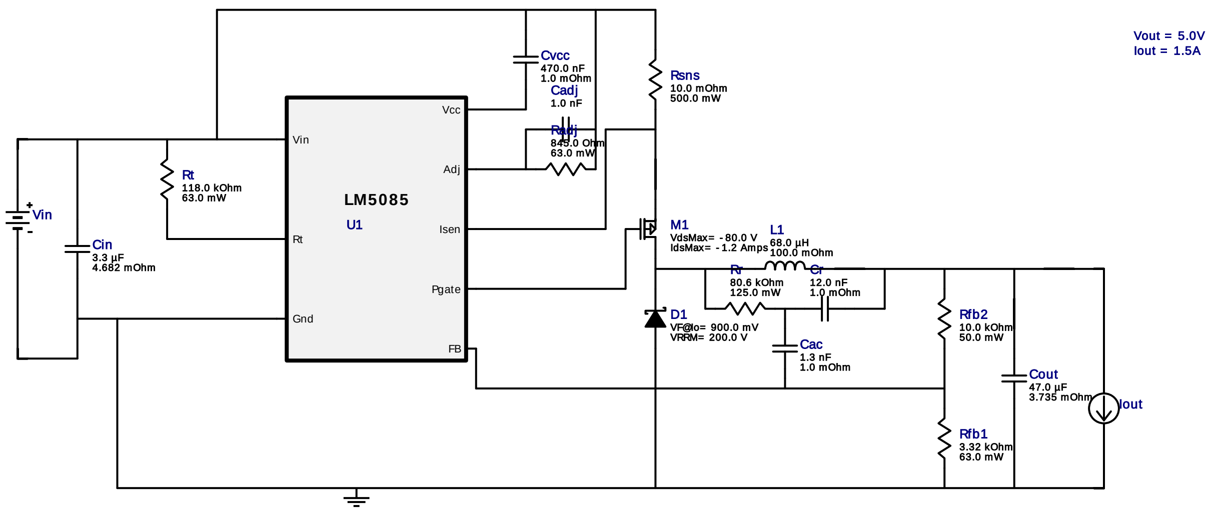
TEXAS INSTRUMENTS

WEBENCH ® Design Report

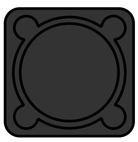
VinMin = 16.0V
VinMax = 58.0V
Vout = 5.0V
Iout = 1.5A

Device = LM5085MY/NOPB
Topology = Buck
Created = 2021-08-19 22:22:22.444
BOM Cost = NA
BOM Count = 16
Total Pd = 1.51W

Design : 13 LM5085MY/NOPB
LM5085MY/NOPB 36V-58V to 5.00V @ 1.5A

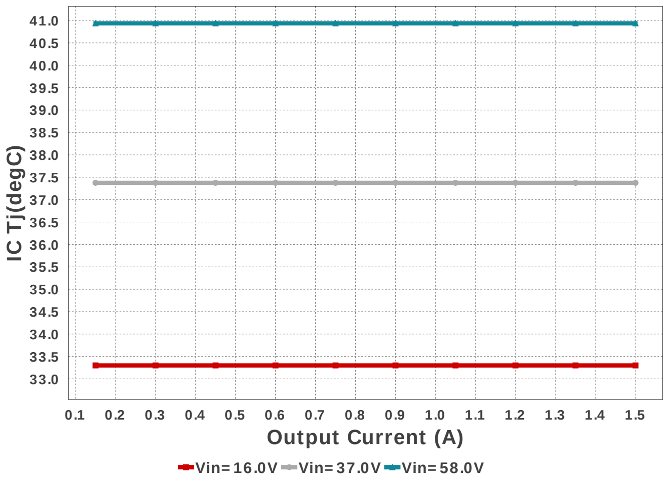


Electrical BOM

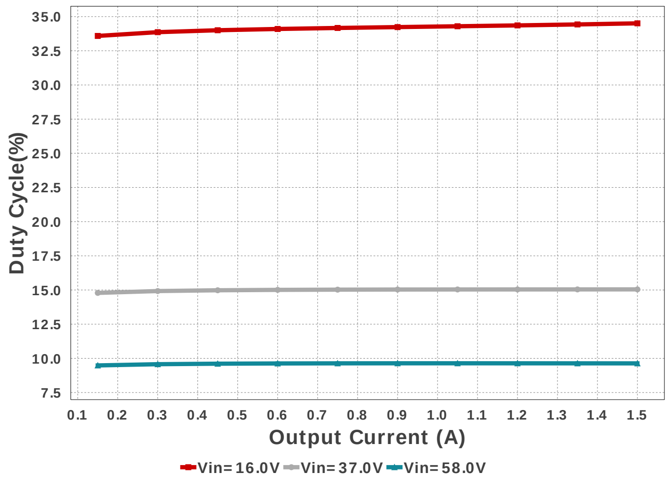
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cac	MuRata	GRM2165C1H132JA01D Series= C0G/NP0	Cap= 1.3 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.03	0805 7 mm²
Cadj	MuRata	GRM1555C1H102JA01J Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cin	TDK	C3225X7S2A335K200AB Series= X7S	Cap= 3.3 uF ESR= 4.682 mOhm VDC= 100.0 V IRMS= 3.39944 A	1	$0.29	1210 15 mm²
Cout	MuRata	GRM31CR60J476ME19L Series= X5R	Cap= 47.0 uF ESR= 3.735 mOhm VDC= 6.3 V IRMS= 4.091 A	1	$0.23	1206_190 11 mm²
Cr	CUSTOM	CUSTOM Series= C0G/NP0	Cap= 12.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	NA	0805 7 mm²
Cvcc	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
D1	SMC Diode Solutions	SK220ATR	VF@Io= 900.0 mV VRRM= 200.0 V	1	$0.04	SMA 37 mm²
L1	Bourns	SRR1210-680M	L= 68.0 µH 100.0 mOhm	1	$0.53	 SRR1210 196 mm²

