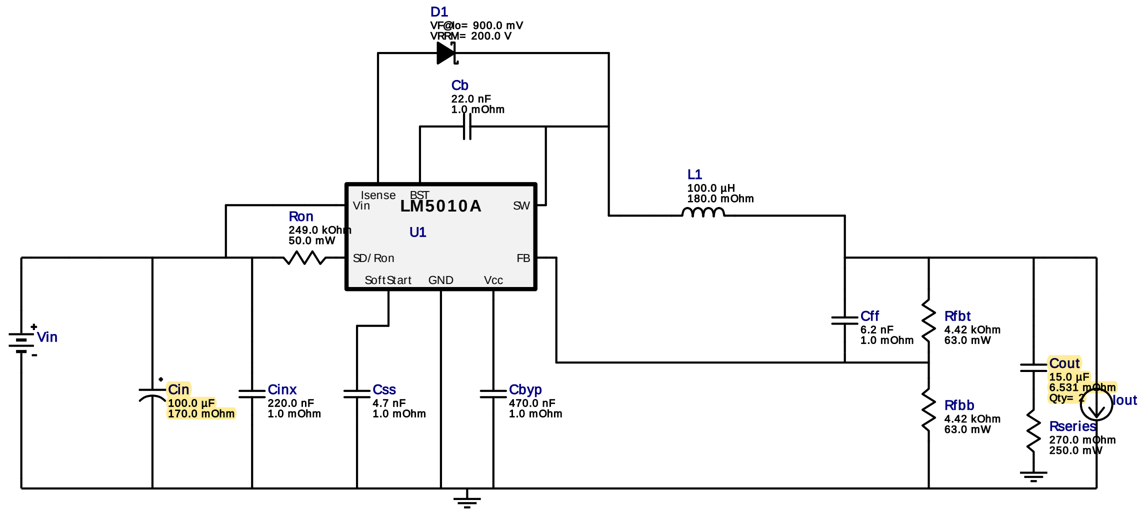
TEXAS INSTRUMENTS

WEBENCH ® Design Report

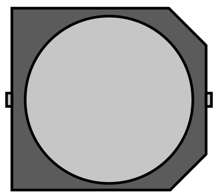
VinMin = 7.0V
VinMax = 75.0V
Vout = 5.0V
Iout = 1.0A

Device = LM5010AMH/NOPB
Topology = Buck
Created = 2019-06-17 00:57:15.998
BOM Cost = $3.49
BOM Count = 15
Total Pd = 3.19W

Design : 94 LM5010AMH/NOPB
LM5010AMH/NOPB 7V-75V to 5.00V @ 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 mm²
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 mm²
Cff	MuRata	GRM2195C1H622JA01D Series= C0G/NP0	Cap= 6.2 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.06	0805 7 mm²
Cin	Panasonic	EEV-FK2A101M Series= FK	Cap= 100.0 uF ESR= 170.0 mOhm VDC= 100.0 V IRMS= 793.0 mA	1	$0.75	 SM_RADIAL_J16 399 mm²
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 mm²
Cout	TDK	C1608X5R1A156M080AC Series= X5R	Cap= 15.0 uF ESR= 6.531 mOhm VDC= 10.0 V IRMS= 2.03438 A	2	$0.13	0603 5 mm²
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 mm²
D1	SMC Diode Solutions	SK220ATR	VF@Io= 900.0 mV VRRM= 200.0 V	1	$0.04	SMA 37 mm²

