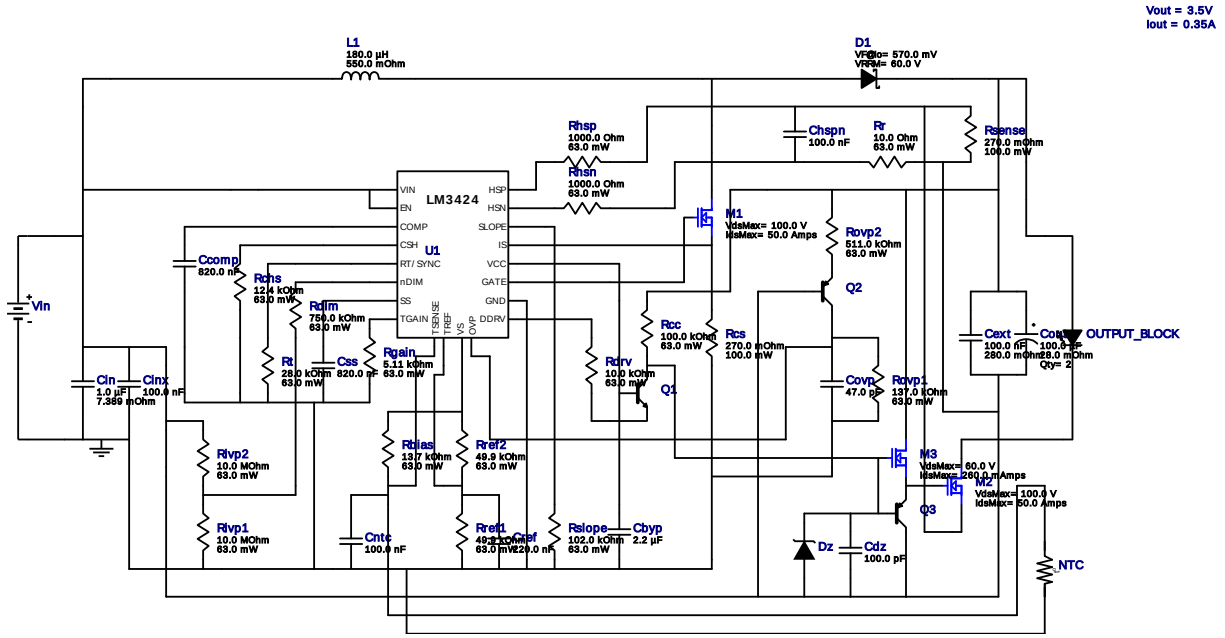
WEBENCH® Design Report

VinMin = 24.0V
VinMax = 32.0V
Vout = 3.5V
Iout = 0.35A

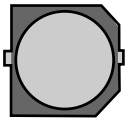
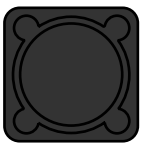
Device = LM3424MHX/NOPB
Topology = Buck_Boost
Created = 8/11/16 11:48:58 PM
BOM Cost = $0.00
BOM Count = 44
Total Pd = 1.19W

