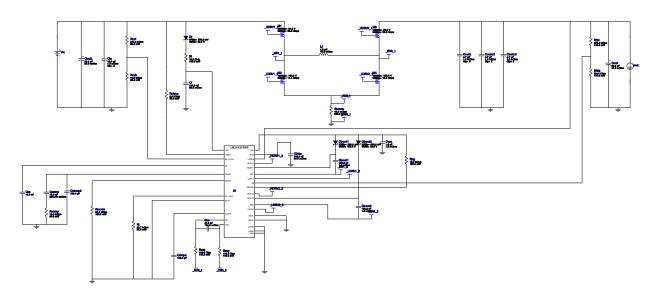


VinMin = 20.0V VinMax = 30.0V Vout = 24.0V Iout = 4.0A Device = LM34936RHFR Topology = Buck_Boost Created = 2020-07-03 06:36:32.730 BOM Cost = \$8.87 BOM Count = 52 Total Pd = 1.41W

WEBENCH® Design Report

LM34936RHFR 20V-30V to 24.00V @ 4A

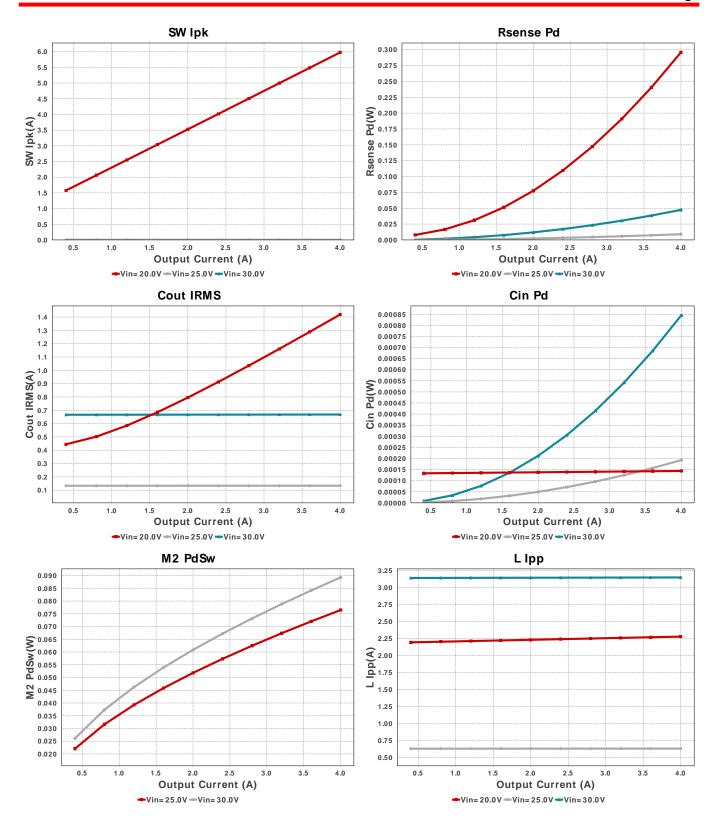


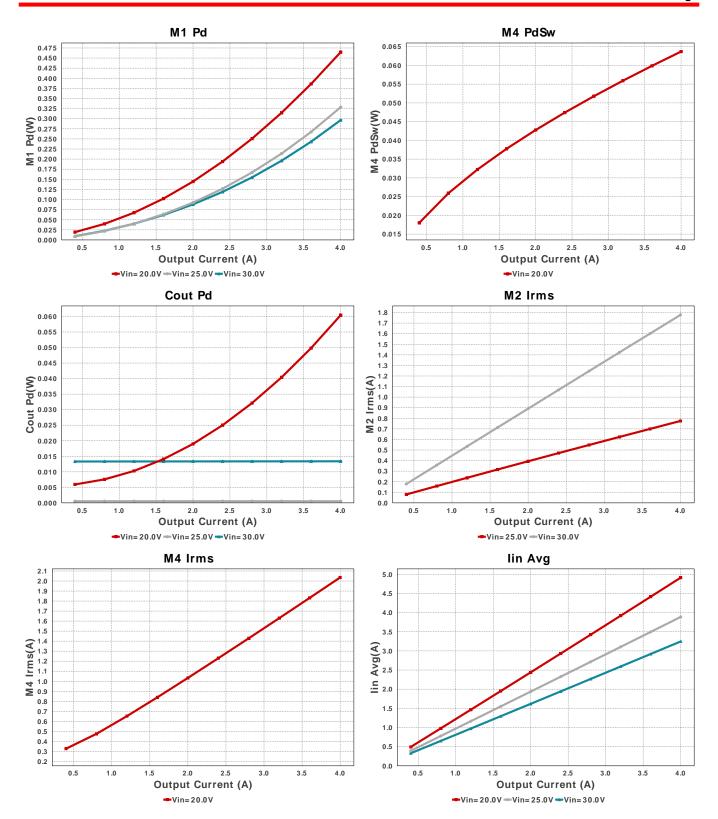
Electrical BOM

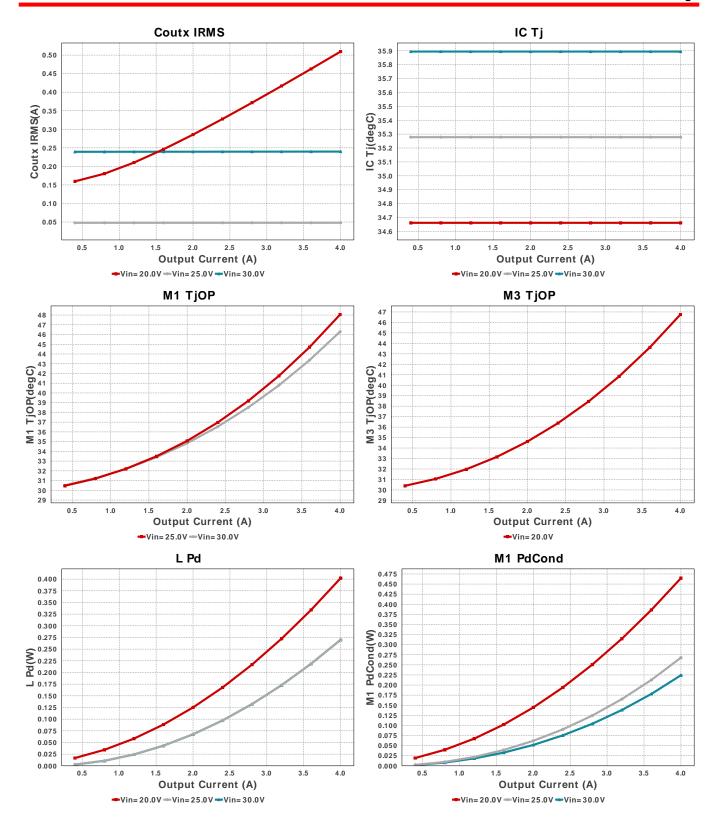
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cbias	Kemet	C0805C104M5RACTU Series= X7R	Cap= 100.0 nF ESR= 64.0 mOhm VDC= 50.0 V IRMS= 1.64 A	1	\$0.01	0805 7 mm ²
2.	Cboot1	Kemet	C0603C104Z3VACTU Series= Y5V	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	\$0.01	0603 5 mm ²
3.	Cboot2	Kemet	C0603C104Z3VACTU Series= Y5V	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	\$0.01	0603 5 mm ²
4.	Cbulk	Panasonic	50SVPF68M Series= SVPF	Cap= 68.0 uF ESR= 20.0 mOhm VDC= 50.0 V IRMS= 4.3 A	1	\$0.95	CAPSMT_62_F12 151 mm²
5.	Ccomp	TDK	CGA1A2X7R1A103K030BA Series= X7R	Cap= 10.0 nF ESR= 280.21 mOhm VDC= 10.0 V IRMS= 245.72 mA	1	\$0.01	0201_033 2 mm ²
6.	Ccomp2	Samsung Electro- Mechanics	CL21C121JBANNNC Series= C0G/NP0	Cap= 120.0 pF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	0805 7 mm ²
7.	Ccs	AVX	06035A470JAT2A Series= C0G/NP0	Cap= 47.0 pF ESR= 174.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	0603 5 mm ²
8.	Cf	TDK	CGA3E2X7R1H104K080AA Series= X7R	Cap= 100.0 nF ESR= 29.6 mOhm VDC= 50.0 V IRMS= 971.99 mA	1	\$0.01	0603 5 mm ²

