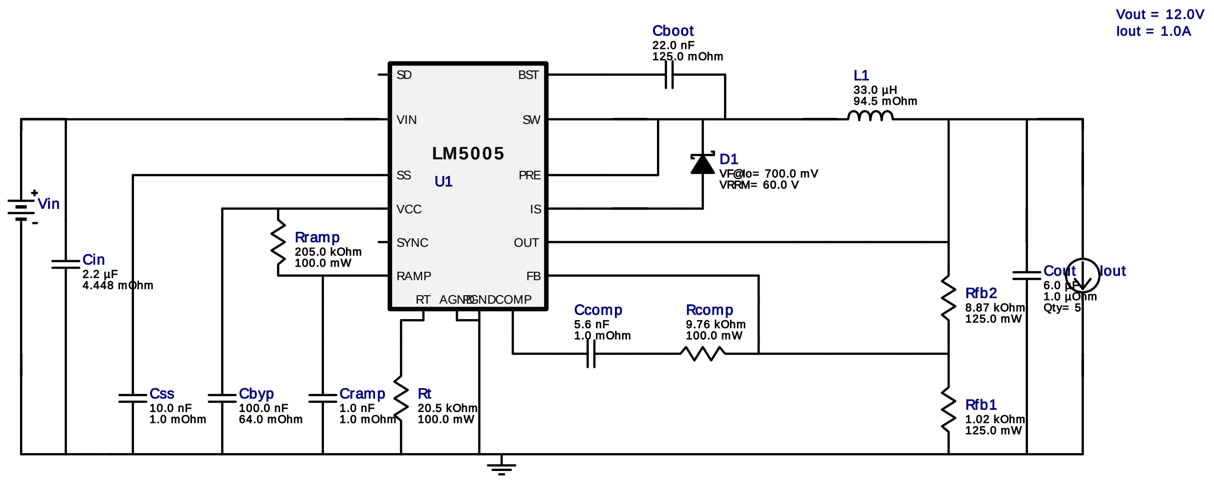
TEXAS INSTRUMENTS

VinMin = 24.0V
VinMax = 32.0V
Vout = 12.0V
Iout = 1.0A

Device = LM5005MHX/NOPB
Topology = Buck
Created = 2019-11-15 02:51:38.647
BOM Cost = NA
BOM Count = 19
Total Pd = 0.94W

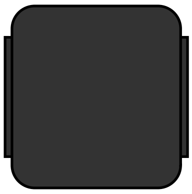
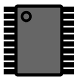
WEBENCH ® Design Report

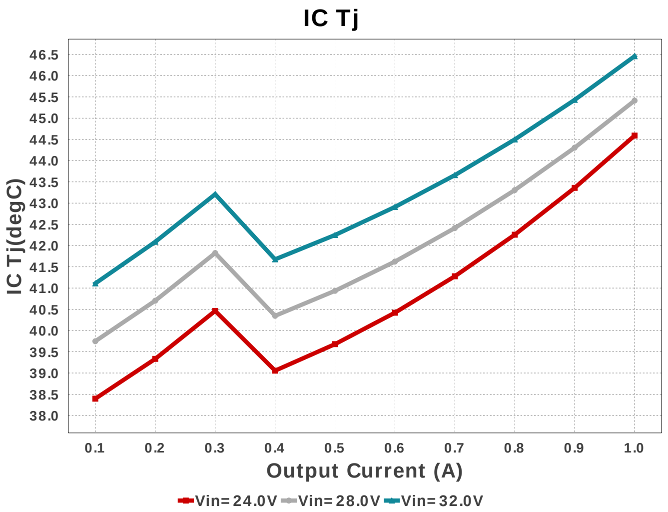
Design : 29 LM5005MHX/NOPB
LM5005MHX/NOPB 24V-32V to 12.00V @ 1A