Design : 4766016/4 LM3424MHX/NOPB
LM3424MHX/NOPB 24.0V-32.0V to 3.50V @ 0.35A

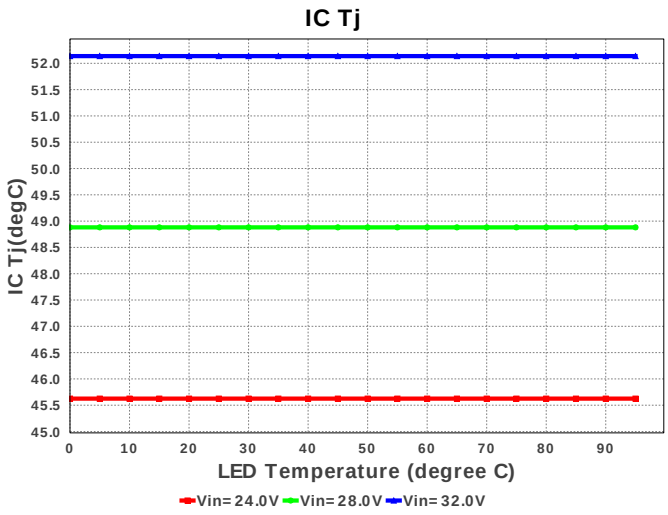


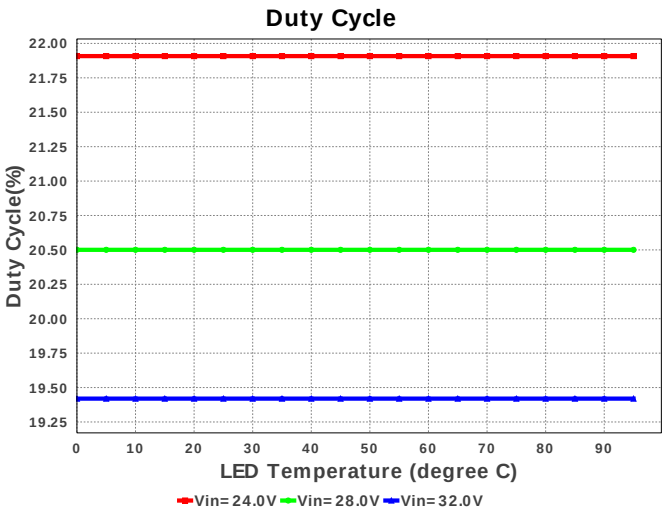
Electrical BOM

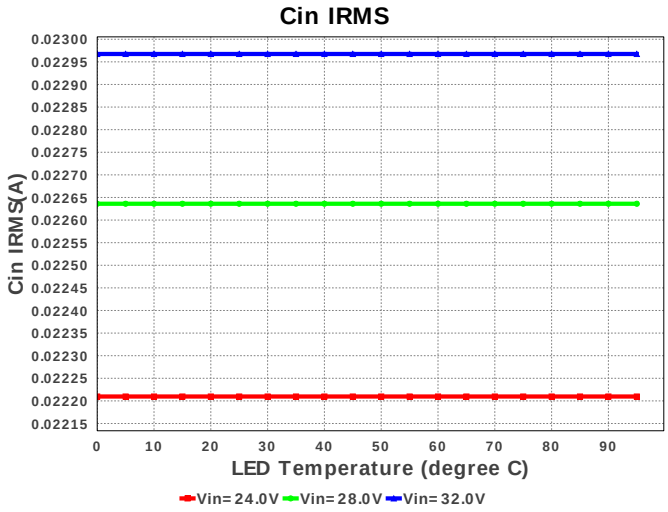
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cbyp	Taiyo Yuden	EMK212B7225KG-T Series= X7R	Cap= 2.2 uF VDC= 16.0 V IRMS= 0.0 A	1	$0.03	0805 7 mm²
2.	Ccomp	MuRata	GRM155R61A824KE15D Series= X5R	Cap= 820.0 nF VDC= 10.0 V IRMS= 0.0 A	1	$0.02	0402 3 mm²
3.	Cdz	Yageo America	CC0805JRNPO9BN101 Series= C0G/NP0	Cap= 100.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
4.	Cext	AVX	08053C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 280.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
5.	Chspn	MuRata	GRM21BR71E104KA01L Series= X7R	Cap= 100.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
6.	Cin	MuRata	GRM31MR71H105KA88L Series= X7R	Cap= 1.0 uF ESR= 7.389 mOhm VDC= 50.0 V IRMS= 979.22 mA	1	$0.03	1206 11 mm²
7.	Cinx	MuRata	GRM188R72A104KA35D Series= X7R	Cap= 100.0 nF VDC= 100.0 V IRMS= 0.0 A	1	$0.03	0603 5 mm²
8.	Cntc	MuRata	GRM21BR71E104KA01L Series= X7R	Cap= 100.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²

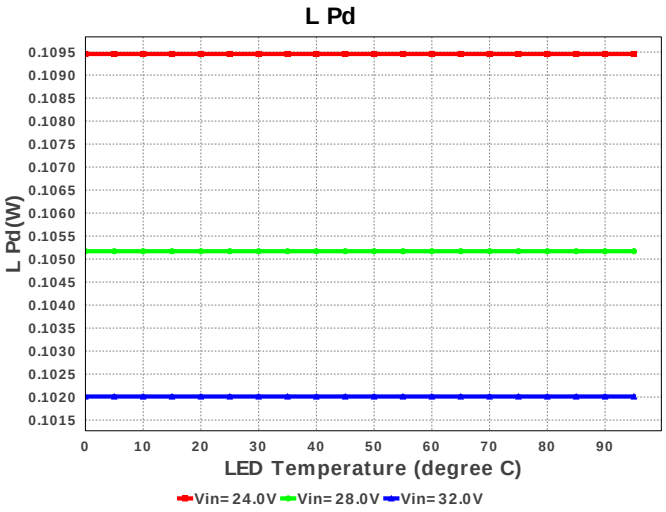
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
9.	Cout	Panasonic	EEHZA1H101P Series= ?	Cap= 100.0 uF ESR= 28.0 mOhm VDC= 50.0 V IRMS= 2.0 A	2	$2.54	 SM_RADIAL_10BMM 160 mm²
10.	Covp	Kemet	C0805C470K5GACTU Series= C0G/NP0	Cap= 47.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	 0805 7 mm²
11.	Cref	MuRata	GRM155C80G224KE01D Series= X6S	Cap= 220.0 nF VDC= 4.0 V IRMS= 0.0 A	1	$0.01	 0402 3 mm²
12.	Css	MuRata	GRM155R61A824KE15D Series= X5R	Cap= 820.0 nF VDC= 10.0 V IRMS= 0.0 A	1	$0.02	 0402 3 mm²
13.	D1	NXP Semiconductor	PMEG6010CEH,115	VF@Io= 570.0 mV VRRM= 60.0 V	1	$0.04	 SOD-123F 12 mm²
14.	D_LED	CUSTOM	CUSTOM	LED	1	NA	CUSTOM 0 mm²
15.	Dz	ON Semiconductor	BZX84C10LT1G	Zener	1	$0.02	 SOT-23 14 mm²
16.	L1	Bourns	SRR1240-181K	L= 180.0 µH DCR= 550.0 mOhm	1	$0.41	 SRR1240 210 mm²
17.	M1	Texas Instruments	CSD19537Q3	VdsMax= 100.0 V IdsMax= 50.0 Amps	1	$0.50	 TRANS_NexFET_Q3 18 mm²
18.	M2	Texas Instruments	CSD19537Q3	VdsMax= 100.0 V IdsMax= 50.0 Amps	1	$0.50	 TRANS_NexFET_Q3 18 mm²
19.	M3	ON Semiconductor	2N7002ET1G	VdsMax= 60.0 V IdsMax= 260.0 mAmps	1	$0.02	 SOT-23 14 mm²
20.	NTC	MuRata	NCP15WB473E03RC Series= NCP15	Thermistor	1	$0.03	 0402 3 mm²
21.	Q1	Diodes Inc.	MMBT3904-7-F	Bipolar Transistor	1	$0.02	 SOT-23 14 mm²
22.	Q2	Diodes Inc.	MMBT3906-7-F	Bipolar Transistor	1	$0.02	 SOT-23 14 mm²
23.	Q3	Diodes Inc.	MMBT3906-7-F	Bipolar Transistor	1	$0.02	 SOT-23 14 mm²
24.	Rbias	Vishay-Dale	CRCW040213K7FKED Series= CRCW..e3	Res= 13.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
25.	Rcc	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
26.	Rchs	Vishay-Dale	CRCW040212K4FKED Series= CRCW..e3	Res= 12.4 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
27.	Rcs	Panasonic	ERJ-3RQFR27V Series= ERJ-3R	Res= 270.0 mOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.02	 0603 5 mm²

