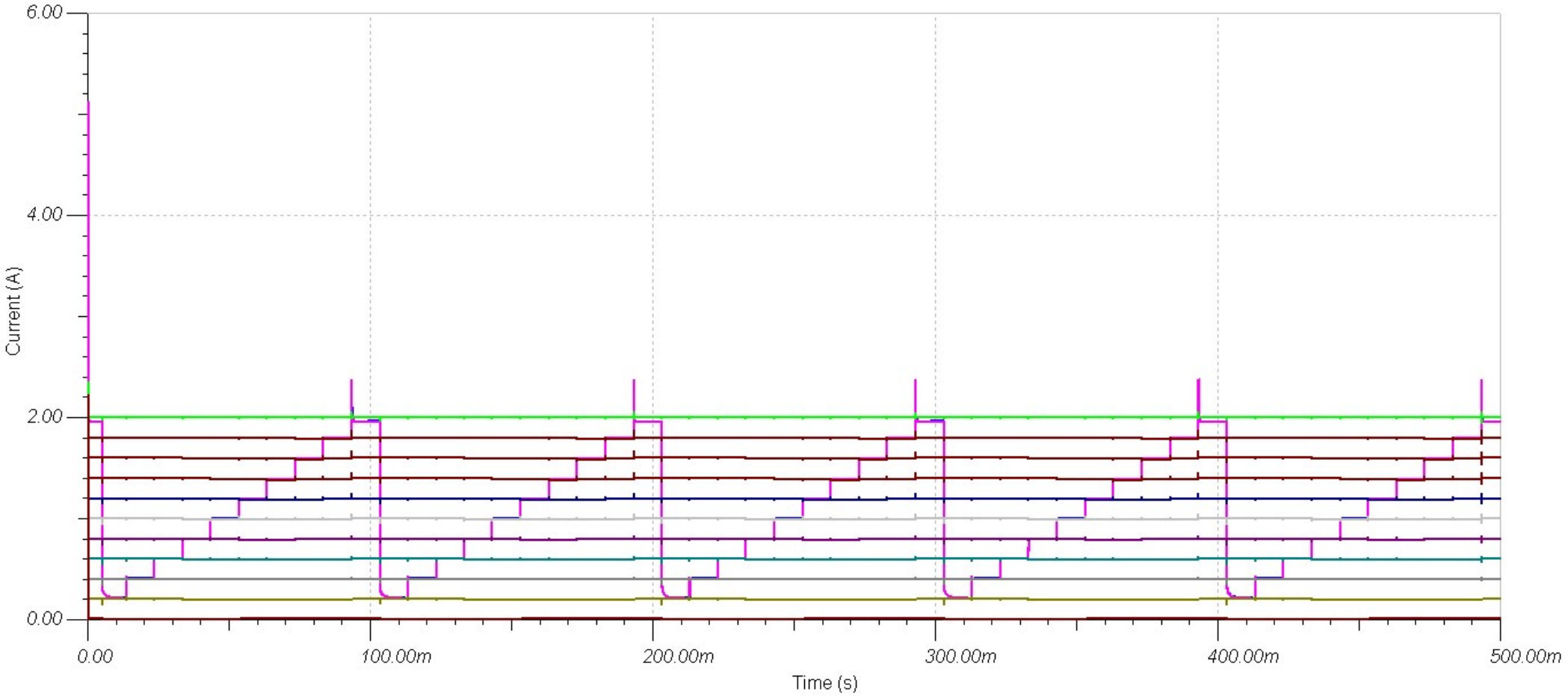
0.1A/20R reference voltage waveforms:



0.01A/200R ammeter waveforms:



0.01A/200R reference voltage waveforms:



Clock signals (/cascaded 4017 waveforms):