

Paralleling the TC1121 to Reduce Output Resistance for Driving Higher Load Currents

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INTRODUCTION

Microchip Technology's TC1121 is a charge pump voltage converter specified to have a 100mA output current capability. The TC1121 has the benefits of selecting different internal charge pump switching frequencies (10KHz or 200KHz), driving the charge pump from an external clock, and a low power shutdown mode. An even greater benefit in certain applications where higher load currents are required (such as disk drive pre-amplifiers) is the ability to connect multiple TC1121s in parallel to drive loads greater than 100mA. The data in this application note compares measurements taken on a single TC1121 and two TC1121s connected in parallel. All measurements were made at ambient temperature ($T_A = +25^\circ\text{C}$).

SINGLE TC1121 APPLICATION CIRCUIT

Figure 1 shows the circuit configuration for measuring various load currents of a single TC1121. Two external capacitors (flying capacitor C1 and output capacitor C2) and a resistive load (comprised of RL1 and RL2) are required to measure the DC output voltage/droop and AC output voltage ripple under varying load conditions. To measure certain higher current loads, resistor RL1 was shorted. All measurements were made using an input voltage of 5.0V.

Table 1 contains typical data for a constant load current of 100mA for different capacitor values and different charge pump oscillator frequencies. External capacitor values varying from $1\mu\text{F}$ to $47\mu\text{F}$ were used, and in each case two different charge pump oscillator frequencies were used: 1) the internal 200KHz, and 2) an external pump frequency that maximized the absolute value of the output voltage. Notice that the larger the external capacitors, the smaller the output voltage droop is for a constant 100mA load current.

Table 2 contains typical data for varying load currents (from 25mA to 125mA) with varying external capacitor values. All measurements were made using the internal 200KHz charge pump switching frequency. Note that output voltage droop increases with higher load currents and smaller external capacitors.

PARALLEL TC1121 APPLICATION CIRCUIT

Figure 2 shows the circuit configuration for measuring various load currents when two TC1121s are connected in parallel. Three external capacitors (flying capacitors C1A/C1B and output capaci-

tor C2) and a resistive load (comprised of RL1 and RL2) are required to measure the DC output voltage droop under varying load conditions. To measure certain higher current loads, resistor RL1 was shorted. As before, all measurements were made using an input voltage of 5.0V.

Table 3 contains typical data for varying load currents (from 25mA to 200mA) with varying external capacitor values. All measurements were made using the internal 200KHz charge pump switching frequency. As in the case of the single TC1121, the output voltage droop increases with higher load currents and smaller external capacitors, but the droop is significantly less than the single TC1121 configuration. The penalty the user pays is the expense of the additional TC1121 and one additional capacitor to achieve these higher load currents and to reduce the output voltage droop.

SUMMARY

Multiple TC1121 charge pumps can be paralleled to reduce output resistance and, therefore, increase the output current capability to load currents greater than 100mA. Voltage droop decreases with multiple TC1121s in parallel at the expense of additional component count and cost.

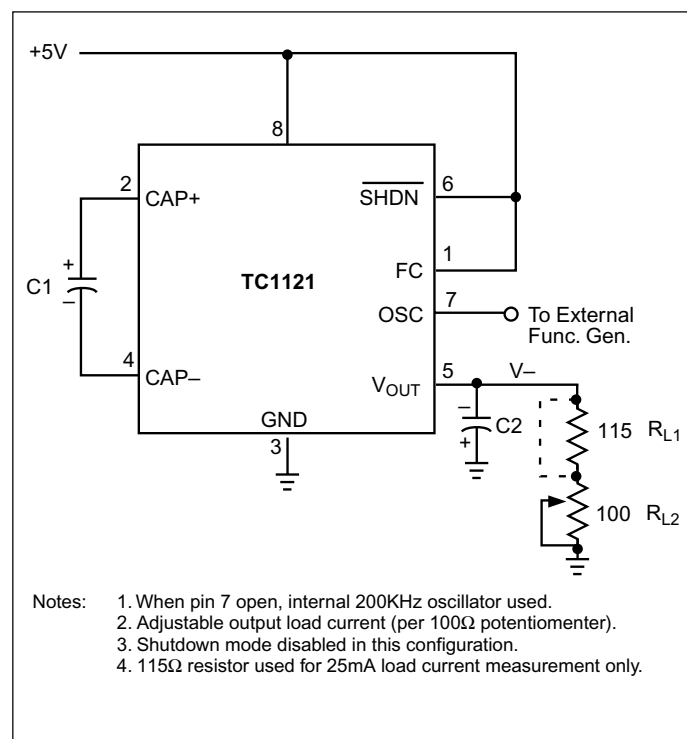


FIGURE 1: Single TC1121 application circuit.