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
M1	Vishay-Siliconix	SI2337DS-T1-E3	VdsMax= -80.0 V IdsMax= -1.2 Amps	1	$0.41	SOT-23 14 mm^2
Radj	Vishay-Dale	CRCW0402845RFKED Series= CRCW..e3	Res= 845.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfb1	Vishay-Dale	CRCW04023K32FKED Series= CRCW..e3	Res= 3.32 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfb2	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rr	Vishay-Dale	CRCW080580K6FKEA Series= CRCW..e3	Res= 80.6 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Rsns	Stackpole Electronics Inc	CSR1206FK10L0 Series= ?	Res= 10.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.12	1206 11 mm^2
Rt	Vishay-Dale	CRCW0402118KFKED Series= CRCW..e3	Res= 118.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	LM5085MY/NOPB	Switcher	1	$0.82	MUY08A 24 mm^2

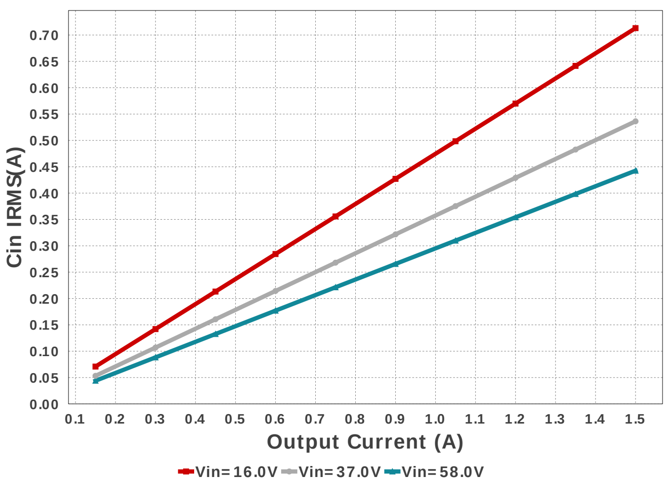
IC Tj



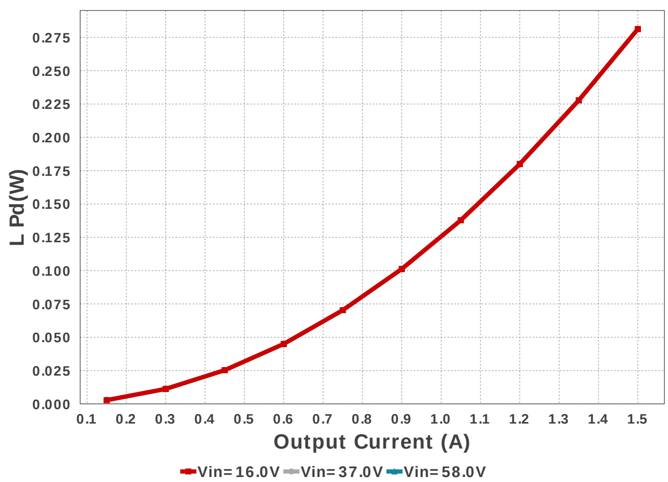
Duty Cycle



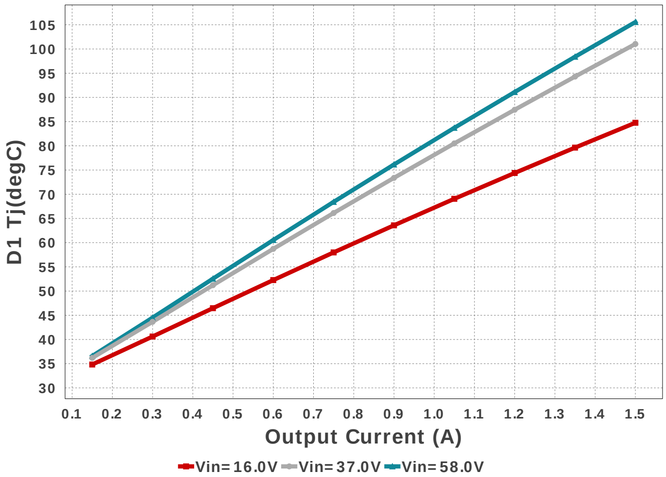
Cin IRMS



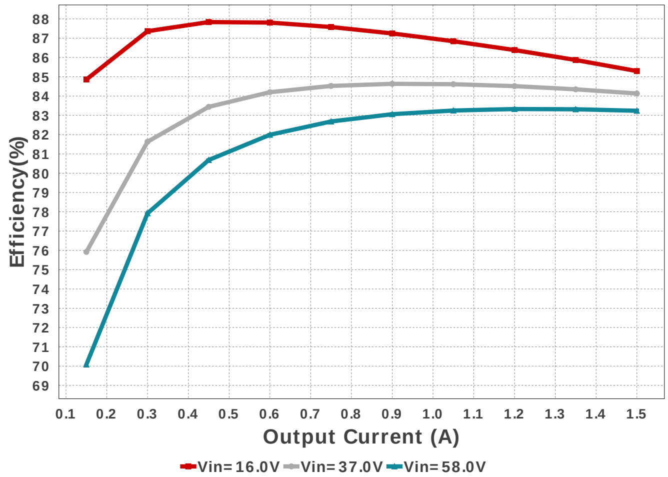
L Pd



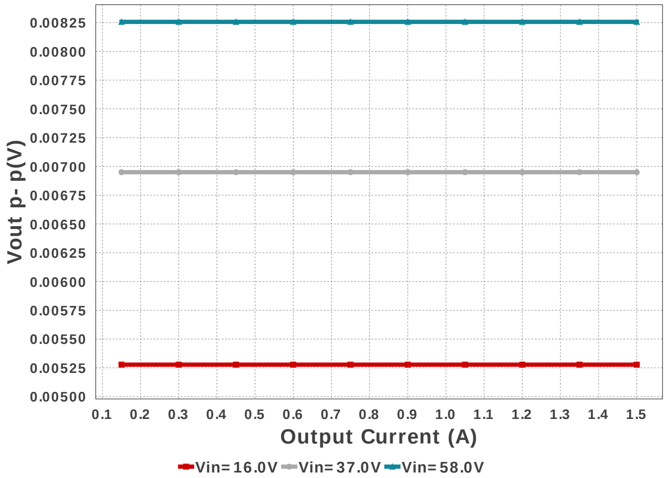
D1 Tj



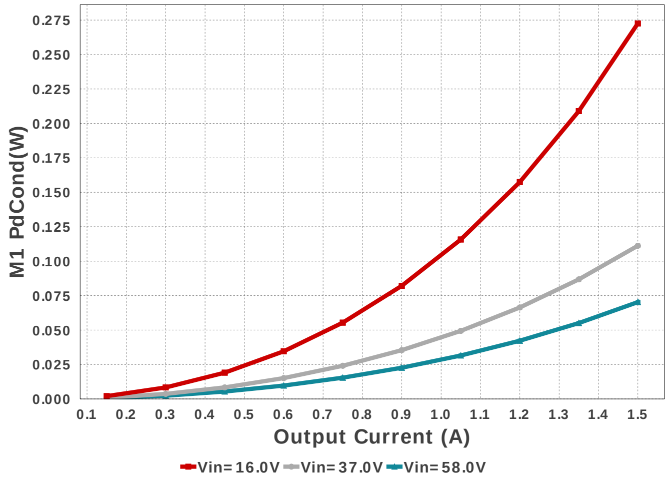
Efficiency



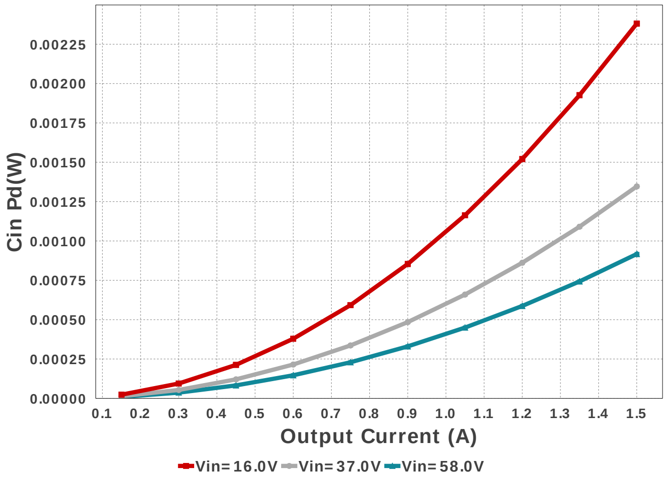
Vout p- p