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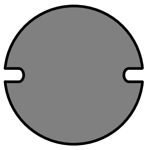
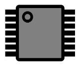
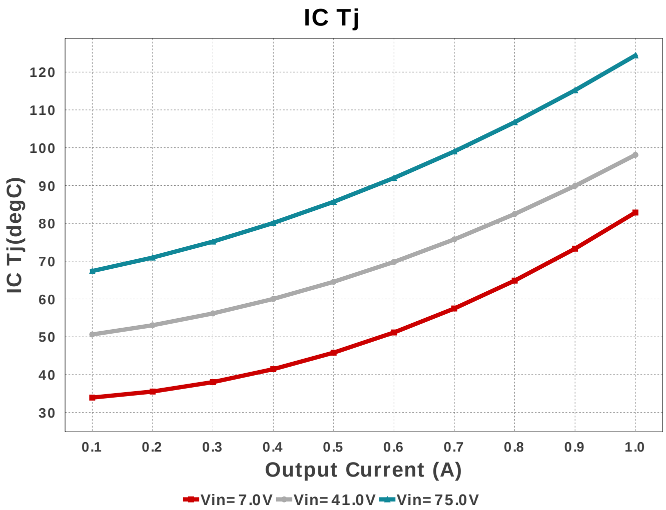
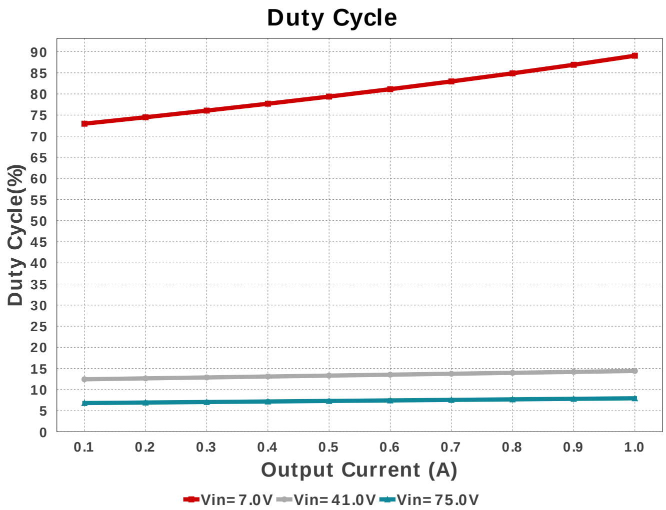
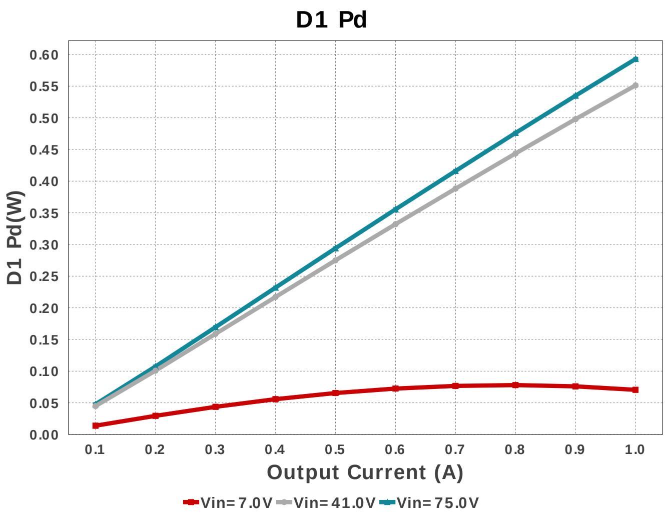
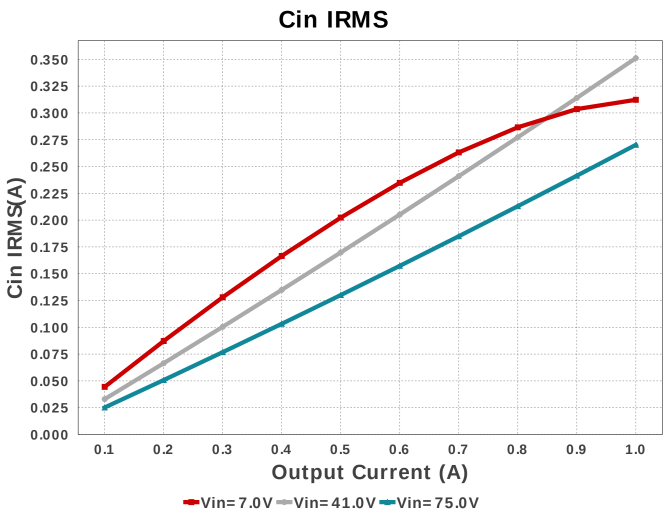
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
L1	Bourns	SDR1307-101KL	L= 100.0 µH 180.0 mOhm	1	$0.42	 SDR1307 226 mm²
Rfbb	Vishay-Dale	CRCW04024K42FKED Series= CRCW..e3	Res= 4.42 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbt	Vishay-Dale	CRCW04024K42FKED Series= CRCW..e3	Res= 4.42 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Ron	Yageo	RC0201FR-07249KL Series= ?	Res= 249.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Rseries	Panasonic	ERJ-8RQFR27V Series= ERJ-8R	Res= 270.0 mOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.04	 1206 11 mm²
U1	Texas Instruments	LM5010AMH/NOPB	Switcher	1	$1.76	 PWP0014A 59 mm²









