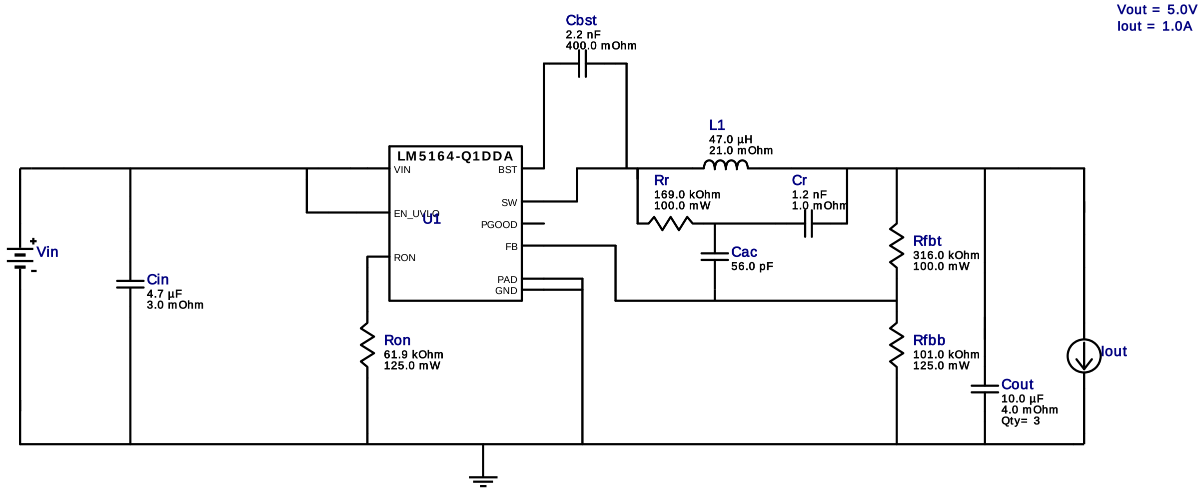
VinMin = 6.0V
VinMax = 36.0V
Vout = 5.0V
Iout = 1.0A

Device = LM5164QDDARQ1
Topology = Buck
Created = 2022-10-07 02:38:47.181
BOM Cost = $3.02
BOM Count = 13
Total Pd = 0.78W

WEBENCH ® Design Report

Design : 2 LM5164QDDARQ1
LM5164QDDARQ1 6V-36V to 5.00V @ 1A



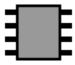
Design Alerts

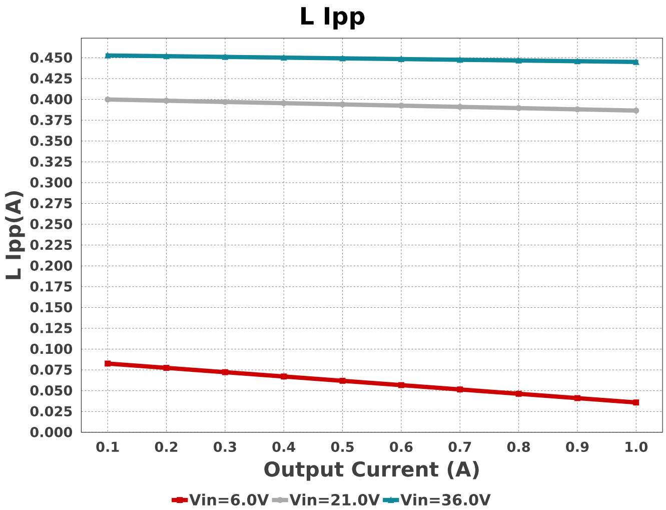
Component Selection Information

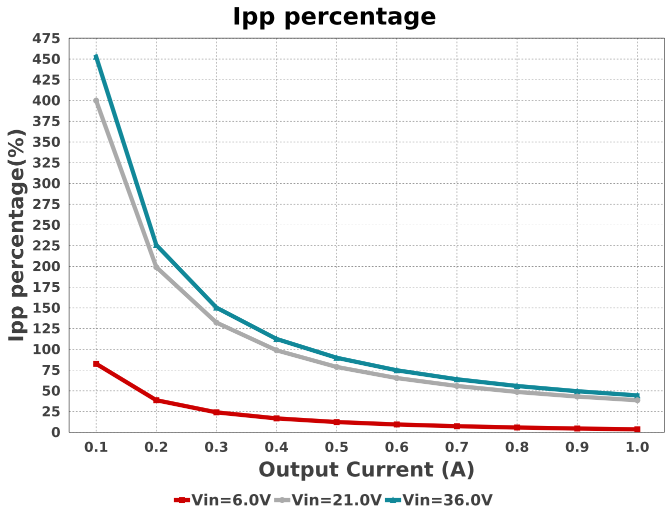
The LM5164-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application.