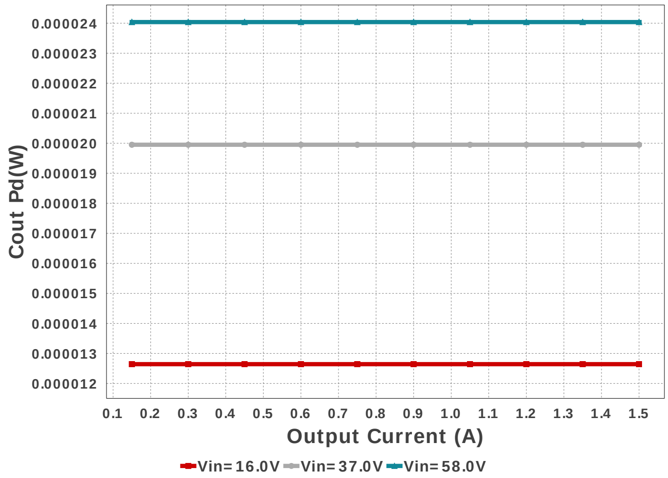
M1 PdCond



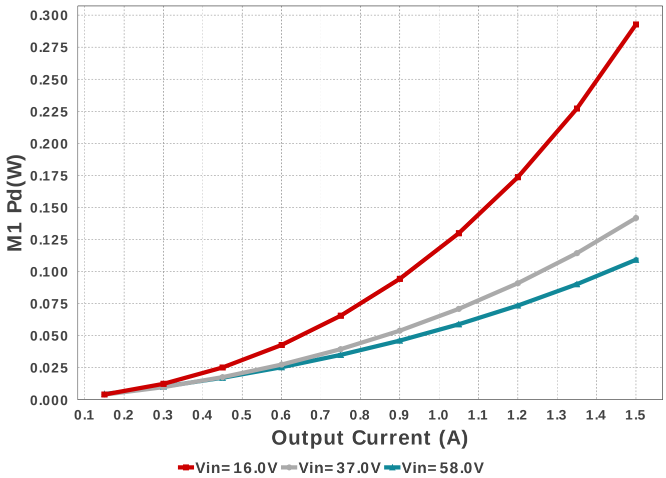
Cin Pd



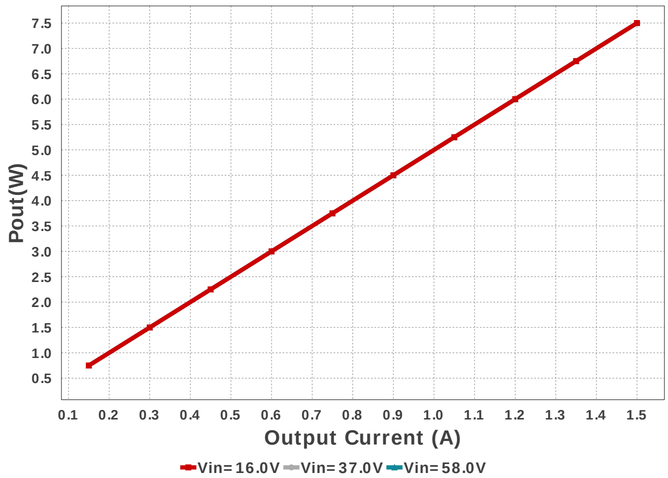
Cout Pd



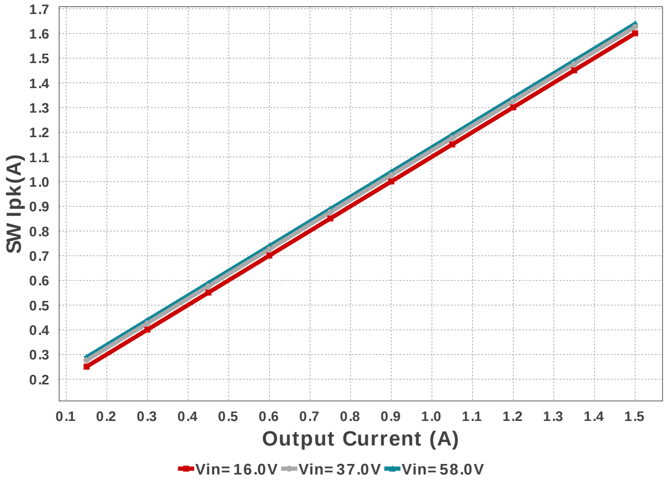
M1 Pd



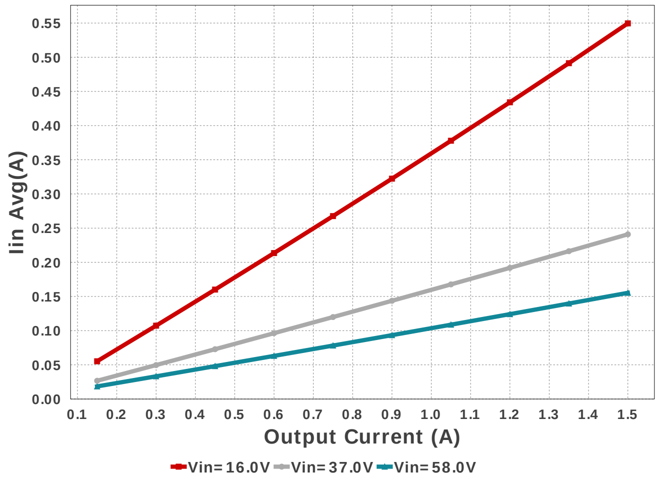
Pout



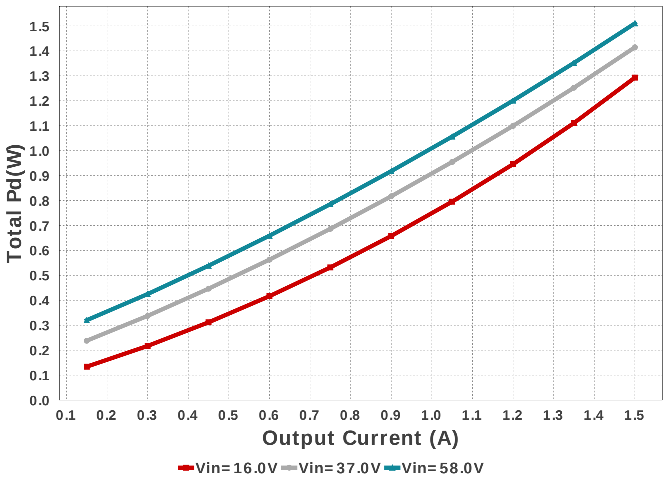
SW Ipk



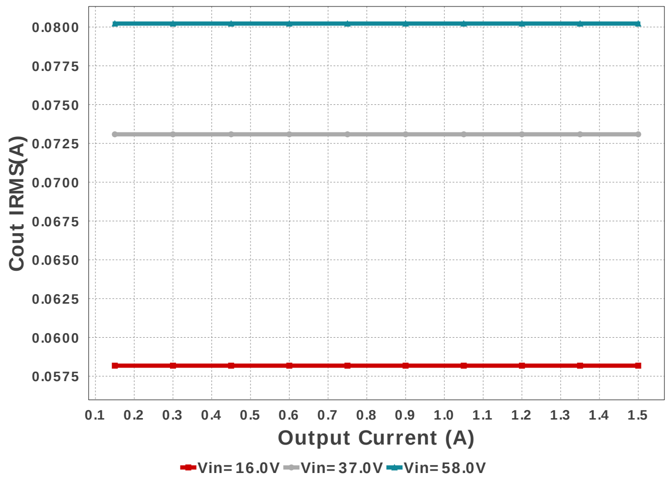
Iin Avg

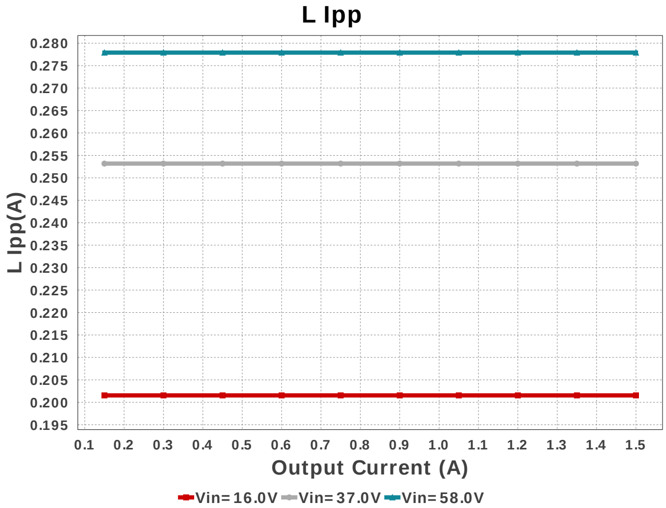


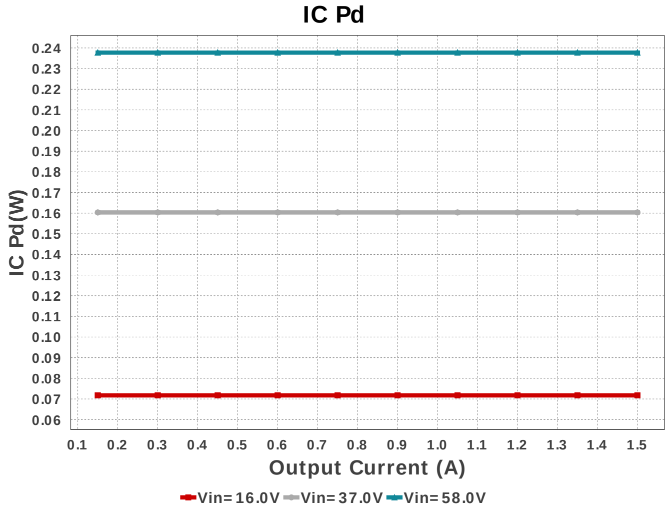
Total Pd

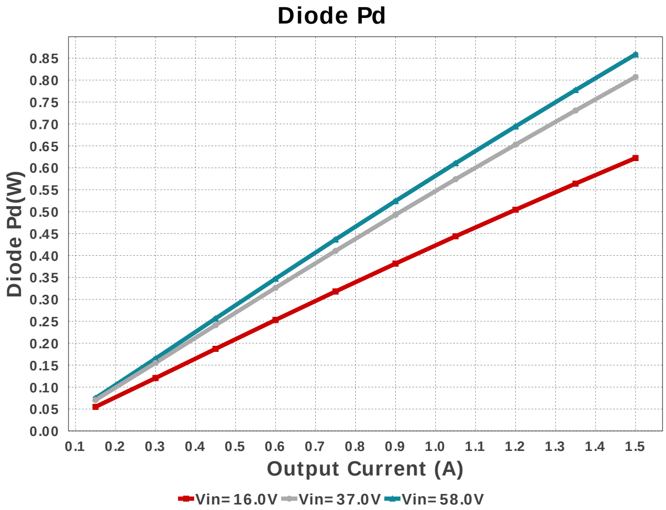


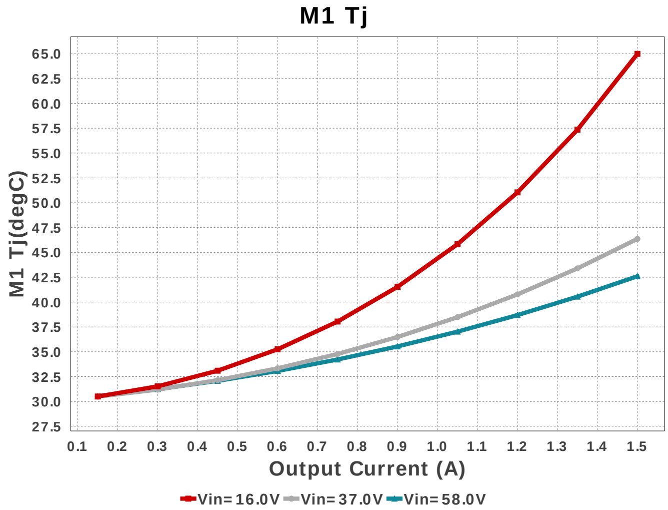
Cout IRMS

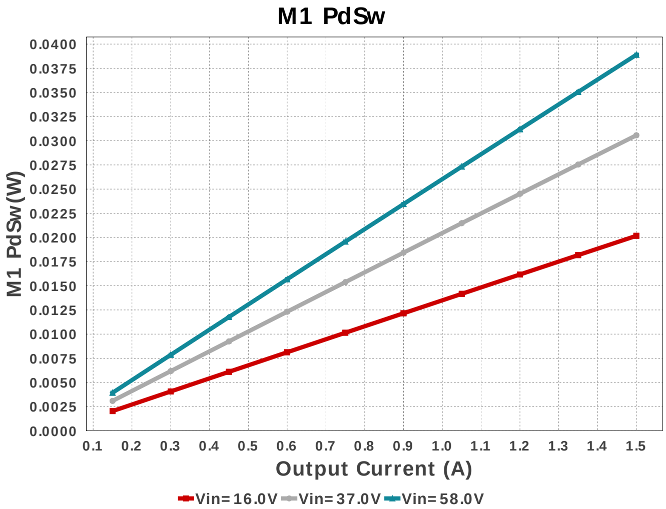












Operating Values

#	Name	Value	Category	Description
1.	BOM Count	16		Total Design BOM count
2.	Total BOM	NA		Total BOM Cost
3.	Cin IRMS	442.56 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	917.01 µW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	80.222 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	24.037 µW	Capacitor	Output capacitor power dissipation
7.	D1 Tj	105.563 degC	Diode	D1 junction temperature
8.	Diode Pd	858.67 mW	Diode	Diode power dissipation
9.	IC Pd	237.74 mW	IC	IC power dissipation
10.	IC Tj	40.936 degC	IC	IC junction temperature
11.	IC Tolerance	25.0 mV	IC	IC Feedback Tolerance

