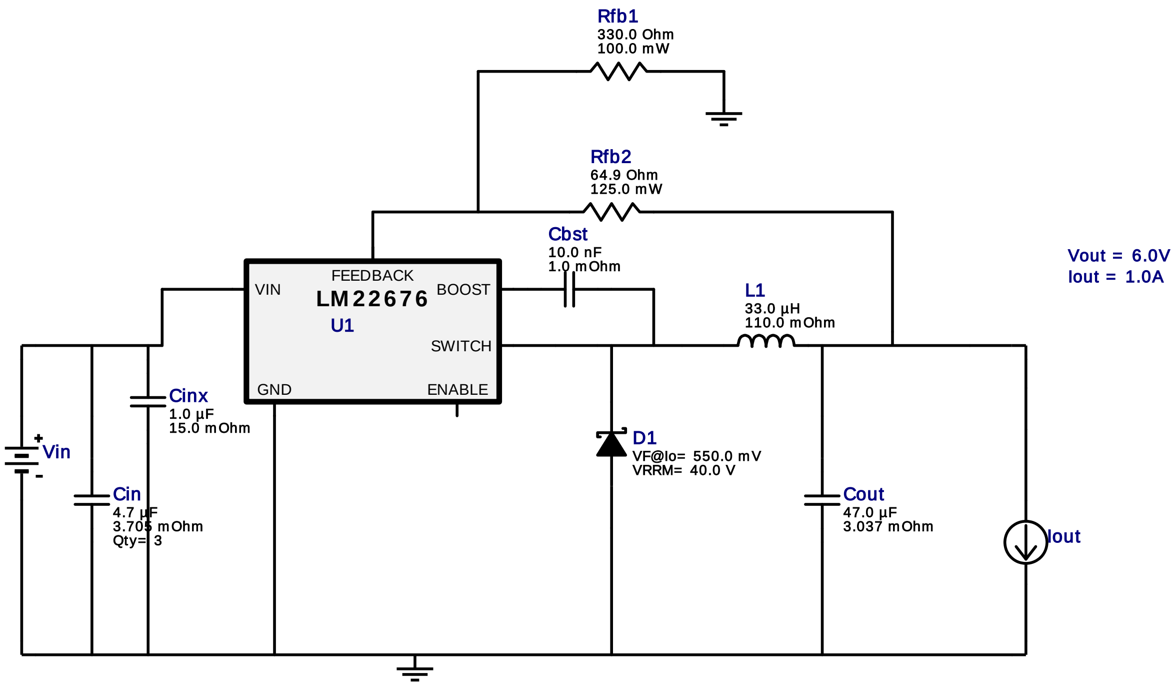
VinMin = 7.4V
VinMax = 13.0V
Vout = 6.0V
Iout = 1.0A

Device = LM22676MRE-5.0/NOPB
Topology = Buck
Created = 2022-02-22 14:56:00.658
BOM Cost = $3.02
BOM Count = 11
Total Pd = 0.58W

WEBENCH ® Design Report

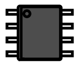
Design : 546 LM22676MRE-5.0/NOPB
LM22676MRE-5.0/NOPB 7.4V-13V to 6.00V @ 1A



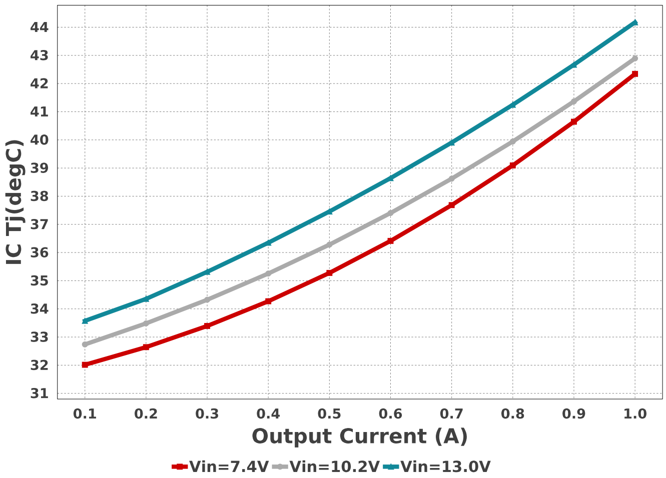
1. This regulator device is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application.View WEBENCH(R) Disclaimer.

