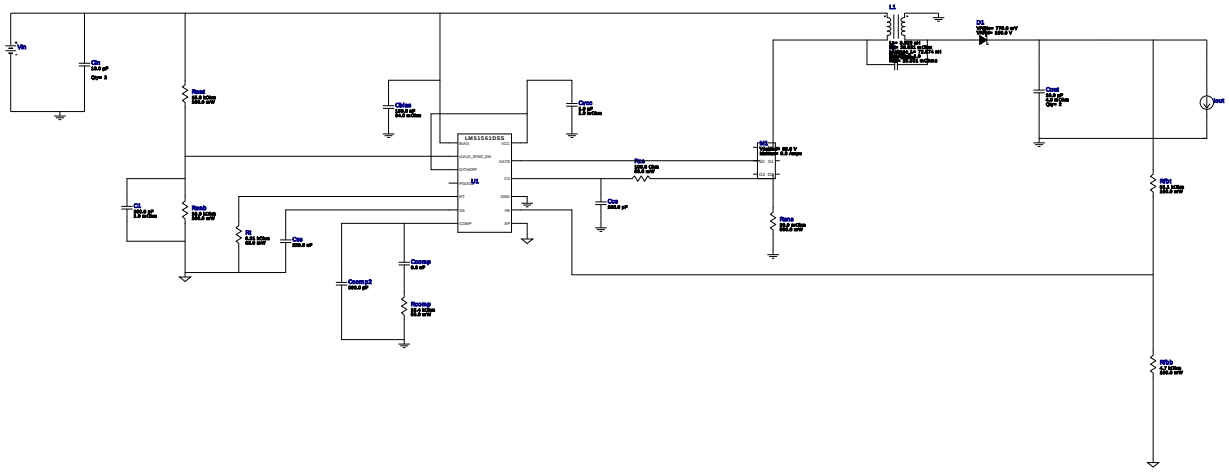
VinMin = 4.0V
VinMax = 40.0V
Vout = 12.0V
Iout = 1.0A

Device = LM51561DSSR
Topology = SEPIC
Created = 2023-12-29 09:46:14.904
BOM Cost = NA
BOM Count = 24
Total Pd = 1.71W

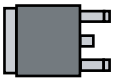
WEBENCH® Design Report

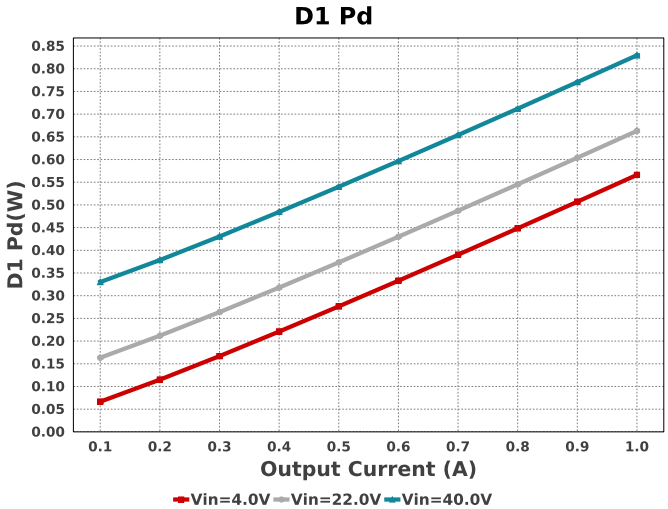
Design : 646 LM51561DSSR
LM51561DSSR 4V-40V to 12.00V @ 1A