#	Name	Value	Category	Description
12.	ICThetaJA	46.0 degC/W	IC	IC junction-to-ambient thermal resistance
13.	Iin Avg	155.35 mA	IC	Average input current
14.	L Ipp	277.898 mA	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	281.25 mW	Inductor	Inductor power dissipation
16.	M1 Pd	109.18 mW	Mosfet	M1 MOSFET total power dissipation
17.	M1 PdCond	70.287 mW	Mosfet	M1 MOSFET conduction losses
18.	M1 PdSw	38.892 mW	Mosfet	M1 MOSFET switching losses
19.	M1 Tj	42.599 degC	Mosfet	M1 MOSFET junction temperature
20.	Cin Pd	917.01 µW	Power	Input capacitor power dissipation
21.	Cout Pd	24.037 µW	Power	Output capacitor power dissipation
22.	Diode Pd	858.67 mW	Power	Diode power dissipation
23.	IC Pd	237.74 mW	Power	IC power dissipation
24.	L Pd	281.25 mW	Power	Inductor power dissipation
25.	M1 Pd	109.18 mW	Power	M1 MOSFET total power dissipation
26.	M1 PdCond	70.287 mW	Power	M1 MOSFET conduction losses
27.	M1 PdSw	38.892 mW	Power	M1 MOSFET switching losses
28.	Total Pd	1.51 W	Power	Total Power Dissipation
29.	Duty Cycle	9.633 %	System Information	Duty cycle
30.	Efficiency	83.238 %	System Information	Steady state efficiency
31.	FootPrint	349.0 mm^2	System Information	Total Foot Print Area of BOM components
32.	Frequency	212.046 kHz	System Information	Switching frequency
33.	Iout	1.5 A	System Information	Iout operating point
34.	Mode	CCM	System Information	Conduction Mode
35.	Pout	7.5 W	System Information	Total output power
36.	SW Ipk	1.639 A	System Information	Peak switch current
37.	Vin	58.0 V	System Information	Vin operating point
38.	Vout	5.0 V	System Information	Operational Output Voltage
39.	Vout Actual	5.015 V	System Information	Vout Actual calculated based on selected voltage divider resistors
40.	Vout Tolerance	3.547 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
41.	Vout p-p	8.256 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	1.5	Maximum Output Current
VinMax	58.0	Maximum input voltage
VinMin	16.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	LM5085	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

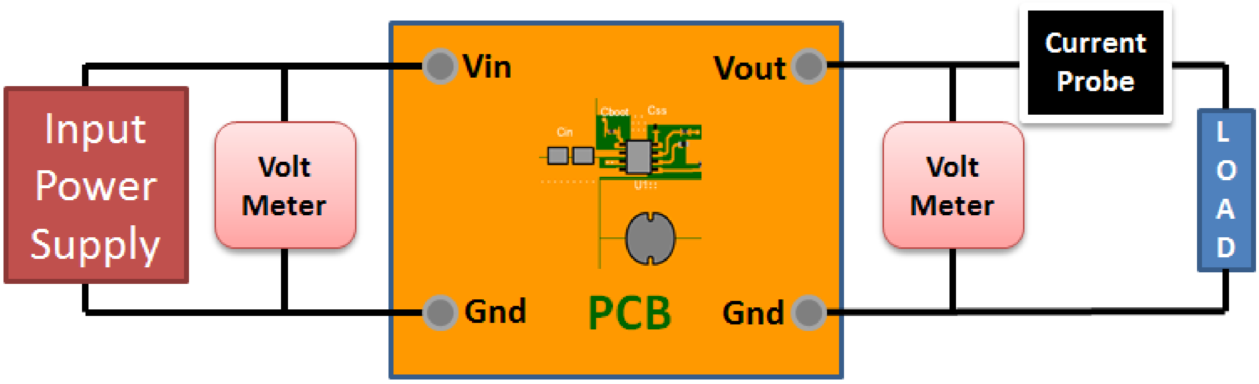
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 16.0V 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.