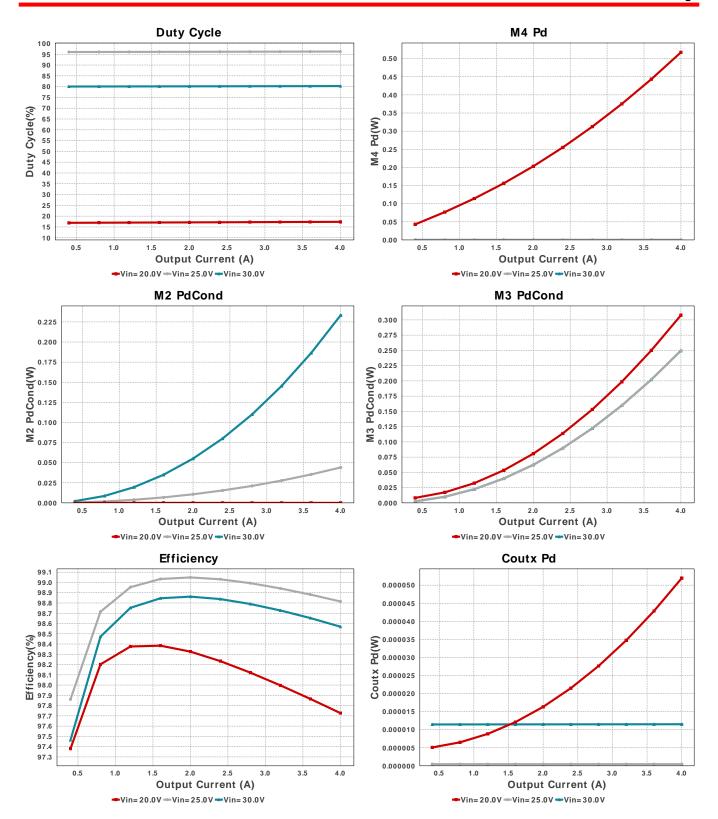
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
9.	Cin	TDK	C3225X7R1H106M250AC Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 5.0 A	3	\$0.28	1210 15 mm ²
10.	Cout	Panasonic	35SVPF39M Series= SVPF	Cap= 39.0 uF ESR= 30.0 mOhm VDC= 35.0 V IRMS= 2.8 A	1	\$0.52	CAPSMT_62_E7 106 mm ²
11.	Coutx	TDK	C2012X5R1H475K125AB Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 4.3 A	5	\$0.18	0805 7 mm ²
12.	Coutx2	TDK	C2012X5R1H475K125AB Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 4.3 A	5	\$0.18	0805 7 mm ²
13.	Coutx3	TDK	C2012X5R1H475K125AB Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 4.3 A	5	\$0.18	0805 7 mm ²
14.	Cslope	Samsung Electro- Mechanics	CL10C131JB8NNNC Series= C0G/NP0	Cap= 130.0 pF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	0603 5 mm ²
15.	Css	Kemet	C0603C153J3GACTU Series= C0G/NP0	Cap= 15.0 nF VDC= 25.0 V IRMS= 0.0 A	1	\$0.10	0603 5 mm ²
16.	Cvcc	Taiyo Yuden	EMK107B7105KA-T Series= X7R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	\$0.02	0603 5 mm ²
17.	Dboot1	SMC Diode Solutions	SK215ATR	VF@Io= 950.0 mV VRRM= 150.0 V	1	\$0.04	SMA 37 mm ²
18.	Dboot2	Fairchild Semiconductor	SS14FL	VF@Io= 550.0 mV VRRM= 40.0 V	1	\$0.04	SOD-123F 12 mm ²
19.	Df	SMC Diode Solutions	SK19TR	VF@Io= 850.0 mV VRRM= 90.0 V	1	\$0.04	SMB 44 mm ²
20.	L1	Bourns	SRR1280-4R5Y	L= 4.5 μH DCR= 13.5 mOhm	1	\$0.45	SRR1280 210 mm ²
21.	M1	Texas Instruments	CSD18543Q3A	VdsMax= 60.0 V ldsMax= 35.0 Amps	1	\$0.25	DNH0008A 18 mm ²
22.	M2	Texas Instruments	CSD19538Q2	VdsMax= 100.0 V IdsMax= 14.4 Amps	1	\$0.15	DQK0006C 9 mm ²
23.	M3	Texas Instruments	CSD17571Q2	VdsMax= 30.0 V ldsMax= 22.0 Amps	1	\$0.10	DQK0006C 9 mm ²
24.	M4	Texas Instruments	CSD19538Q3A	VdsMax= 100.0 V IdsMax= 15.0 Amps	1	\$0.15	DNH0008A 18 mm ²
25.	Rcomp	Yageo	RC0201FR-0710KL Series= ?	Res= 10000.00hm Power= 50.0 mW Tolerance= 1.0%	1	\$0.01	0201 2 mm ²
26.	Rcsg	Vishay-Dale	CRCW0603100RFKEA Series= CRCWe3	Res= 100.00hm Power= 100.0 mW Tolerance= 1.0%	1	\$0.01	0603 5 mm ²

