Reference Design: Dual-Output ADP1621 Sepic-Cùk

Contents

User Input Data & Solution Schematic

User Target Specs, Vout1

Spec	Target Value	Actual Value	Units
Vout1	+15V	14.93	Volts
Iout1	1.0	1.0	Amps
Tamb	50	50	degC
Vinmin	10	10	Volts
Vinmax	30	30	Volts

User Target Specs, Vout2

Spec	Target Value	Actual Value	Units
Vout2	-15V	-14.90	Volts
Iout2	-1.0	-1.0	Amps
Tamb	50	50	degC
Vinmin	10	10	Volts
Vinmax	30	30	Volts

Default Design Target Specs, Vout1

Spec	Target Value	Actual Value	Units
Vout1 ripple max	0.150	0.030	Volts
Ioutstep1	0.5	0.5	Apk
Vout1 step error	0.300	0.190	Volts
MaxHeight	25	7.4	mm

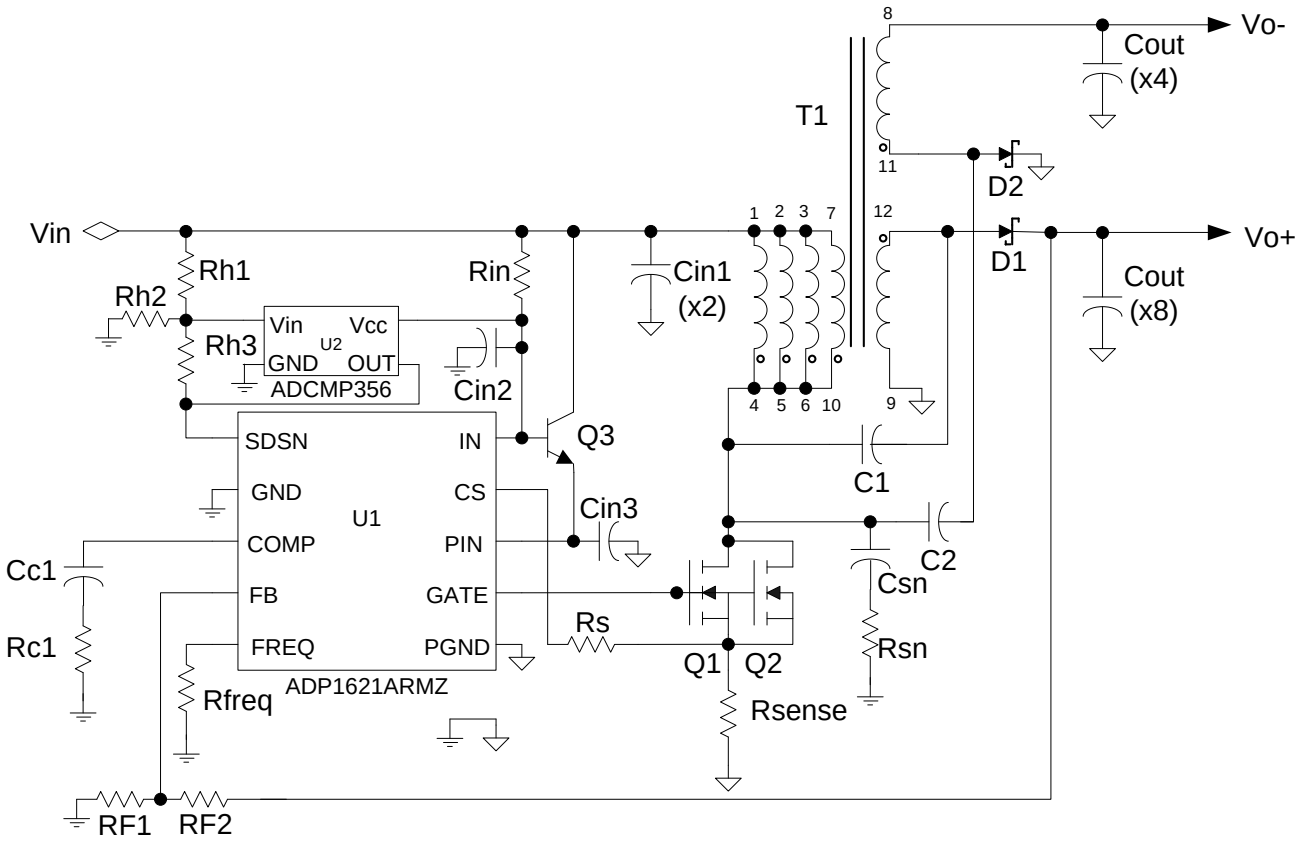
Default Design Target Specs, Vout2

Spec	Target Value	Actual Value	Units
Vout2 ripple max	0.150	0.017	Volts
Ioutstep2	0.5	0.5	Apk
Vout2 step error	0.300	0.305	Volts
MaxHeight	25	7.4	mm

Notes:

1. Minimum load current of 50mA on each rail required to maintain cross regulation within +/-10% limits
2. Best regulation is achieved if load currents track.

Schematic



Notes:

1. For load range of 0-0.5A, only Q1 is needed. For loads up to 1.0A, Q1 and Q2 are paralleled.
2. The (xn) on the capacitors refers to the number of capacitors of the given type to be paralleled.
3. U2 forms a precision UVLO circuit allowing the regulator to start at Vin=9.5V rising.
4. Rin/Q3 in conjunction with U1's on-chip shunt regulator allow the ADP1621 to operate at up to Vin=36V.
5. Csn and Rsn snub voltage spikes due to T1 leakage inductance and C1/C2's package inductance..
6. If low-noise is required, an LC post-filter (100nH/1uF ceramic) can be added, but the compensation will need adjustment if the loop is closed around it.

Bill of Materials

Disclaimer:

1. BOM prices shown are 1000 piece estimates in US Dollars that should be used for comparison purposes only.
2. It is the user's responsibility to verify actual design performance through prototyping and test.

Item #	Des	Mfg	Part Number	Component Specs	Package	Qty	Area (mm^2)	Height (mm)	Cost
1	U1	ADI	ADP1621ARMZ	Integrated Switching Regulator	MSOP-10	1	14.7	1.1	1.32
2	U2	ADI	ADCMP356	Comparator/Reference	SC70	1	5.3	1.1	0.31
3	T1	Coilcraft	HP2-0116L	5.7uH 6-winding transformer	Shielded	1	274.0	7.4	3.02
4	Q1,Q2	Vishay	Si4850EY	60V, 42mohm N-ch	SO8	2	37.2	1.1	0.32
5	Q3	Fairchild	MMBT3904	40V NPN Transistor	SOT23	1	8.0	1.1	0.02
6	D1,D2	Diodes, Inc	B360B	3A, 60V Schottky Diode	SMB	2	42.6	2.4	0.34
7	Cout	Murata	GRM31CR61E106KA12	10uF, 25V, X5R	1206	12	61.4	1.6	1.20
8	Rsense	Susumu	RL1220T-R010-J	10mohm 5% 1/4W	805	1	3.2	0.8	0.044
9	Cin1	Murata	GRM32ER71H475KA	4.7uF, 50V, X5R	1210	2	16.0	2.0	0.566
10	Cin2,Cin3	Murata	GRM188R61A105K	1uF, 10V, X5R	603	1	1.3	0.8	0.01
11	C1,C2	Murata	GRM32ER71H475K	4.7uF, 50V, X5R	1210	2	16.0	2.0	0.566
12	Rin			2.37 kohm, 1% resistor	603	1	1.3	0.4	0.005
13	Rs			200 ohm, 1% resistor	603	1	1.3	0.4	0.005
14	Rfreq			24.3 kohm, 1% resistor	603	1	1.3	0.4	0.005
15	Rc1			33.2k, 1% resistor	603	1	1.3	0.4	0.005
16	Cc1			10 nF, NPO/C0G	603	1	1.3	0.8	0.005
17	RF1			10 kohm, 1% resistor	603	1	1.3	0.4	0.005
18	RF2			113 kohm, 1% resistor	603	1	1.3	0.4	0.005
19	Rh1			10 kohm, 1% resistor	603	1	1.3	0.4	0.005
20	Rh2			681 ohm, 1% resistor	603	1	1.3	0.4	0.005
21	Rh3			1 Mohm, 1% resistor	603	1	1.3	0.4	0.005
22	Rsn			3.4 ohm 1% resistor	805	1	3.2	0.8	0.005
23	Csn			1nF, NPO/C0G	0603	1	1.3	0.4	0.005
							Comp Area	Max Height	Cost
						Total	497.2	7.4	$7.84