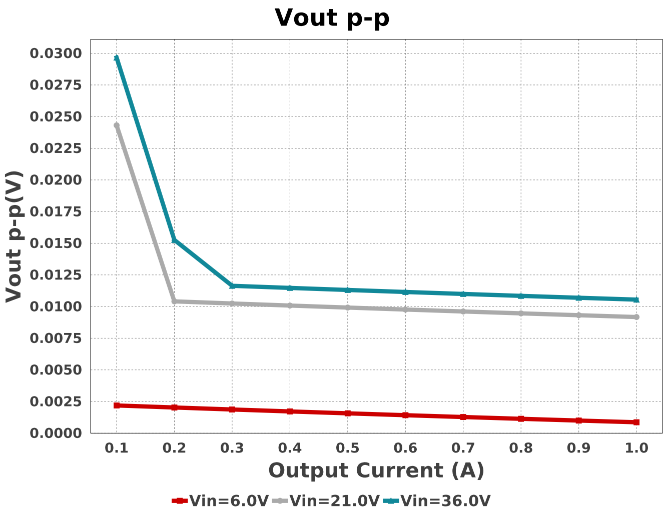
Electrical BOM

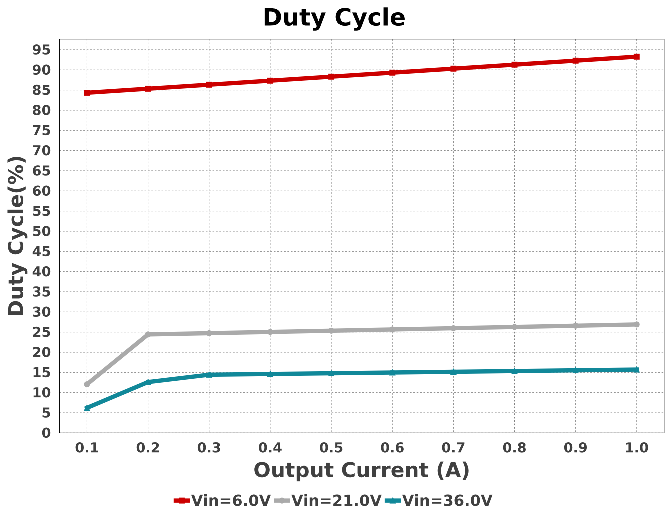
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cac	Yageo	CC0805JRNPO9BN560 Series= C0G/NP0	Cap= 56.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Cbst	Kemet	C0805C222K5RACTU Series= X7R	Cap= 2.2 nF ESR= 400.0 mOhm VDC= 50.0 V IRMS= 251.0 mA	1	$0.01	0805 7 mm²
Cin	MuRata	GRM31CR71H475KA12L Series= X7R	Cap= 4.7 uF ESR= 3.0 mOhm VDC= 50.0 V IRMS= 4.98 A	1	$0.10	1206 11 mm²
Cout	MuRata	GRM31CR71E106KA12L Series= X7R	Cap= 10.0 uF ESR= 4.0 mOhm VDC= 25.0 V IRMS= 6.0 A	3	$0.06	1206_180 11 mm²
Cr	MuRata	GRM155R71H122KA01D Series= X7R	Cap= 1.2 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
L1	Coilcraft	SER1390-473MLB	L= 47.0 µH 21.0 mOhm	1	$0.95	SER1390 240 mm²
Rfbb	Yageo	RT0805BRD07101KL Series= RT0805	Res= 101.0 kOhm Power= 125.0 mW Tolerance= 0.1%	1	$0.06	0805 7 mm²

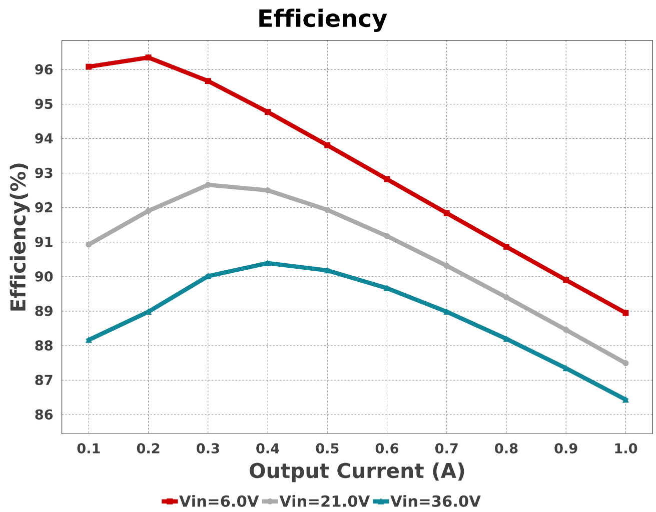
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rfbt	Yageo	RC0603FR-07316KL Series= ?	Res= 316.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Ron	Vishay-Dale	CRCW080561K9FKEA Series= CRCW..e3	Res= 61.9 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
Rr	Vishay-Dale	CRCW0603169KFKEA Series= CRCW..e3	Res= 169.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
U1	Texas Instruments	LM5164QDDARQ1	Switcher	1	$1.67	 DDA0008E_N 55 mm²