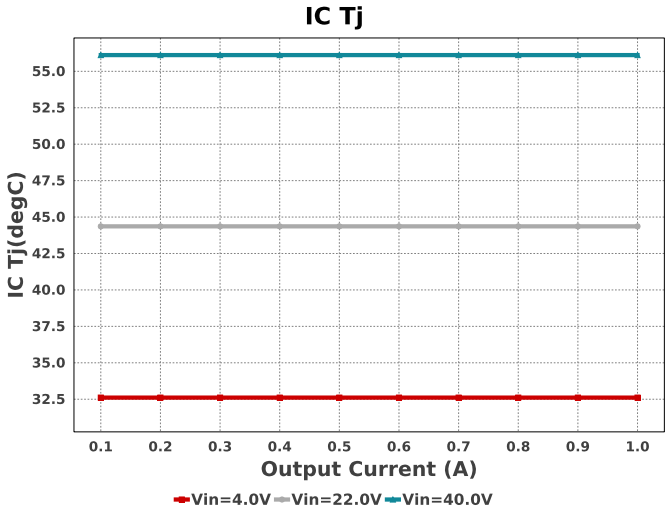


Electrical BOM

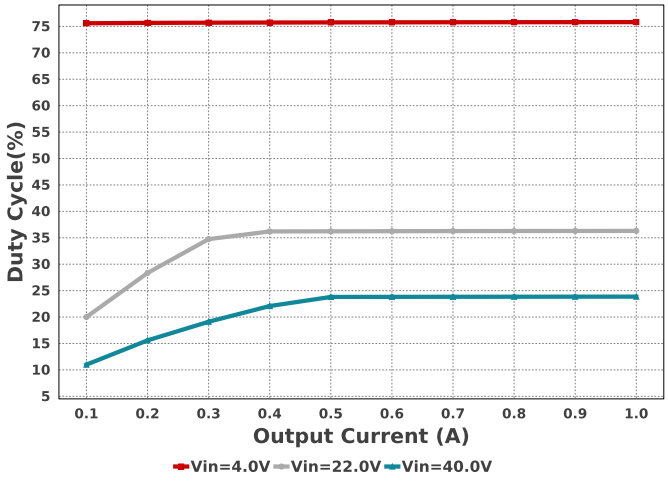
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
C1	MuRata	GRM033R71E101KA01D Series= X7R	Cap= 100.0 pF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm²
Cbias	Kemet	C0805C104M5RACTU Series= X7R	Cap= 100.0 nF ESR= 64.0 mOhm VDC= 50.0 V IRMS= 1.64 A	1	$0.01	0805 7 mm²
Ccomp	TDK	CGA4C2C0G1H392J060AA Series= C0G/NP0	Cap= 3.9 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.04	0805 7 mm²
Ccomp2	MuRata	GRM1555C1H391JA01J Series= C0G/NP0	Cap= 390.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Ccs	Samsung Electro-Mechanics	CL21C101JBANNNC Series= C0G/NP0	Cap= 100.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Cin	MuRata	KCM55TR72A106MH01K Series= X7R	Cap= 10.0 uF VDC= 100.0 V IRMS= 0.0 A	2	$2.33	KCM55T 59 mm²
Cout	MuRata	GRM31CR71E106KA12L Series= X7R	Cap= 10.0 uF ESR= 4.0 mOhm VDC= 25.0 V IRMS= 6.0 A	2	$0.06	1206_180 11 mm²
Cs	TDK	C3225X7S2A475M200AB Series= X7S	Cap= 4.7 uF ESR= 5.89 mOhm VDC= 100.0 V IRMS= 6.7739 A	1	$0.45	1210 15 mm²
Css	TDK	CGA8R2C0G1H224J320KA Series= C0G/NP0	Cap= 220.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.47	1812 23 mm²
Cvcc	Taiyo Yuden	EMK107B7105KA-T Series= X7R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm²

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
D1	Vishay-Semiconductor	50WQ10FNPBF	VF@Io= 770.0 mV VRRM= 100.0 V	1	$0.80	 DPAK 102 mm²
L1	CUSTOM	CUSTOM	Lp= 3.629 µH Rp= 29.531 mOhm Leakage_L= 72.574 nH Ns1toNp= 1.0 Rs1= 29.531 mOhms	1	NA	CUSTOM 0 mm²
M1	Texas Instruments	CSD88539ND	VdsMax= 60.0 V IdsMax= 6.3 Amps	1	$0.24	 D0008A 57 mm²
Rcomp	Yageo	RC0201FR-0715K4L Series= ?	Res= 15.4 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	 0201 2 mm²
Rcs	Vishay-Dale	CRCW0402100RFKED Series= CRCW..e3	Res= 100.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
Renb	Susumu Co Ltd	RG1608P-103-B-T5 Series= RG1608	Res= 10.0 kOhm Power= 100.0 mW Tolerance= 0.1%	1	$0.04	 0603 5 mm²
Rent	Susumu Co Ltd	RG1608P-153-B-T5 Series= RG1608	Res= 15.0 kOhm Power= 100.0 mW Tolerance= 0.1%	1	$0.04	 0603 5 mm²
Rfbb	Susumu Co Ltd	RG1608P-472-B-T5 Series= RG1608	Res= 4.7 kOhm Power= 100.0 mW Tolerance= 0.1%	1	$0.04	 0603 5 mm²
Rfbt	Susumu Co Ltd	RG1608P-5112-B-T5 Series= RG1608	Res= 51.1 kOhm Power= 100.0 mW Tolerance= 0.1%	1	$0.06	 0603 5 mm²
Rsns	Stackpole Electronics Inc	CSR1206FK20L0 Series= ?	Res= 20.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.10	 1206 11 mm²
Rt	Vishay-Dale	CRCW04029K31FKED Series= CRCW..e3	Res= 9.31 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
U1	Texas Instruments	LM51561DSSR	Switcher	1	$0.63	 DSS0012B 12 mm²