Notes:

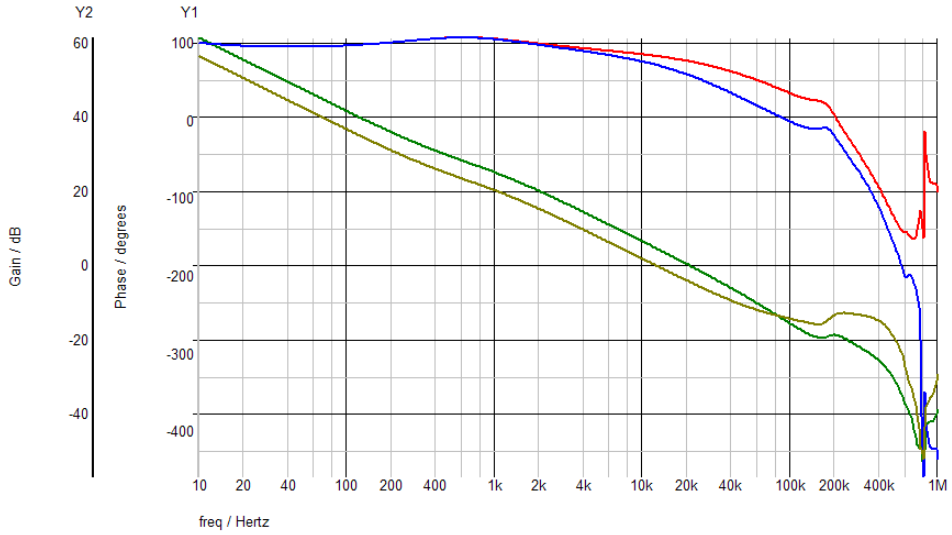
1. Design optimized for 1A load. For 0.5A max load Q2 may be omitted.

2. D1 and D2 are sized to withstand up to a 3A short on either output to ground for 1 min. If more protection against overloads is needed, B560C diodes can be used and will withstand up to 10A short for 1 min. In either case, T1 will eventually overheat if the short is maintained indefinitely.

Graphs

Bode Plot

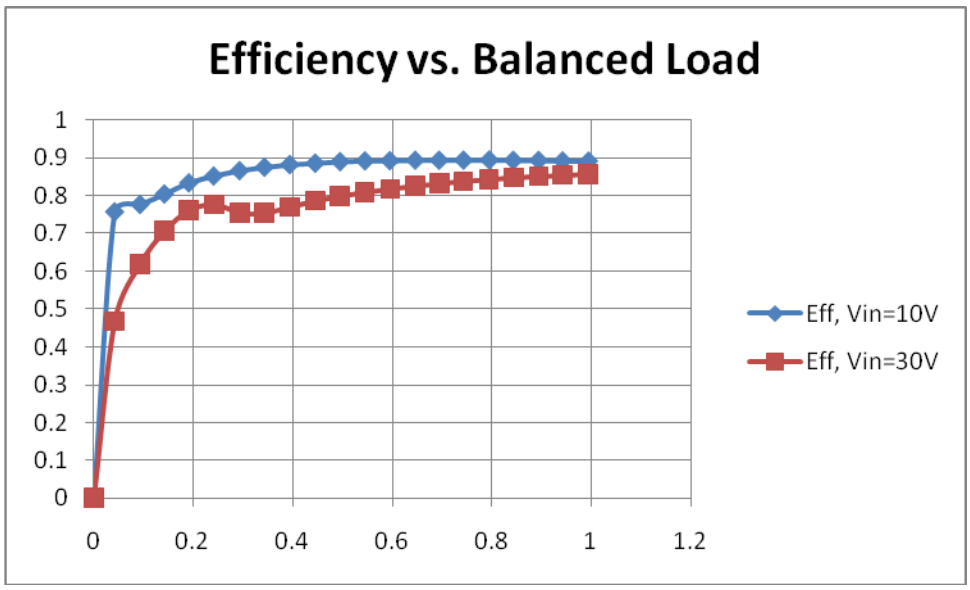
(from simulation)