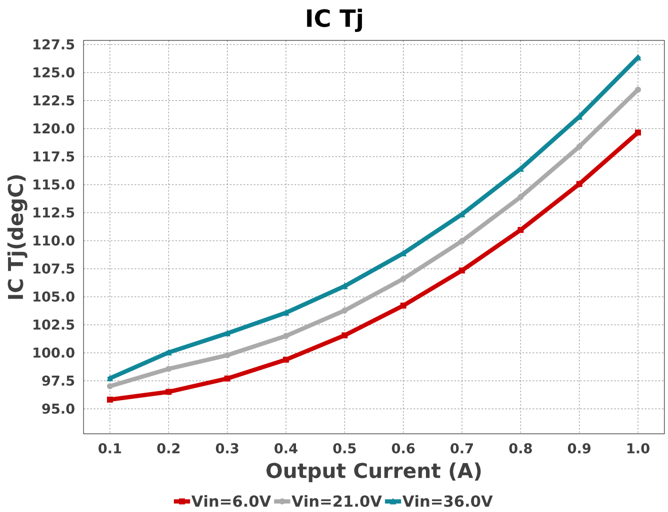


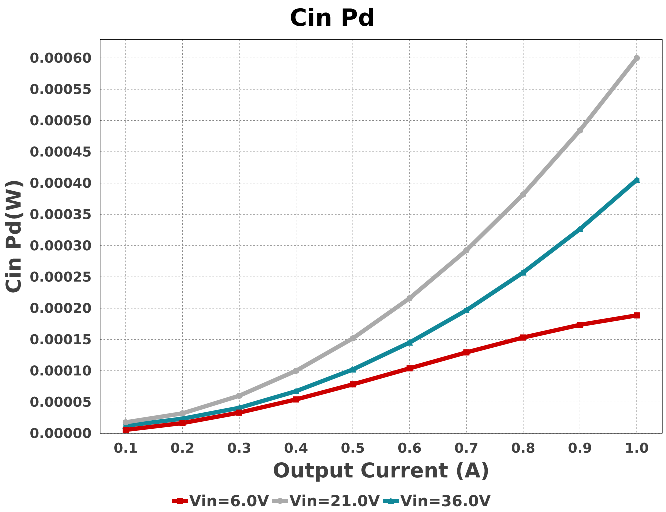


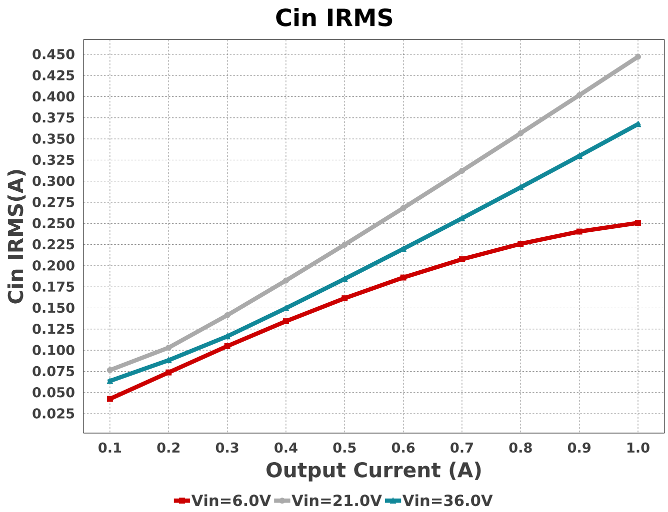


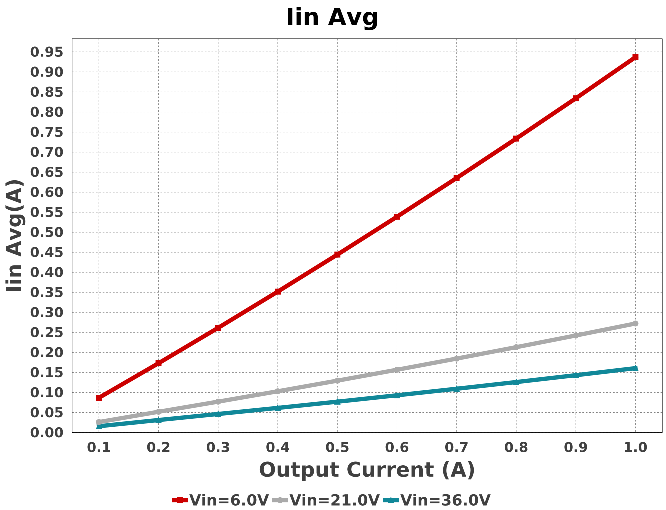


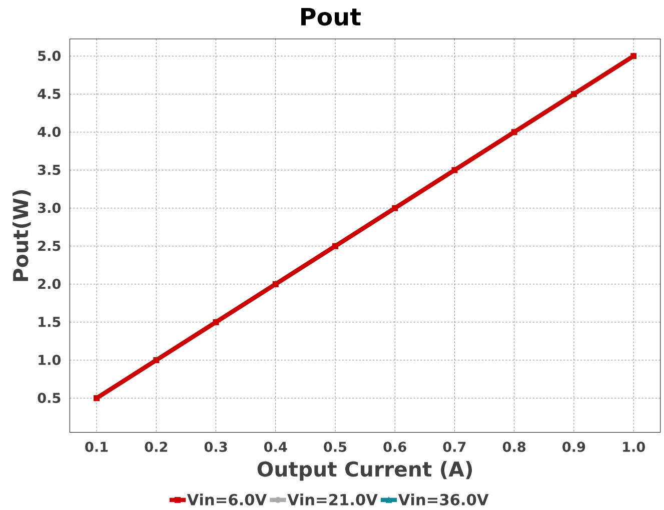

Efficiency
Efficiency(%)
Output Current (A)
Vin=6.0V
Vin=21.0V
Vin=36.0V


IC Tj
IC Tj(degC)
Output Current (A)
Vin=6.0V
Vin=21.0V
Vin=36.0V

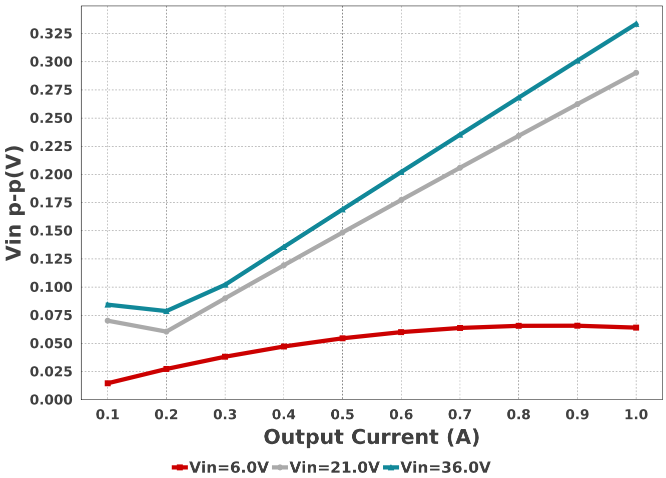

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=6.0V
Vin=21.0V
Vin=36.0V


Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=6.0V
Vin=21.0V
Vin=36.0V

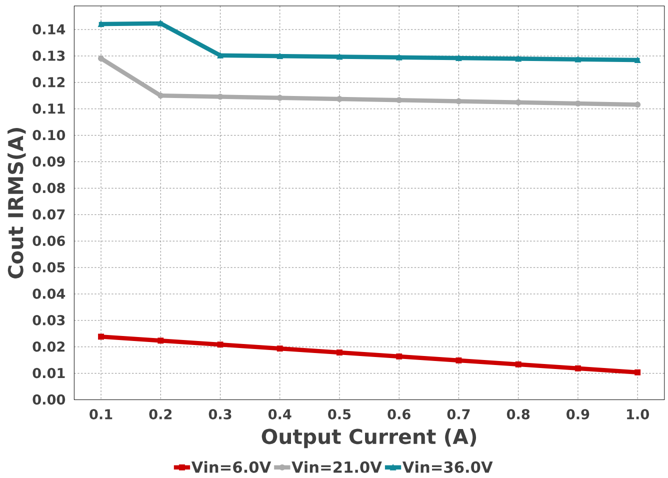

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=6.0V
Vin=21.0V
Vin=36.0V


Pout
Pout(W)
Output Current (A)
Vin=6.0V
Vin=21.0V
Vin=36.0V

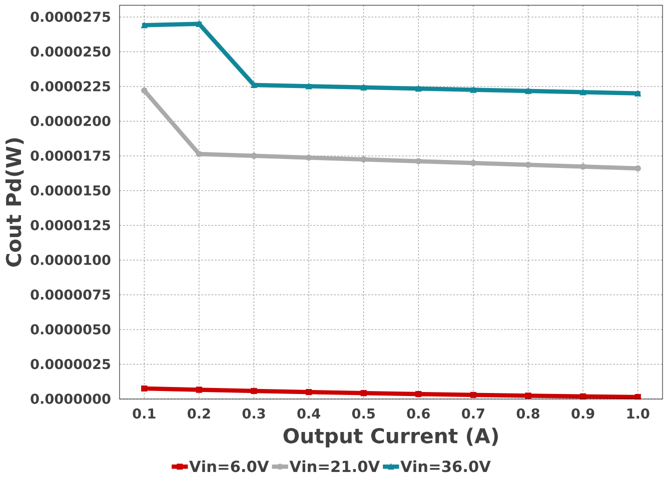
Vin p-p



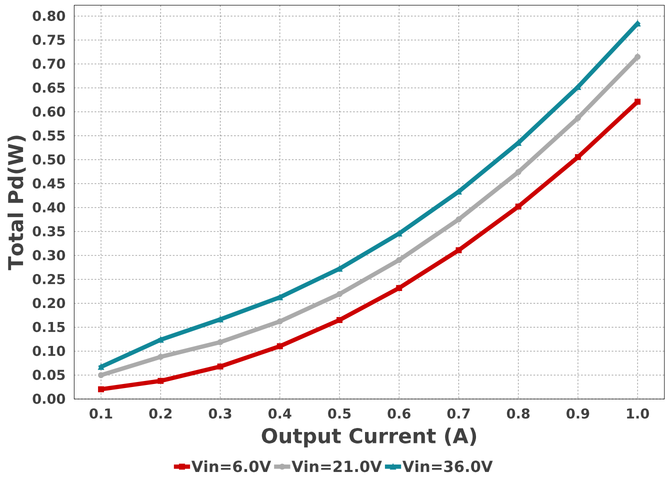
Cout IRMS



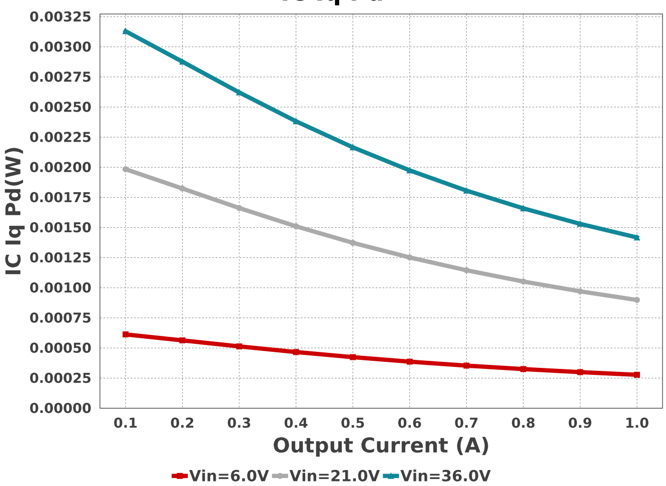
Cout Pd



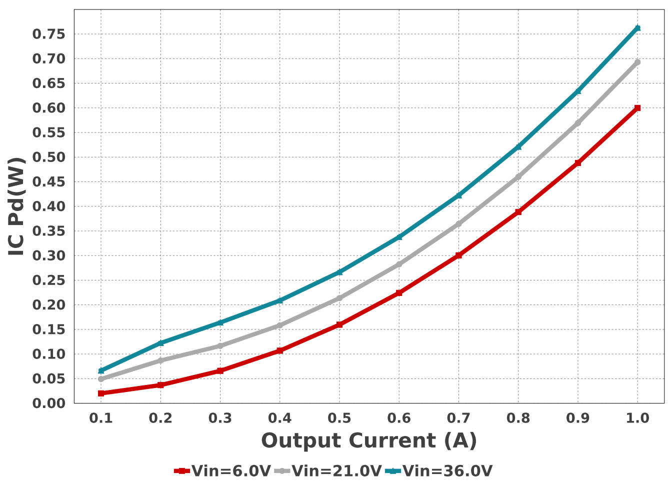
Total Pd

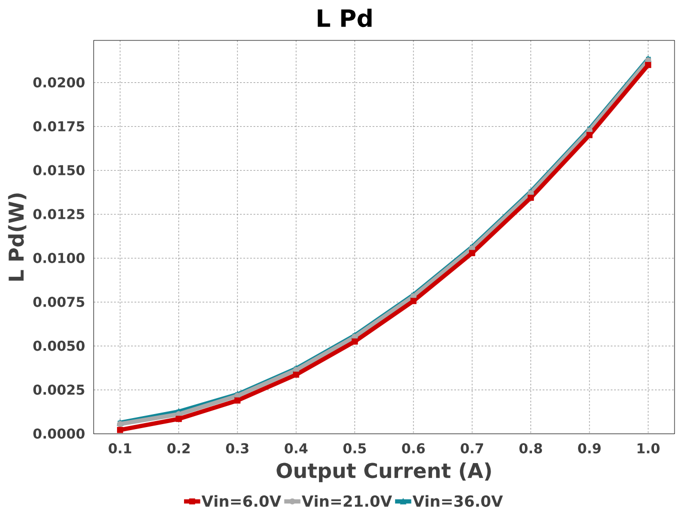


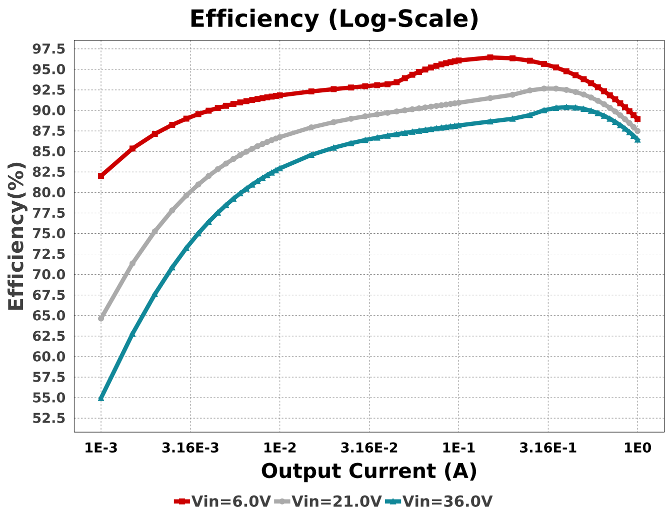
IC Iq Pd



IC Pd







Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	367.535 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	405.25 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	129.713 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	22.434 µW	Capacitor	Output capacitor power dissipation
5.	IC Iq Pd	1.417 mW	IC	IC Iq Pd
6.	IC Pd	761.77 mW	IC	IC power dissipation
7.	IC Tj	126.309 degC	IC	IC junction temperature
8.	ICThetaJA	41.1 degC/W	IC	IC junction-to-ambient thermal resistance
9.	Iin Avg	160.66 mA	IC	Average input current
10.	Ipp percentage	44.934 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
11.	L Ipp	449.34 mA	Inductor	Peak-to-peak inductor ripple current
12.	L Pd	21.353 mW	Inductor	Inductor power dissipation
13.	Cin Pd	405.25 µW	Power	Input capacitor power dissipation
14.	Cout Pd	22.434 µW	Power	Output capacitor power dissipation
15.	IC Pd	761.77 mW	Power	IC power dissipation
16.	L Pd	21.353 mW	Power	Inductor power dissipation
17.	Total Pd	783.642 mW	Power	Total Power Dissipation
18.	BOM Count	13	System Information	Total Design BOM count
19.	Duty Cycle	15.713 %	System Information	Duty cycle
20.	Efficiency	86.451 %	System Information	Steady state efficiency
21.	FootPrint	378.0 mm^2	System Information	Total Foot Print Area of BOM components
22.	Frequency	226.263 kHz	System Information	Switching frequency
23.	Iout	1.0 A	System Information	Iout operating point
24.	Mode	CCM	System Information	Conduction Mode
25.	Pout	5.0 W	System Information	Total output power
26.	Total BOM	$3.02	System Information	Total BOM Cost
27.	Vin	36.0 V	System Information	Vin operating point
28.	Vin p-p	336.82 mV	System Information	Peak-to-peak input voltage
29.	Vout	5.0 V	System Information	Operational Output Voltage
30.	Vout Actual	4.954 V	System Information	Vout Actual calculated based on selected voltage divider resistors
31.	Vout Tolerance	2.431 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
32.	Vout p-p	10.752 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	1.0	Maximum Output Current
VinMax	36.0	Maximum input voltage
VinMin	6.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	LM5164-Q1	Base Product Number
source	DC	Input Source Type
Ta	95.0	Ambient temperature
UserFsw	226.0 k	Customer Selected Frequency