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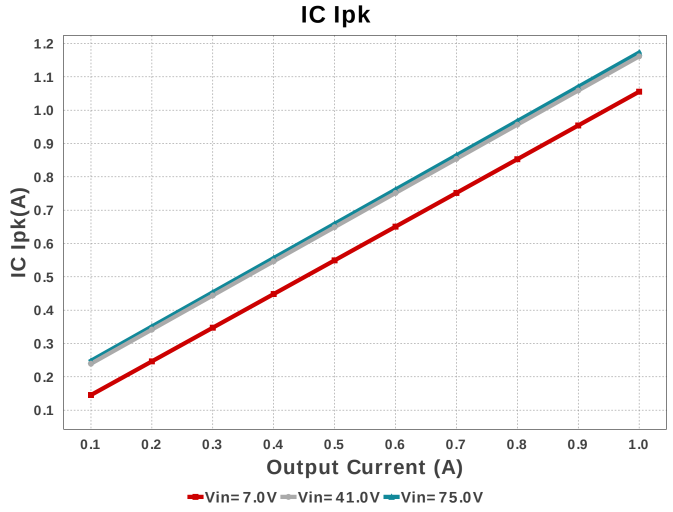
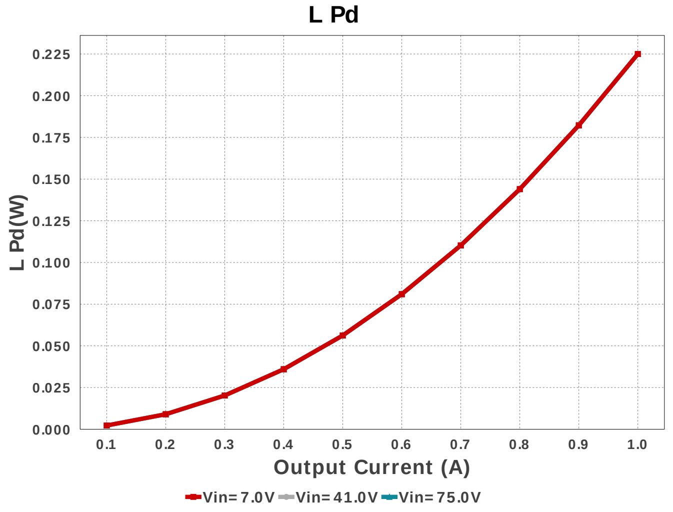