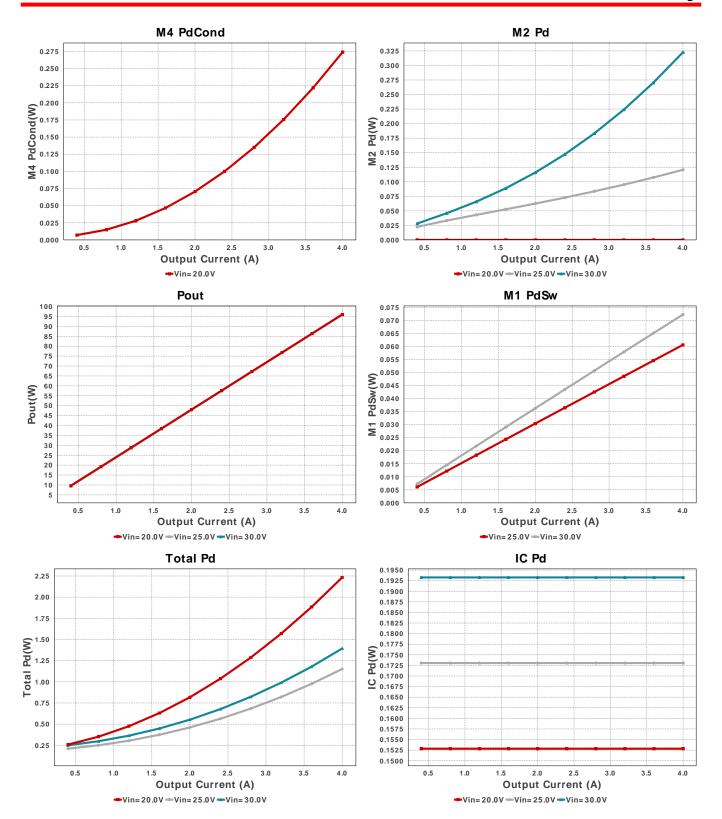
# Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
27. Rcsp	Vishay-Dale	CRCW0603100RFKEA Series= CRCWe3	Res= 100.00hm Power= 100.0 mW Tolerance= 1.0%	1	\$0.01	0603 5 mm ²
28. Rf	Vishay-Dale	CRCW060310R0FKEA Series= CRCWe3	Res= 10.00hm Power= 100.0 mW Tolerance= 1.0%	1	\$0.01	0603 5 mm ²
29. Rfbb	Vishay-Dale	CRCW060320K0FKEA Series= CRCWe3	Res= 20000.00hm Power= 100.0 mW Tolerance= 1.0%	1	\$0.01	0603 5 mm ²
30. Rfbt	Yageo	RC0603FR-07576KL Series= ?	Res= 576000.00hm Power= 100.0 mW Tolerance= 1.0%	1	\$0.01	0603 5 mm ²
31. Rmode	Vishay-Dale	CRCW060393K1FKEA Series= CRCWe3	Res= 93100.00hm Power= 100.0 mW Tolerance= 1.0%	1	\$0.01	0603 5 mm ²
32. Rpg	Vishay-Dale	CRCW060310K0FKEA Series= CRCWe3	Res= 10000.00hm Power= 100.0 mW Tolerance= 1.0%	1	\$0.01	0603 5 mm ²
33. Rsense	Stackpole Electronics Inc	CSR1206FK15L0 Series= ?	Res= 0.015Ohm Power= 500.0 mW Tolerance= 1.0%	1	\$0.12	1206 11 mm ²
34. Rt	Yageo	RC0201FR-0723K7L Series= ?	Res= 23700.00hm Power= 50.0 mW Tolerance= 1.0%	1	\$0.01	0201 2 mm ²
35. Ruvb	Vishay-Dale	CRCW040216K9FKED Series= CRCWe3	Res= 16900.00hm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm ²
36. Ruvt	Yageo	RC0201FR-07249KL Series= ?	Res= 249000.00hm Power= 50.0 mW Tolerance= 1.0%	1	\$0.01	0201 2 mm ²
37. Rvisns	Vishay-Dale	CRCW04022K00FKED Series= CRCWe3	Res= 2000.00hm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm ²
38. U1	Texas Instruments	LM34936RHFR	Switcher	1	\$2.20	RHF0028A 42 mm ²

