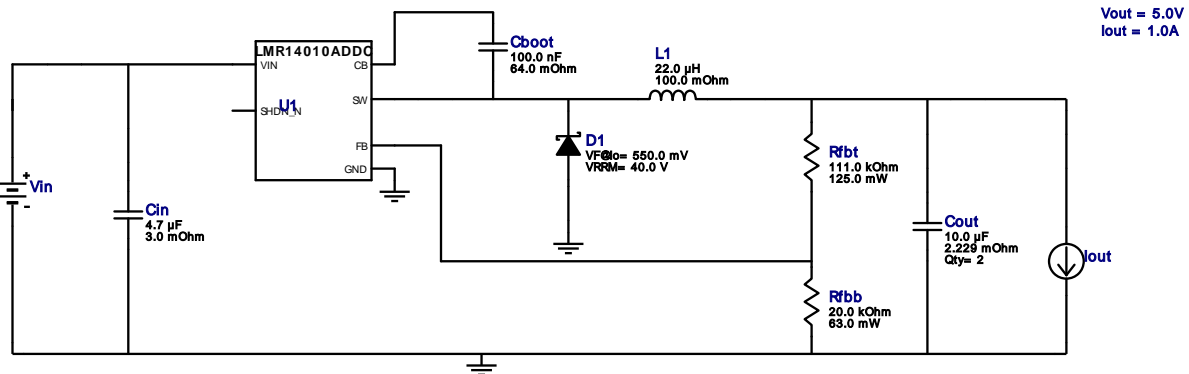


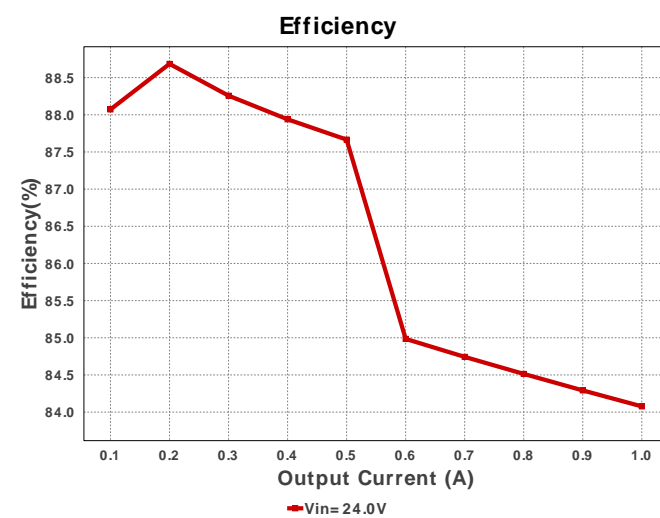
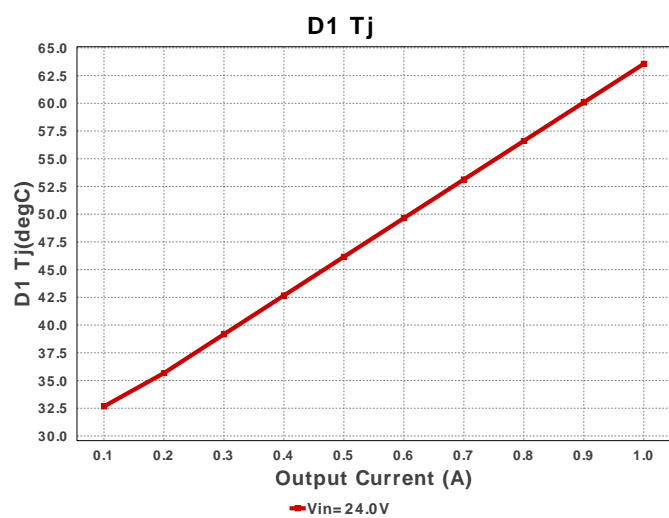
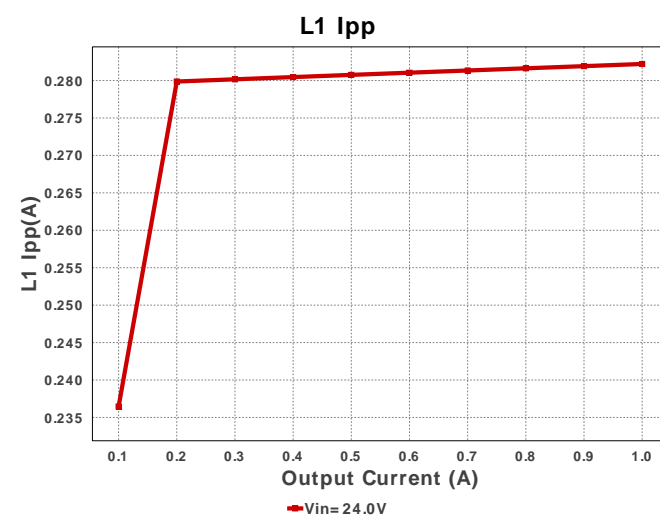