Electrical BOM

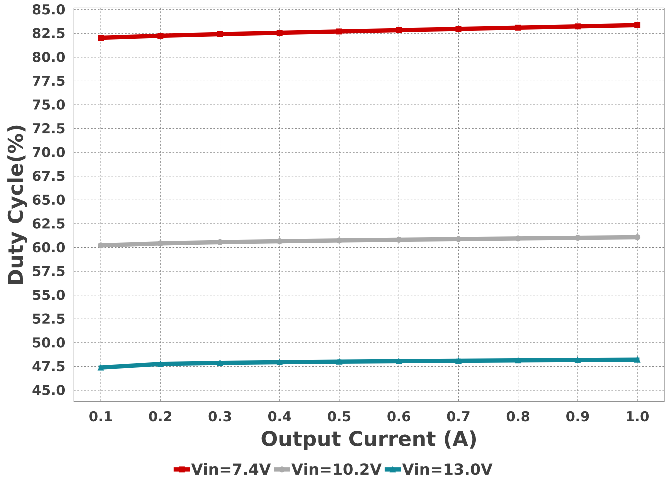
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbst	Yageo	CC0805KRX7R9BB103 Series= X7R	Cap= 10.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
Cin	MuRata	GRM31CR71E475KA88L Series= X7R	Cap= 4.7 uF ESR= 3.705 mOhm VDC= 25.0 V IRMS= 2.8649 A	3	$0.08	1206_190 11 mm^2
Cinx	Kemet	C0805C105K4RACTU Series= X7R	Cap= 1.0 uF ESR= 15.0 mOhm VDC= 16.0 V IRMS= 8.19 A	1	$0.02	0805 7 mm^2
Cout	MuRata	GRM32ER61C476KE15L Series= X5R	Cap= 47.0 uF ESR= 3.037 mOhm VDC= 16.0 V IRMS= 4.59346 A	1	$0.38	1210_280 15 mm^2
D1	Fairchild Semiconductor	SS14FL	VF@Io= 550.0 mV VRRM= 40.0 V	1	$0.04	SOD-123F 12 mm^2
L1	TDK	VLP8040T-330M	L= 33.0 µH 110.0 mOhm	1	$0.22	VLP8040 113 mm^2
Rfb1	Yageo	RC0603FR-07330RL Series= ?	Res= 330.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rfb2	Vishay-Dale	CRCW080564R9FKEA Series= CRCW..e3	Res= 64.9 Ohm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
U1	Texas Instruments	LM22676MRE-5.0/NOPB	Switcher	1	$2.09	 MRA08B 56 mm²