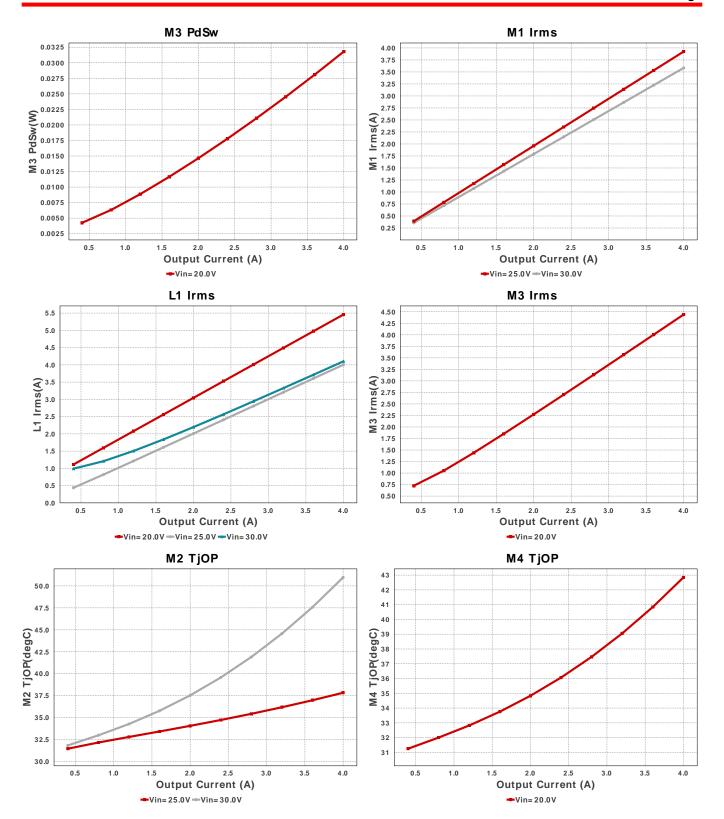


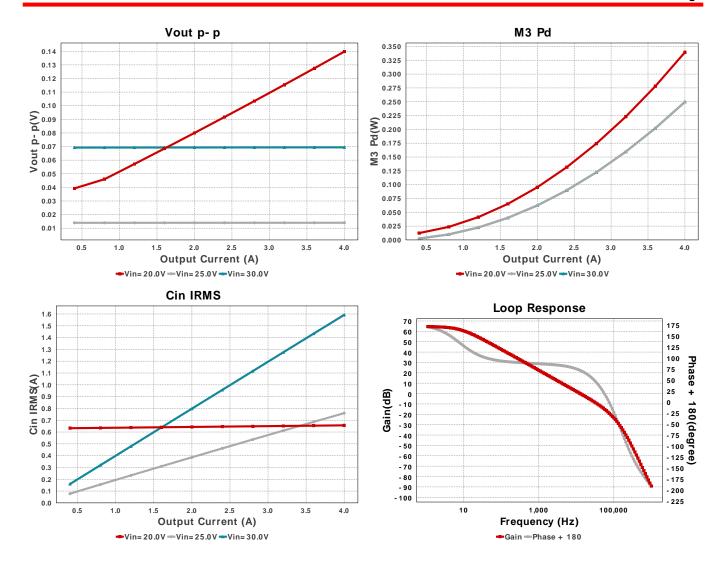












Operating Values

rating values			
Name	Value	Category	Description
Cin IRMS	1.592 A	Capacitor	Input capacitor RMS ripple current
Cin Pd	845.25 μW	Capacitor	Input capacitor power dissipation
Cout IRMS	668.475 mA	Capacitor	Output capacitor RMS ripple current
Cout Pd	13.406 mW	Capacitor	Output capacitor power dissipation
Coutx IRMS	239.409 mA	Capacitor	Output capacitor_x RMS ripple current
Coutx Pd	11.463 μW	Capacitor	Output capacitor_x power loss
IC Pd	193.26 mW	IC	IC power dissipation
IC Tj	35.894 degC	IC	IC junction temperature
IC Tolerance	0.0 V	IC	IC Feedback Tolerance
ICThetaJA	30.5 degC/W	IC	IC junction-to-ambient thermal resistance
lin Avg	3.247 A	IC	Average input current
L lpp	3.145 A	Inductor	Peak-to-peak inductor ripple current
L Pd	270.0 mW	Inductor	Inductor power dissipation
L1 Irms	4.102 A	Inductor	Inductor ripple current
M1 Irms	3.583 A	Mosfet	MOSFET RMS ripple current
M1 Pd	298.66 mW	Mosfet	MOSFET power dissipation
M1 PdCond	226.46 mW	Mosfet	M1 MOSFET conduction losses
M1 PdSw	72.203 mW	Mosfet	M1 MOSFET switching losses
M1 Rdson	15.6 mOhm	Mosfet	Drain-Source On-resistance
M1 ThetaJA	55.0 degC/W	Mosfet	MOSFET junction-to-ambient thermal resistance
