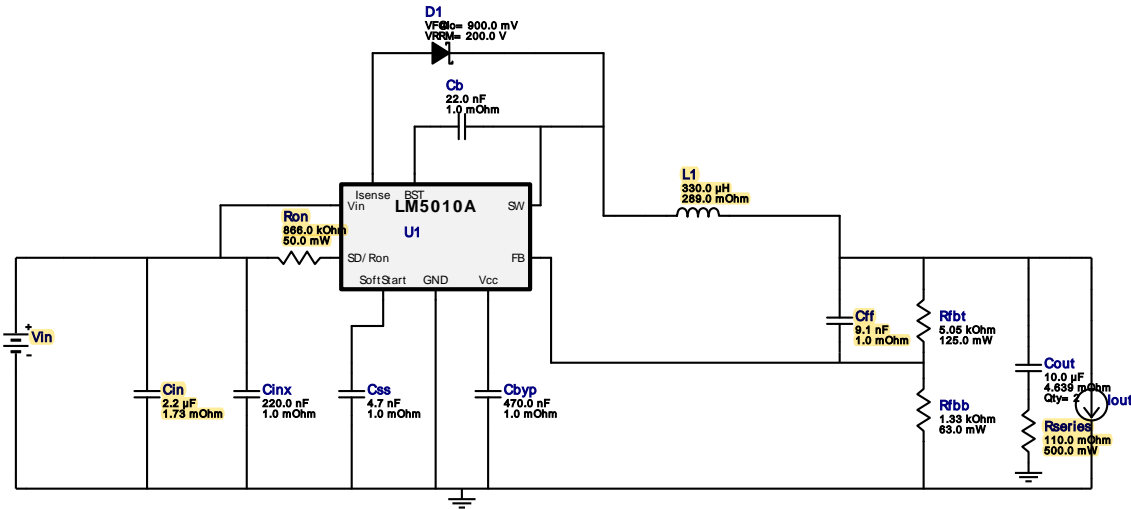
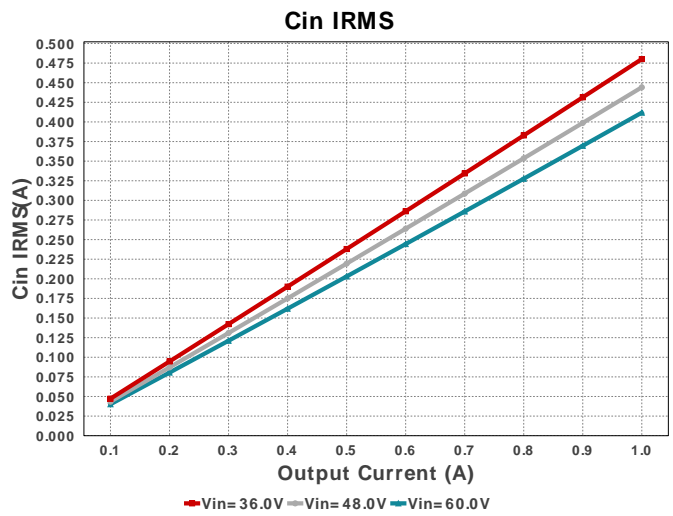
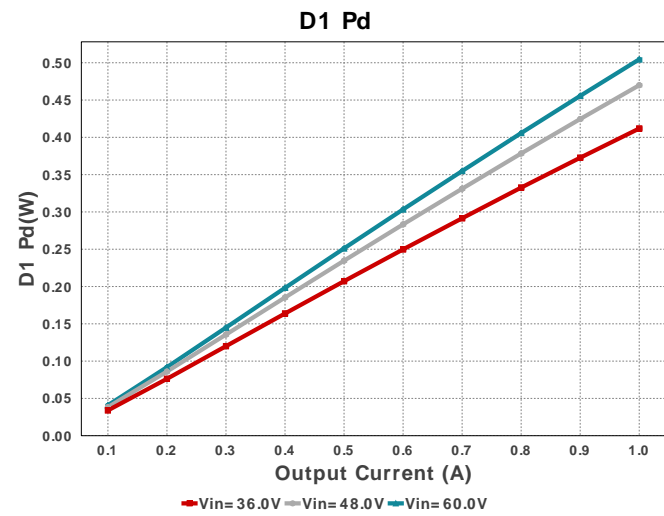
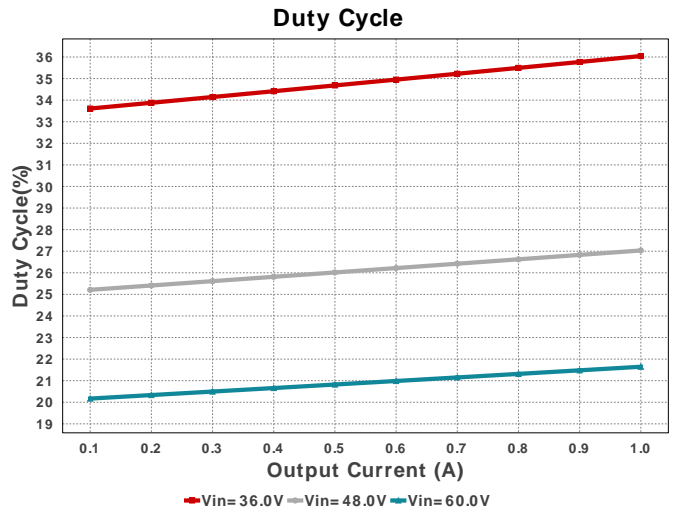
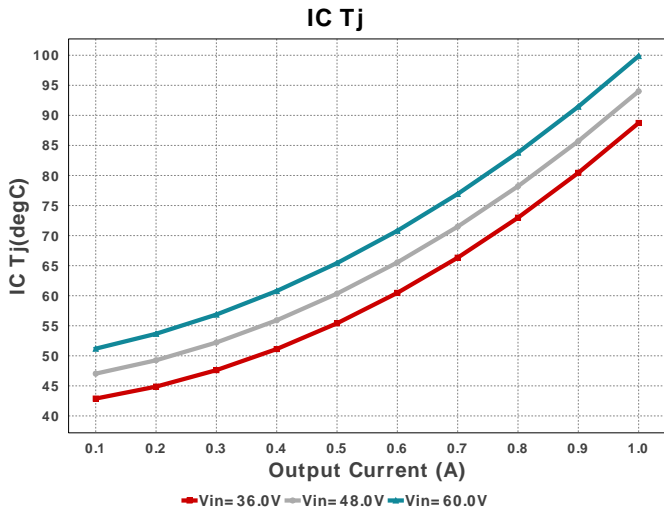


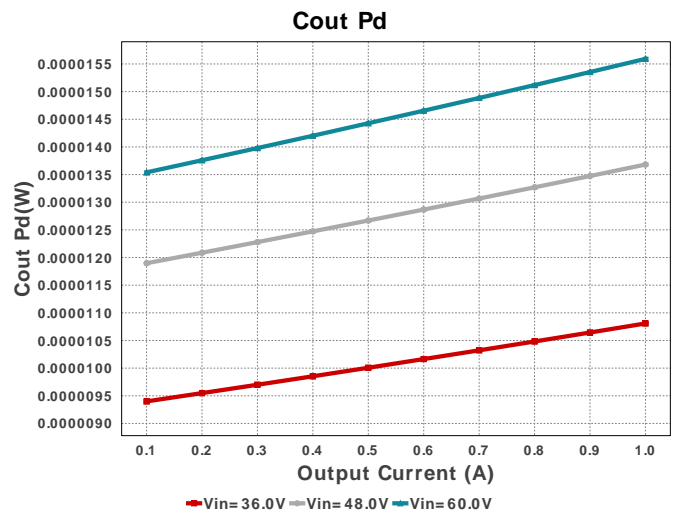
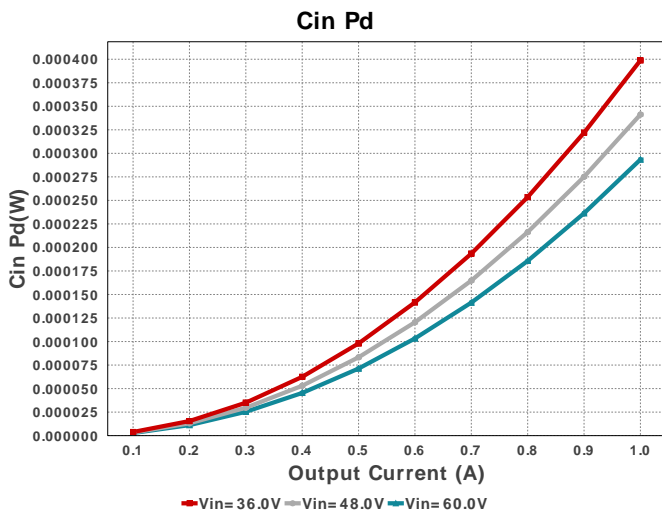
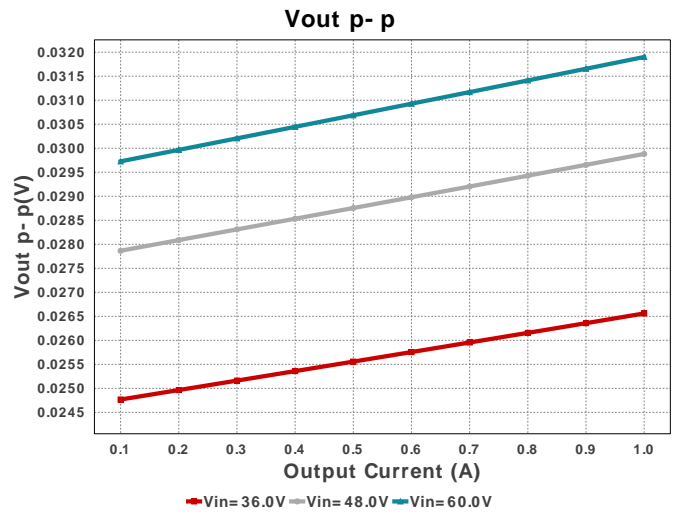
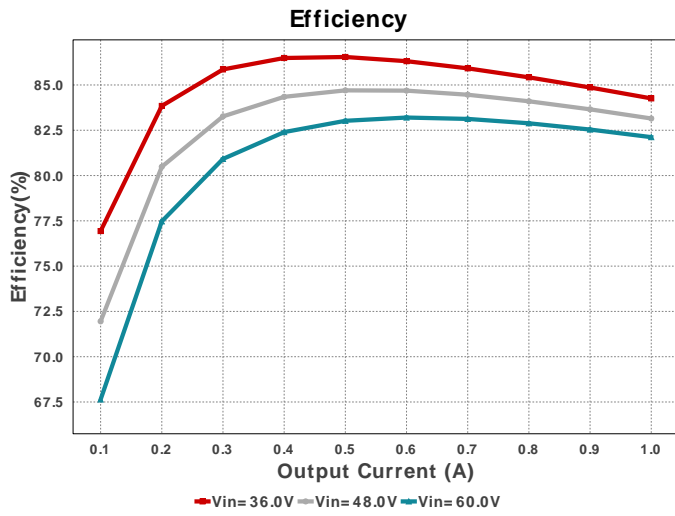
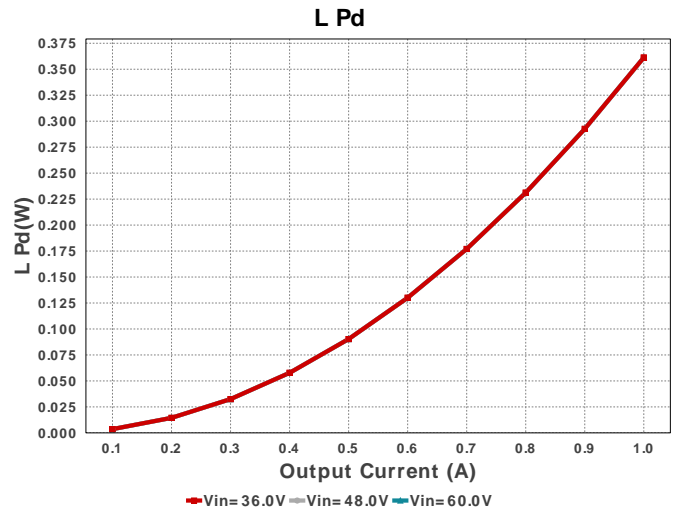
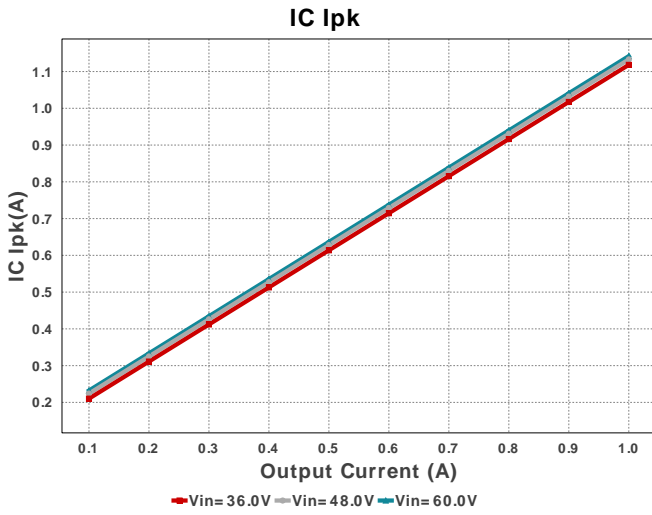
WEBENCH® Design Report

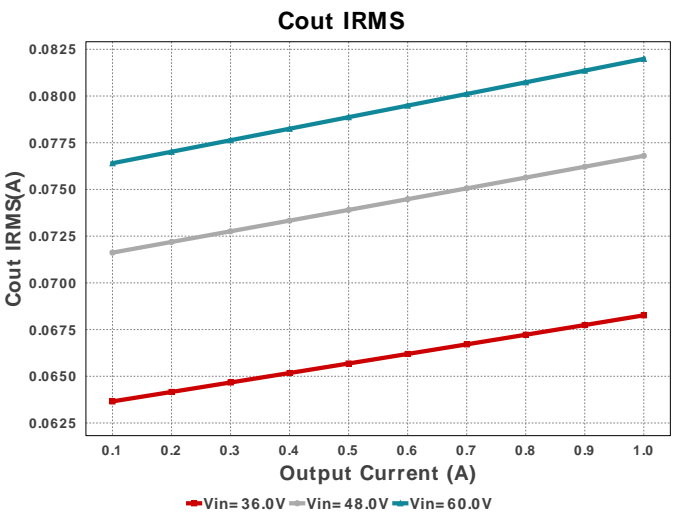
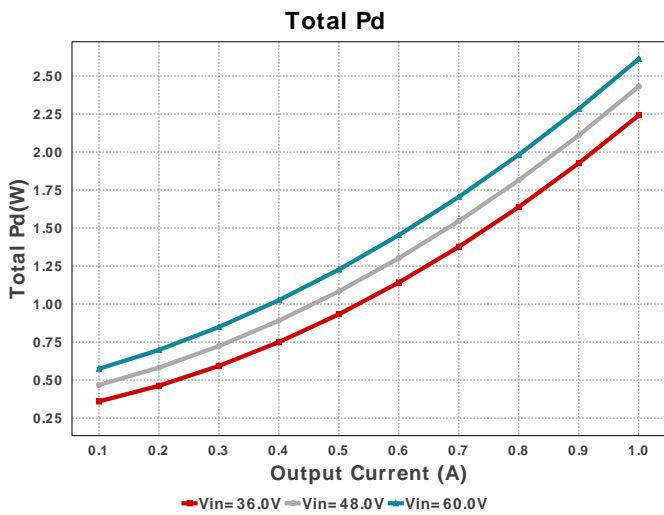
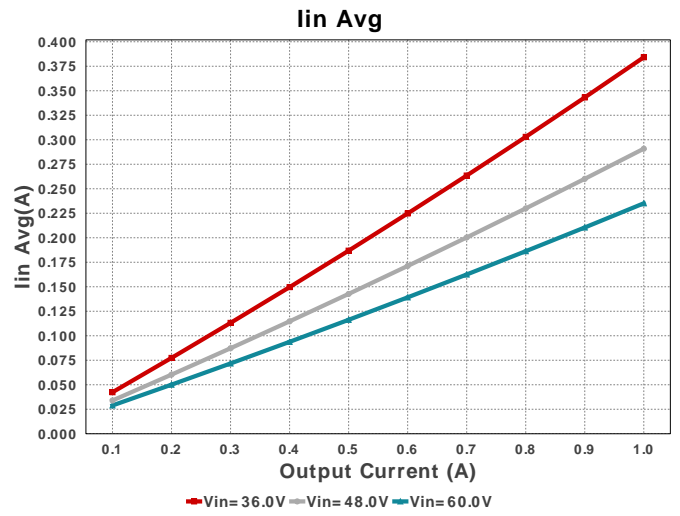
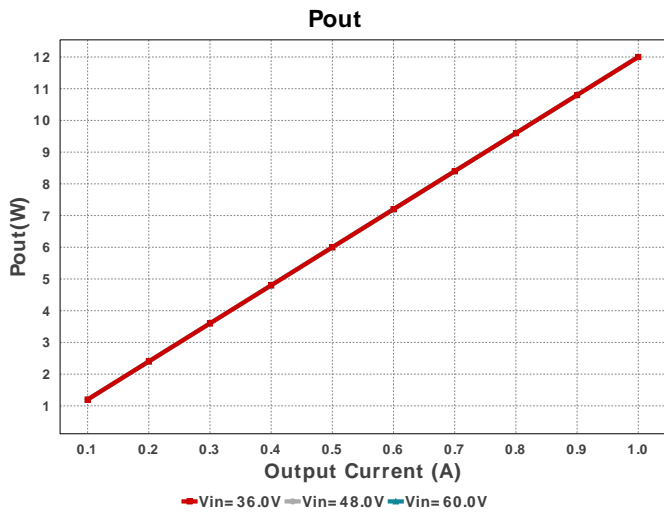
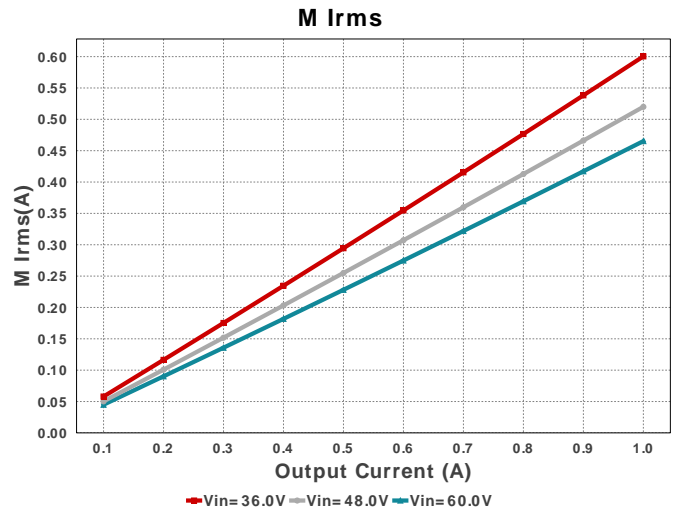
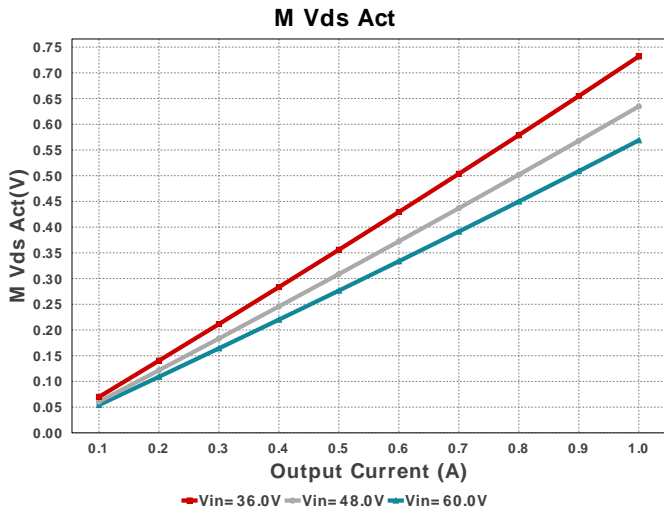
 Design : 92 LM5010AMH/NOPB
 LM5010AMH/NOPB 36V-60V to 12.00V @ 1A

Electrical BOM

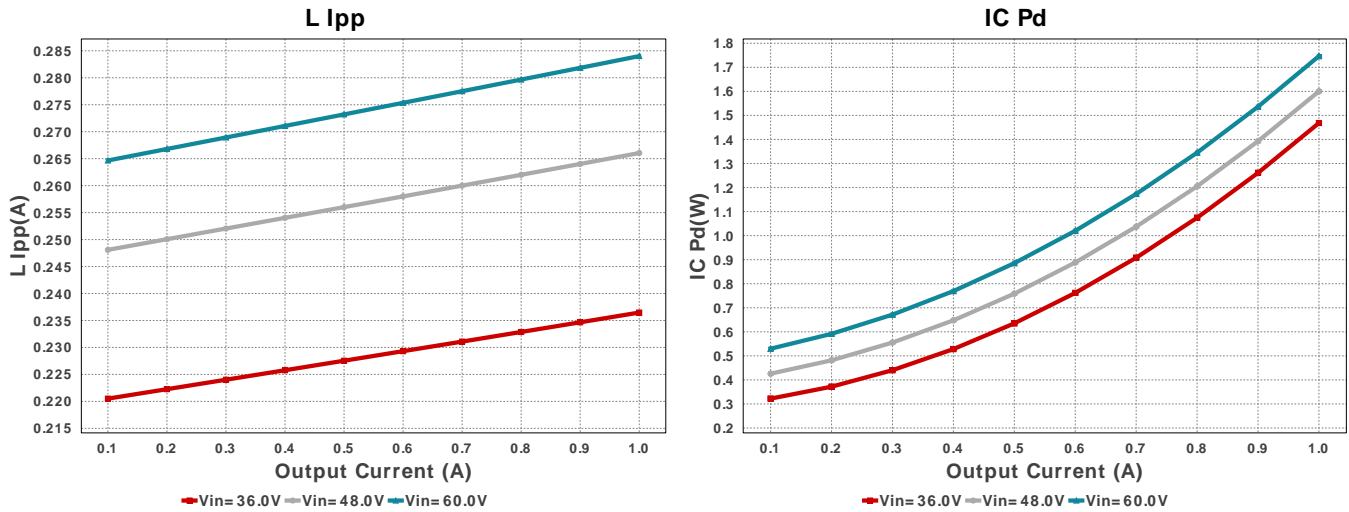