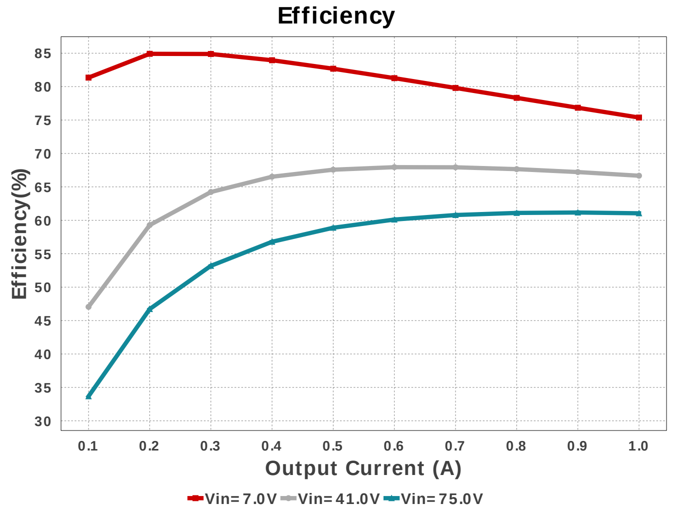
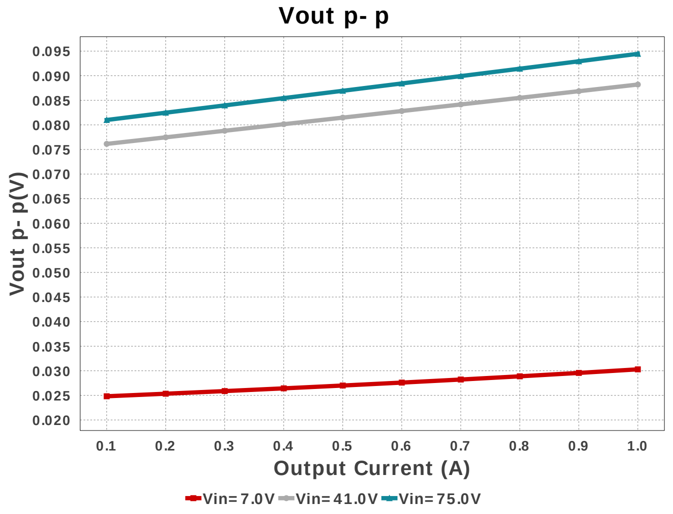
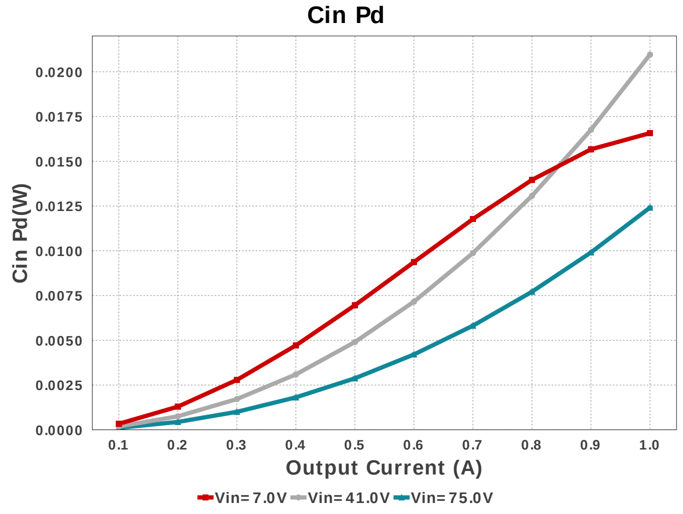
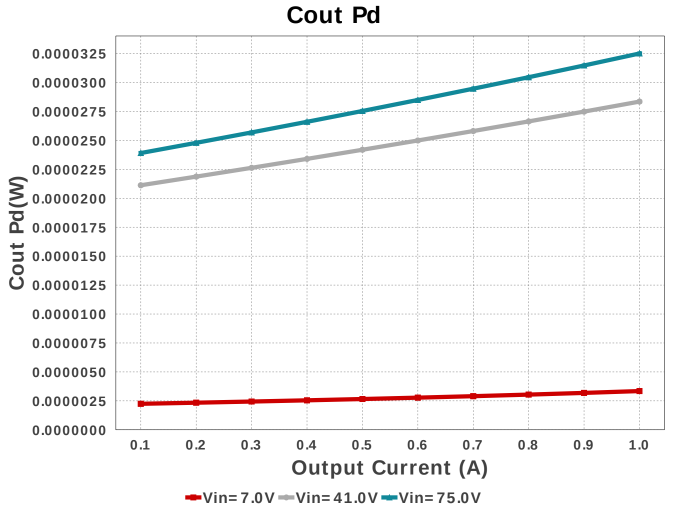