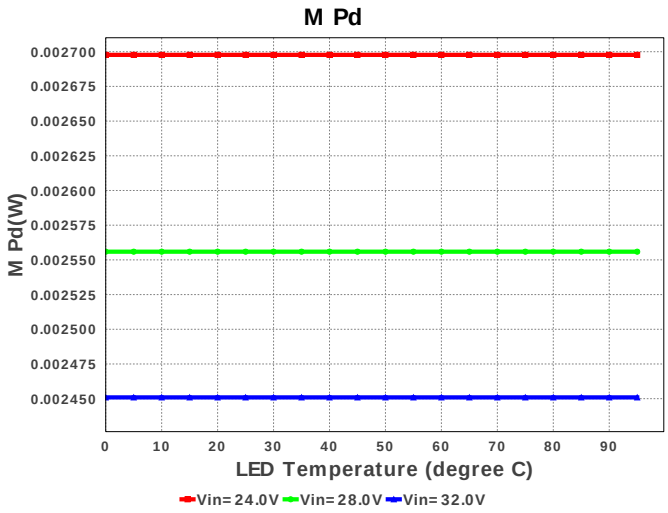
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
28.	Rdim	Vishay-Dale	CRCW0402750KFKED Series= CRCW..e3	Res= 750.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
29.	Rdrv	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
30.	Rgain	Vishay-Dale	CRCW04025K11FKED Series= CRCW..e3	Res= 5.11 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
31.	Rhsn	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
32.	Rhsp	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
33.	Rivp1	Vishay-Dale	CRCW040210M0FKED Series= CRCW..e3	Res= 10.0 MOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
34.	Rivp2	Vishay-Dale	CRCW040210M0FKED Series= CRCW..e3	Res= 10.0 MOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
35.	Rovp1	Vishay-Dale	CRCW0402137KFKED Series= CRCW..e3	Res= 137.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
36.	Rovp2	Vishay-Dale	CRCW0402511KFKED Series= CRCW..e3	Res= 511.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
37.	Rr	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
38.	Rref1	Vishay-Dale	CRCW040249K9FKED Series= CRCW..e3	Res= 49.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
39.	Rref2	Vishay-Dale	CRCW040249K9FKED Series= CRCW..e3	Res= 49.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
40.	Rsense	Panasonic	ERJ-3RQFR27V Series= ERJ-3R	Res= 270.0 mOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.02	0603 5 mm²
41.	Rslope	Vishay-Dale	CRCW0402102KFKED Series= CRCW..e3	Res= 102.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
42.	Rt	Vishay-Dale	CRCW040228K0FKED Series= CRCW..e3	Res= 28.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
43.	U1	Texas Instruments	LM3424MHX/NOPB	Switcher	1	$1.30	 MXA20A 71 mm²