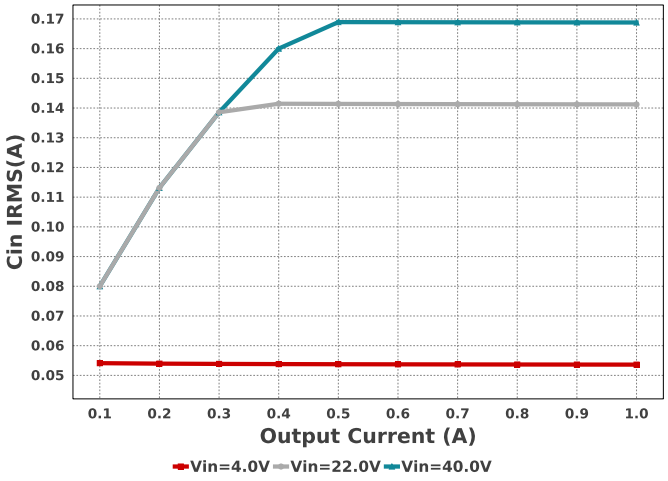




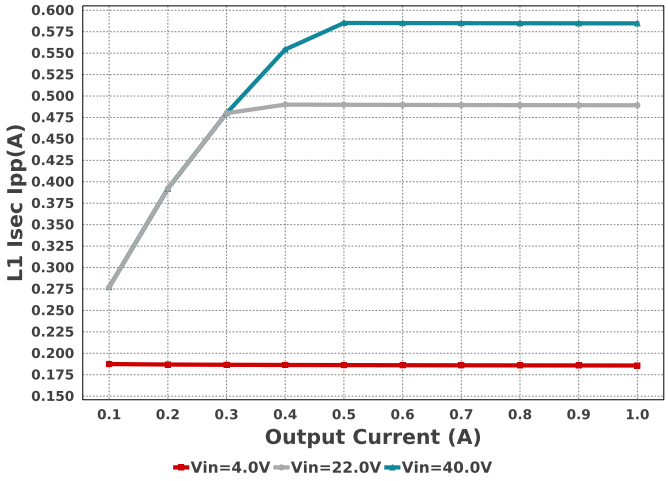
Duty Cycle



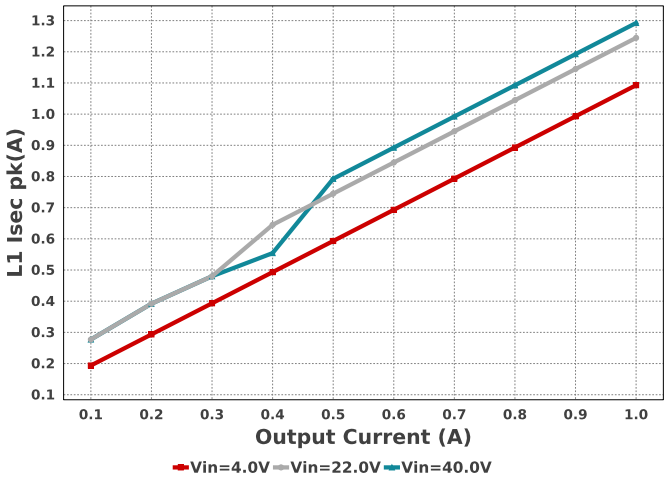
Cin IRMS



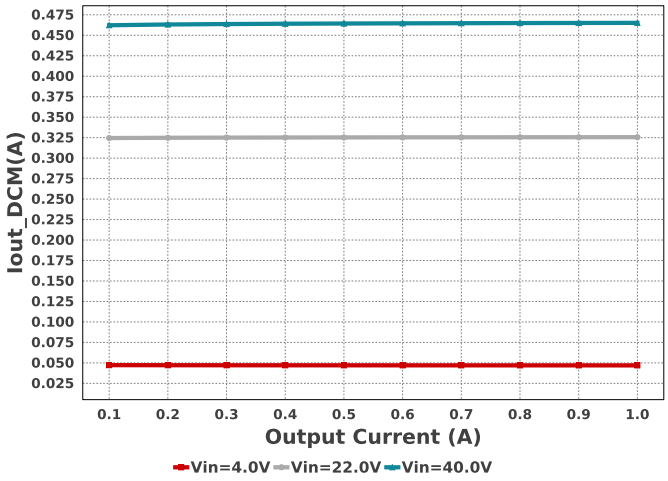
L1 Isec Ipp



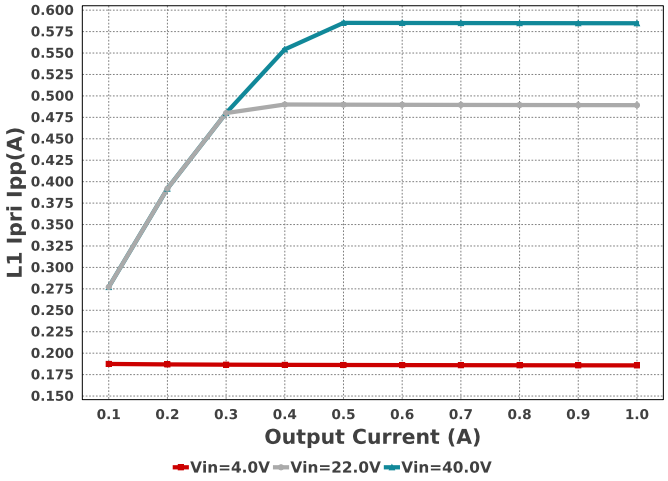
L1 Isec pk

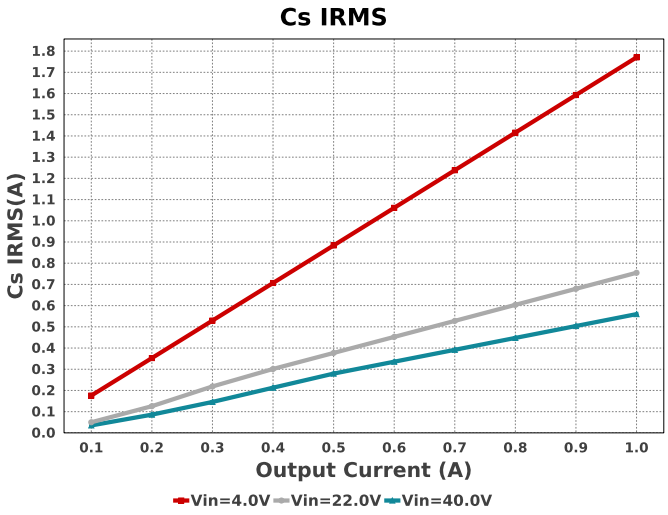


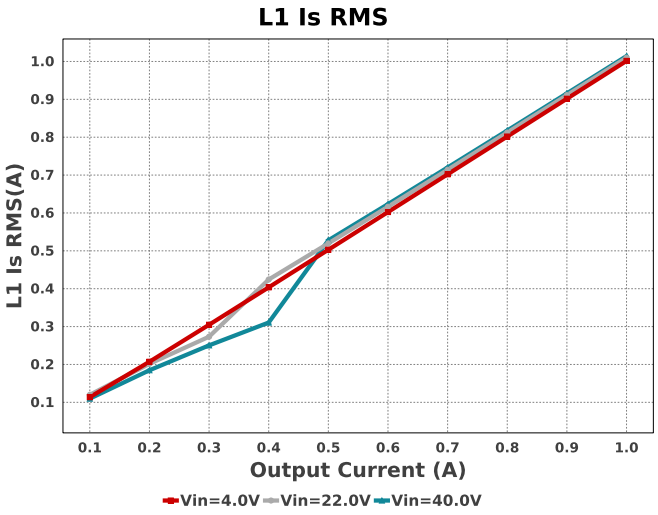