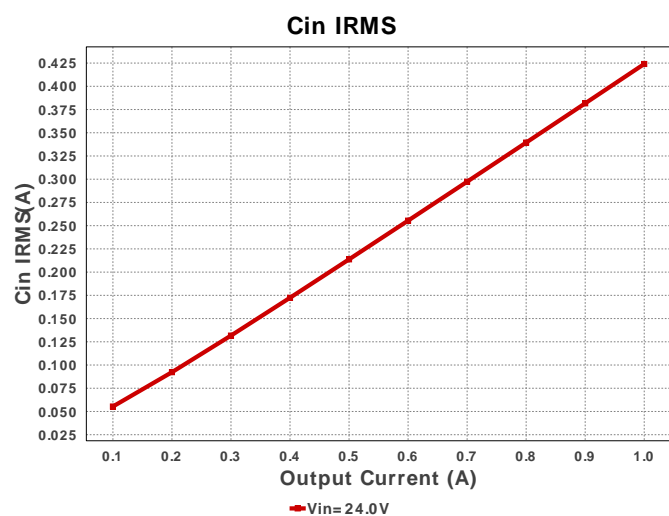
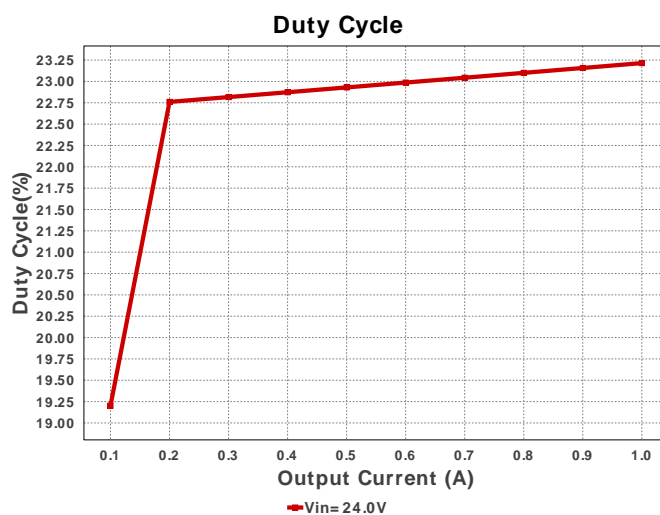
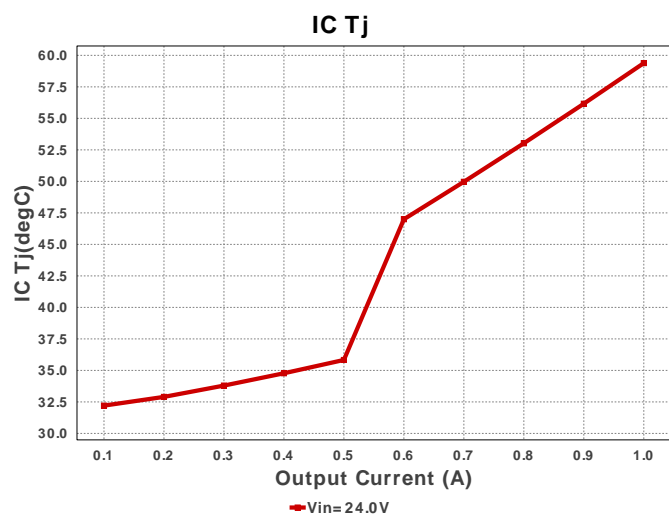
## WEBENCH® Design Report