M1 TjOP	46.426 degC	Mosfet	MOSFET junction temperature
M2 Irms	1.778 A	Mosfet	MOSFET RMS ripple current
M2 Pd	337.63 mW	Mosfet	MOSFET power dissipation
M2 PdCond	248.35 mW	Mosfet	M2 MOSFET conduction losses
M2 PdSw	89.276 mW	Mosfet	M2 MOSFET switching losses
M2 Rdson	66.08 mOhm	Mosfet	Drain-Source On-resistance
M2 ThetaJA	65.0 degC/W	Mosfet	MOSFET junction-to-ambient thermal resistance
M2 TjOP	51.946 degC	Mosfet	MOSFET junction temperature
M3 Pd	249.6 mW	Mosfet	M3 MOSFET total power dissipation
M3 PdCond	249.6 mW	Mosfet	M3 MOSFET conduction losses
M4 Pd	100.0 pW	Mosfet	M4 MOSFET total power dissipation
Cin Pd	845.25 μW	Power	Input capacitor power dissipation
	Name Cin IRMS Cin Pd Cout IRMS Cout Pd Coutx IRMS Coutx Pd IC Pd IC Tj IC Tolerance ICThetaJA Iin Avg L Ipp L Pd L1 Irms M1 Irms M1 Pd M1 PdCond M1 PdSw M1 Rdson M1 ThetaJA M1 TjOP M2 Irms M2 Pd M2 PdCond M2 PdSw M2 Rdson M2 ThetaJA M3 PdCond M4 Pd M3 PdCond M4 Pd	Name Value Cin IRMS 1.592 A Cin Pd 845.25 μW Cout IRMS 668.475 mA Cout Pd 13.406 mW Coutx IRMS 239.409 mA Coutx Pd 11.463 μW IC Pd 193.26 mW IC Tj 35.894 degC IC Tolerance 0.0 V ICThetaJA 30.5 degC/W lin Avg 3.247 A L Ipp 3.145 A L Pd 270.0 mW L1 Irms 4.102 A M1 Irms 3.583 A M1 Pd 298.66 mW M1 PdSw 72.203 mW M1 PdSw 