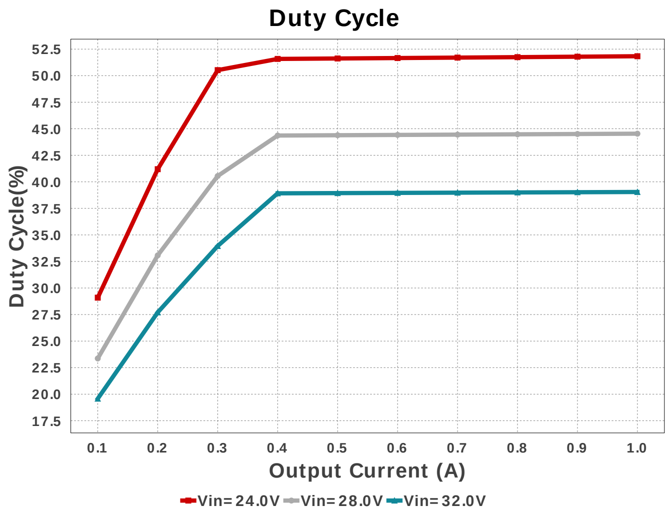


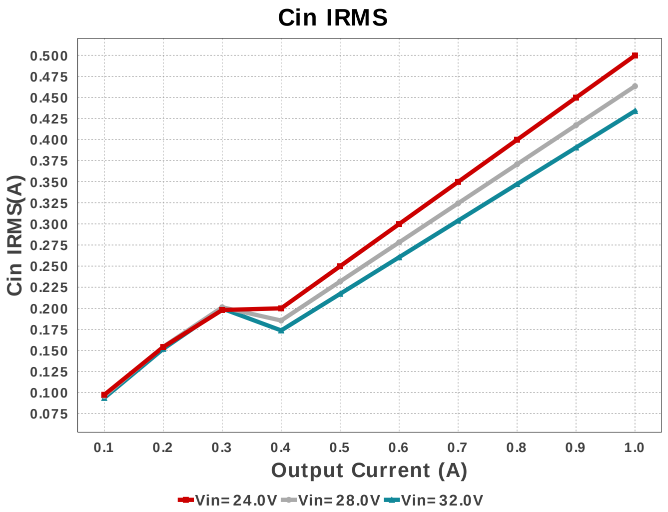
Electrical BOM

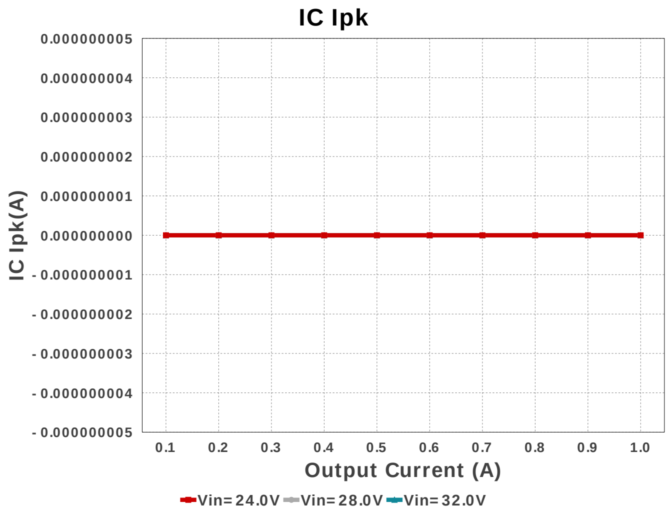
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	Kemet	C0805C223K5RACTU Series= X7R	Cap= 22.0 nF ESR= 125.0 mOhm VDC= 50.0 V IRMS= 645.0 mA	1	$0.01	0805 7 mm²
Cbyp	Kemet	C0805C104M5RACTU Series= X7R	Cap= 100.0 nF ESR= 64.0 mOhm VDC= 50.0 V IRMS= 1.64 A	1	$0.01	0805 7 mm²
Ccomp	MuRata	GRM155R71E562KA01D Series= X7R	Cap= 5.6 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cin	MuRata	GRM31CR61H225KA88L Series= X5R	Cap= 2.2 uF ESR= 4.448 mOhm VDC= 50.0 V IRMS= 2.2252 A	1	$0.10	1206_190 11 mm²
Cout	CUSTOM	CUSTOM Series= X5R	Cap= 6.0 uF ESR= 1.0 uOhm VDC= 16.0 V IRMS= 3.8281 A	5	NA	1206_190 0 mm²
Cramp	MuRata	GRM216R71E102KA01D Series= X7R	Cap= 1.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Css	Yageo	CC0805KRX7R9BB103 Series= X7R	Cap= 10.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
D1	Fairchild Semiconductor	SS26FL	VF@Io= 700.0 mV VRRM= 60.0 V	1	$0.07	SOD-123F 12 mm²