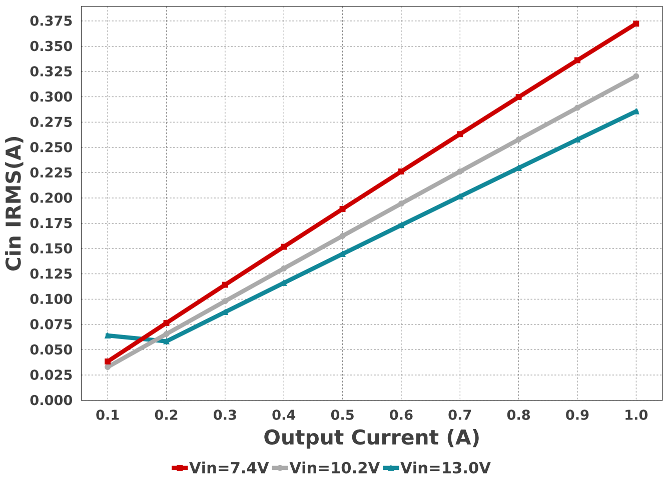
IC Tj



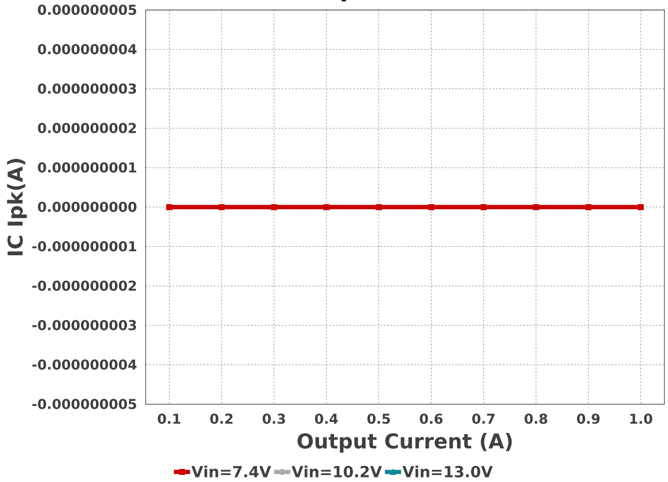
Duty Cycle



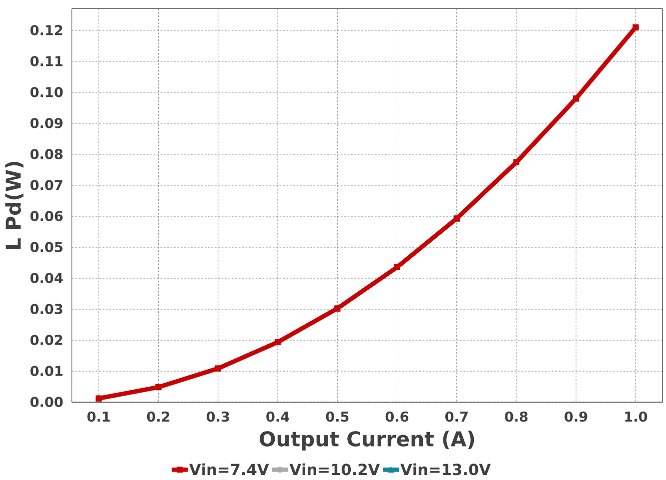
Cin IRMS



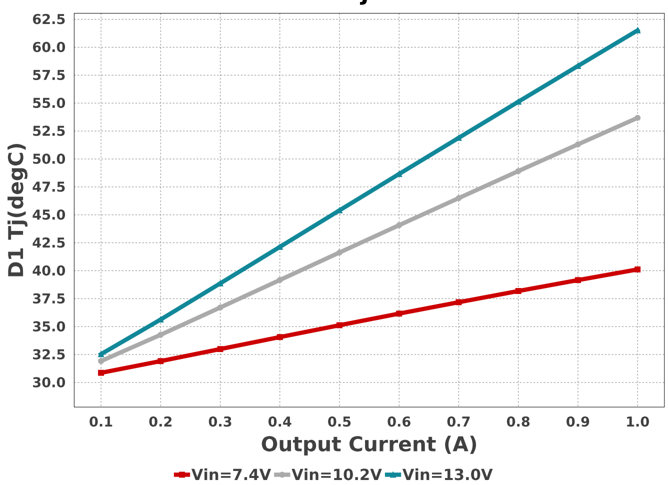
IC Ipk

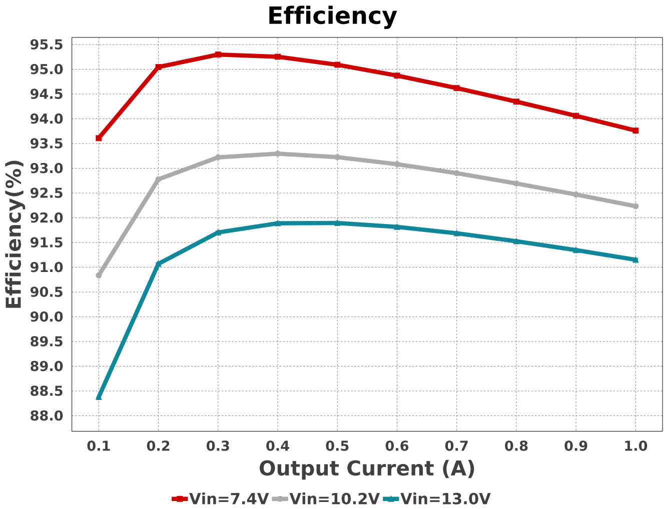


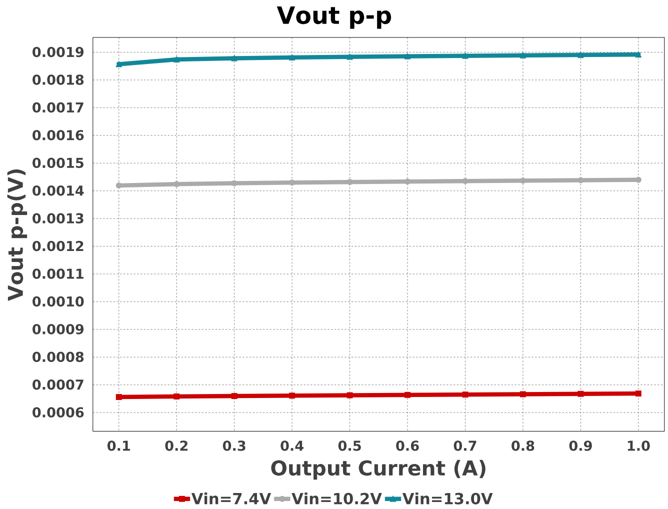
L Pd

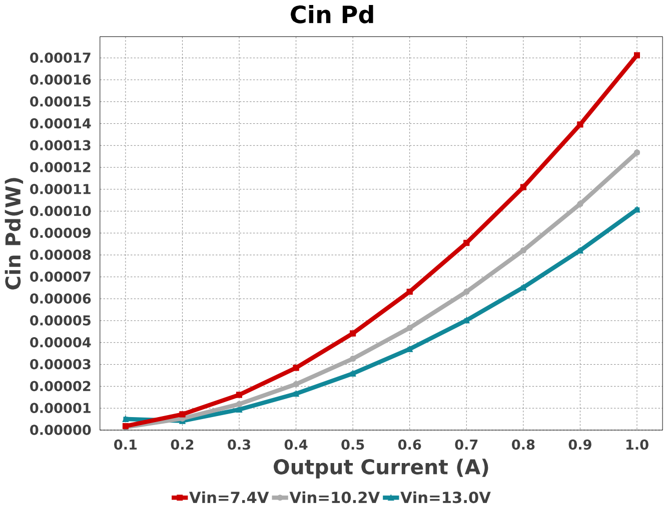


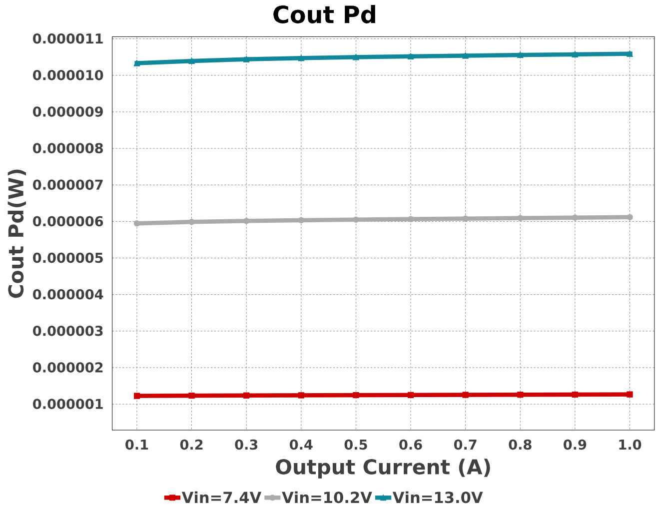
D1 Tj