72.203 mW M1 Rdson 15.6 mOhm M1 TjOP 46.426 degC M2 Irms 1.778 A M2 Pd 337.63 mW M2 PdSw 89.276 mW M2 PdSw 89.276 mW M2 PdSw 89.276 mW M2 TjOP 51.946 degC M3 Pd 249.6 mW M4 Pd 100.0 pW <td>Name Value Category Cin IRMS 1.592 A Capacitor Cin Pd 845.25 μW Capacitor Cout IRMS 668.475 mA Capacitor Cout Pd 13.406 mW Capacitor Coutx IRMS 239.409 mA Capacitor Coutx Pd 11.463 μW Capacitor IC Pd 193.26 mW IC IC Tj 35.894 degC IC IC Tolerance 0.0 V IC IC Tolerance 0.0 V IC ICThetaJA 30.5 degC/W IC In Avg 3.247 A IC L Ipp 3.145 A Inductor L Pd 270.0 mW Inductor L1 Irms 4.102 A Inductor L1 Irms 4.102 A Inductor M1 Pd 298.66 mW Mosfet M1 Pd 298.66 mW Mosfet M1 PdSw 72.203 mW Mosfet M1 Rdson 15.6 mOhm Mosfet M1 ThetaJA 55.0 degC/</td>	Name Value Category Cin IRMS 1.592 A Capacitor Cin Pd 845.25 μW Capacitor Cout IRMS 668.475 mA Capacitor Cout Pd 13.406 mW Capacitor Coutx IRMS 239.409 mA Capacitor Coutx Pd 11.463 μW Capacitor IC Pd 193.26 mW IC IC Tj 35.894 degC IC IC Tolerance 0.0 V IC IC Tolerance 0.0 V IC ICThetaJA 30.5 degC/W IC In Avg 3.247 A IC L Ipp 3.145 A Inductor L Pd 270.0 mW Inductor L1 Irms 4.102 A Inductor L1 Irms 4.102 A Inductor M1 Pd 298.66 mW Mosfet M1 Pd 298.66 mW Mosfet M1 PdSw 72.203 mW Mosfet M1 Rdson 15.6 mOhm Mosfet M1 ThetaJA 55.0 degC/