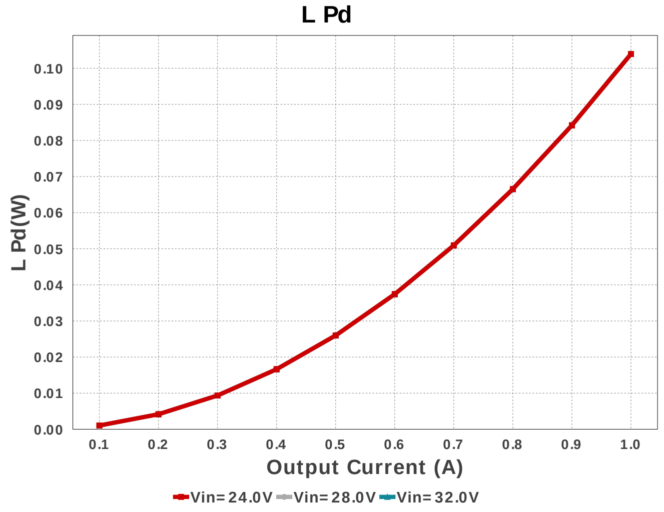
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
L1	CUSTOM	CUSTOM	L= 33.0 µH 94.5 mOhm	1	NA	 IHLP-6767GZ 0 mm²
Rcomp	Yageo	RC0603FR-079K76L Series= ?	Res= 9.76 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rfb1	Panasonic	ERJ-6ENF1021V Series= ERJ-6E	Res= 1.02 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
Rfb2	Panasonic	ERJ-6ENF8871V Series= ERJ-6E	Res= 8.87 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
Rramp	Vishay-Dale	CRCW0603205KFKEA Series= CRCW..e3	Res= 205.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rt	Vishay-Dale	CRCW060320K5FKEA Series= CRCW..e3	Res= 20.5 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
U1	Texas Instruments	LM5005MHX/NOPB	Switcher	1	$1.75	 MXA20A 71 mm²