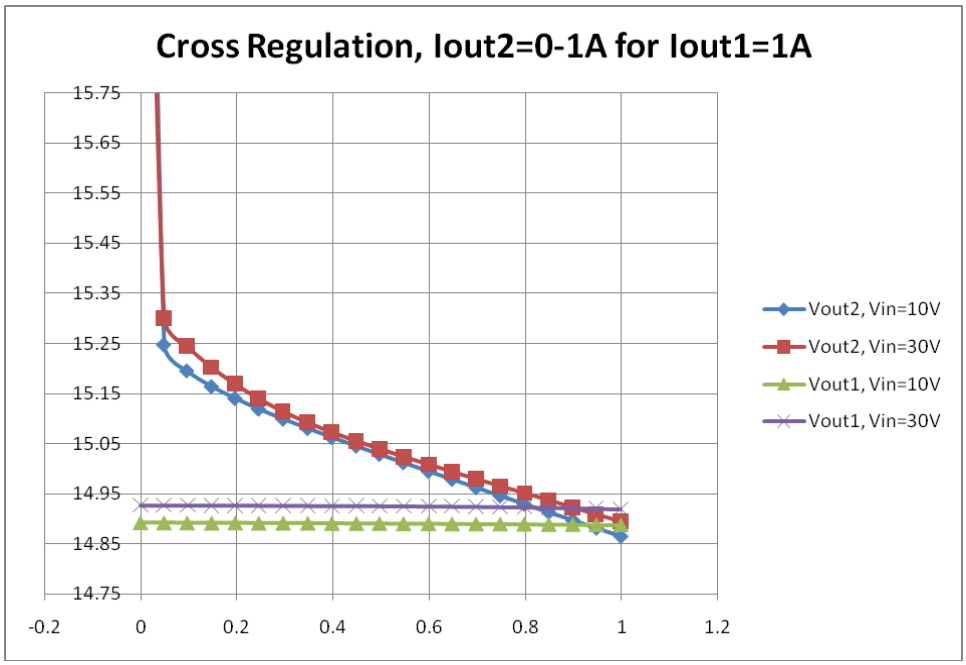
Legend: /Gain/phase @Vin=10V /Gain/phase @Vin=30V