Iout_DCM

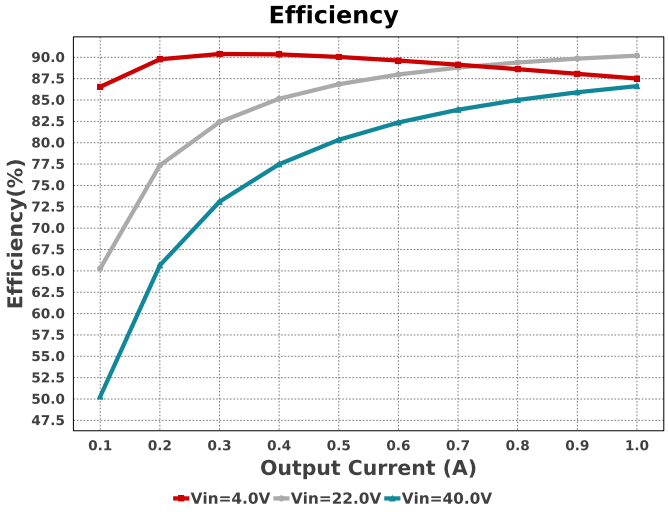


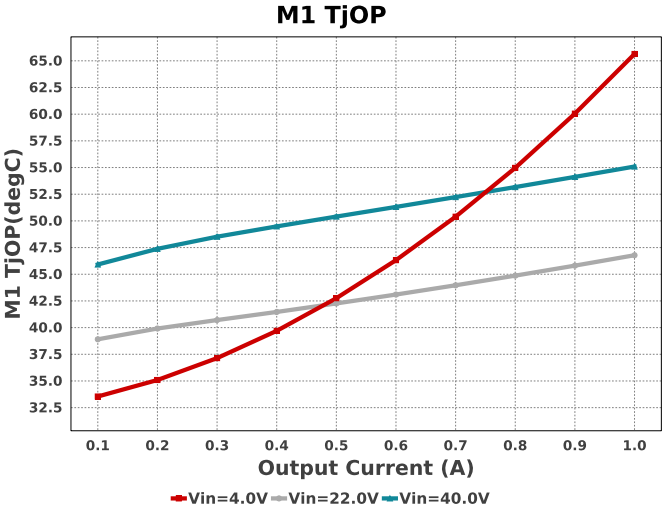
L1 Ipri Ipp

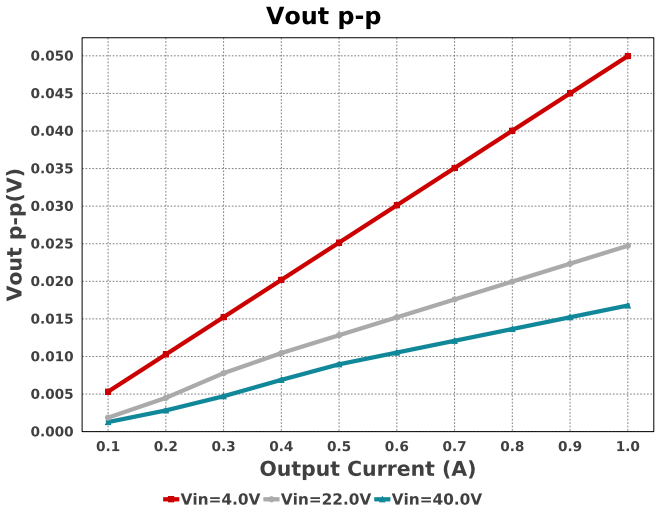


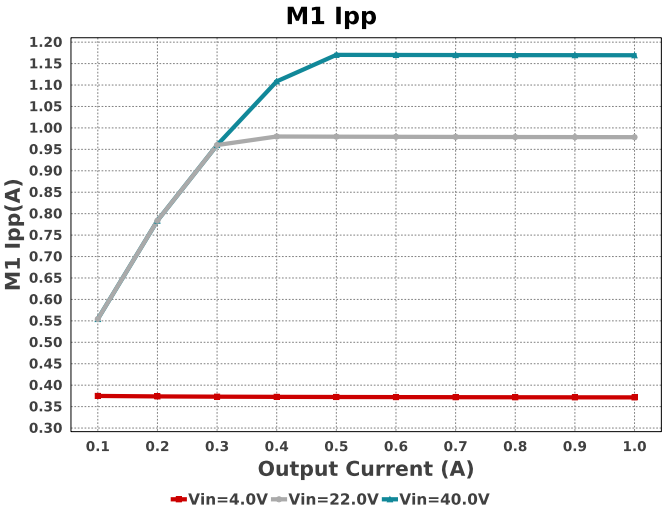


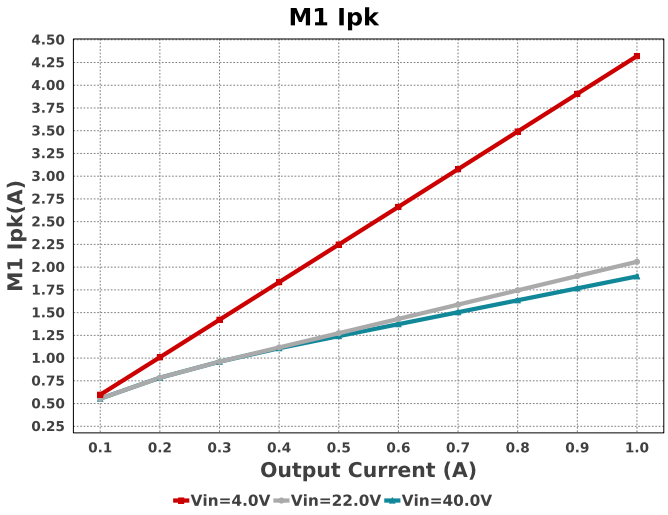


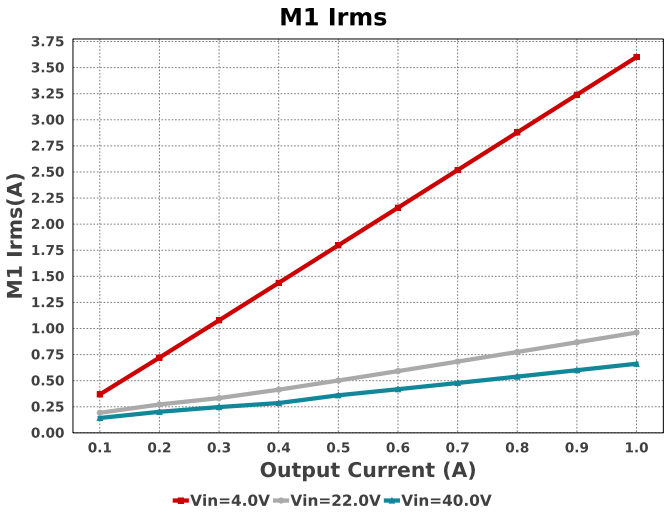


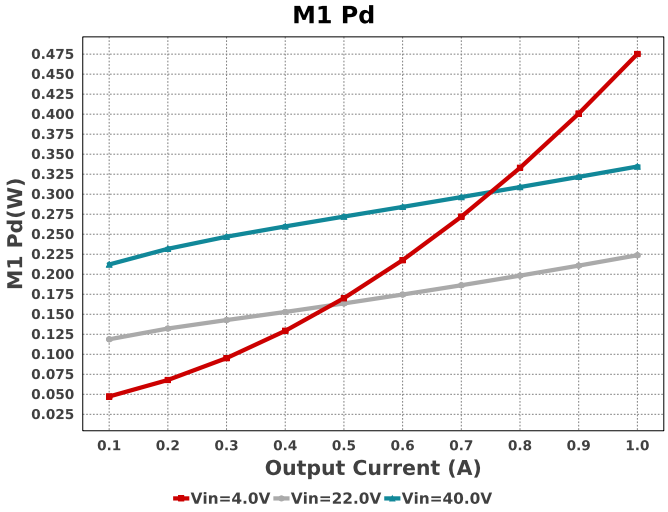