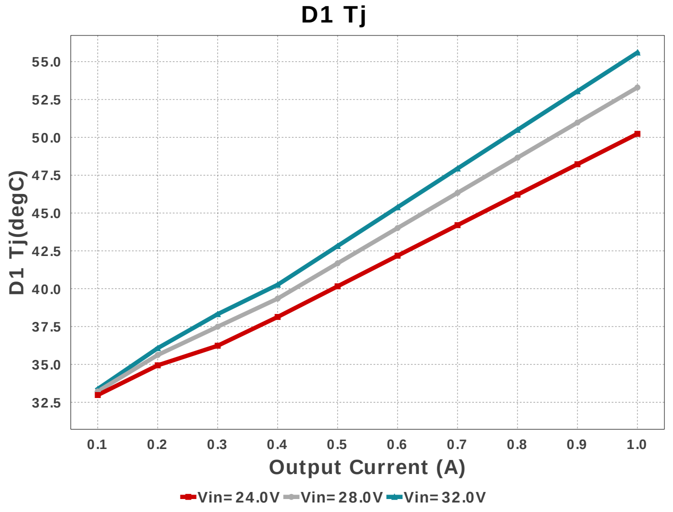


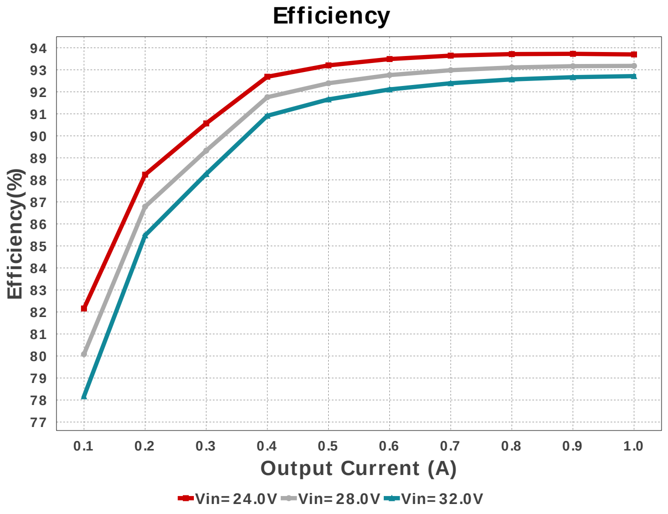


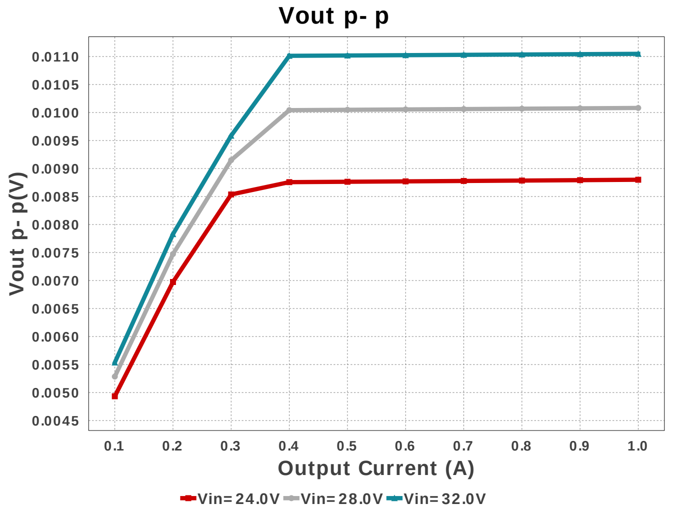


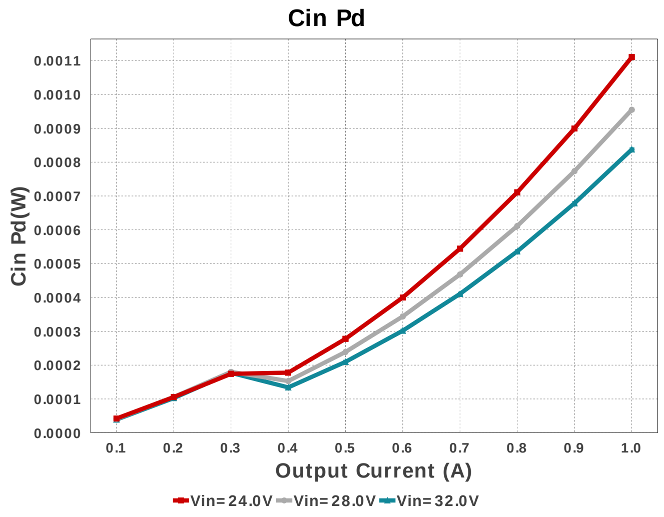


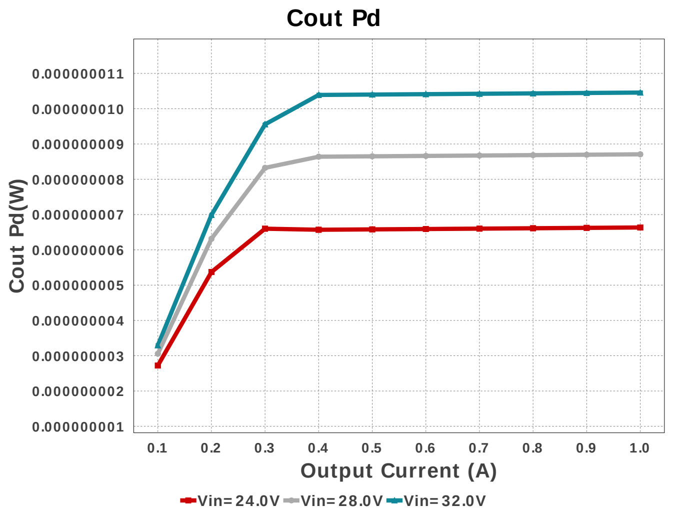

L Pd
L Pd(W)
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.10
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin= 24.0V
Vin= 28.0V
Vin= 32.0V