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=7.0V Vin=41.0V Vin=75.0V

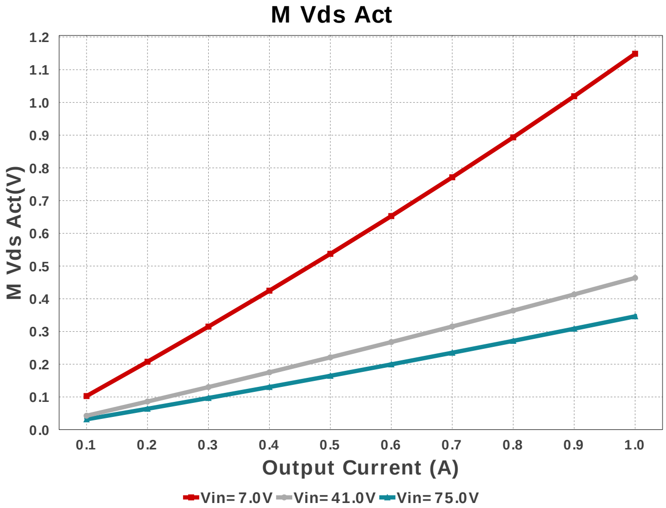

L Pd
L Pd(W)
Output Current (A)
Vin=7.0V Vin=41.0V Vin=75.0V

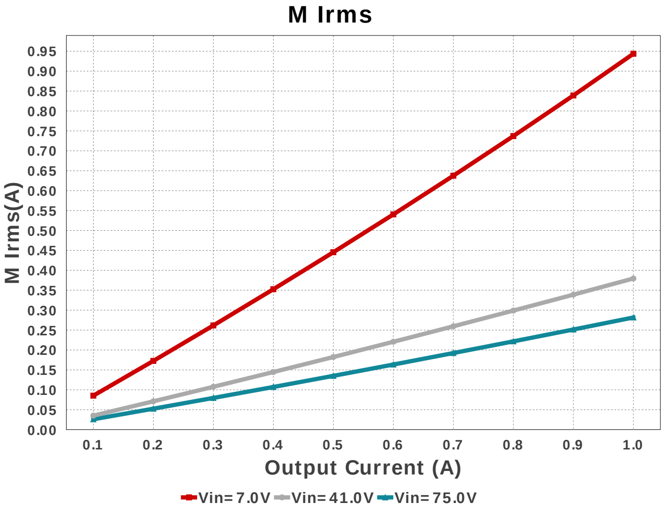

Efficiency
Efficiency(%)
Output Current (A)
Vin=7.0V Vin=41.0V Vin=75.0V

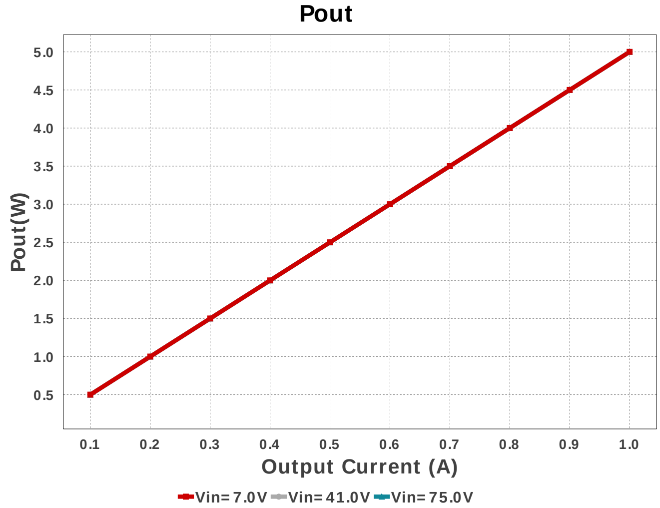

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=7.0V Vin=41.0V Vin=75.0V

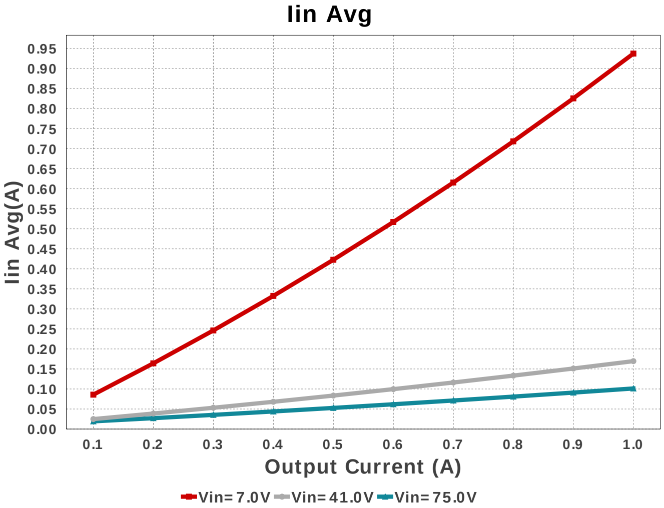

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=7.0V Vin=41.0V Vin=75.0V

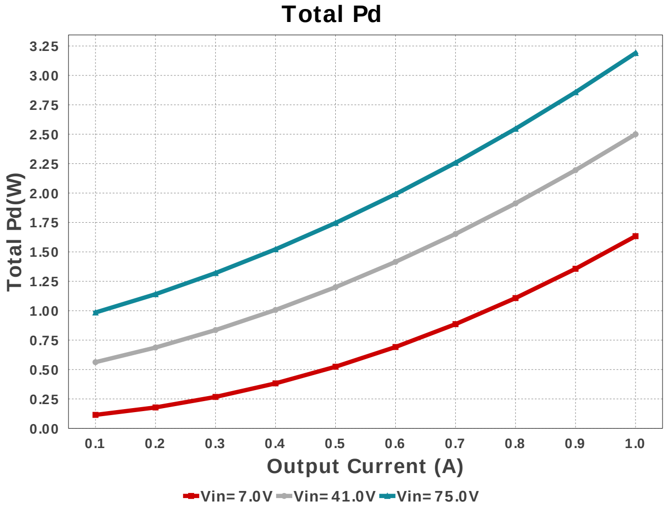

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=7.0V Vin=41.0V Vin=75.0V

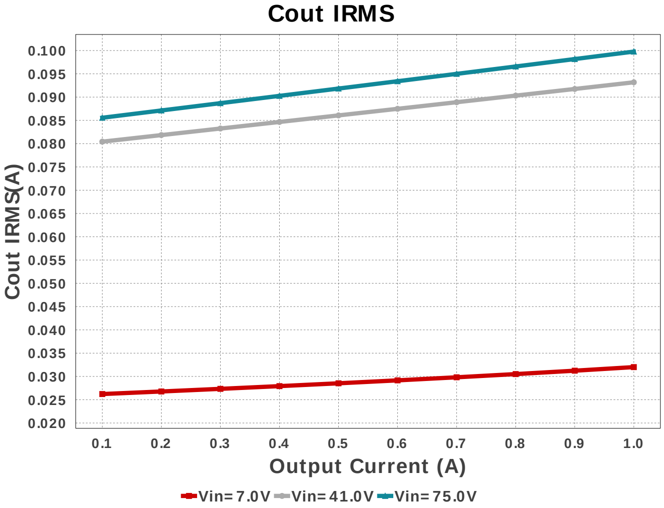

M Vds Act
M Vds Act(V)
Output Current (A)
Vin=7.0V
Vin=41.0V
Vin=75.0V

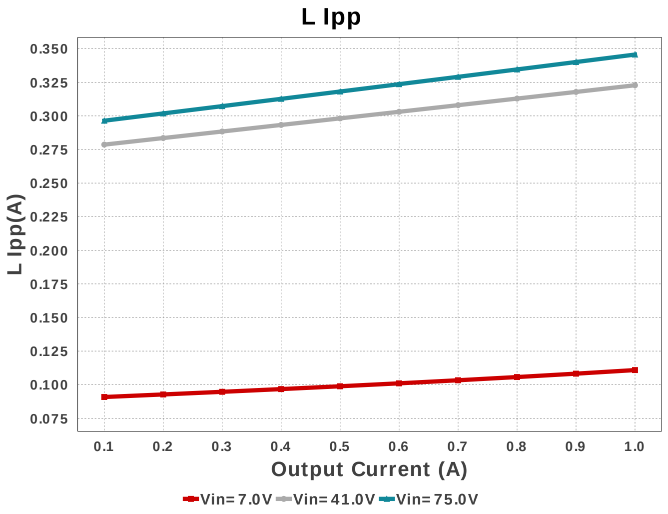

M Irms
M Irms(A)
Output Current (A)
Vin=7.0V
Vin=41.0V
Vin=75.0V

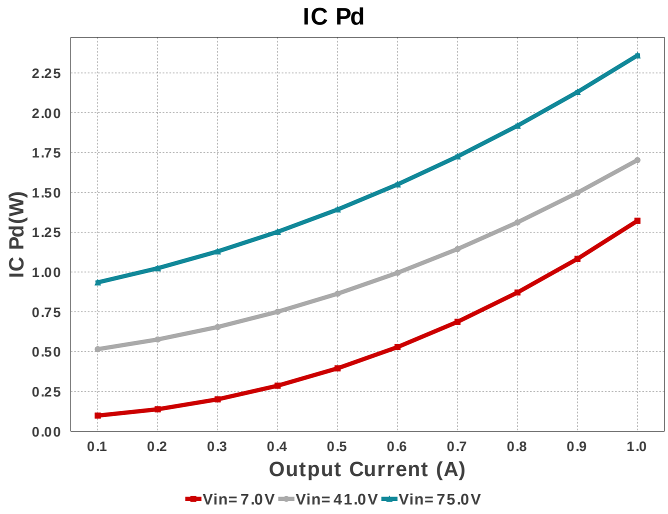

Pout
Pout(W)
Output Current (A)
Vin=7.0V
Vin=41.0V
Vin=75.0V


Iin Avg
Iin Avg(A)
Output Current (A)
Vin=7.0V
Vin=41.0V
Vin=75.0V


Total Pd
Total Pd(W)
Output Current (A)
Vin=7.0V
Vin=41.0V
Vin=75.0V


Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=7.0V
Vin=41.0V
Vin=75.0V





Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	270.234 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	12.414 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	99.774 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	32.508 µW	Capacitor	Output capacitor power dissipation