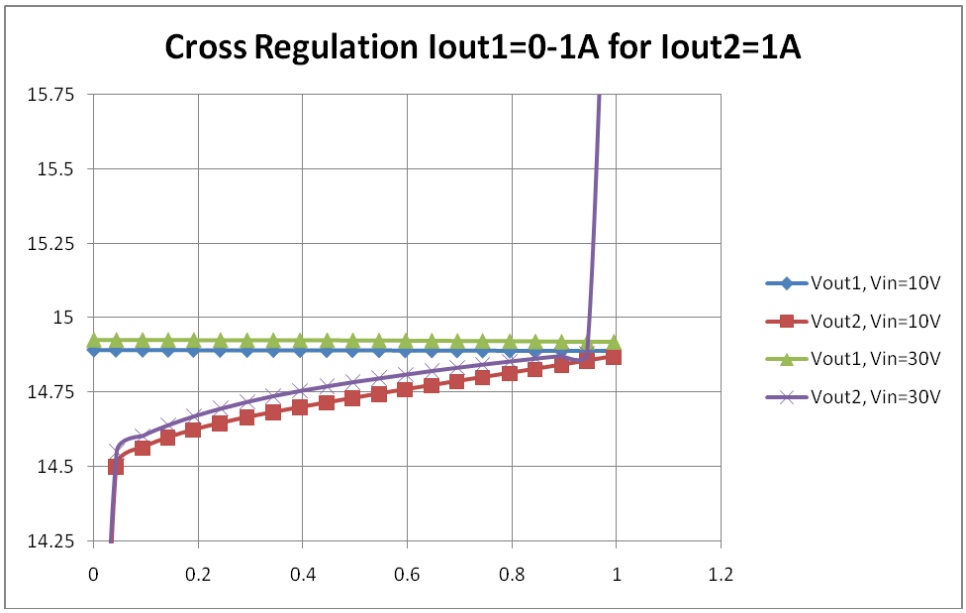
Efficiency

(equal load on Vout1/Vout2)