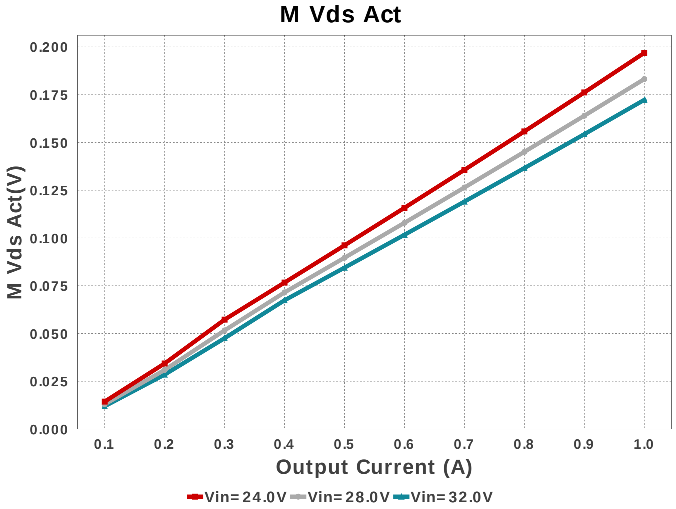

D1 Tj
D1 Tj(degC)
32.5
35.0
37.5
40.0
42.5
45.0
47.5
50.0
52.5
55.0
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin= 24.0V
Vin= 28.0V
Vin= 32.0V

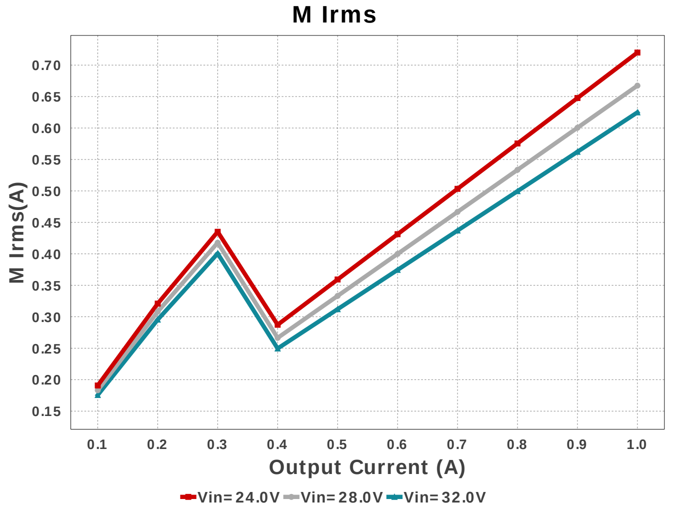

Efficiency
Efficiency(%)
77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin= 24.0V
Vin= 28.0V
Vin= 32.0V

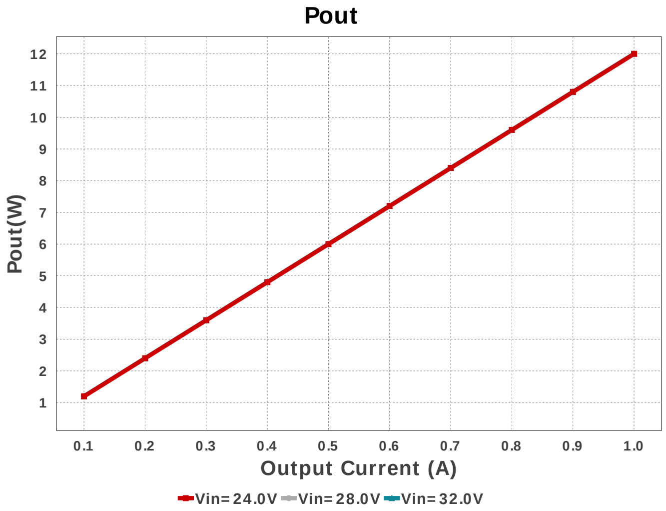

Vout p- p
Vout p- p(V)
0.0045
0.0050
0.0055
0.0060
0.0065
0.0070
0.0075
0.0080
0.0085
0.0090
0.0095
0.0100
0.0105
0.0110
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin= 24.0V
Vin= 28.0V
Vin= 32.0V