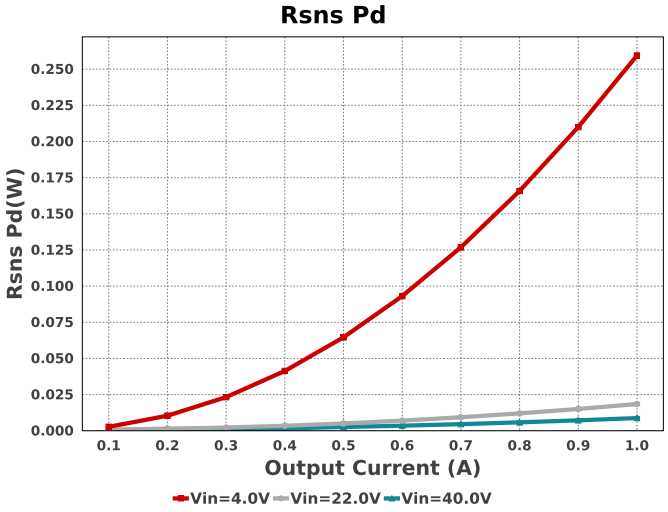


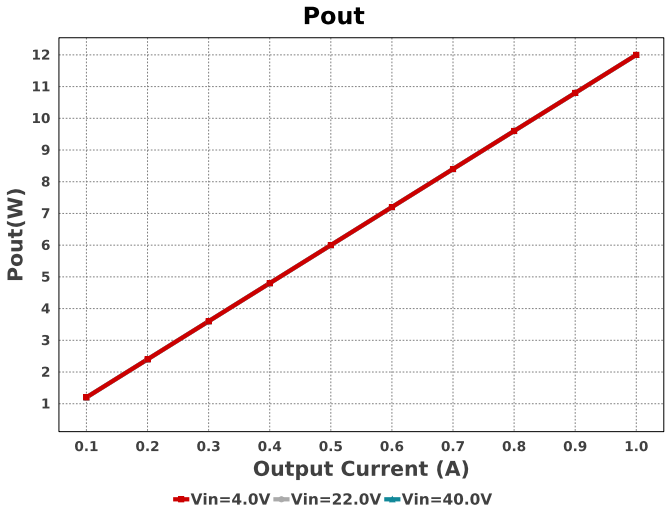


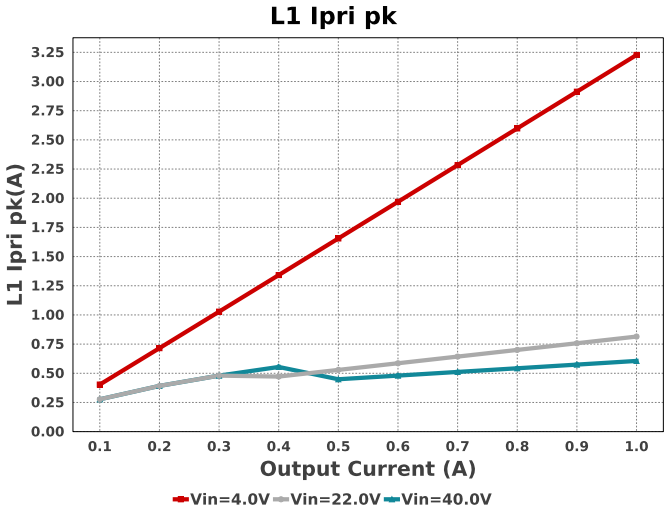


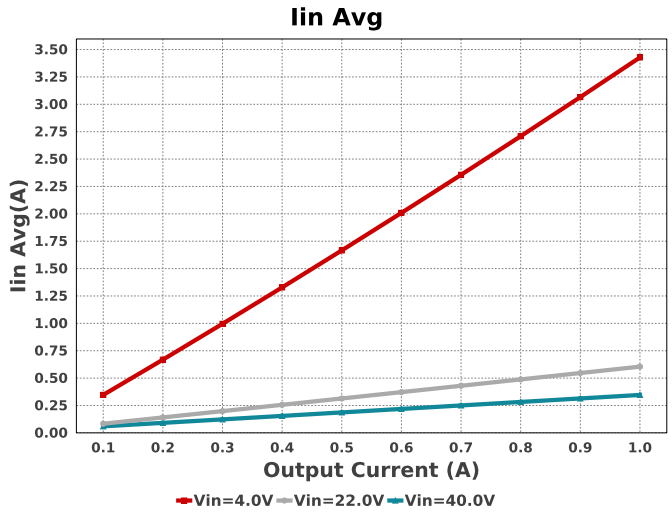


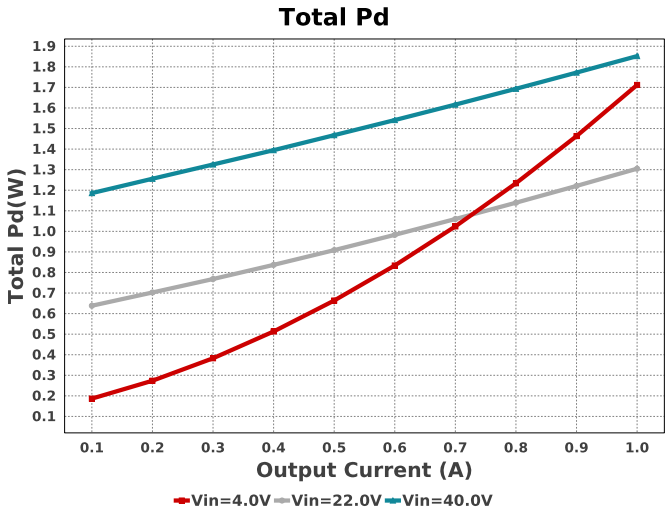


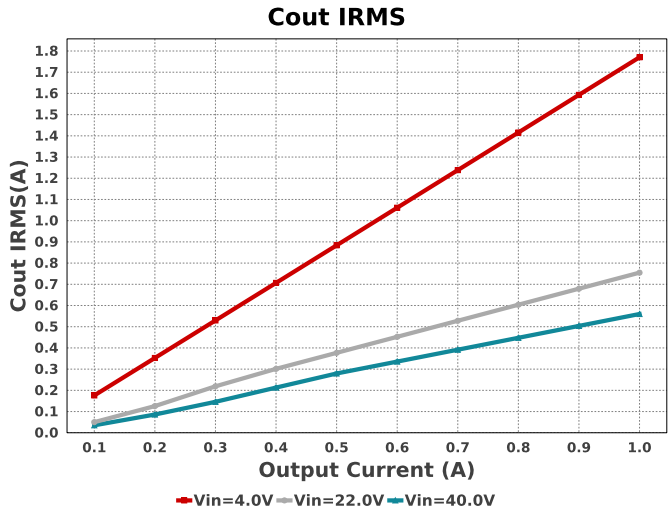


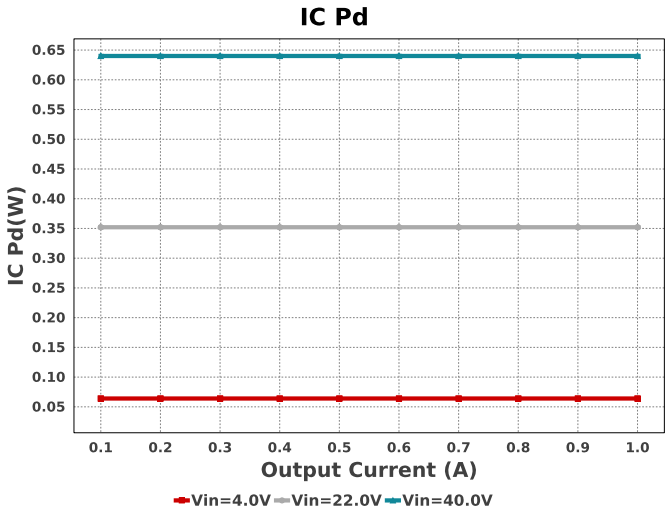


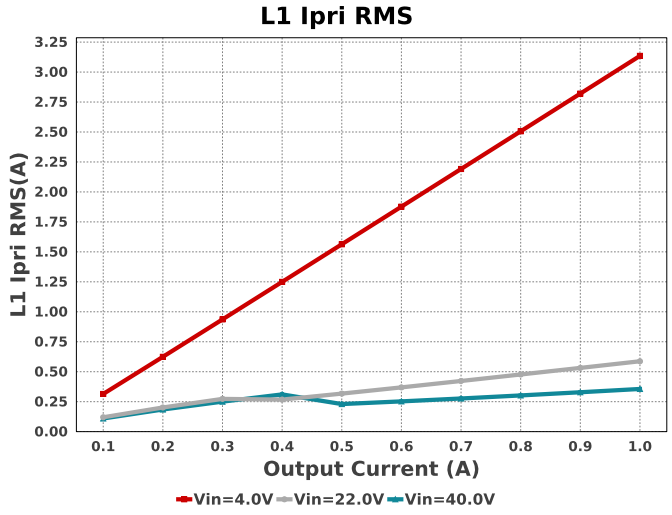