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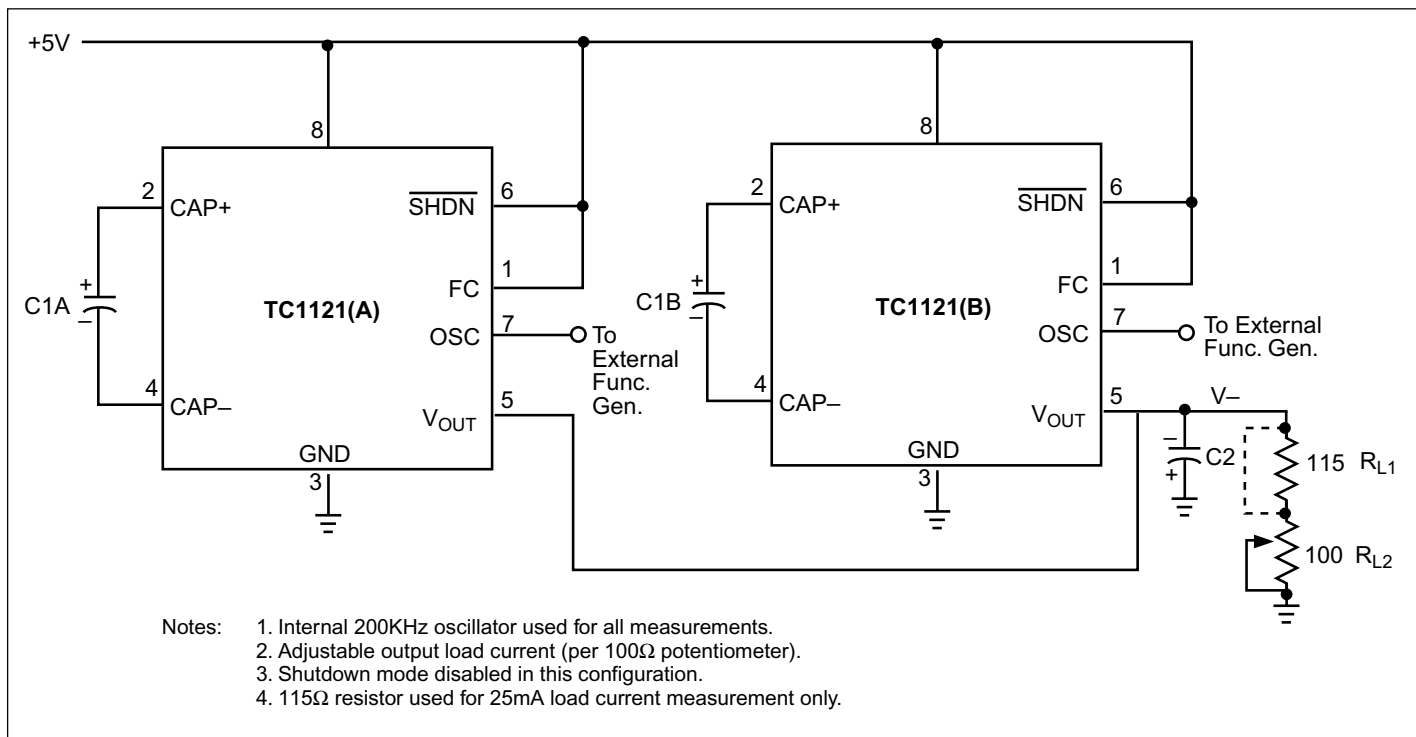


FIGURE 2: Parallel TC1121s application circuit.

V _{IN} Voltage (V)	Flying Capacitor C1 (μF)	Output Capacitor C2 (μF)	Load Current (mA)	V _{OUT} Voltage (V)	V _{OUT} Droop (V)	Osc. (Int/Ext)	Osc. Freq. (KHz)	Output Ripple (mV _{p-p})
5.0	1	1	100	-3.04	1.96	Internal	200	800
5.0	1	1	100	-3.22	1.78	External	300	720
5.0	4.7	4.7	100	-3.60	1.40	Internal	200	240
5.0	4.7	4.7	100	-3.67	1.33	External	145	310
5.0	10	10	100	-3.77	1.23	Internal	200	200
5.0	10	10	100	-3.87	1.13	External	105	240
5.0	22	22	100	-3.90	1.10	Internal	200	120
5.0	22	22	100	-3.95	1.05	External	120	150
5.0	47	47	100	-4.05	0.95	Internal	200	80
5.0	47	47	100	-4.10	0.90	External	115	95

TABLE 1: Single TC1121 data summary with 100mA load current.