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

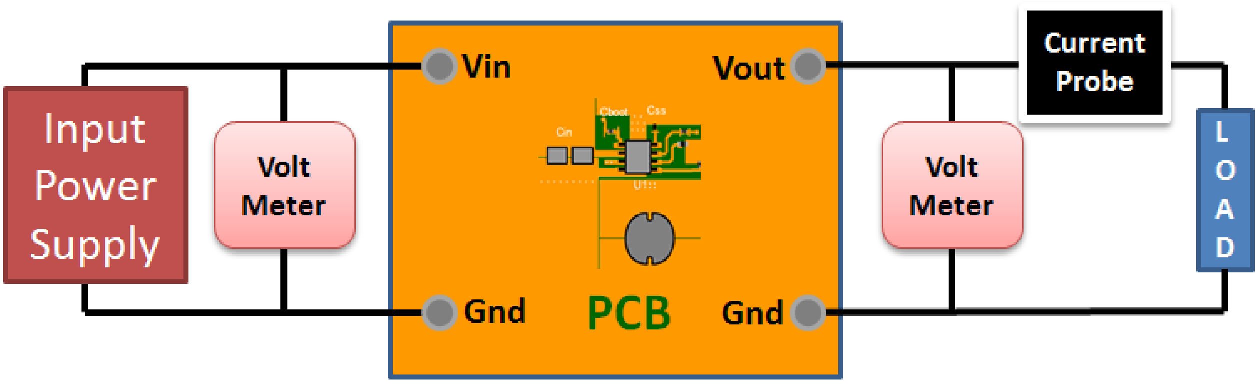
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 6.0V 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.

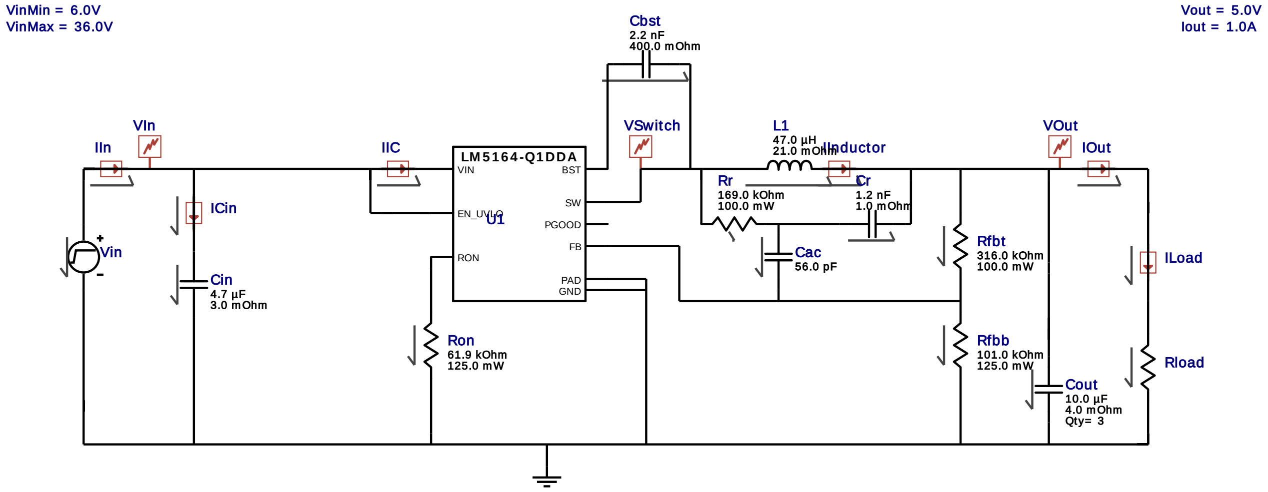


WEBENCH® Electrical Simulation Report

Design Id = 2

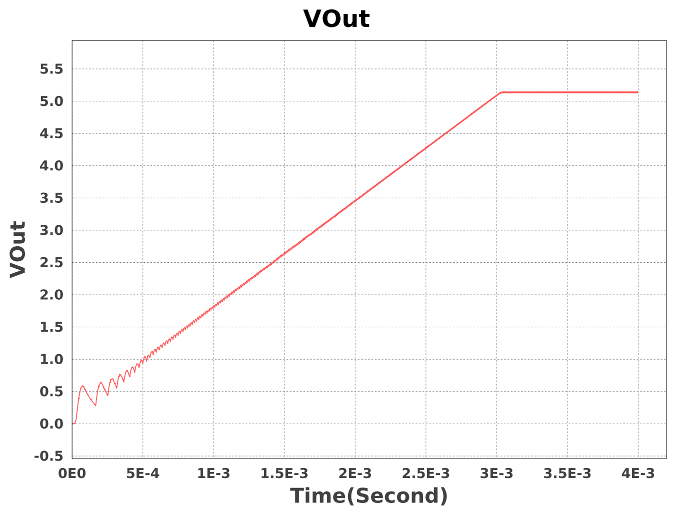
sim_id = 1

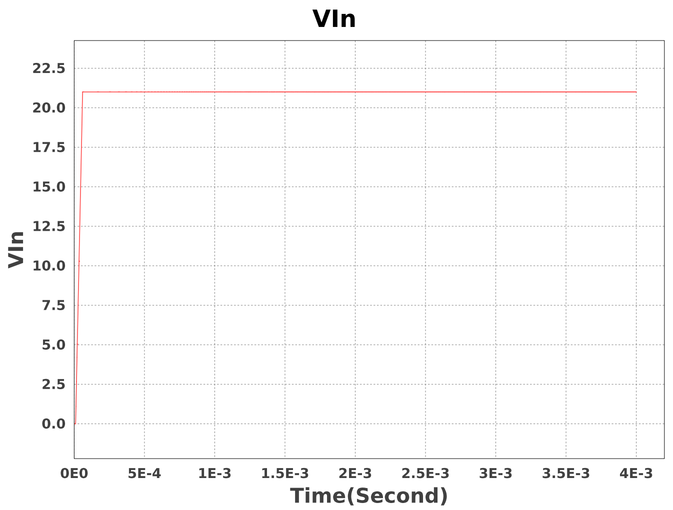
Simulation Type = Startup



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Rload	R	Load Resistance	5.0 ohm