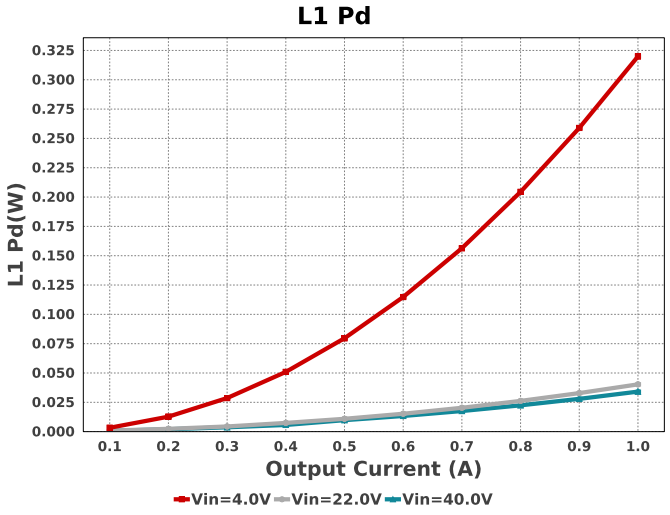












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	53.621 mA	Capacitor	Input capacitor RMS ripple current
2.	Cout IRMS	1.77 A	Capacitor	Output capacitor RMS ripple current
3.	Cs IRMS	1.77 A	Capacitor	Coupling capacitor RMS ripple current
4.	M1 Ipk	4.32 A	Current	M1 peak current.
5.	D1 Pd	566.14 mW	Diode	Output Diode Power Dissipation
6.	IC Pd	64.005 mW	IC	IC power dissipation
7.	IC Tj	32.611 degC	IC	IC junction temperature
8.	ICThetaJA	40.8 degC/W	IC	IC junction-to-ambient thermal resistance
9.	Iin Avg	3.428 A	IC	Average input current
10.	M1 Irms	3.601 A	Mosfet	M1 MOSFET Irms
11.	M1 Pd	475.2 mW	Mosfet	M1 MOSFET total power dissipation