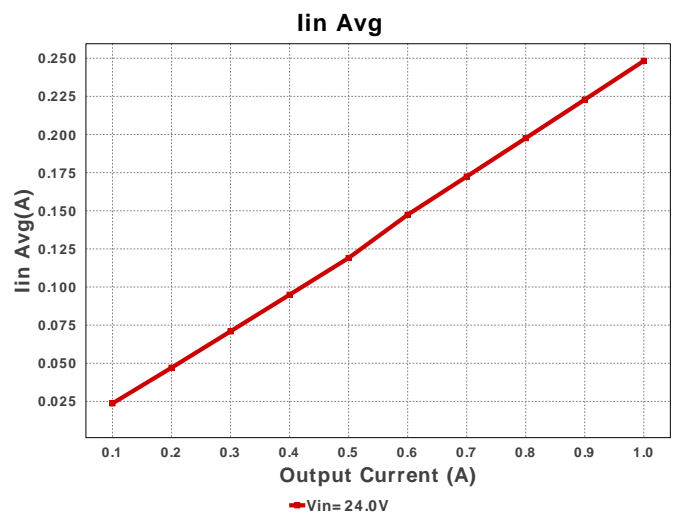
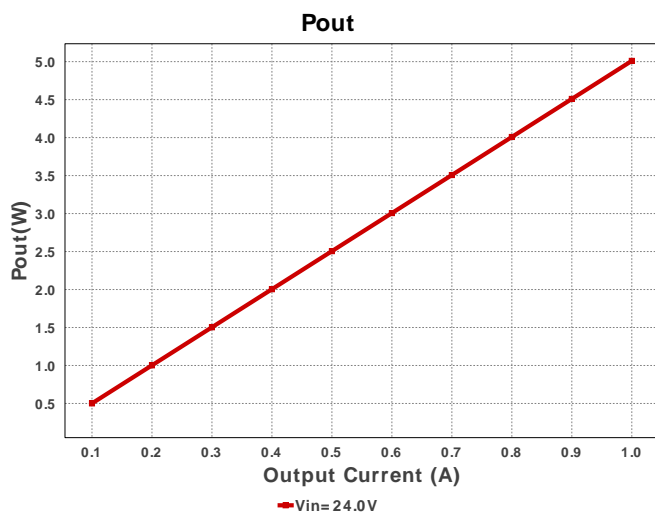
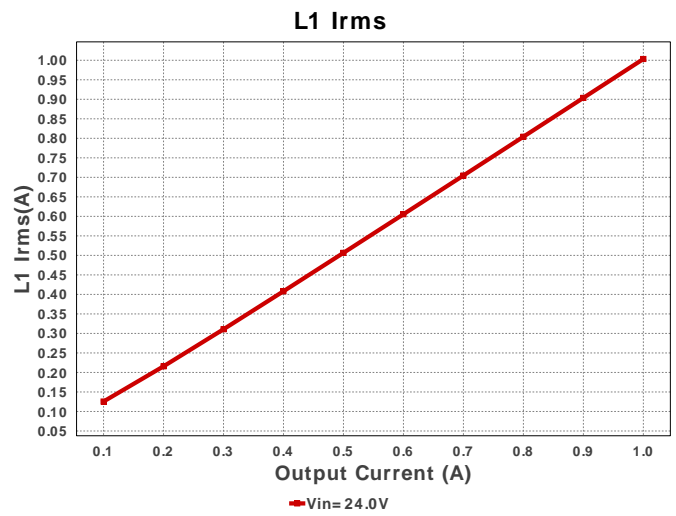
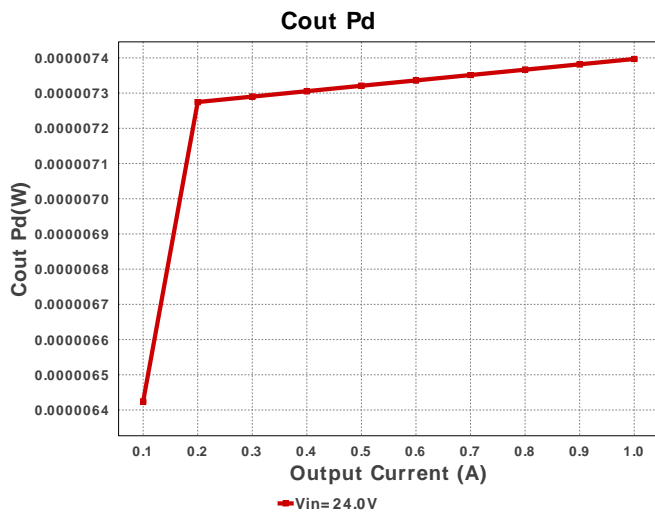