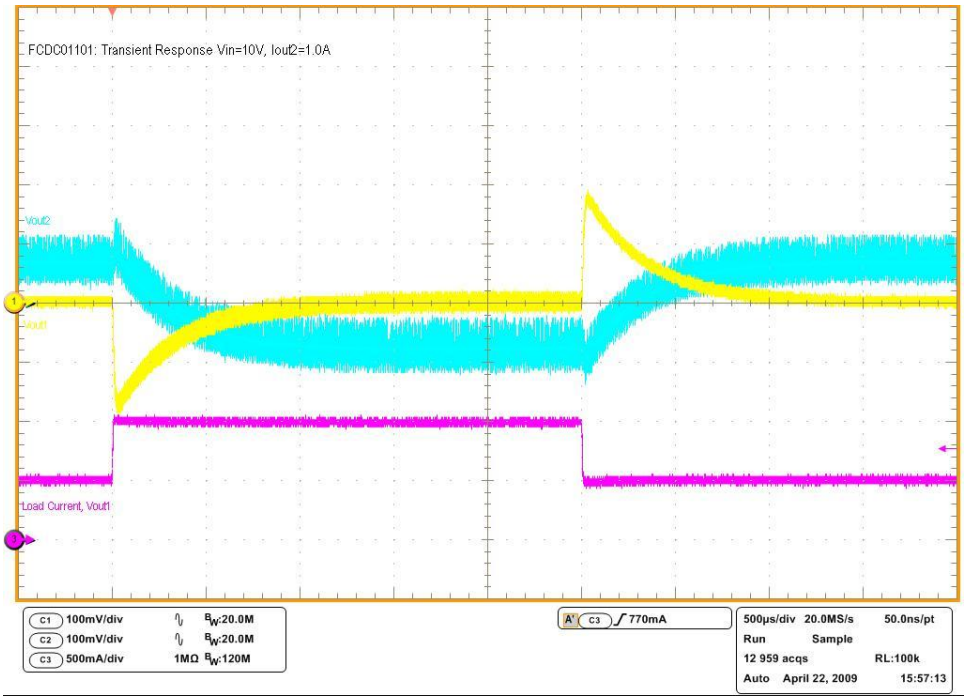
Cross Regulation

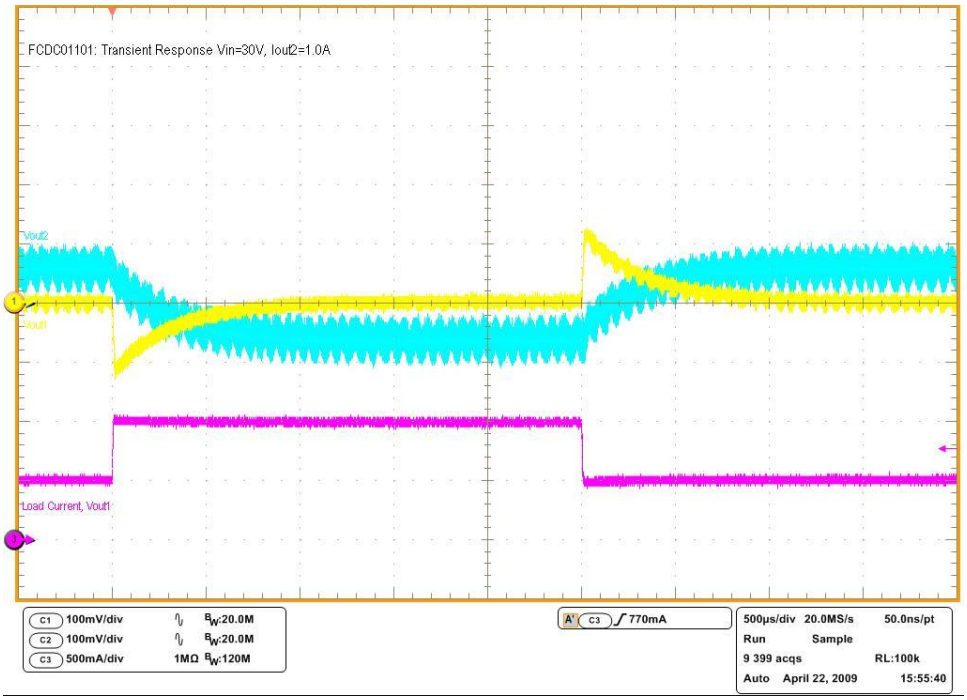




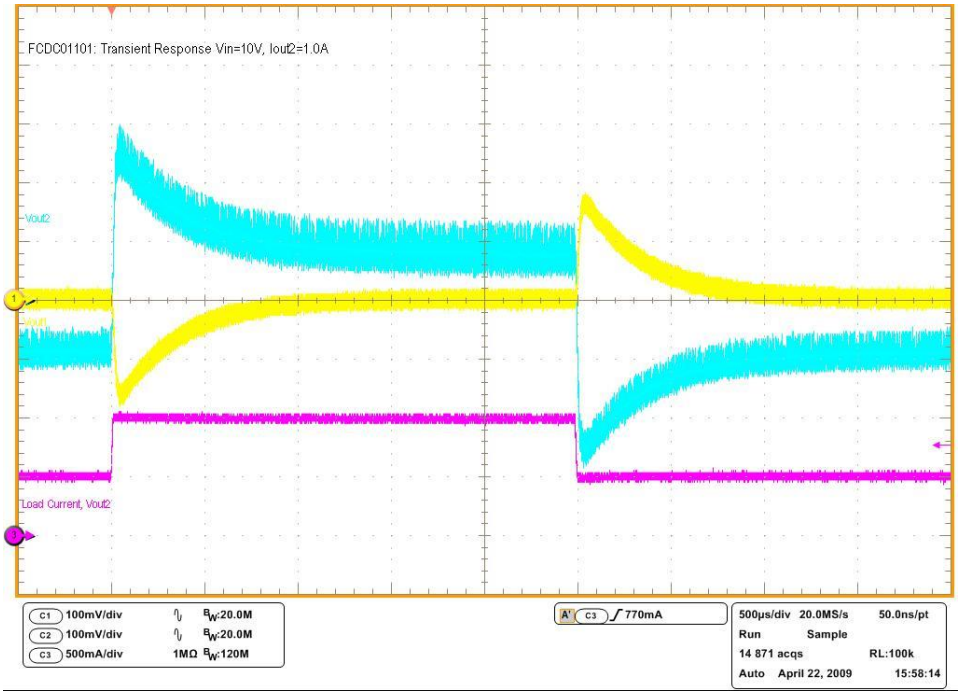
Transient Response

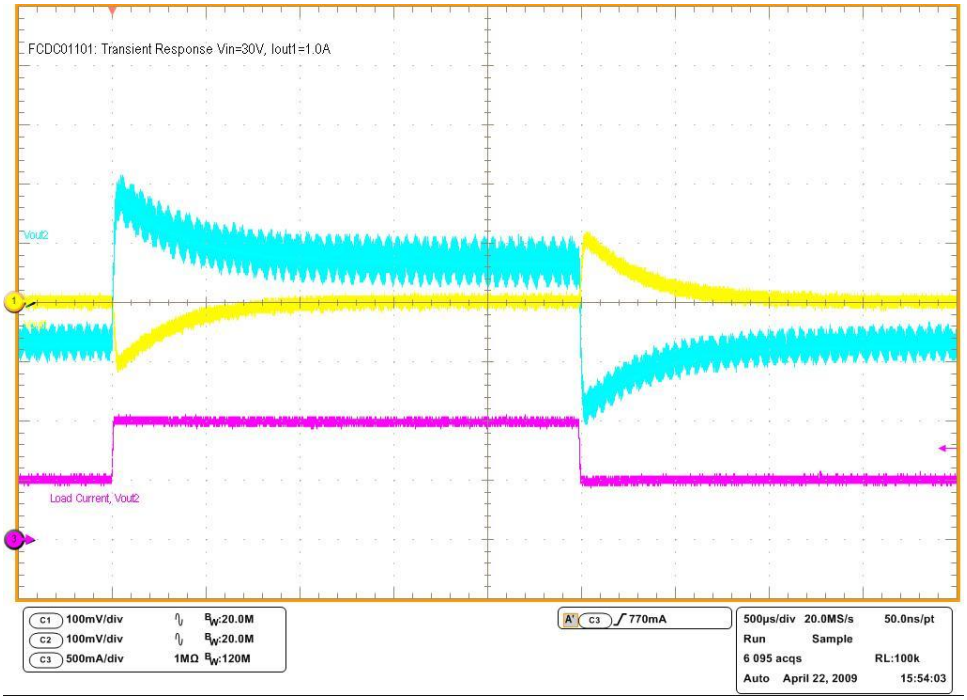
Vout1/Vout2 in response to 0.5A step on Vout1:





Vout1/Vout2 in response to 0.5A step on Vout2:





Performance Data

Operational Estimates

Spec	Vinmin	Vinmax	Units
PWM Frequency	800	800	kHz
PFM Threshold	0.005	0.005	A
Don	0.611	0.341	Ton/Tpd
Doff	0.389	0.659	Toff/Tpd
Iin Avg	3.334	1.029	A

Temperatures

From measured data on two-layer board at 25.6C extrapolated to 50C

Component	Vinmin	Vinmax	Units	Tja, degC/W
U1	88	105	degC	172
T1	103	115	degC	62
Q1	132	152	degC	60
Q2	135	152	degC	60
D1	94.9	99	degC	73
D2	94	100	degC	73
Rsense	103	113	degC	110

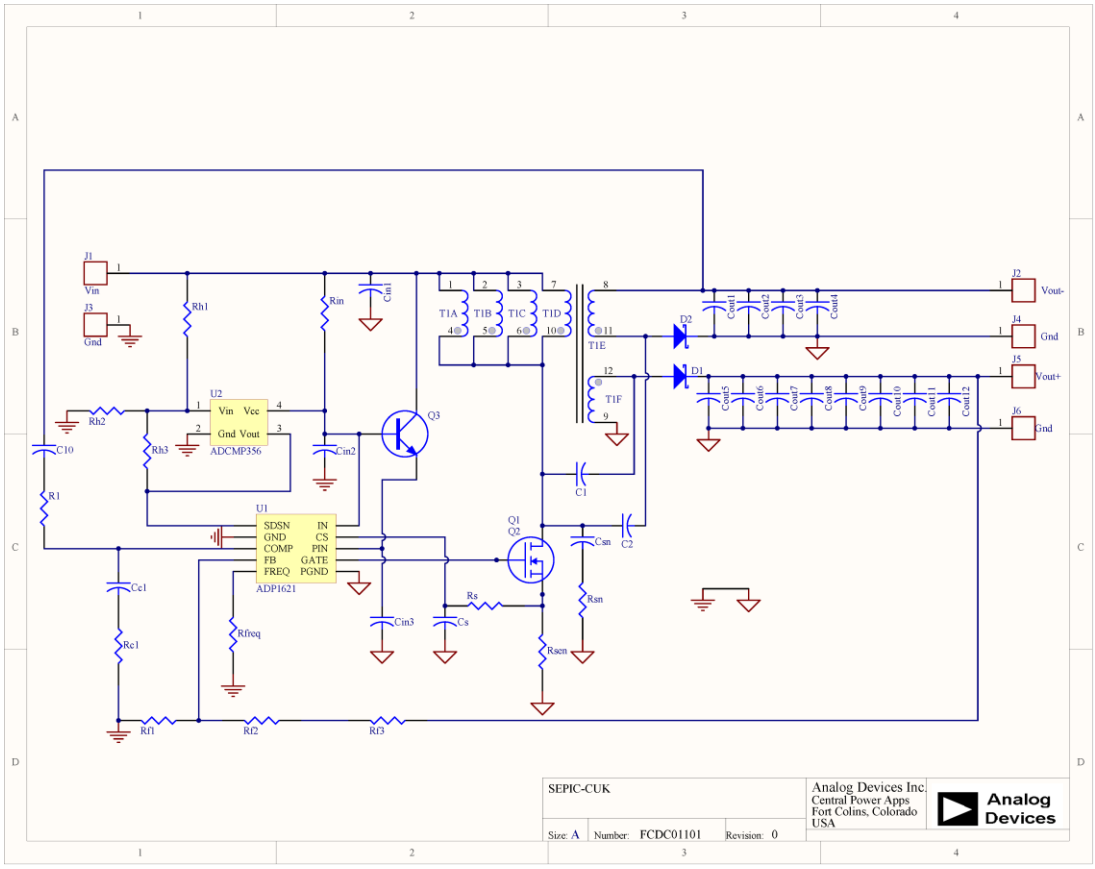
Notes:

1. Q1 and Q2 are 175C rated parts.
2. T1 is rated for up to 40C rise over 85C.

Layouts

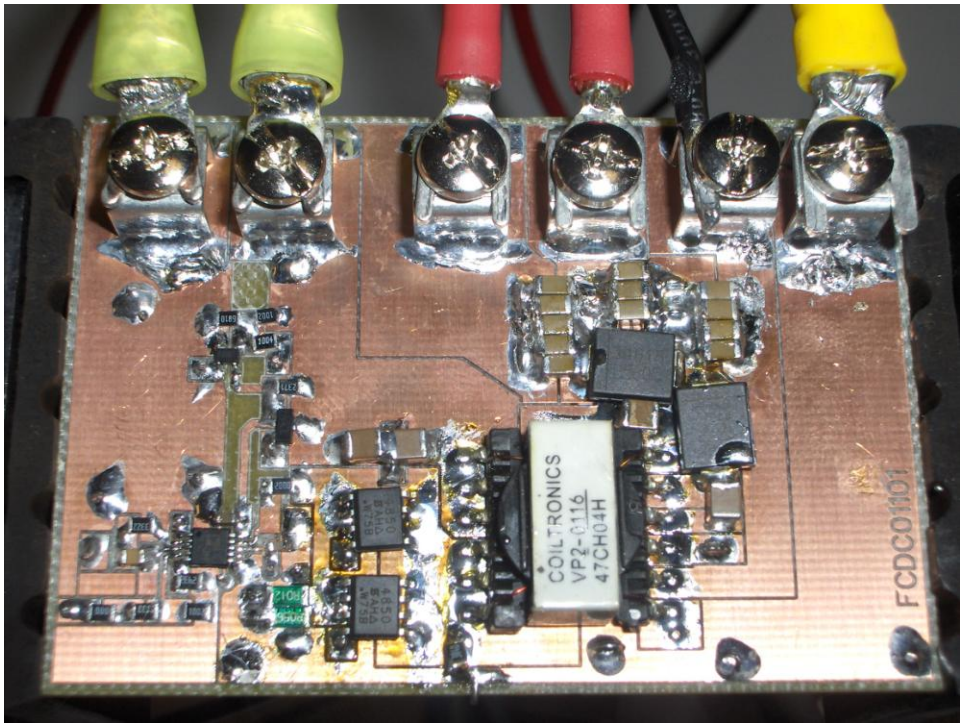
Circuit was prototyped on 2-layer mill-routed copper board and tested to verify performance. The following schematic and layouts were used:

Test board schematic



(note Rf3, R1, and C10 were used for test purposes and are not in the final design. Rf3 should be a short, and R1 and C10 are no-pop.)

Test board photograph



Test board top/bottom layout