LM386 Charge Pump

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Assumptions

- symmetrical output swing,
- LM386 common mode input not exceeded on -ve swing
- Not considered: LM386 bandwidth, difference when pin 1 & 8 open or shorted

	LM386 DS	Article	AMZ 9V	AMZ 12V	
LM386					**Comment**
Vsat [V]	1.2	1.2	1.2	1.2	saturation of output stage
R368 [ohms]	50000	50000	50000	50000	internal input impedance
Circuit					
Vcc [V]	9	10	9	10	supply voltage
Ct [F]	1.00E-07	1.80E-08	2.20E-09	2.20E-09	timing cap
Rt [ohms]	30000	10000	10000	10000	external timing resistor
R1 [ohms]	10000	10000	10000	10000	external voltage divider to opamp
R2 [ohms]	1000	1000	1000	1000	external voltage divider to ground
Analysis					
Resistive divider ckt:					
Voac [V]	3.3	3.8	3.3	3.8	Voac = Vcc/2 – Vsat ; ac coupled swing at opamp output
kr	0.0893	0.0893	0.0893	0.0893	kr = [(50k // Rr2) / ((50k // R2) + R1)] = 1/ (1 + R2 * (1/50k + 1/R1)) ; resistive voltage divider including LM386 input R
Vr [V]	0.2946	0.3393	0.2946	0.3393	Vr = Voac * kr ; swing at output of voltage divider
Capacitor ckt:					
kc	0.6250	0.8333	0.8333	0.8333	kc = 50k / (50k + Rt) = 1 / (1 + Rt / 50k) ; voltage divider on capacitance arm due to LM386 input R
Vx [V]	2.0625	3.1667	2.7500	3.1667	Vx = Voac * kc ; thevenin voltage source driving capacitor
Rx [ohms]	18750.0	8333.3	8333.3	8333.3	Rx = 50k // Rt ; thevenin source impedance driving capacitor
tau [s]	1.88E-03	1.50E-04	1.83E-05	1.83E-05	tau = Rx * Ct ; effective RC time constant

Timing:

Capacitor charges from -Vr toward Vx via resistor Rx and stops at +Vr

vc(t) = Vx + (-Vr – Vx) exp(-t/tau)	cap voltage
Vr = Vx - (Vr + Vx) exp(- t / tau)	
t = tau * ln ((Vx + Vr) / (Vx – Vr))	charge time
T = 2 * t	period

Results					
t [s]	5.39E-04	3.23E-05	3.94E-06	3.94E-06	charge time
T [s]	1.08E-03	6.45E-05	7.89E-06	7.89E-06	period
f [Hz]	926.9	15495.8	126784.2	126784.2	frequency
Expected f [Hz]	1000	25000	102500	113000	

Conclusions

The effective formula based on the detail analysis,

kt	0.58	0.43	0.43	0.43	f = 1 / (kt * tau), tau = Rx * Ct ie. including LM386 input R
kt’	0.36	0.36	0.36	0.36	f = 1 / (kt’ * tau), tau = Rt * Ct ie. ignore LM386 input R

The results do not depend on Vsat

The results only weakly depend on the LM386 input R; Rt=50k produces 7% higher freq than Rt=10k