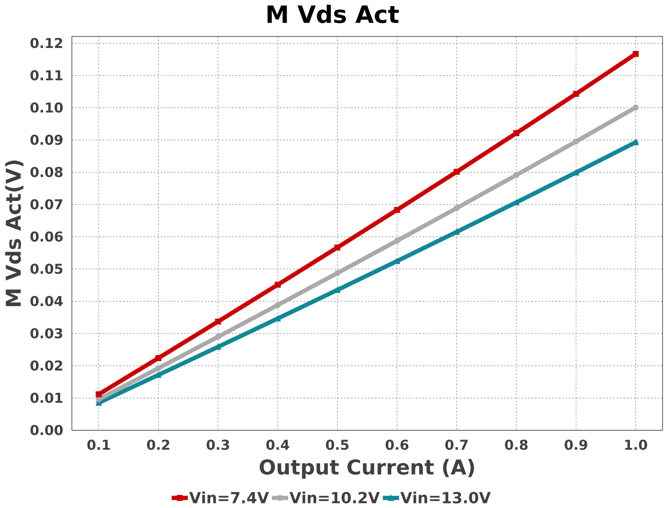


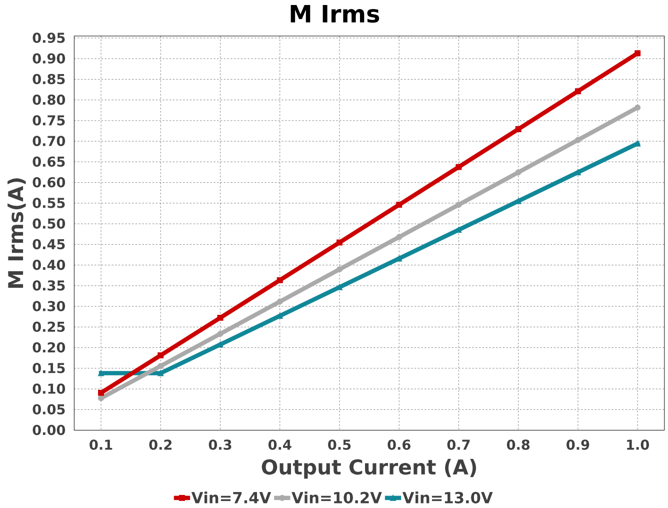

Efficiency
Efficiency(%)
Output Current (A)
Vin=7.4V Vin=10.2V Vin=13.0V

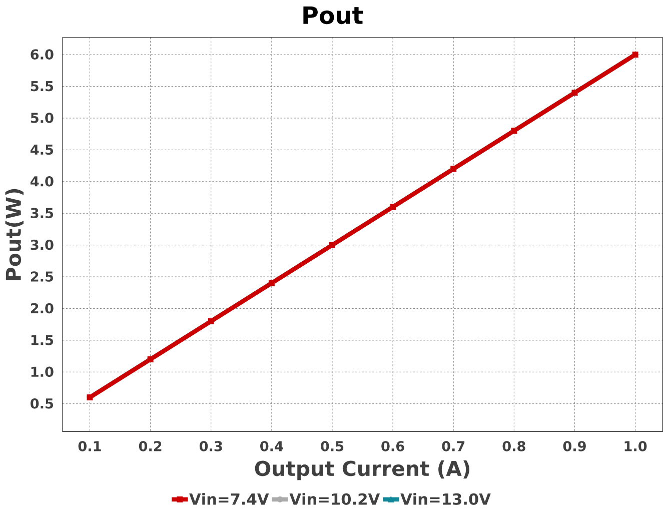

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=7.4V Vin=10.2V Vin=13.0V

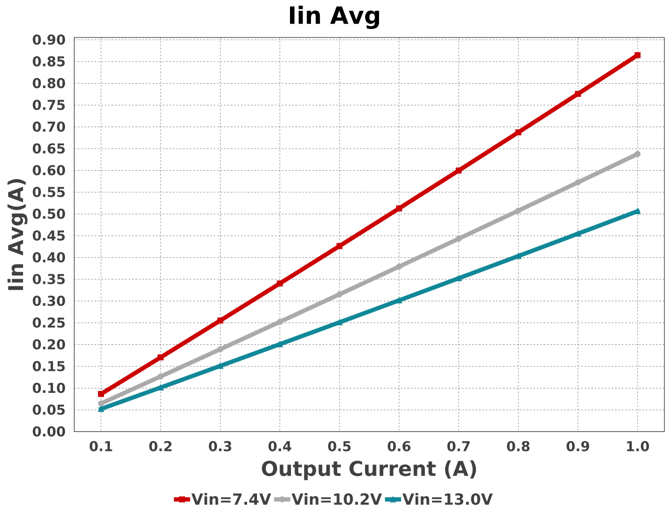

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=7.4V Vin=10.2V Vin=13.0V