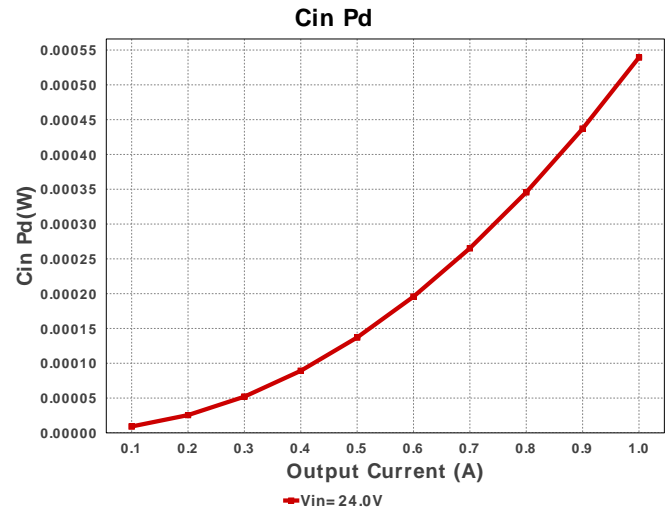
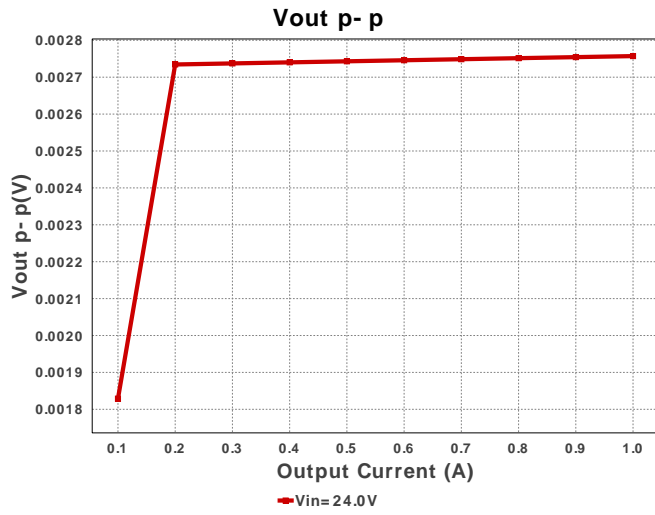
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LMR14010ADDCR 24V-24V to 5.01V @ 1A