#	Name	Value	Category	Description
12.	M1 TjOP	65.64 degC	Mosfet	M1 MOSFET junction temperature
13.	D1 Pd	566.14 mW	Power	Output Diode Power Dissipation
14.	IC Pd	64.005 mW	Power	IC power dissipation
15.	L1 Pd	319.87 mW	Power	Power Dissipation in the Inductor
16.	M1 Pd	475.2 mW	Power	M1 MOSFET total power dissipation
17.	Rsns Pd	259.39 mW	Power	Current Limit Sense Resistor Power Dissipation
18.	Total Pd	1.712 W	Power	Total Power Dissipation
19.	Rsns Pd	259.39 mW	Resistor	Current Limit Sense Resistor Power Dissipation
20.	BOM Count	24	System Information	Total Design BOM count
21.	Duty Cycle	75.814 %	System Information	Duty cycle
22.	Efficiency	87.515 %	System Information	Steady state efficiency
23.	FootPrint	616.0 mm^2	System Information	Total Foot Print Area of BOM components
24.	Frequency	2.153 MHz	System Information	Switching frequency
25.	Iout	1.0 A	System Information	Iout operating point
26.	Iout_DCM	46.942 mA	System Information	Approximate Current below which DCM mode of operation will begin
27.	M1 Ipp	371.5 mA	System Information	M1 ripple pk-pk.
28.	Mode	CCM	System Information	Conduction Mode
29.	Pout	12.0 W	System Information	Total output power
30.	Total BOM	NA	System Information	Total BOM Cost
31.	Vin	4.0 V	System Information	Vin operating point
32.	Vout	12.0 V	System Information	Operational Output Voltage
33.	Vout Actual	11.872 V	System Information	Vout Actual calculated based on selected voltage divider resistors
34.	Vout Tolerance	2.788 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
35.	Vout p-p	49.883 mV	System Information	Peak-to-peak output ripple voltage
36.	L1 Ipri Ipp	185.75 mA	Transformer	L1 primary side ripple pk-pk.
37.	L1 Ipri RMS	3.135 A	Transformer	L1 primary rms current.
38.	L1 Ipri pk	3.228 A	Transformer	L1 primary pk current.
39.	L1 Is RMS	1.001 A	Transformer	L1 secondary rms current
40.	L1 Isec Ipp	185.75 mA	Transformer	L1 secondary side ripple pk-pk.
41.	L1 Isec pk	1.093 A	Transformer	Peak current in L1 secondary
42.	L1 Pd	319.87 mW	Transformer	Power Dissipation in the Inductor

Design Inputs

Name	Value	Description
Iout	1.0	Maximum Output Current
VinMax	40.0	Maximum input voltage
VinMin	4.0	Minimum input voltage
Vout	12.0	Output Voltage
base_pn	LM51561	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

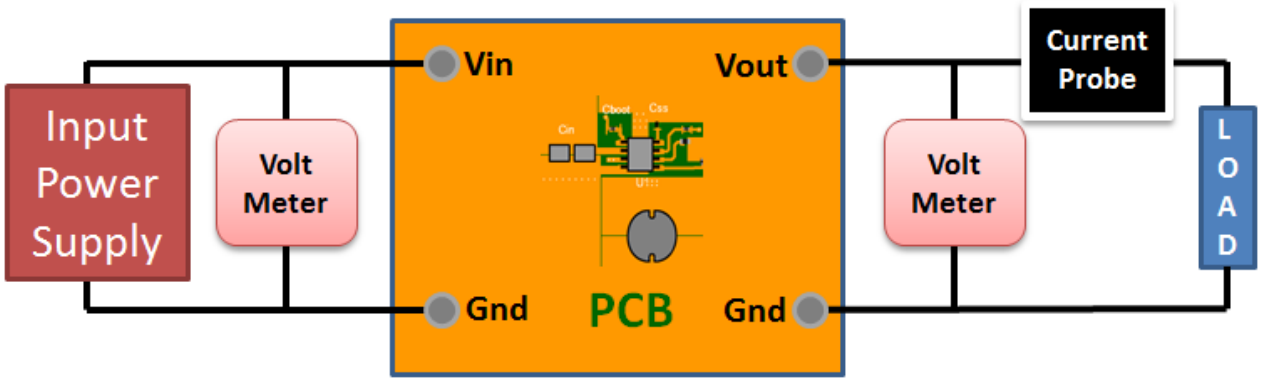
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 4.0V 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 : 40EE3F1E021441DB[v1]
2. **LM51561** Product Folder : http://www.ti.com/product/LM51561 : contains the data sheet and other resources.