5.	D1 Pd	592.84 mW	Diode	Output Diode Power Dissipation
6.	IC Ipk	1.173 A	IC	Peak switch current in IC
7.	IC Pd	2.36 W	IC	IC power dissipation
8.	IC Tj	124.394 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	101.3 mA	IC	Average input current
12.	L Ipp	345.63 mA	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	225.0 mW	Inductor	Inductor power dissipation
14.	M1 Irms	281.634 mA	Mosfet	Q Iavg
15.	M Vds Act	346.359 mV	Mosfet	Voltage drop across the MosFET
16.	Cin Pd	12.414 mW	Power	Input capacitor power dissipation
17.	Cout Pd	32.508 µW	Power	Output capacitor power dissipation
18.	D1 Pd	592.84 mW	Power	Output Diode Power Dissipation
19.	IC Pd	2.36 W	Power	IC power dissipation
20.	L Pd	225.0 mW	Power	Inductor power dissipation
21.	Total Pd	3.19 W	Power	Total Power Dissipation
22.	BOM Count	15	System Information	Total Design BOM count
23.	Duty Cycle	7.932 %	System Information	Duty cycle
24.	Efficiency	61.049 %	System Information	Steady state efficiency
25.	FootPrint	776.0 mm^2	System Information	Total Foot Print Area of BOM components
26.	Frequency	160.643 kHz	System Information	Switching frequency
27.	Iout	1.0 A	System Information	Iout operating point
28.	Mode	CCM	System Information	Conduction Mode
29.	Pout	5.0 W	System Information	Total output power
30.	Total BOM	$3.49	System Information	Total BOM Cost