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cb	MuRata	GRM155R71H223KA12D Series= X7R	Cap= 22.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm ²
Cbyp	Taiyo Yuden	TMK212BJ474KD-T Series= X5R	Cap= 470.0 nF ESR= 1.0 mOhm VDC= 20.0 V IRMS= 0.0 A	1	\$0.02	0805 7 mm ²
Cff	MuRata	GRM2195C1H912JA01D Series= C0G/NP0	Cap= 9.1 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	\$0.06	0805 7 mm ²
Cin	TDK	C3225X7R2A225K230AB Series= X7R	Cap= 2.2 uF ESR= 1.73 mOhm VDC= 100.0 V IRMS= 5.5932 A	1	\$0.22	1210_250 15 mm ²
Cinx	MuRata	GRM21AR72A224KAC5L Series= X7R	Cap= 220.0 nF ESR= 1.0 mOhm VDC= 100.0 V IRMS= 0.0 A	1	\$0.09	0805 7 mm ²
Cout	TDK	C1608X5R1E106M080AC Series= X5R	Cap= 10.0 uF ESR= 4.639 mOhm VDC= 25.0 V IRMS= 2.4141 A	2	\$0.21	0603 5 mm ²
Css	MuRata	GRM155R61C472KA01D Series= X5R	Cap= 4.7 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm ²