V _{IN} Voltage (V)	Flying Capacitor C1 (μF)	Output Capacitor C2 (μF)	Load Current (mA)	V _{OUT} Voltage (V)	V _{OUT} Droop (V)	Osc. (Int/Ext)	Osc. Freq. (KHz)	Output Ripple (mV _{p-p})
5.0	1	1	25	-4.52	0.48	Internal	200	200
5.0	1	1	50	-4.03	0.97	Internal	200	400
5.0	1	1	75	-3.55	1.45	Internal	200	600
5.0	1	1	100	-3.04	1.96	Internal	200	800
5.0	1	1	125	-2.50	2.50	Internal	200	1000
5.0	4.7	4.7	25	-4.68	0.32	Internal	200	70
5.0	4.7	4.7	50	-4.35	0.65	Internal	200	125
5.0	4.7	4.7	75	-3.99	1.01	Internal	200	200
5.0	4.7	4.7	100	-3.60	1.40	Internal	200	240
5.0	4.7	4.7	125	-3.23	1.77	Internal	200	330
5.0	10	10	25	-4.73	0.27	Internal	200	50
5.0	10	10	50	-4.44	0.56	Internal	200	100
5.0	10	10	75	-4.13	0.87	Internal	200	150
5.0	10	10	100	-3.77	1.23	Internal	200	200
5.0	10	10	125	-3.44	1.56	Internal	200	230
5.0	22	22	25	-4.75	0.25	Internal	200	30
5.0	22	22	50	-4.47	0.53	Internal	200	65
5.0	22	22	75	-4.19	0.81	Internal	200	100
5.0	22	22	100	-3.90	1.10	Internal	200	120
5.0	22	22	125	-3.58	1.42	Internal	200	175
5.0	47	47	25	-4.79	0.21	Internal	200	20
5.0	47	47	50	-4.55	0.45	Internal	200	40
5.0	47	47	75	-4.30	0.70	Internal	200	65
5.0	47	47	100	-4.05	0.95	Internal	200	80
5.0	47	47	125	-3.76	1.24	Internal	200	100

TABLE 2: Single TC1121 data summary at various load currents.

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V _{IN} Voltage (V)	Flying Capacitors C1A – C1B (μF)	Output Capacitor C2 (μF)	Load Current (mA)	V _{OUT} Voltage (V)	V _{OUT} Droop (V)	Improvement from Single TC1121 (V)	Osc. (Int/Ext)	Osc. Freq. (KHz)
5.0	1	1	25	–4.82	0.18	0.30	Internal	200
5.0	1	1	50	–4.63	0.37	0.60	Internal	200
5.0	1	1	75	–4.43	0.57	0.88	Internal	200
5.0	1	1	100	–4.20	0.80	1.16	Internal	200
5.0	1	1	125	–3.98	1.02	1.48	Internal	200
5.0	1	1	150	–3.89	1.11	N/A	Internal	200
5.0	1	1	175	–3.77	1.23	N/A	Internal	200
5.0	1	1	200	–3.59	1.41	N/A	Internal	200
5.0	4.7	4.7	25	–4.85	0.15	0.17	Internal	200
5.0	4.7	4.7	50	–4.70	0.30	0.35	Internal	200
5.0	4.7	4.7	75	–4.54	0.46	0.55	Internal	200
5.0	4.7	4.7	100	–4.38	0.62	0.78	Internal	200
5.0	4.7	4.7	125	–4.27	0.73	1.04	Internal	200
5.0	4.7	4.7	150	–4.12	0.88	N/A	Internal	200
5.0	4.7	4.7	175	–3.96	1.04	N/A	Internal	200
5.0	4.7	4.7	200	–3.81	1.19	N/A	Internal	200
5.0	10	10	25	–4.88	0.12	0.15	Internal	200
5.0	10	10	50	–4.75	0.25	0.31	Internal	200
5.0	10	10	75	–4.62	0.38	0.49	Internal	200
5.0	10	10	100	–4.48	0.52	0.71	Internal	200
5.0	10	10	125	–4.35	0.65	0.91	Internal	200
5.0	10	10	150	–4.21	0.79	N/A	Internal	200
5.0	10	10	175	–4.07	0.93	N/A	Internal	200
5.0	10	10	200	–3.74	1.26	N/A	Internal	200
5.0	22	22	25	–4.88	0.12	0.13	Internal	200
5.0	22	22	50	–4.74	0.26	0.27	Internal	200
5.0	22	22	75	–4.61	0.39	0.42	Internal	200
5.0	22	22	100	–4.42	0.58	0.52	Internal	200
5.0	22	22	125	–4.27	0.73	0.69	Internal	200
5.0	22	22	150	–4.11	0.89	N/A	Internal	200
5.0	22	22	175	–3.95	1.05	N/A	Internal	200
5.0	22	22	200	–3.80	1.20	N/A	Internal	200
5.0	47	47	25	–4.89	0.11	0.10	Internal	200
5.0	47	47	50	–4.78	0.22	0.23	Internal	200
5.0	47	47	75	–4.66	0.34	0.36	Internal	200
5.0	47	47	100	–4.55	0.45	0.50	Internal	200
5.0	47	47	125	–4.43	0.57	0.67	Internal	200
5.0	47	47	150	–4.31	0.69	N/A	Internal	200
5.0	47	47	175	–4.19	0.81	N/A	Internal	200
5.0	47	47	200	–4.06	0.94	N/A	Internal	200

Note: Output ripple is similar to single TC1121 for identical values of output capacitor (C2) and load current.

TABLE 3: Parallel TC1121s data summary at various load currents.

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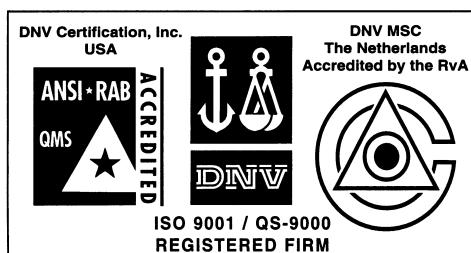
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