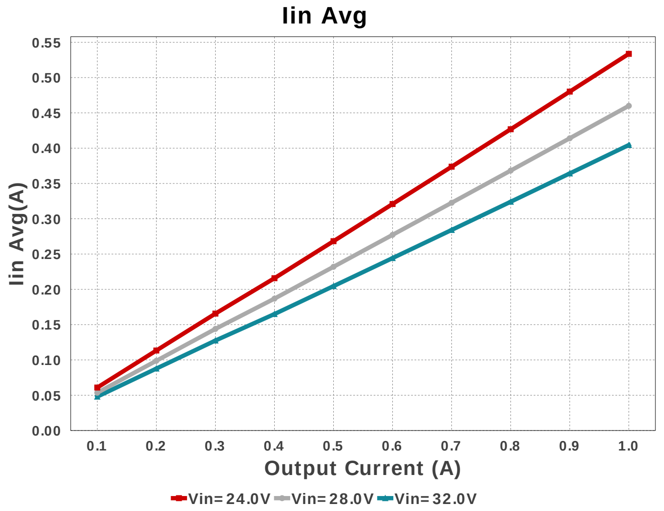

Cin Pd
Cin Pd(W)
0.0000
0.0001
0.0002
0.0003
0.0004
0.0005
0.0006
0.0007
0.0008
0.0009
0.0010
0.0011
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin= 24.0V
Vin= 28.0V
Vin= 32.0V

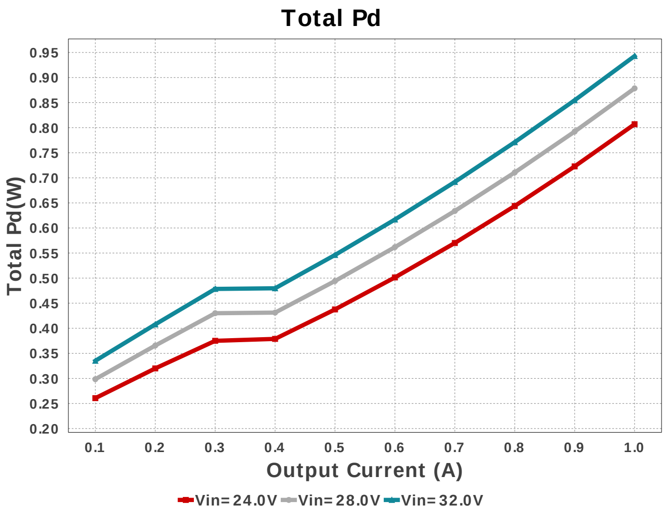

Cout Pd
Cout Pd(W)
0.000000001
0.000000002
0.000000003
0.000000004
0.000000005
0.000000006
0.000000007
0.000000008
0.000000009
0.000000010
0.000000011
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin= 24.0V
Vin= 28.0V
Vin= 32.0V