31.	Vin	75.0 V	System Information	Vin operating point
32.	Vout	5.0 V	System Information	Operational Output Voltage
33.	Vout Actual	5.0 V	System Information	Vout Actual calculated based on selected voltage divider resistors
34.	Vout Tolerance	3.03 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
35.	Vout p-p	94.448 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	1.0	Maximum Output Current
VinMax	75.0	Maximum input voltage
VinMin	7.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	LM5010A	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature
UserFsw	135.369 k	Customer Selected Frequency

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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 Cin and Cout, 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

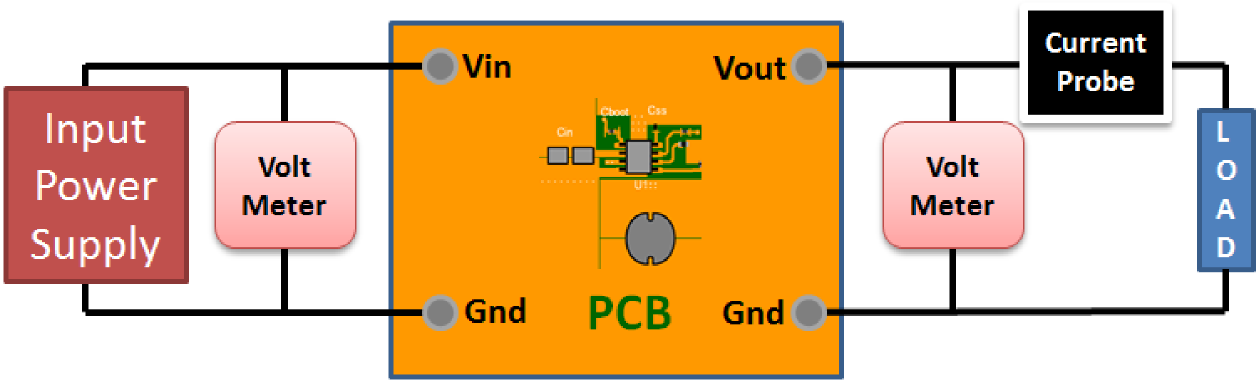
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. To solder the tab town 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 7.0V and set the input supply's current limit to zero. With the input supply off connect up the input supply to Vin and GND. Connect a digital volt meter and a load if needed to set the minimum Iout of the design from Vout 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 Vin and GND, a load is connected between Vout and GND and a current meter is connected in series between Vout 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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