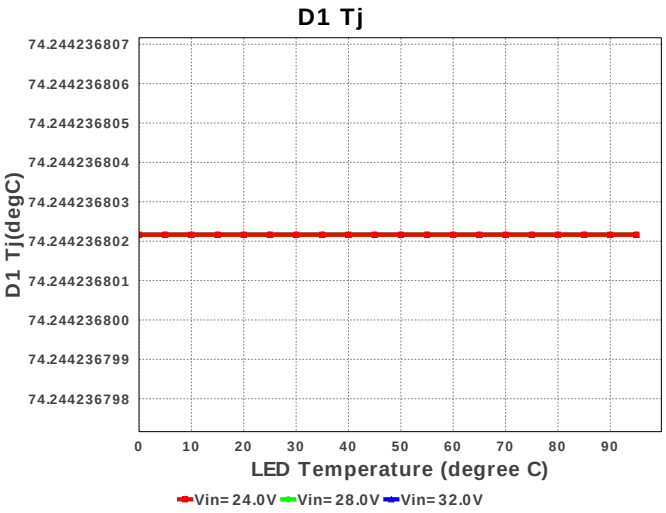


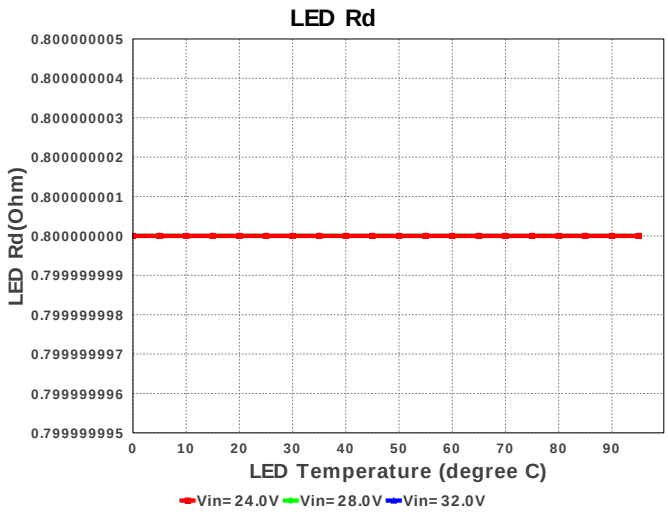


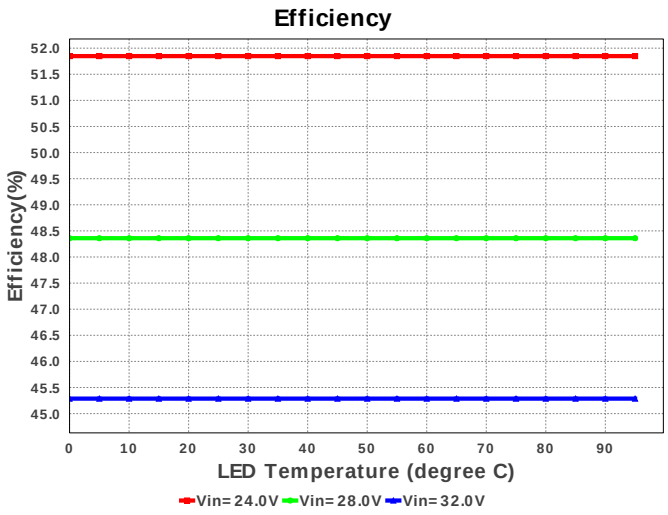


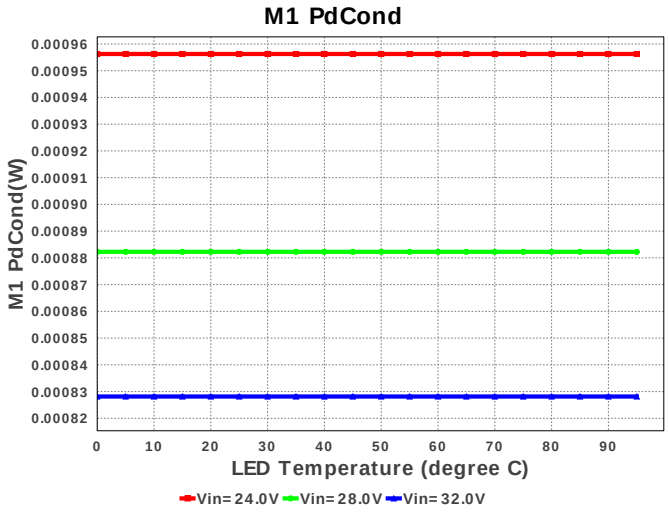


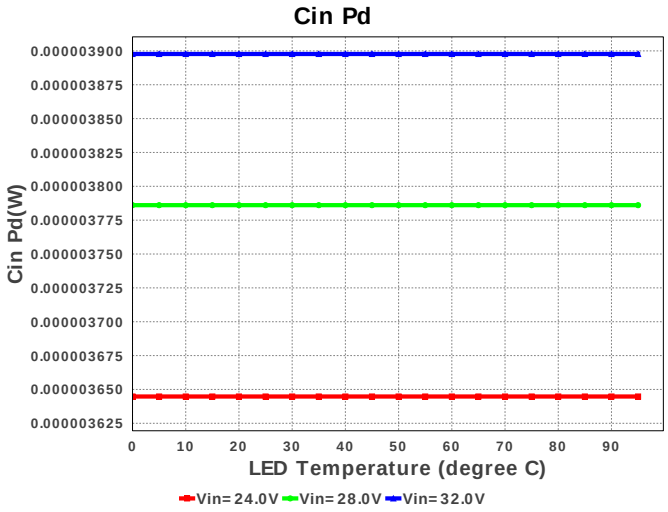


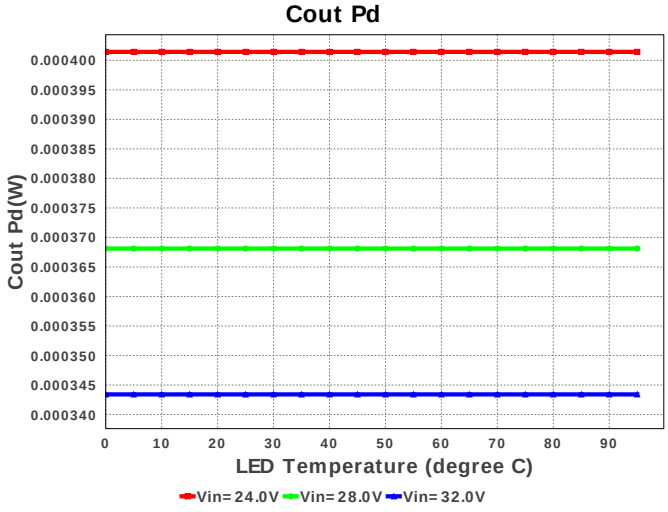


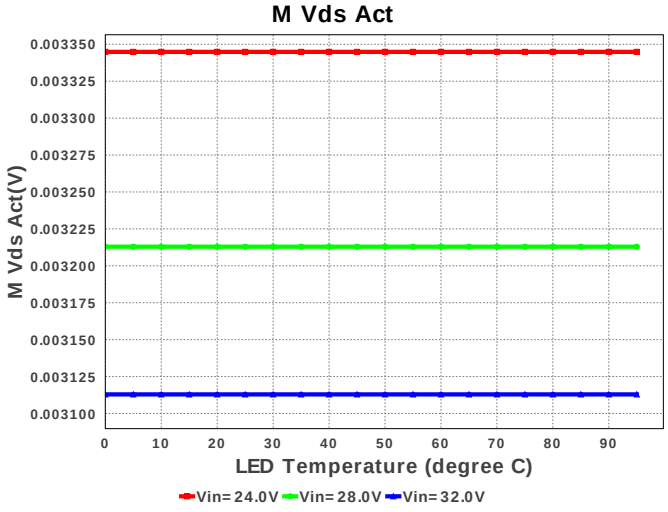


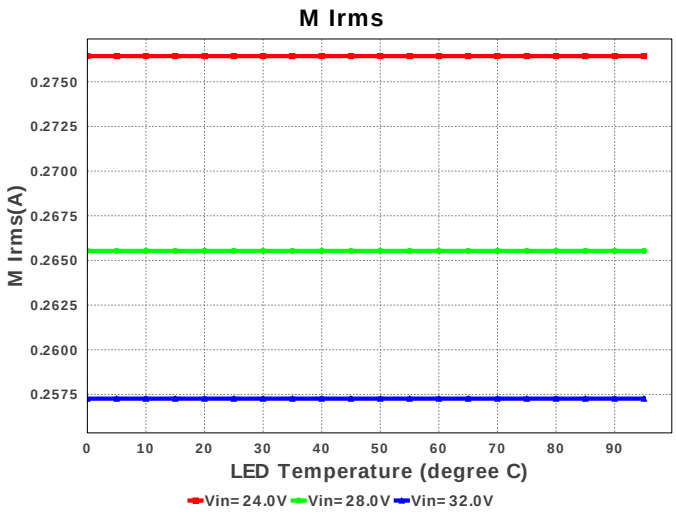


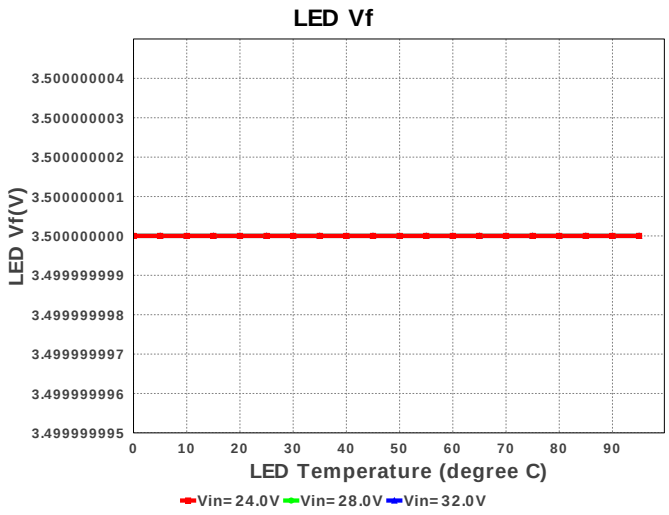


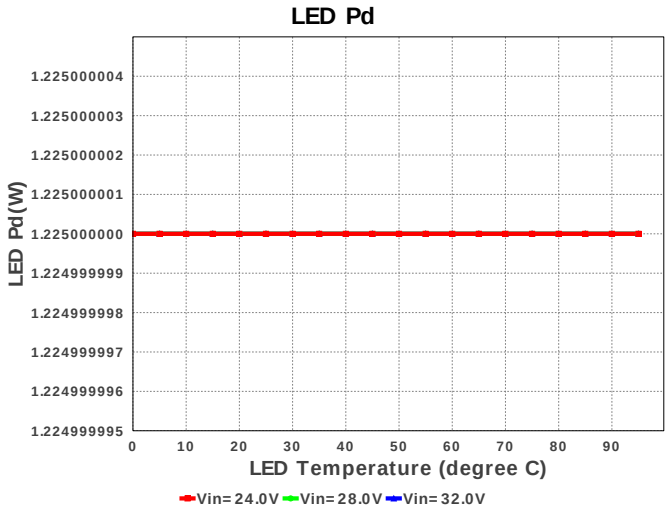


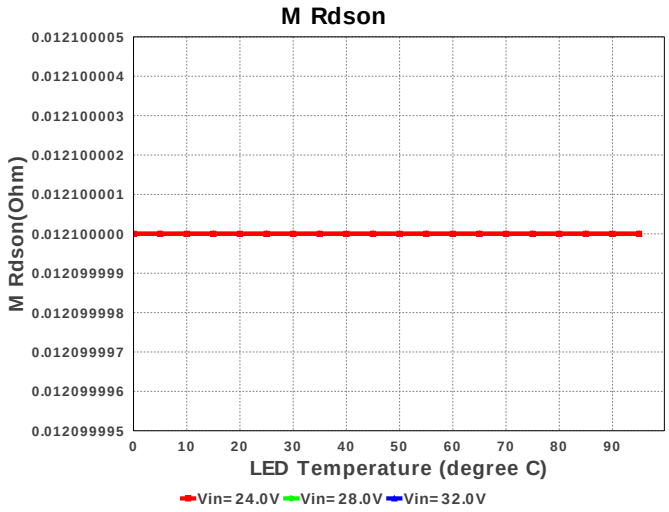


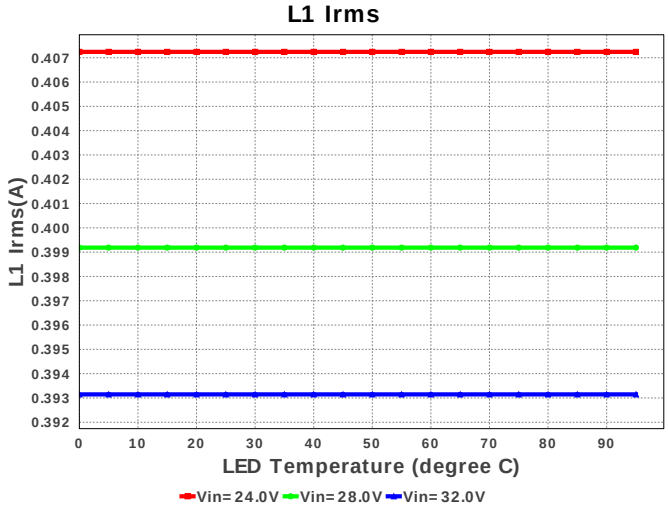


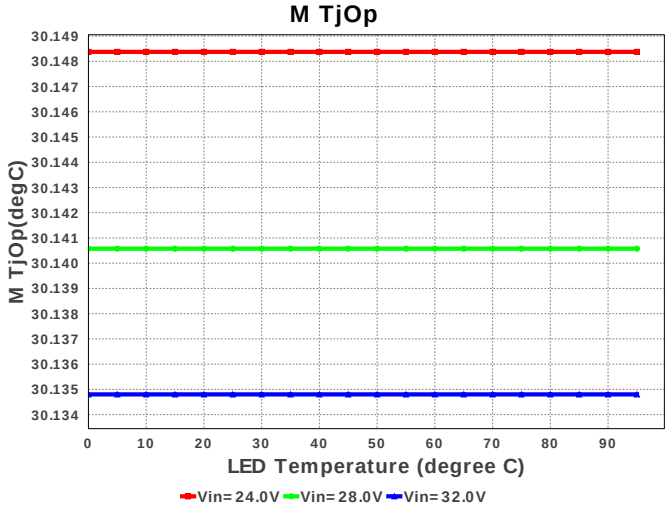


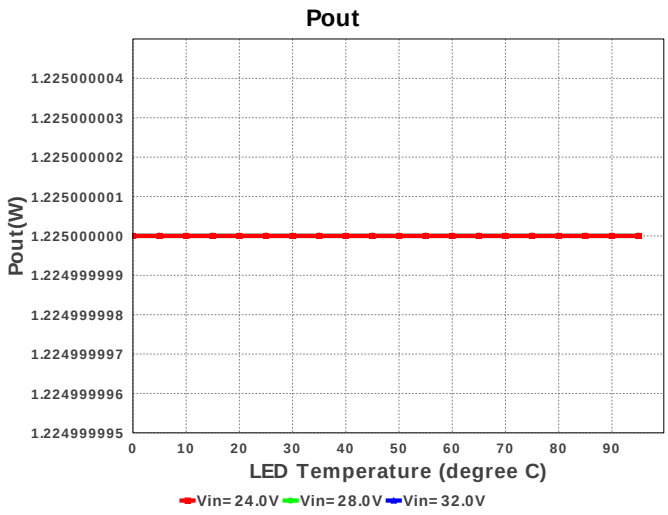


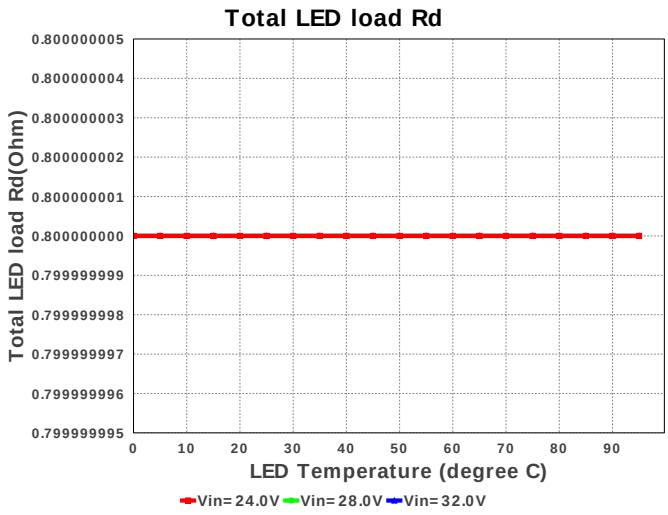


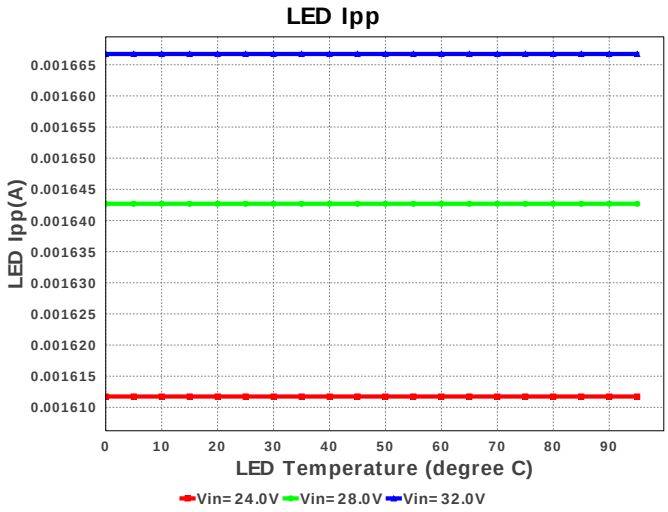


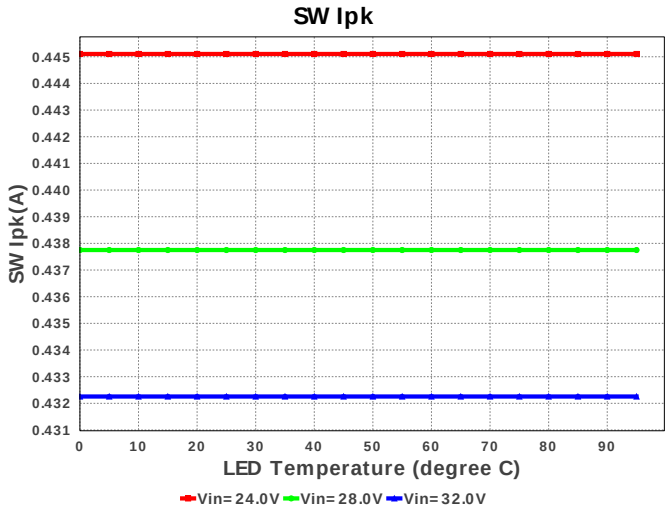


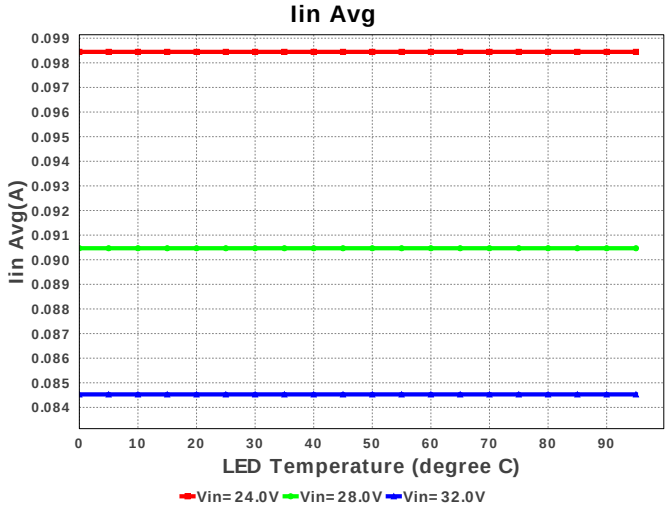


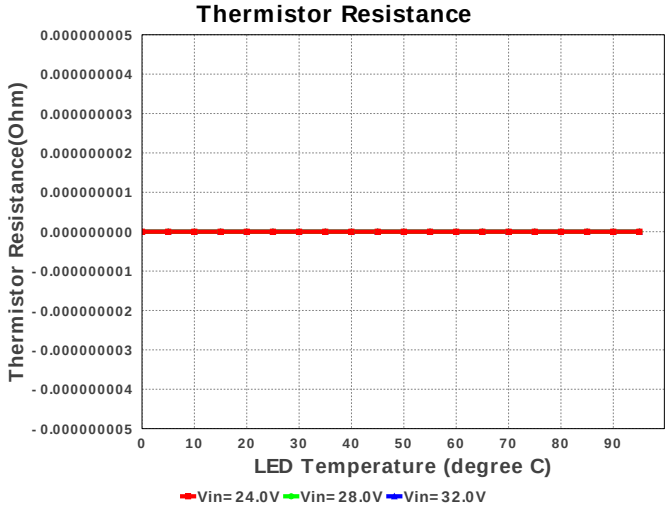


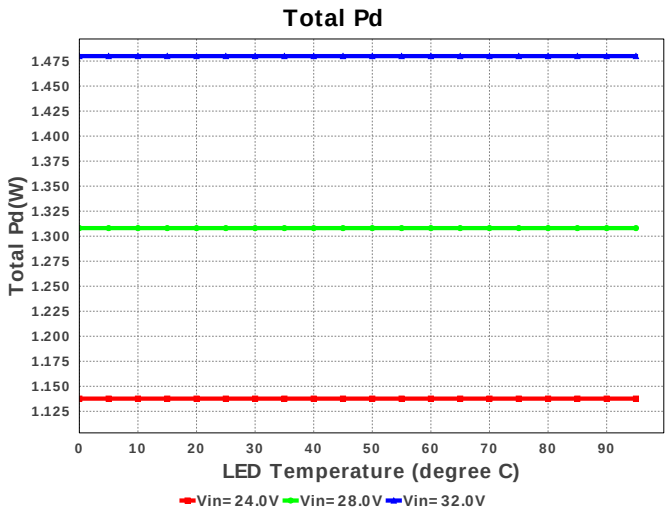


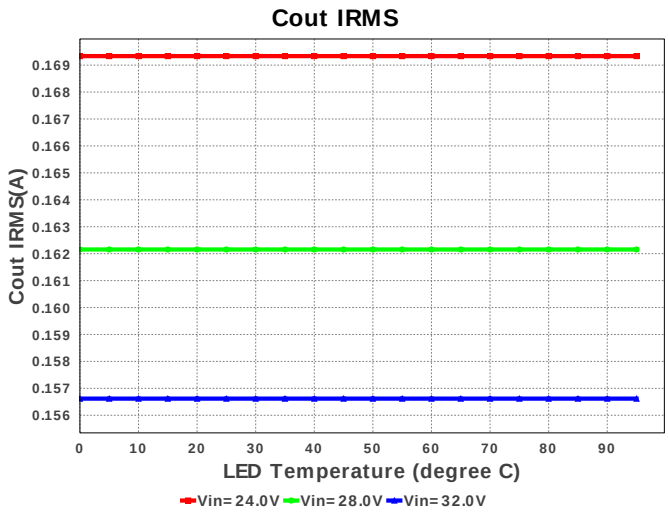


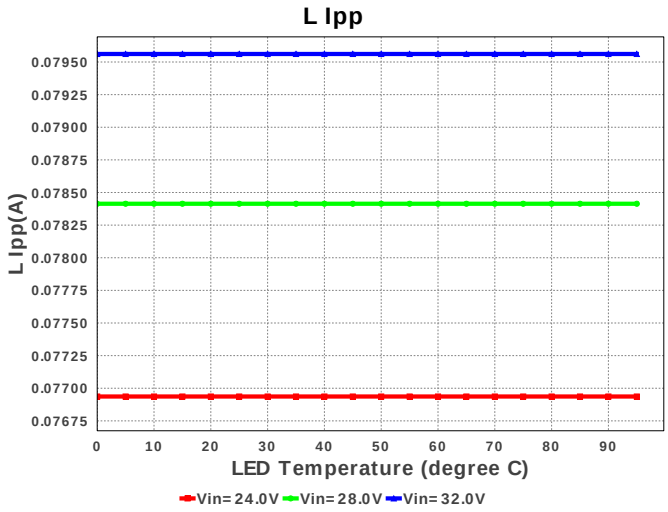


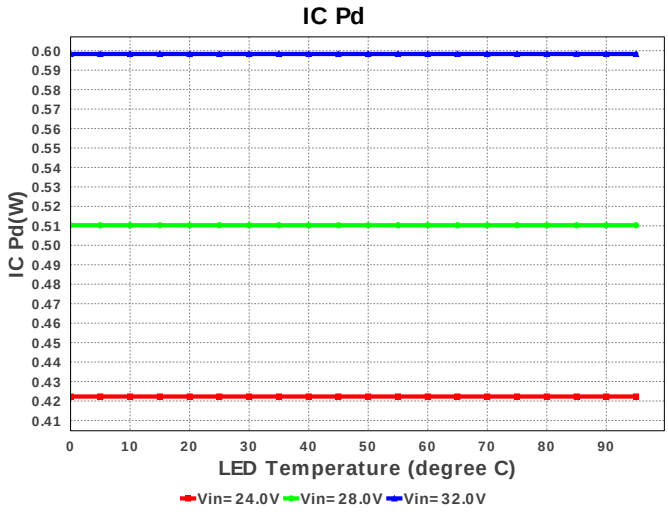


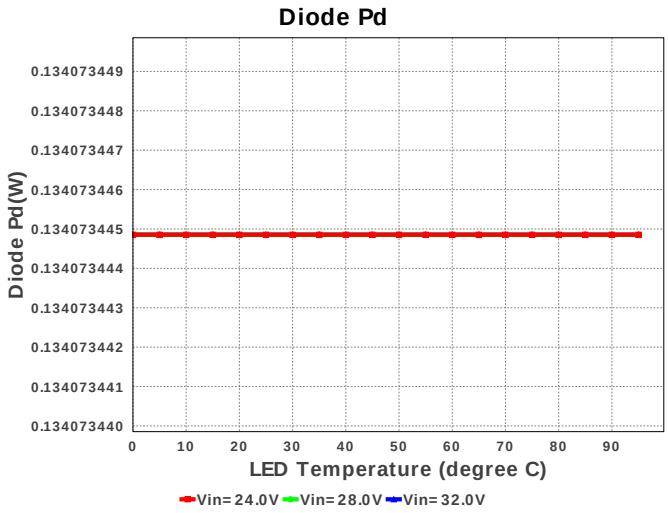