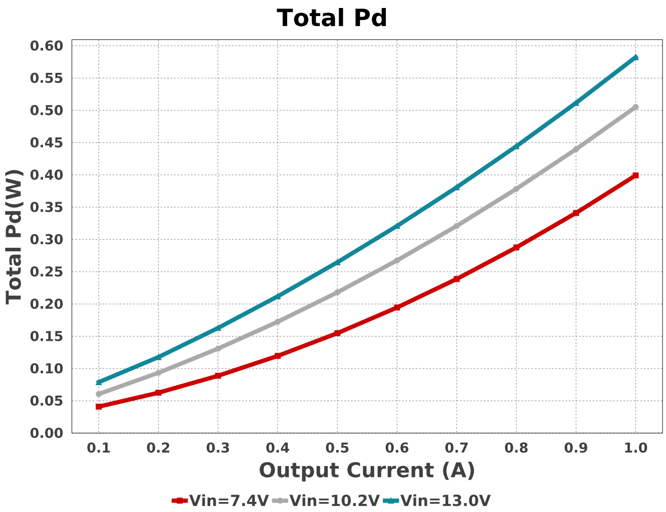

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=7.4V Vin=10.2V Vin=13.0V

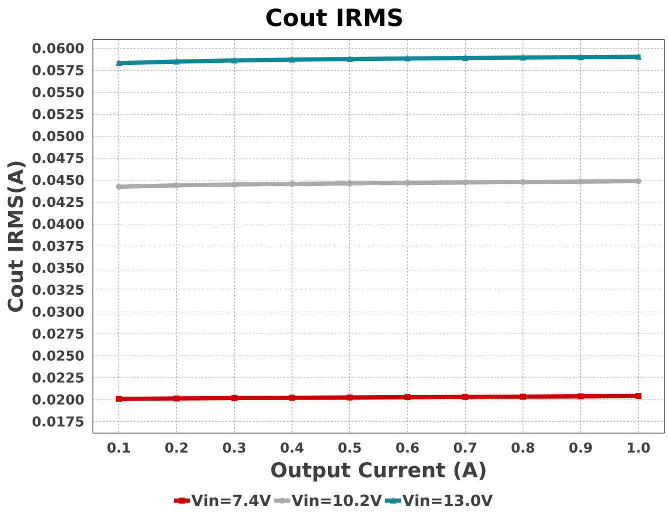

M Vds Act
M Vds Act(V)
Output Current (A)
Vin=7.4V Vin=10.2V Vin=13.0V

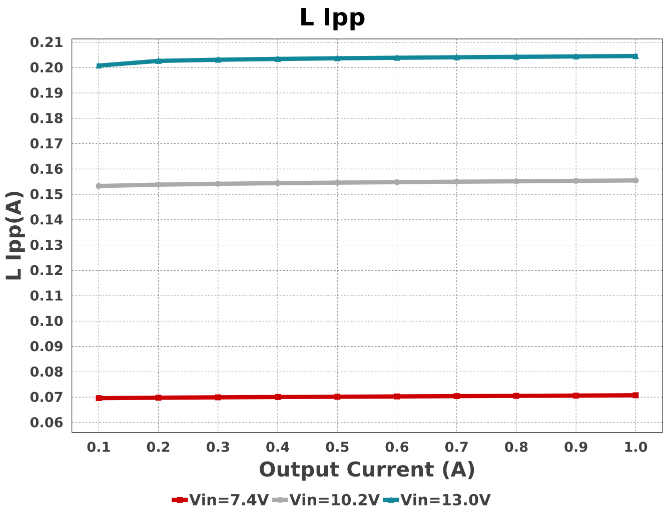

M Irms
M Irms(A)
Output Current (A)
Vin=7.4V Vin=10.2V Vin=13.0V

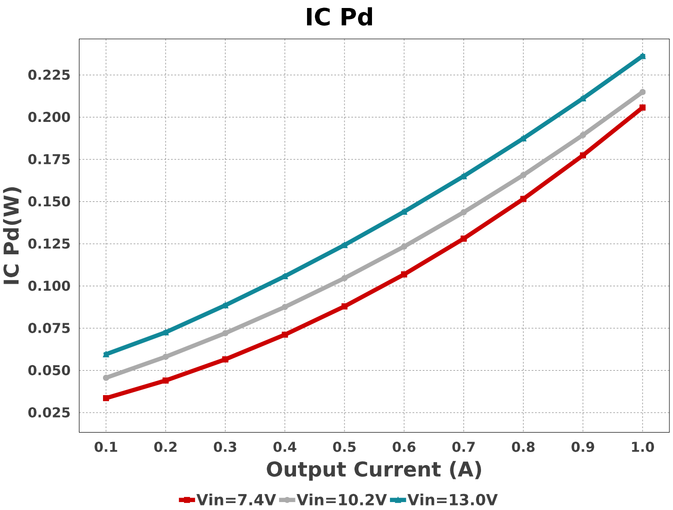