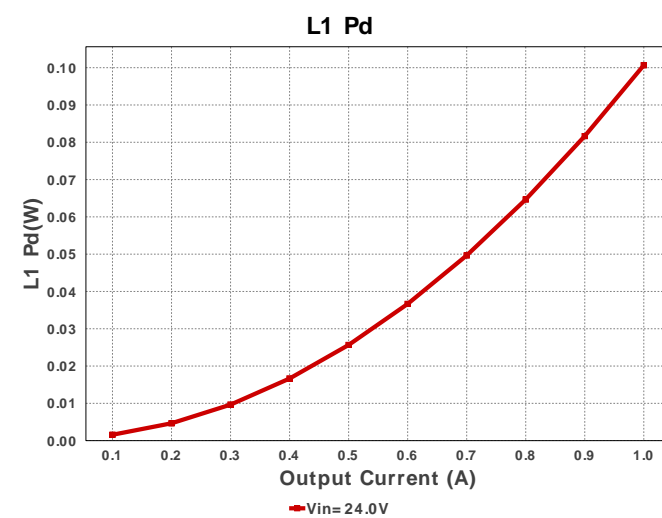
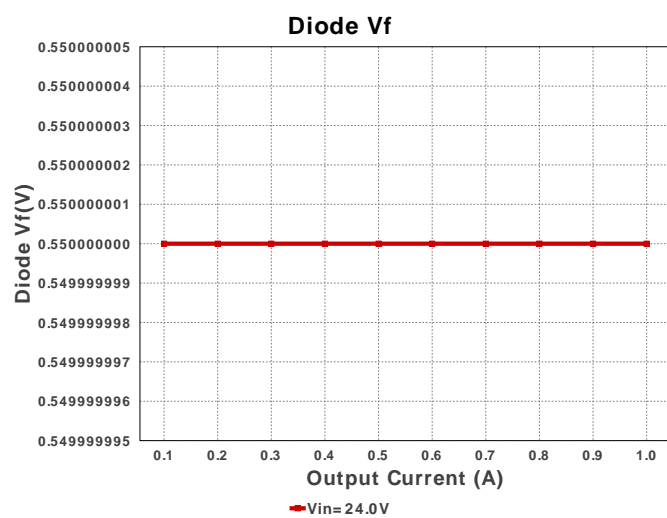
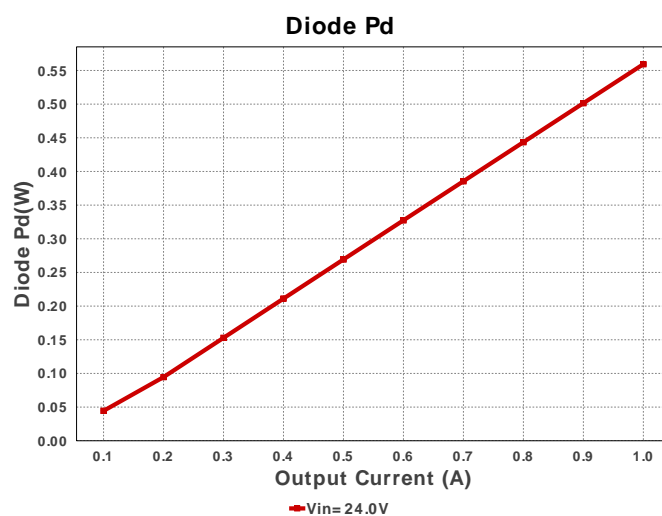
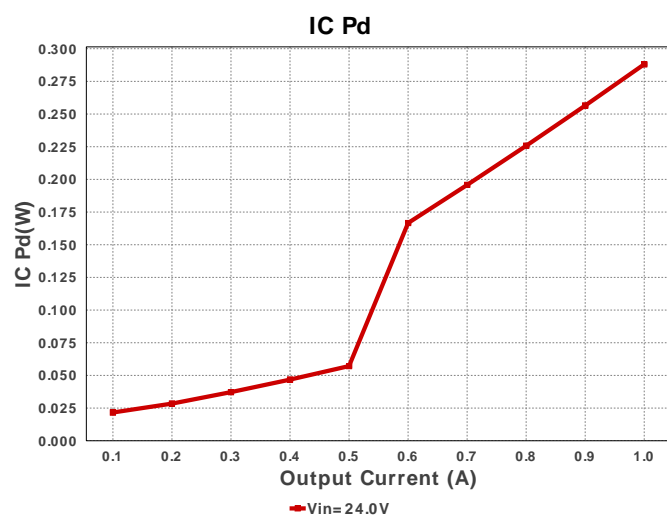
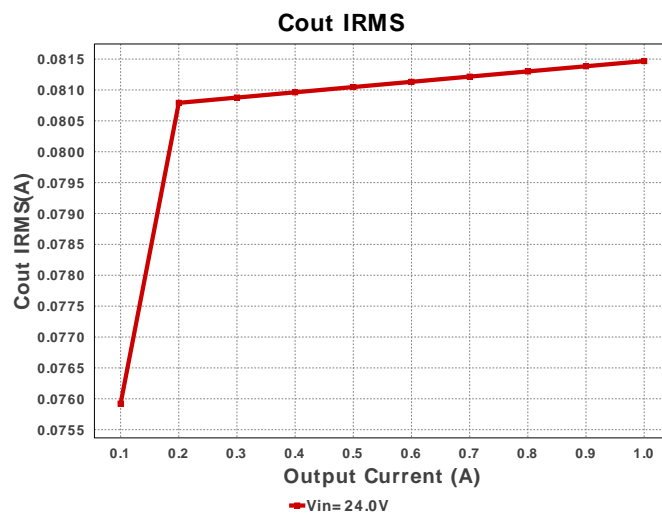
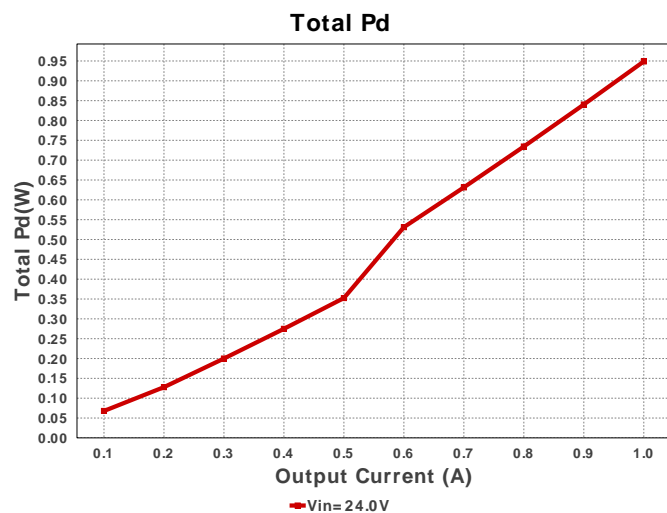