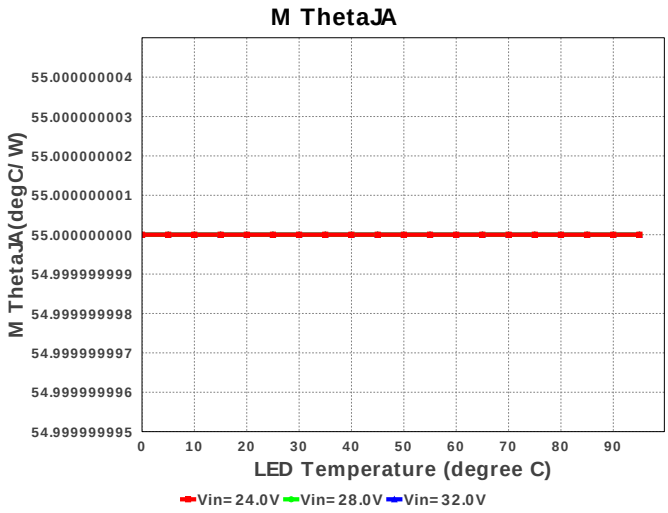


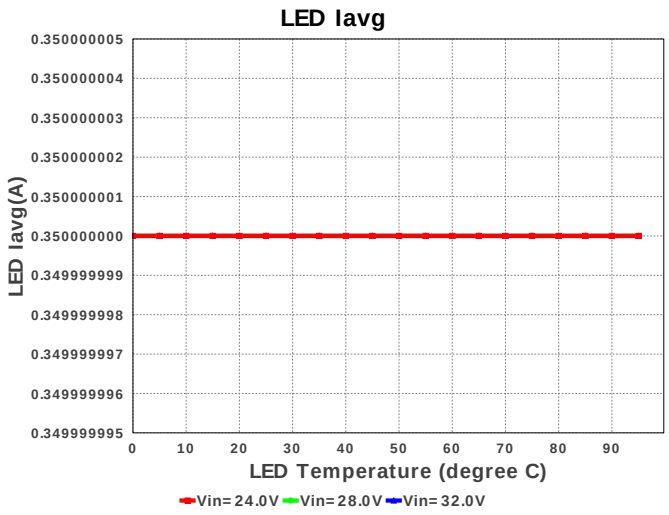


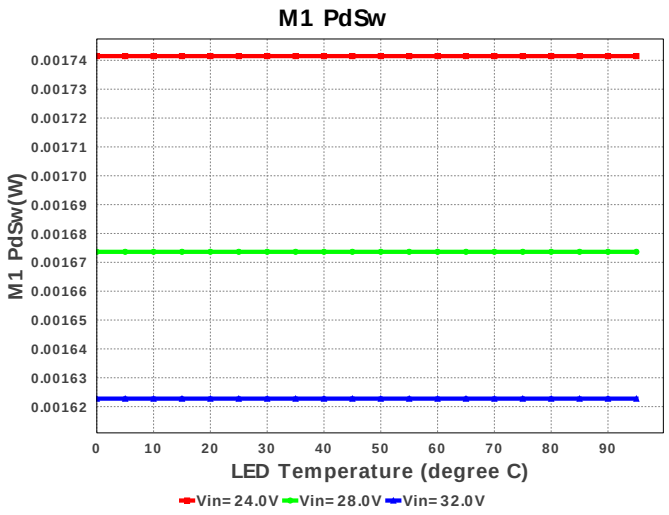












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	22.422 mA	Current	Input capacitor RMS ripple current
2.	Cout IRMS	170.587 mA	Current	Output capacitor RMS ripple current
3.	Iin Avg	100.5 mA	Current	Average input current
4.	L Ipp	77.671 mA	Current	Peak-to-peak inductor ripple current
5.	L1 Irms	407.908 mA	Current	Inductor ripple current
6.	LED Iavg	350.0 mA	Current	LED Average Current
7.	LED Ipp	1.627 mA	Current	LED Ripple Current
8.	M Irms	275.864 mA	Current	MOSFET RMS ripple current
9.	SW Ipk	446.127 mA	Current	Peak switch current
10.	BOM Count	44	General	Total Design BOM count
11.	FootPrint	849.0 mm^2	General	Total Foot Print Area of BOM components
12.	Frequency	255.241 kHz	General	Switching frequency
13.	IC Tolerance	25.0 mV	General	IC Feedback Tolerance
14.	M Rdson	0.0 Ohm	General	Drain-Source On-resistance
15.	M Vds Act	0.0 V	General	M Vds
16.	Mode	CCM	General	Conduction Mode