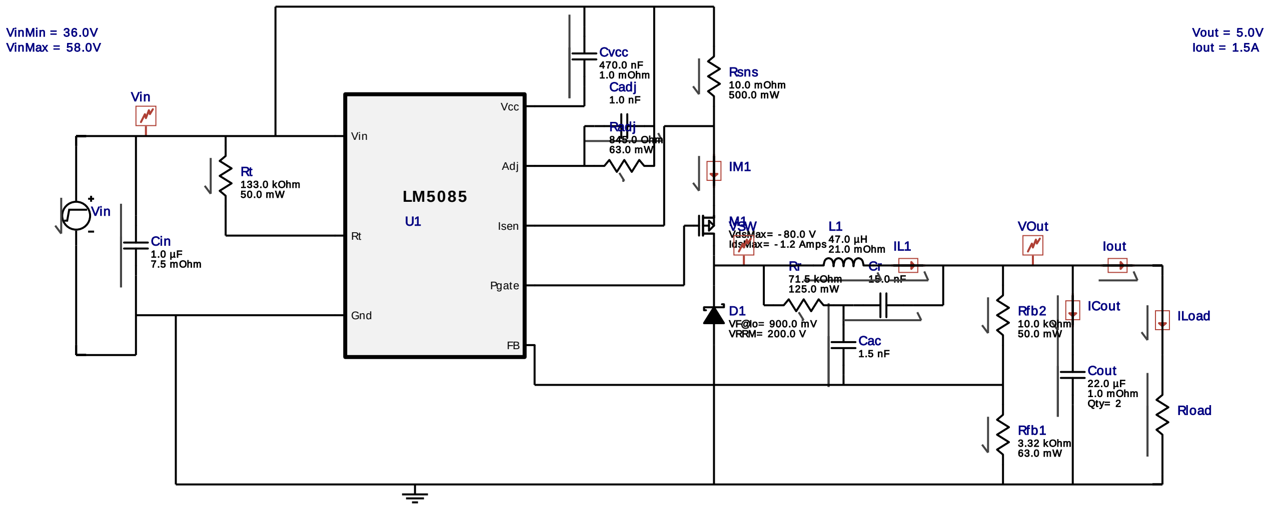


WEBENCH® Electrical Simulation Report

Design Id = 13

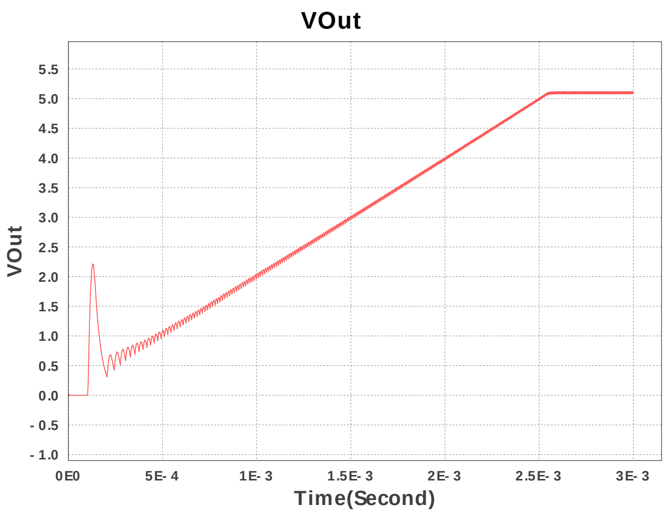
sim_id = 3

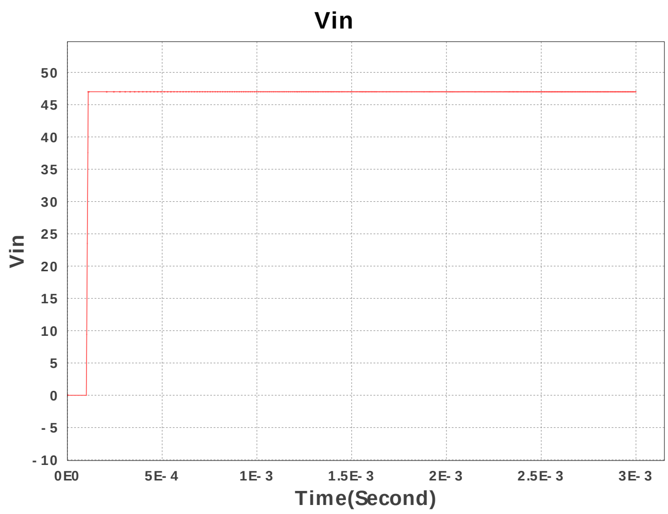
Simulation Type = Startup



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Rload	R	Load Resistance	3.3333333333333335 Ohm