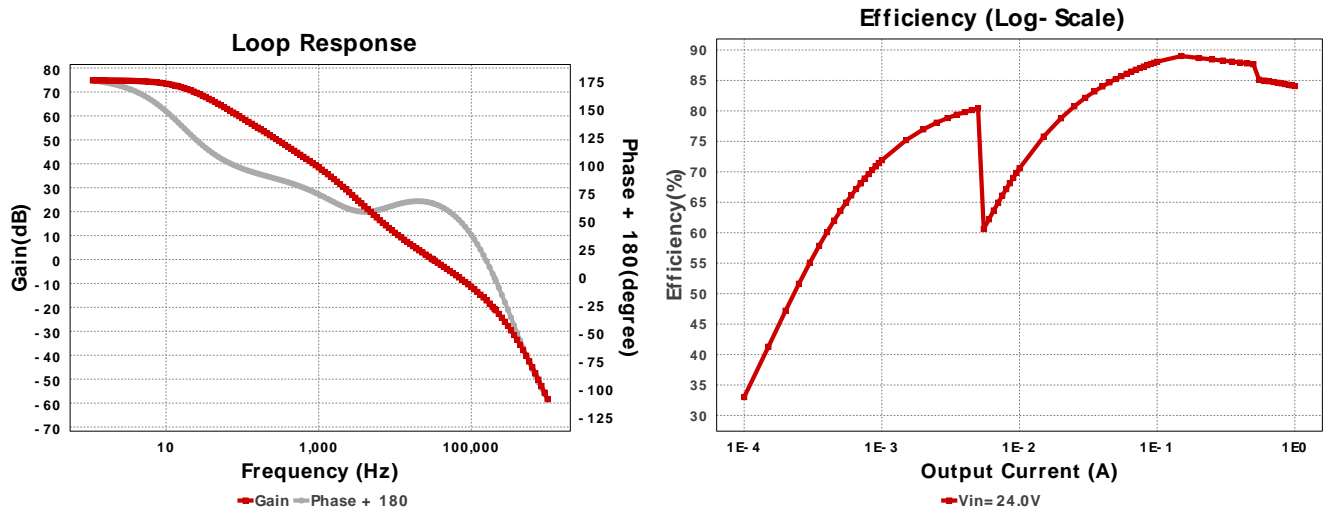
## Electrical BOM

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	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 <sup>2</sup>
Cin	MuRata	GRM31CR71H475KA12L Series= X7R	Cap= 4.7 uF ESR= 3.0 mOhm VDC= 50.0 V IRMS= 4.98 A	1	\$0.22	1206 11 mm <sup>2</sup>
Cout	TDK	C3216X6S1V106K160AC Series= X6S	Cap= 10.0 uF ESR= 2.229 mOhm VDC= 35.0 V IRMS= 4.8593 A	2	\$0.18	1206_180 11 mm <sup>2</sup>
D1	Fairchild Semiconductor	SS24FL	VF@Io= 550.0 mV VRRM= 40.0 V	1	\$0.05	SOD-123F 12 mm <sup>2</sup>
L1	NIC Components	NPI105C220MTRF	L= 22.0 uH 100.0 mOhm	1	\$0.18	IND_NPI105C 141 mm <sup>2</sup>
Rfbb	Vishay-Dale	CRCW040220K0FKED Series= CRCW...e3	Res= 20.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>
Rfbs	Yageo	RT0805BRD07111KL Series= RT0805	Res= 111.0 kOhm Power= 125.0 mW Tolerance= 0.1%	1	\$0.06	0805 7 mm <sup>2</sup>
U1	Texas Instruments	LMR14010ADDCR	Switcher	1	\$0.40	DDC0006A_N 10 mm <sup>2</sup>









## Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	424.023 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	539.39 $\mu$ W	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	81.467 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	7.397 $\mu$ W	Capacitor	Output capacitor power dissipation
5.	D1 Tj	63.56 degC	Diode	D1 junction temperature
6.	Diode Pd	559.33 mW	Diode	Diode power dissipation
7.	Diode Vf	550.0 mV	Diode	Forward voltage drop of diode D1
8.	IC Pd	288.09 mW	IC	IC power dissipation
9.	IC Tj	59.385 degC	IC	IC junction temperature
10.	IC Tolerance	18.0 mV	IC	IC Feedback Tolerance
11.	ICThetaJA	102.0 degC/W	IC	IC junction-to-ambient thermal resistance
12.	Iin Avg	248.28 mA	IC	Average input current
13.	L1 Irms	1.003 A	Inductor	Inductor ripple current
14.	L1 Pd	100.66 mW	Inductor	Inductor power dissipation
15.	Cin Pd	539.39 $\mu$ W	Power	Input capacitor power dissipation
16.	Cout Pd	7.397 $\mu$ W	Power	Output capacitor power dissipation
17.	Diode Pd	559.33 mW	Power	Diode power dissipation
18.	IC Pd	288.09 mW	Power	IC power dissipation
19.	L1 Pd	100.66 mW	Power	Inductor power dissipation
20.	Total Pd	948.807 mW	Power	Total Power Dissipation
21.	BOM Count	9	System	Total Design BOM count
22.	Cross Freq	31.447 kHz	System	Bode plot crossover frequency
23.	Duty Cycle	23.215 %	System	Duty cycle
24.	Efficiency	84.077 %	System	Steady state efficiency
25.	FootPrint	213.0 mm <sup>2</sup>	System	Total Foot Print Area of BOM components
26.	Frequency	700.0 kHz	System	Switching frequency
27.	Gain Marg	-20.656 dB	System	Bode Plot Gain Margin
28.	Iout	1.0 A	System	Iout operating point
29.	L1 Ipp	282.211 mA	System	
30.	Low Freq Gain	74.822 dB	System	Gain at 1Hz
31.	Mode	CCM	System	Conduction Mode
32.	Phase Marg	66.506 deg	System	Bode Plot Phase Margin
33.	Pout	5.01 W	System	Total output power
34.	Total BOM	\$1.29	System	Total BOM Cost
35.	Vin	24.0 V	System	Vin operating point
36.	Vout	5.0 V	System	Operational Output Voltage

#	Name	Value	Category	Description
37.	Vout Actual	5.011 V	System Information	Vout Actual calculated based on selected voltage divider resistors
38.	Vout Tolerance	3.317 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
39.	Vout p-p	2.758 mV	System Information	Peak-to-peak output ripple voltage

## Design Inputs

Name	Value	Description
Iout	1.0	Maximum Output Current
VinMax	24.0	Maximum input voltage
VinMin	24.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	LMR14010A	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature

## WEBENCH® Assembly

### Component Testing

Some published data on components in datasheets such as Capacitor ESR and Inductor DC resistance is based on conservative values that will guarantee that the components always exceed the specification. For design purposes it is usually better to work with typical values. Since this data is not always available it is a good practice to measure the Capacitance and ESR values of  $C_{in}$  and  $C_{out}$ , and the inductance and DC resistance of  $L1$  before assembly of the board. Any large discrepancies in values should be electrically simulated in WEBENCH to check for instabilities and thermally simulated in WebTHERM to make sure critical temperatures are not exceeded.

### Soldering Component to Board

If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. To solder the tab down to the board place the iron down on the board while resting against the tab, heating both surfaces simultaneously. Apply light pressure to the top of the plastic case until the solder flows around the part and the part is flush with the PCB. If the solder is not flowing around the board you may need a higher wattage iron (generally 25W to 30W is enough).

### Initial Startup of Circuit

It is best to initially power up the board by setting the input supply voltage to the lowest operating input voltage 24.0V and set the input supply's current limit to zero. With the input supply off connect up the input supply to  $V_{in}$  and GND. Connect a digital volt meter and a load if needed to set the minimum load of the design from  $V_{out}$  and GND. Turn on the input supply and slowly turn up the current limit on the input supply. If the voltage starts to rise on the input supply continue increasing the input supply current limit while watching the output voltage. If the current increases on the input supply, but the voltage remains near zero, then there may be a short or a component misplaced on the board. Power down the board and visually inspect for solder bridges and recheck the diode and capacitor polarities. Once the power supply circuit is operational then more extensive testing may include full load testing, transient load and line tests to compare with simulation results.