17.	Pout	1.225 W	General	Total output power
18.	Total BOM	$0.0	General	Total BOM Cost
19.	D1 Tj	79.499 degC	Op_Point	D1 junction temperature
20.	Vout OP	3.5 V	Op_Point	Operational Output Voltage
21.	Duty Cycle	22.263 %	Op_point	Duty cycle
22.	Efficiency	50.785 %	Op_point	Steady state efficiency
23.	IC Tj	46.26 degC	Op_point	IC junction temperature
24.	ICThetaJA	37.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
25.	IOUT_OP	350.0 mA	Op_point	Iout operating point
26.	LED Rd	800.0 mOhm	Op_point	LED DynamicResistance
27.	LED Vf	3.5 V	Op_point	Total LED Forward Calculated Voltage
28.	M ThetaJA	50.0 degC/W	Op_point	MOSFET junction-to-ambient thermal resistance
29.	M TjOp	30.136 degC	Op_point	MOSFET junction temperature
30.	VIN_OP	24.0 V	Op_point	Vin operating point
31.	Cin Pd	3.715 µW	Power	Input capacitor power dissipation
32.	Cout Pd	407.4 µW	Power	Output capacitor power dissipation
33.	Diode Pd	149.998 mW	Power	Diode power dissipation
34.	IC Pd	439.457 mW	Power	IC power dissipation
35.	L Pd	109.817 mW	Power	Inductor power dissipation