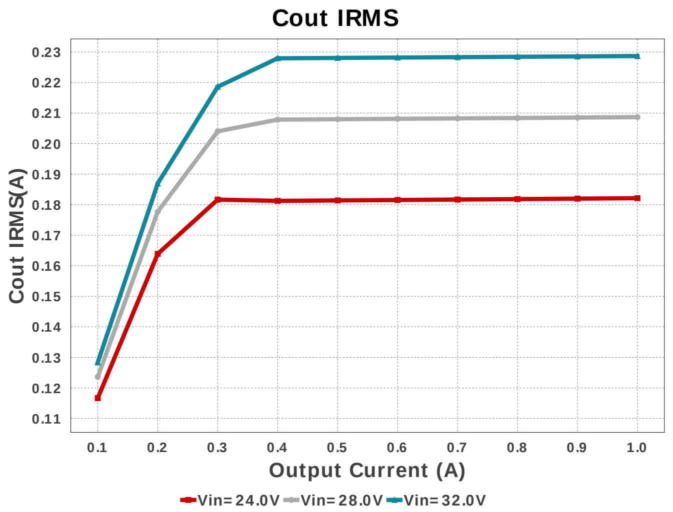

M Vds Act
M Vds Act(V)
Output Current (A)
Vin=24.0V Vin=28.0V Vin=32.0V

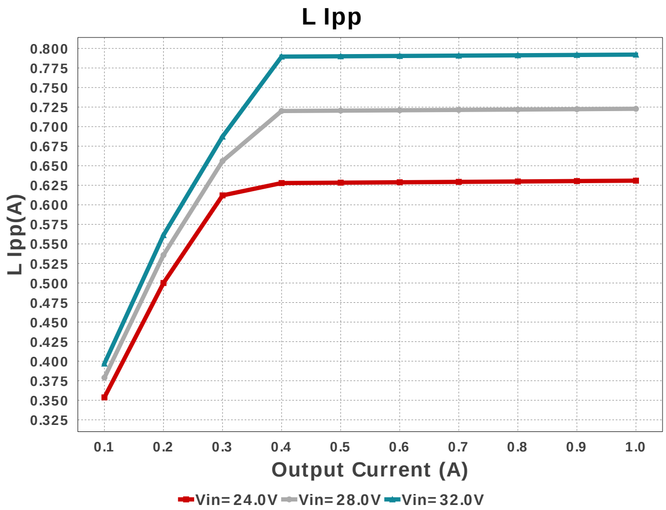

M Irms
M Irms(A)
Output Current (A)
Vin=24.0V Vin=28.0V Vin=32.0V

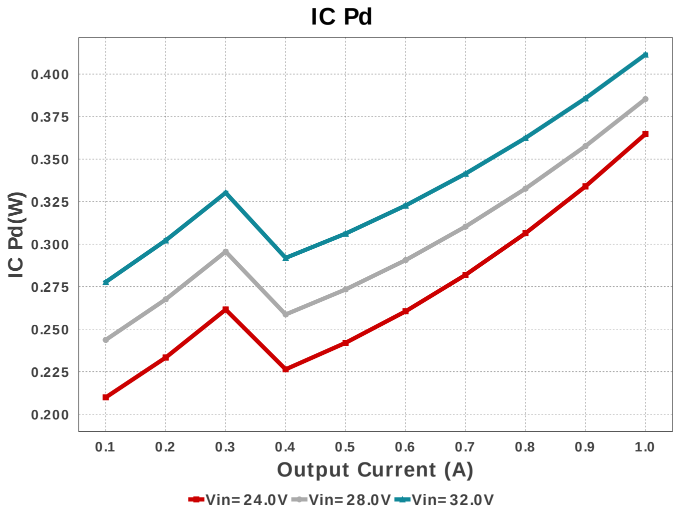

Pout
Pout(W)
Output Current (A)
Vin=24.0V Vin=28.0V Vin=32.0V

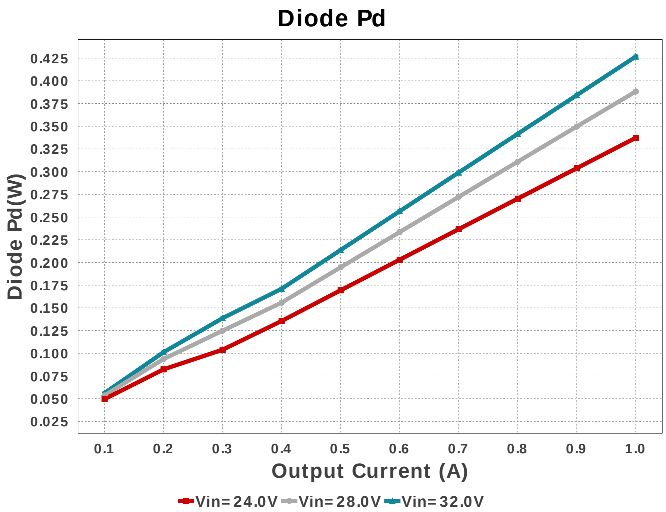

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=24.0V Vin=28.0V Vin=32.0V


Total Pd
Total Pd(W)
Output Current (A)
Vin=24.0V Vin=28.0V Vin=32.0V


Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=24.0V Vin=28.0V Vin=32.0V







Operating Values

#	Name	Value	Category	Description
1.	BOM Count	19		Total Design BOM count
2.	Total BOM	NA		Total BOM Cost
3.	Cin IRMS	433.907 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	837.45 µW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	228.663 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	10.457 nW	Capacitor	Output capacitor power dissipation
7.	D1 Tj	55.602 degC	Diode	D1 junction temperature
8.	Diode Pd	426.69 mW	Diode	Diode power dissipation
9.	IC Ipk	0.0 A	IC	Peak switch current in IC
10.	IC Pd	411.45 mW	IC	IC power dissipation
11.	IC Tj	46.458 degC	IC	IC junction temperature
12.	IC Tolerance	18.0 mV	IC	IC Feedback Tolerance
13.	ICThetaJA	40.0 degC/W	IC	IC junction-to-ambient thermal resistance
14.	Iin Avg	404.47 mA	IC	Average input current
15.	L Ipp	792.113 mA	Inductor	Peak-to-peak inductor ripple current
16.	L Pd	103.95 mW	Inductor	Inductor power dissipation
17.	M Irms	624.849 mA	Mosfet	MOSFET RMS ripple current
18.	M Vds Act	172.302 mV	Mosfet	Voltage drop across the MosFET
19.	Cin Pd	837.45 µW	Power	Input capacitor power dissipation