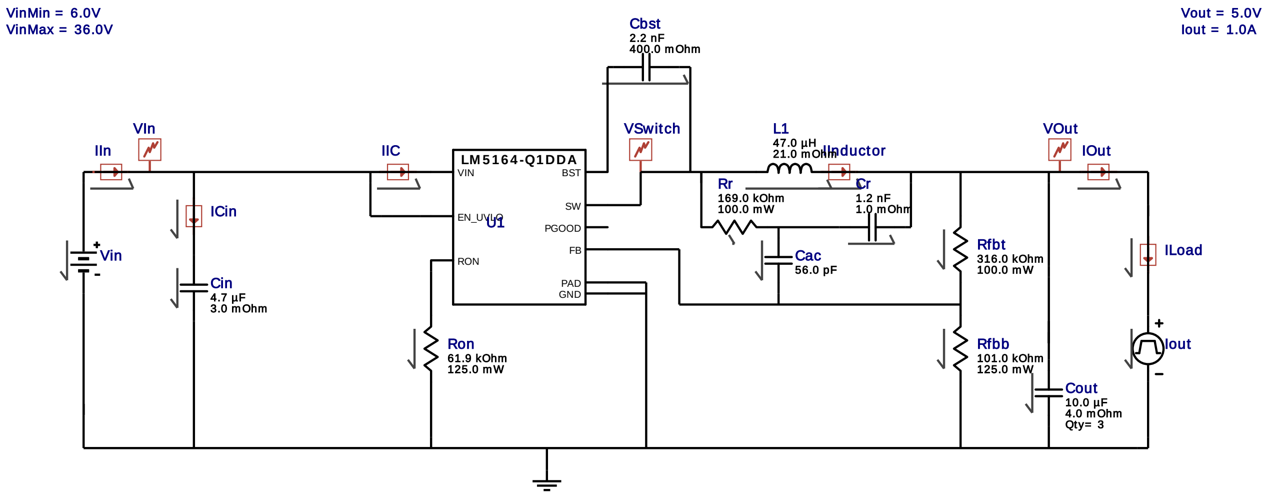




Design Id = 2

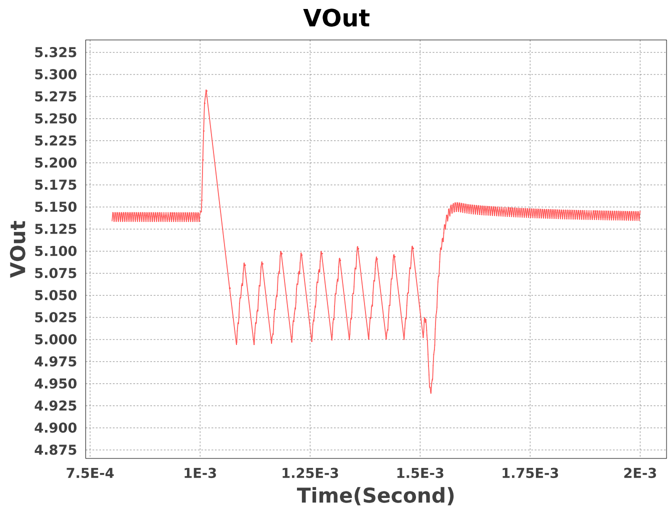
sim_id = 2

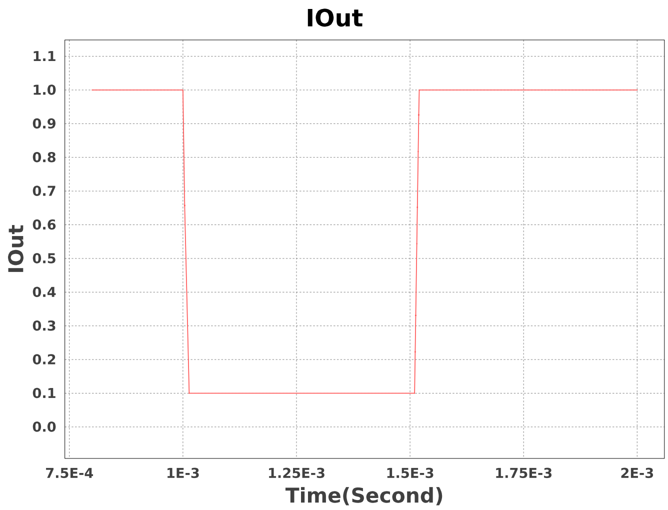
Simulation Type = Load Transient



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Cout	IC	Initial Voltage	5.0 V
2.	Cbst	IC	Initial Voltage	5 V
3.	Iout	signal_type	Signal Type	PULSE
		I1	Initial Load Current	1.0 A
		I2	Minimum Load Current	0.1 A
		Td	Initial Time Delay	1000u s
		Tf	Fall Time	10u s
		Tr	Rise Time	10u s
		Pw	Pulse Width	500u s