36.	LED Pd	1.225 W	Power	LED Power Dissipation
37.	M Pd	2.715 mW	Power	MOSFET power dissipation
38.	M1 PdCond	0.0 W	Power	M1 MOSFET conduction losses
39.	M1 PdSw	2.715 mW	Power	M1 MOSFET switching losses
40.	Total Pd	1.187 W	Power	Total Power Dissipation
41.	Thermistor Resistance	0.0 Ohm		The scaled resistance of the thermistor based on the temperature
42.	Total LED load Rd	800.0 mOhm		Total LED Load DynamicResistance
43.	Vout Tolerance	714.29 m%		Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable

Design Inputs

#	Name	Value	Description
1.	Iout	350.0 m	Maximum Output Current
2.	VinMax	32.0	Maximum input voltage
3.	VinMin	24.0	Minimum input voltage
4.	Vout	3.5	Output Voltage

#	Name	Value	Description
5.	application	LED_DRIVER	LED Application
6.	base_pn	LM3424	Base Product Number
7.	LED_Architect	N	LED Architect Project
8.	ledparallel	1.0	Number of LED in parallel
9.	ledpartnumber	Custom	LED Part number
10.	ledseries	1.0	Number of LED in series
11.	line_fsw	60.0	AC Line Frequency
12.	source	DC	Input Source Type
13.	Ta	30.0	Ambient temperature

Design Assistance

1. Thermal foldback is necessary in many applications due to the extreme temperatures created in LED environments. In general, two functions are necessary a temperature break-point after which the nominal operating current needs to be reduced, and a slope corresponding to the amount of LED current decrease per temperature increase.

2. The user can set the 'Start' and 'Stop' temperatures for the thermal foldback by changing the default settings on the 'Thermal Foldback start and end temperatures' in the 'Advanced Options' menu on the left side bar. These values are then updated on the 'Op-Vals' section. The 'Op-Vals' section has a slider to simulate the increase or decrease in temperature. The operating value 'Thermal Resistance' changes based on the change in temperature. This is the resistance of the thermistor at the selected temperature and it's value is then updated in the simulation directly

3. **LM3424** Product Folder : http://www.ti.com/product/LM3424 : contains the data sheet and other resources.