### Load Testing

The setup is the same as the initial startup, except that an additional digital voltmeter is connected between  $V_{in}$  and GND, a load is connected between  $V_{out}$  and GND and a current meter is connected in series between  $V_{out}$  and the load. The load must be able to handle at least rated output power + 50% ( 7.5 watts for this design). Ideally the load is supplied in the form of a variable load test unit. It can also be done in the form of suitably large power resistors. When using an oscilloscope to measure waveforms on the prototype board, the ground leads of the oscilloscope probes should be as short as possible and the area of the loop formed by the ground lead should be kept to a minimum. This will help reduce ground lead inductance and eliminate EMI noise that is not actually present in the circuit.

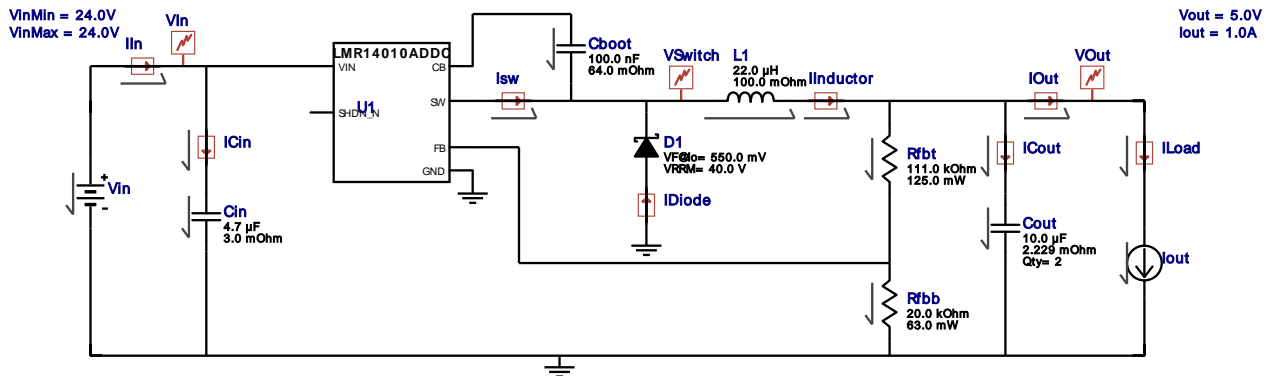


# WEBENCH® Electrical Simulation Report

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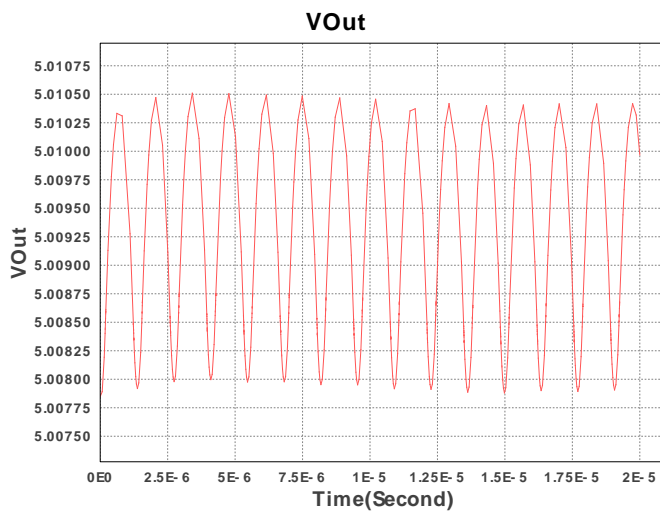
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Simulation Type = Steady State



## Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Cboot	IC	Initial Voltage	7 V
2.	Cin	IC	Initial Voltage	24.0 V
3.	Cout	IC	Initial Voltage	5.0 V
4.	L1	IC	Initial Current	1.0 A
5.	Iout	I	Load Current	1.0 A



## Design Assistance

1. Master key : 9810EF8B6453D2AE[v1]

2. **LMR14010A** Product Folder : <http://www.ti.com/product/LMR14010A> : contains the data sheet and other resources.



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