20.	Cout Pd	10.457 nW	Power	Output capacitor power dissipation
21.	Diode Pd	426.69 mW	Power	Diode power dissipation
22.	IC Pd	411.45 mW	Power	IC power dissipation
23.	L Pd	103.95 mW	Power	Inductor power dissipation
24.	Total Pd	942.9 mW	Power	Total Power Dissipation
25.	Duty Cycle	39.044 %	System Information	Duty cycle
26.	Efficiency	92.715 %	System Information	Steady state efficiency
27.	FootPrint	573.0 mm^2	System Information	Total Foot Print Area of BOM components
28.	Frequency	298.73 kHz	System Information	Switching frequency

#	Name	Value	Category	Description
29.	Iout	1.0 A	System Information	Iout operating point
30.	Mode	CCM	System Information	Conduction Mode
31.	Pout	12.0 W	System Information	Total output power
32.	Vin	32.0 V	System Information	Vin operating point
33.	Vout	12.0 V	System Information	Operational Output Voltage
34.	Vout Actual	11.878 V	System Information	Vout Actual calculated based on selected voltage divider resistors
35.	Vout Tolerance	3.308 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
36.	Vout p-p	11.048 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	1.0	Maximum Output Current
VinMax	32.0	Maximum input voltage
VinMin	24.0	Minimum input voltage
Vout	12.0	Output Voltage
base_pn	LM5005	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 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

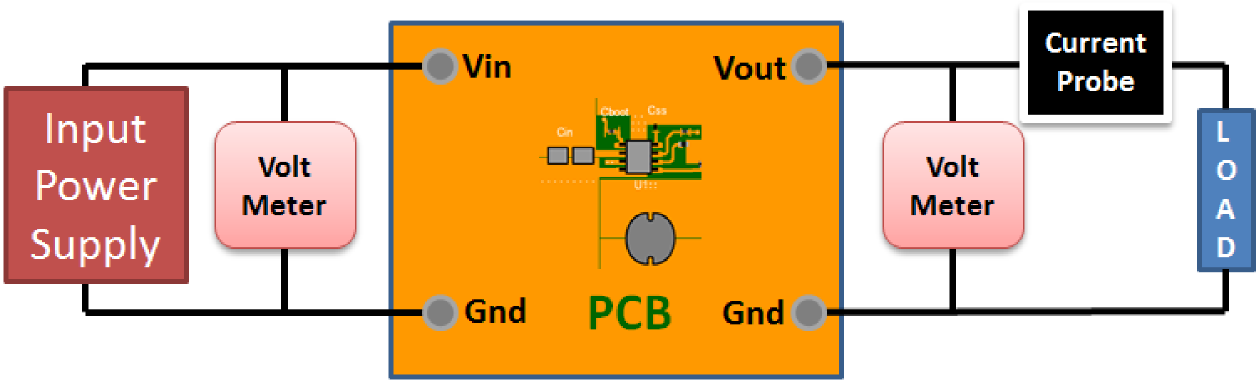
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 24.0V 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. Master key : 4BB4D4A5A0543D66[v1]

2. **LM5005** Product Folder : http://www.ti.com/product/LM5005 : contains the data sheet and other resources.

Important Notice and Disclaimer