D1	SMC Diode Solutions	SK220ATR	VF@Io= 900.0 mV VRRM= 200.0 V	1	\$0.04	SMA 37 mm ²

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
L1	Coilcraft	MSS1210-334KEB	L= 330.0 μ H 289.0 mOhm	1	\$0.81	 MSS1210 204 mm ²
Rfbf	Vishay-Dale	CRCW04021K33FKED Series= CRCW..e3	Res= 1.33 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
Rfbt	Yageo	RT0805BRD075K05L Series= ?	Res= 5.05 kOhm Power= 125.0 mW Tolerance= 0.1%	1	\$0.05	 0805 7 mm ²
Ron	Yageo	RC0201FR-07866KL Series= ?	Res= 866.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	\$0.01	 0201 2 mm ²
Rseries	Rohm	MCR25JZHFLR110 Series= MCR25	Res= 110.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	\$0.03	 1210 15 mm ²
U1	Texas Instruments	LM5010AMH/NOPB	Switcher	1	\$1.76	 PWP0014A 59 mm ²









Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	411.829 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	293.41 μ W	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	81.989 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	15.592 μ W	Capacitor	Output capacitor power dissipation
5.	D1 Pd	504.54 mW	Diode	Output Diode Power Dissipation
6.	IC Ipk	1.142 A	IC	Peak switch current in IC
7.	IC Pd	1.747 W	IC	IC power dissipation
8.	IC Tj	99.869 degC	IC	IC junction temperature
9.	IC Tolerance	50.0 mV	IC	IC Feedback Tolerance
10.	ICThetaJA	40.0 degC/W	IC	IC junction-to-ambient thermal resistance
11.	Iin Avg	235.14 mA	IC	Average input current
12.	L Ipp	284.02 mA	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	361.25 mW	Inductor	Inductor power dissipation
14.	M1 Irms	465.249 mA	Mosfet	Q lavg
15.	M Vds Act	568.749 mV	Mosfet	Voltage drop across the MosFET
16.	Cin Pd	293.41 μ W	Power	Input capacitor power dissipation