Pout
Pout(W)
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=7.4V Vin=10.2V Vin=13.0V

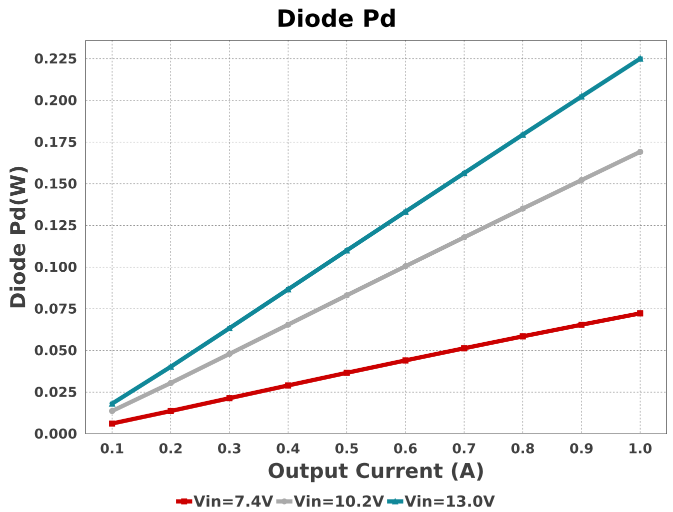

Iin Avg
Iin Avg(A)
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=7.4V Vin=10.2V Vin=13.0V


Total Pd
Total Pd(W)
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=7.4V Vin=10.2V Vin=13.0V


Cout IRMS
Cout IRMS(A)
0.0600
0.0575
0.0550
0.0525
0.0500
0.0475
0.0450
0.0425
0.0400
0.0375
0.0350
0.0325
0.0300
0.0275
0.0250
0.0225
0.0200
0.0175
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=7.4V Vin=10.2V Vin=13.0V


L Ipp
L Ipp(A)
0.21
0.20
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=7.4V Vin=10.2V Vin=13.0V


IC Pd
IC Pd(W)
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=7.4V Vin=10.2V Vin=13.0V



Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	285.645 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	100.77 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	59.05 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	10.59 µW	Capacitor	Output capacitor power dissipation
5.	D1 Tj	61.508 degC	Diode	D1 junction temperature
6.	Diode Pd	225.06 mW	Diode	Diode power dissipation
7.	IC Ipk	0.0 A	IC	Peak switch current in IC
8.	IC Pd	236.22 mW	IC	IC power dissipation
9.	IC Tj	44.173 degC	IC	IC junction temperature
10.	IC Tolerance	75.0 mV	IC	IC Feedback Tolerance
11.	ICThetaJA	60.0 degC/W	IC	IC junction-to-ambient thermal resistance
12.	Iin Avg	506.34 mA	IC	Average input current
13.	L Ipp	204.55 mA	Inductor	Peak-to-peak inductor ripple current
14.	L Pd	121.0 mW	Inductor	Inductor power dissipation
15.	M Irms	694.38 mA	Mosfet	MOSFET RMS ripple current
16.	M Vds Act	89.317 mV	Mosfet	Voltage drop across the MosFET
17.	Cin Pd	100.77 µW	Power	Input capacitor power dissipation
18.	Cout Pd	10.59 µW	Power	Output capacitor power dissipation
19.	Diode Pd	225.06 mW	Power	Diode power dissipation
20.	IC Pd	236.22 mW	Power	IC power dissipation
21.	L Pd	121.0 mW	Power	Inductor power dissipation
22.	Total Pd	582.413 mW	Power	Total Power Dissipation
23.	BOM Count	11	System Information	Total Design BOM count
24.	Cross Freq	39.759 kHz	System Information	Bode plot crossover frequency
25.	Duty Cycle	48.216 %	System Information	Duty cycle
26.	Efficiency	91.152 %	System Information	Steady state efficiency
27.	FootPrint	253.0 mm^2	System Information	Total Foot Print Area of BOM components
28.	Frequency	500.0 kHz	System Information	Switching frequency
29.	Iout	1.0 A	System Information	Iout operating point
30.	Mode	CCM	System Information	Conduction Mode
31.	Phase Marg	47.305 deg	System Information	Bode Plot Phase Margin
32.	Pout	6.0 W	System Information	Total output power
33.	Total BOM	$3.02	System Information	Total BOM Cost
34.	Vin	13.0 V	System Information	Vin operating point
35.	Vout	6.0 V	System Information	Operational Output Voltage
36.	Vout Actual	5.983 V	System Information	Achieved Vout with feedback resistor pair
37.	Vout Tolerance	1.837 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable

#	Name	Value	Category	Description
38.	Vout p-p	1.892 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	1.0	Maximum Output Current
VinMax	13.0	Maximum input voltage
VinMin	7.4	Minimum input voltage
Vout	6.0	Output Voltage
base_pn	LM22676	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

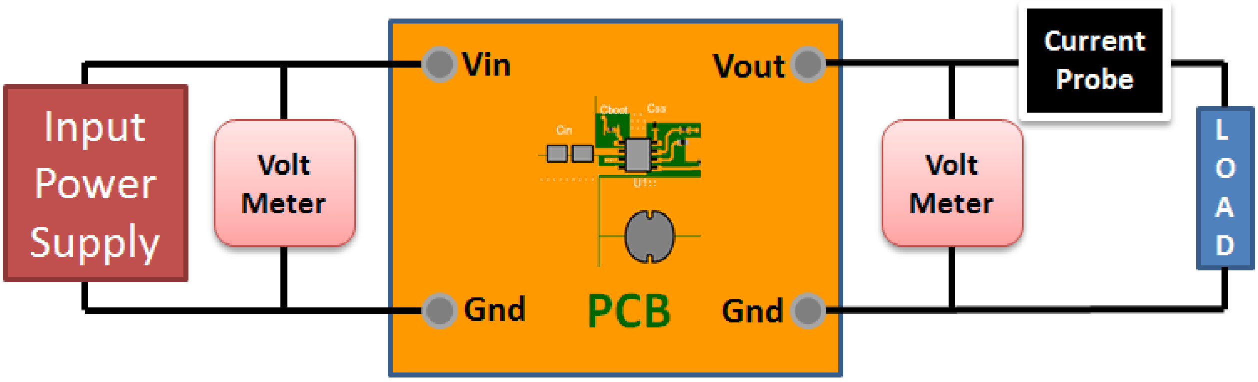
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 7.4V 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. Why WEBENCH recomends the 5.0 option for your 6.0V output: The internal compensation for the ADJ version of the LM22676 is optimized for output voltages below 5V. Therefore it is recommended that for outputs greater than 5V, the 5.0 option be used with an additional external resitive feedback divider. Part Description The LM22676 is a monolithic integrated circuit that provides all of the active functions for a step-down (buck) switching regulator capable of driving up to 3.0A loads with excellent line and load regulation characteristics. High efficiency (>90%) is obtained through the use of a low ON-resistance N-channel MOSFET.

2. Master key : 40EE3F1E021441DB[v1]

3. **LM22676** Product Folder : http://www.ti.com/product/LM22676 : contains the data sheet and other resources.

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