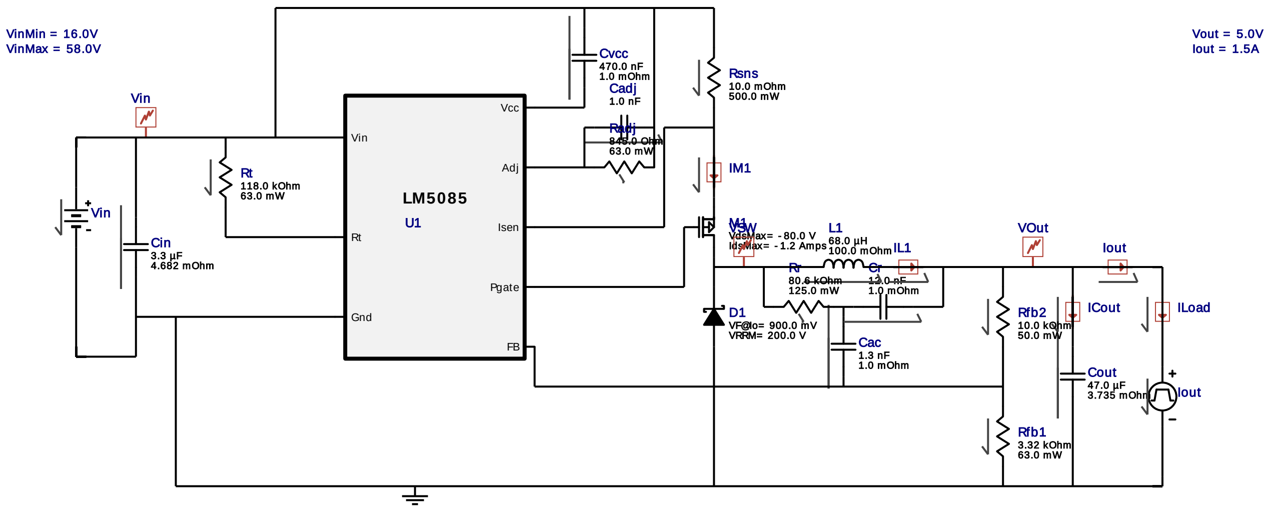




Design Id = 13

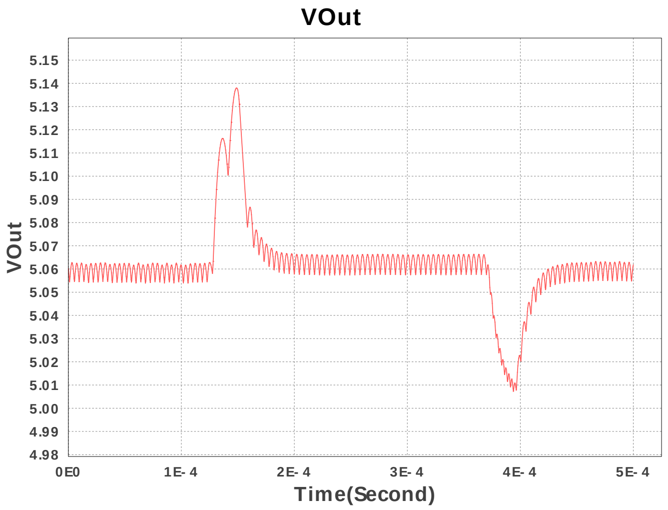
sim_id = 9

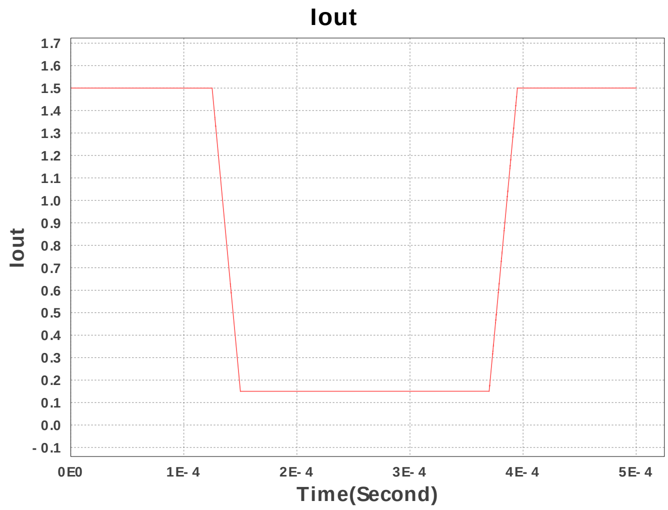
Simulation Type = Load Transient



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Iout	signal_type	Signal Type	PULSE
		I1	Initial Current	1.5 A
		I2	Peak Current	0.15 A
		Td	Initial Delay Time	125u Sec
		Tr	Rise Time	25u Sec
		Tf	Fall Time	25u Sec
		Pw	Pulse Width	220u Sec

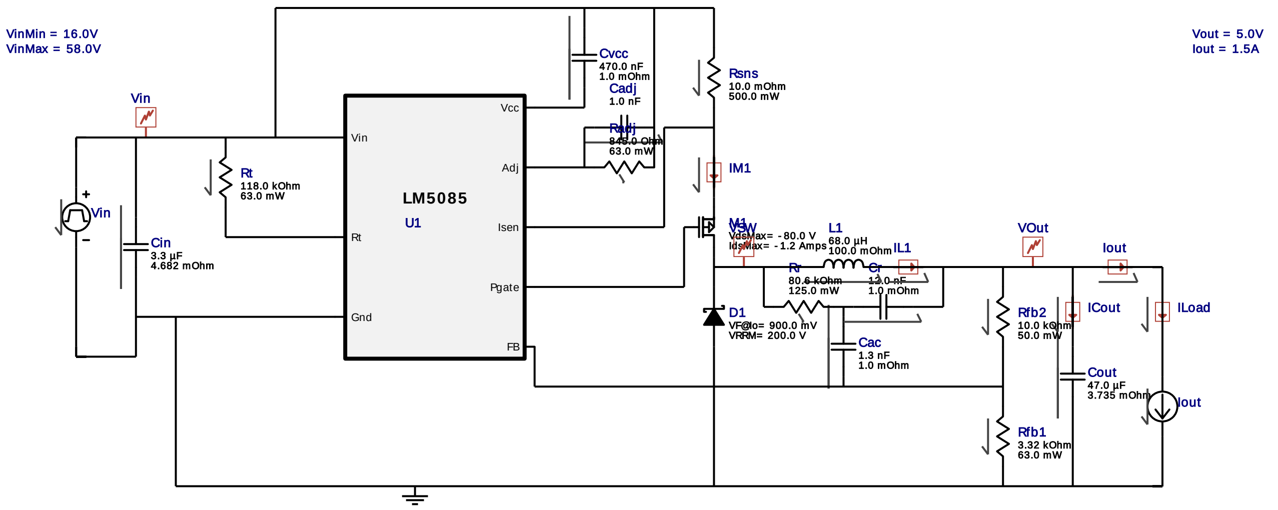




Design Id = 13

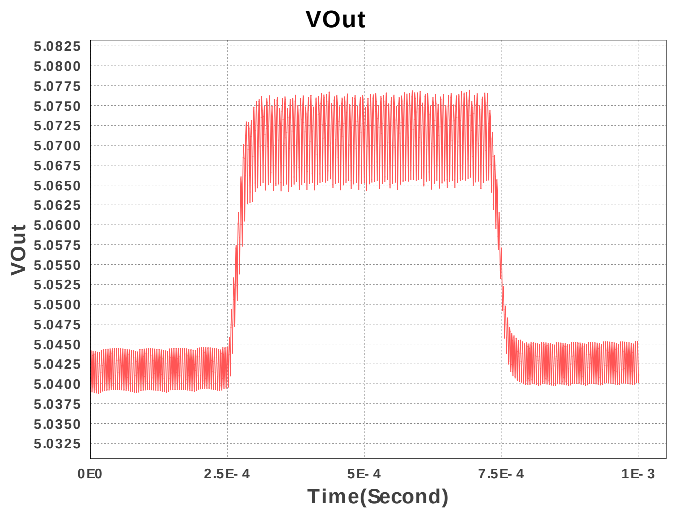
sim_id = 10

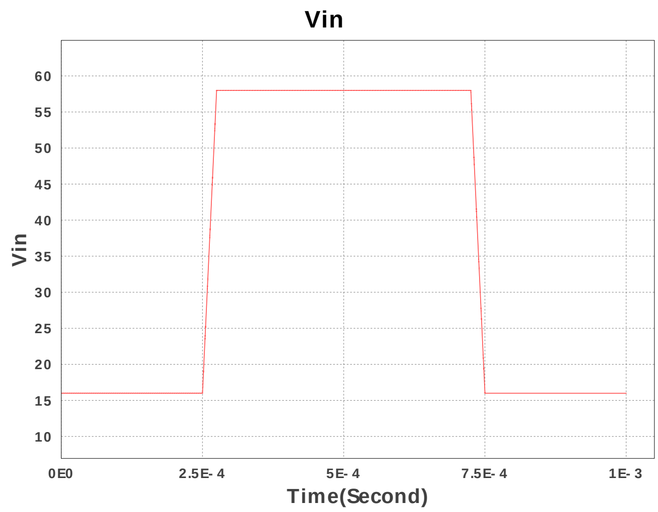
Simulation Type = Input Transient



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Iout	I	Load Current	1.5 A





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 : 1B5B86B7914DF16B[v1]

3. **LM5085** Product Folder : http://www.ti.com/product/LM5085 : contains the data sheet and other resources.

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