#	Name	Value	Category	Description
33.	Cout Pd	13.406 mW	Power	Output capacitor power dissipation
34.	Coutx Pd	11.463 μW	Power	Output capacitor_x power loss
35.	IC Pd	193.26 mW	Power	IC power dissipation
36.	L Pd	270.0 mW	Power	Inductor power dissipation
37.	M1 Pd	298.66 mW	Power	MOSFET power dissipation
38.	M1 PdCond	226.46 mW	Power	M1 MOSFET conduction losses
39.	M1 PdSw	72.203 mW	Power	M1 MOSFET switching losses
40.	M2 Pd	337.63 mW	Power	MOSFET power dissipation
41.	M2 PdCond	248.35 mW	Power	M2 MOSFET conduction losses
42.	M2 PdSw	89.276 mW	Power	M2 MOSFET switching losses
43.	M3 Pd	249.6 mW	Power	M3 MOSFET total power dissipation
44.	M3 PdCond	249.6 mW	Power	M3 MOSFET conduction losses
45.	M4 Pd	100.0 pW	Power	M4 MOSFET total power dissipation
46.	Rsense Pd	47.396 mW	Power	LED Current Rsns Power Dissipation
47.	Total Pd	1.41 W	Power	Total Power Dissipation
48.	Rsense Pd	47.396 mW	Resistor	LED Current Rsns Power Dissipation
49.	BOM Count	52	System	Total Design BOM count
			Information	•
50.	Cross Freq	12.727 kHz	System	Bode plot crossover frequency
			Information	· · ·
51.	Duty Cycle	80.251 %	System	Duty cycle
	. ,		Information	
52.	Efficiency	98.552 %	System	Steady state efficiency
			Information	
53.	FootPrint	907.0 mm ²	System	Total Foot Print Area of BOM components
			Information	·
54.	Frequency	340.229 kHz	System	Switching frequency
	, ,		Information	
55.	Gain Marg	-19.081 dB	System	Bode Plot Gain Margin
	_		Information	
56.	lout	4.0 A	System	lout operating point
			Information	
57.	Low Freq Gain	64.518 dB	System	Gain at 1Hz
			Information	
58.	Mode	CCM	System	Conduction Mode
			Information	
59.	Operating Topology	Buck	System	The current operating topology of the device
			Information	
60.	Phase Marg	72.883 deg	System	Bode Plot Phase Margin
			Information	
61.	Pout	96.0 W	System	Total output power
			Information	
62.	SW lpk	0.0 A	System	Peak switch current
			Information	
63.	Total BOM	\$8.87	System	Total BOM Cost
			Information	
64.	Vin	30.0 V	System	Vin operating point
			Information	
65.	Vout	24.0 V	System	Operational Output Voltage
			Information	
66.	Vout Actual	23.84 V	System	Vout Actual calculated based on selected voltage divider resistors
			Information	-
67.	Vout Tolerance	1.952 %	System	Vout Tolerance based on IC Tolerance (no load) and voltage divider
			Information	resistors if applicable
68.	Vout p-p	69.471 mV	System	Peak-to-peak output ripple voltage
			Information	

Design Inputs

#	Name	Value	Description
1.	lout	4.0	Maximum Output Current
2.	VinMax	30.0	Maximum input voltage
3.	VinMin	20.0	Minimum input voltage
4.	Vout	24.0	Output Voltage
5.	acFrequency	60.0	AC Frequency
6.	base_pn	LM34936	Base Product Number
7.	source	DC	Input Source Type
8.	Ta	30.0	Ambient temperature

Design Assistance

- 1. Tip: Snubbers and/or gate resistors may be required to limit the SW1,2 node switching spikes below the IC and FET abs max ratings.
- 2. Tip: Slope Capacitor: smaller slope capacitors provide better transition region behavior.
- $3. \ \textbf{LM34936} \ Product \ Folder: http://www.ti.com/product/LM34936: contains \ the \ data \ sheet \ and \ other \ resources.$

Important Notice and Disclaimer

TI provides technical and reliability data (including datasheets), design resources (including reference designs), application or other design advice, web tools, safety information, and other resources AS IS and with all faults, and disclaims all warranties. These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

Providing these resources does not expand or otherwise alter TI's applicable Terms of Sale or other applicable terms available either on ti.com or provided in conjunction with TI products.