17.	Cout Pd	15.592 μ W	Power	Output capacitor power dissipation
18.	D1 Pd	504.54 mW	Power	Output Diode Power Dissipation
19.	IC Pd	1.747 W	Power	IC power dissipation
20.	L Pd	361.25 mW	Power	Inductor power dissipation
21.	Total Pd	2.613 W	Power	Total Power Dissipation
22.	BOM Count	15	System	Total Design BOM count
23.	Duty Cycle	21.646 %	System Information	Duty cycle
24.	Efficiency	82.12 %	System Information	Steady state efficiency
25.	FootPrint	377.0 mm ²	System Information	Total Foot Print Area of BOM components
26.	Frequency	110.855 kHz	System Information	Switching frequency
27.	Iout	1.0 A	System Information	Iout operating point
28.	Mode	CCM	System Information	Conduction Mode
29.	Pout	12.0 W	System Information	Total output power
30.	Total BOM	\$3.54	System Information	Total BOM Cost
31.	Vin	60.0 V	System Information	Vin operating point
32.	Vout	12.0 V	System Information	Operational Output Voltage
33.	Vout Actual	11.992 V	System Information	Vout Actual calculated based on selected voltage divider resistors
34.	Vout Tolerance	2.897 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
35.	Vout p-p	31.901 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	1.0	Maximum Output Current
VinMax	60.0	Maximum input voltage
VinMin	36.0	Minimum input voltage
Vout	12.0	Output Voltage
base_pn	LM5010A	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 36.0V 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.



Design Assistance

1. For a Constant On Time device to be stable, we need to provide a ripple at the feedback comparator. There are various methods to implement the ripple. Depending on the circuit complexity vs. the allowable ripple, we have three options to choose from. The simplest option, 'Low Complexity', would require only a high ESR cap at the output. This means that the BOM count will be small, but the output voltage ripple will be quite large. The 'Optimal Solution' would require a feed-forward cap in parallel with the upper feedback resistor to AC couple the ripple to the feedback node. This increases the BOM count slightly, but now we have more control over the output voltage ripple. If the output voltage requirement is very tight, then the best option is to go for the 'Low Output Ripple' solution. In this option we can go with very low ESR output caps and have very good control over the output voltage ripple.

2. Master key : 797BAAD8AB40C637[v1]

3. **LM5010A** Product Folder : <http://www.ti.com/product/LM5010A> : contains the data sheet and other resources.

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