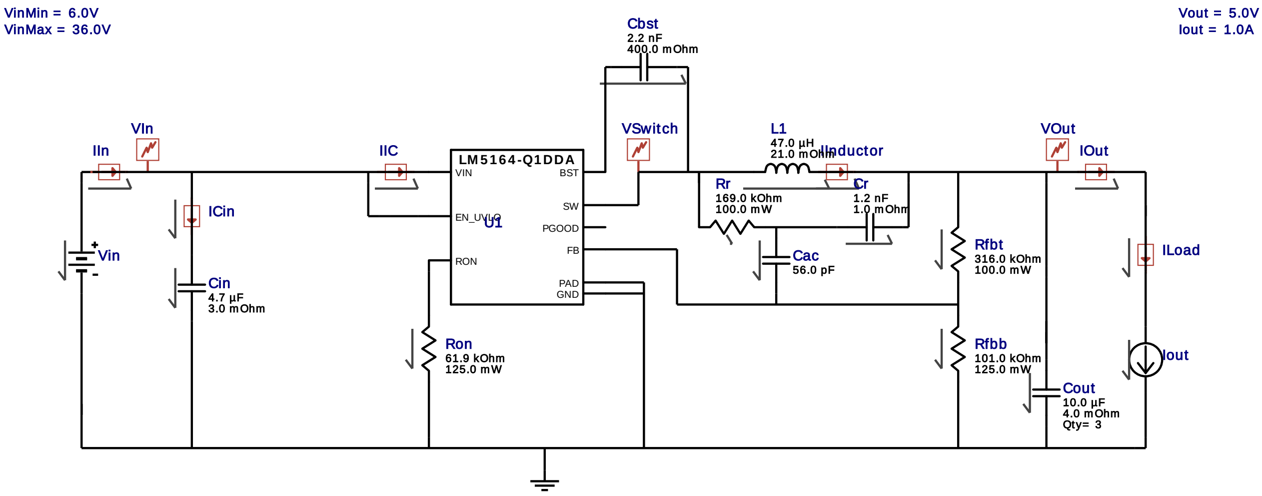




Design Id = 2

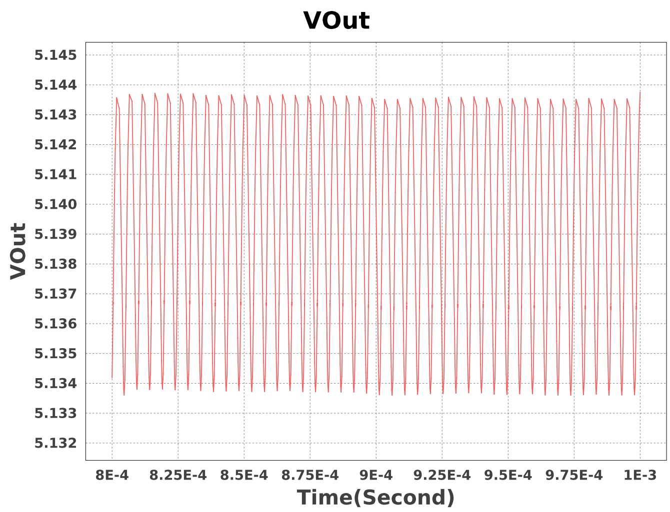
sim_id = 3

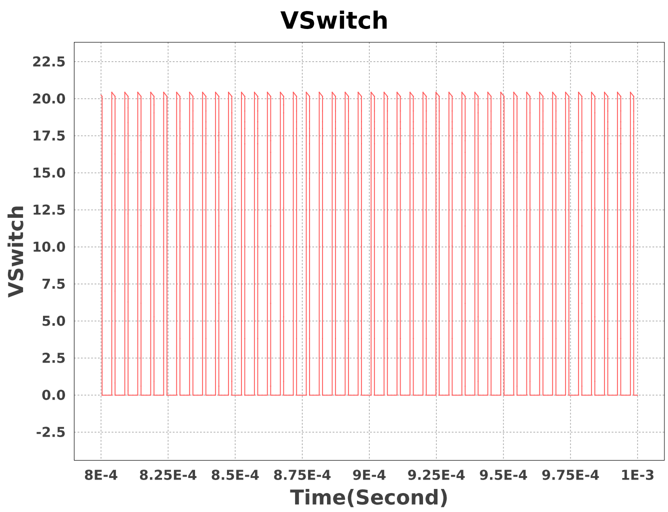
Simulation Type = Steady State

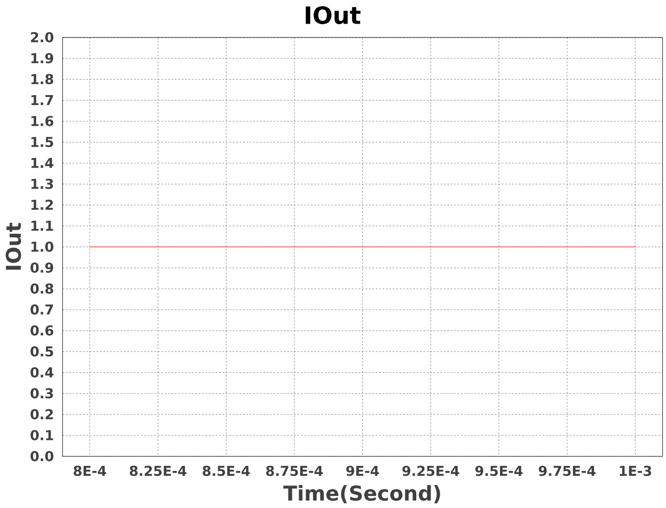


Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Cout	IC	Initial Voltage	5.0 V
2.	Cbst	IC	Initial Voltage	5 V
3.	Iout	I	Load current	1.0 A







Design Assistance

1. The LM5164-Q1 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

2. Master key : F9F8DA5E13C03374B9F44F73762D1F6C[v1]

3. **LM5164-Q1** Product Folder : http://www.ti.com/product/lm5164%2Dq1 : contains the data sheet and other resources.