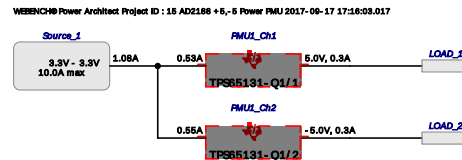


WEBENCH® Power Architect



Project Report

Project : 811229/15 : AD2188 +5,-5 Power
Created : 2017-09-17 17:16:03.017

Project Summary

1. Total System Efficiency	84.513 %
2. Total System BOM Count	31.0
3. Total System Footprint	346.0 mm2
4. Total System BOM Cost	\$7.30
5. Total System Power Dissipation	549.8 mW

--> Launch WEBENCH Power Architect.

My Comments

No comments

Sequencer Flag Table

Supply	Sequencer Flag	Load	Load Name
PMU1_Ch1	0	LOAD_1	
PMU1_Ch2	0	LOAD_2	
PMU1	NA		

Power Supplies

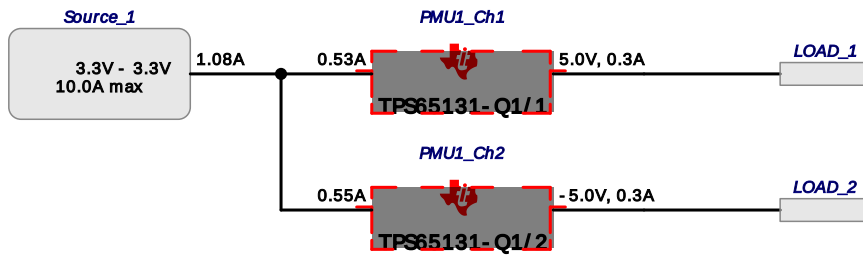
#	Name	NSID	Description	Vout	Iout	Efficiency	Foot-print	Cost	Design	Page
1.	PMU1_Ch1	TPS65131-Q1/1	Boost : TPS6513x Positive and Negative Output Dc-DC Converter	5.0 V	0.3 A	85.7%	106	\$2.32	53	8
2.	PMU1_Ch2	TPS65131-Q1/2	Inverting_Buck_Boost : TPS6513x Positive and Negative Output Dc-DC Converter	-5.0 V	0.3 A	83.3%	265	\$6.46	54	14
3.	PMU1	TPS65131-Q1	PMU : TPS6513x Positive and Negative Output Dc-DC Converter	V	NaN A	84.5%	346	\$7.38	52	4

Power Loads

#	Name	VLoad	ILoad	Description
1.	LOAD_1	5.0 V	0.3 A	VoutRipple=10%
2.	LOAD_2	-5.0 V	0.3 A	VoutRipple=10%

Project Diagram

WEBENCH® Power Architect Project ID : 15 AD2188 +5,-5 Power PMU 2017-09-17 17:16:03.017



Electrical Procurement BOM

Manufacturer	Part Number	Description	Quantity	Budgetary Price	Footprint (mm ²)
AVX	04025A471JAT2A	0402	2	\$0.01	6
Kemet	C0402C150J4GACTU	0402	2	\$0.01	6
Yageo America	CC0402JRNPO9BN200	0402	2	\$0.01	6
Vishay-Dale	CRCW0402110KFKED	0402	2	\$0.01	6
Vishay-Dale	CRCW0402133KFKED	0402	2	\$0.01	6
Vishay-Dale	CRCW0402340KFKED	0402	2	\$0.01	6
Vishay-Dale	CRCW040251K1FKED	0402	2	\$0.01	6
Vishay-Dale	CRCW0402536KFKED	0402	2	\$0.01	6
Vishay-Dale	CRCW040297R6FKED	0402	2	\$0.01	6
Texas Instruments	CSD25402Q3A	DNH0008A	2	\$0.29	37
MuRata	GRM155C80G224KE01D	0402	2	\$0.01	6
MuRata	GRM155R60J103KA01D	0402	2	\$0.01	6
MuRata	GRM188R70J104KA01D	0603	2	\$0.01	9
MuRata	GRM219R61A475KE34D	0805	2	\$0.03	14
MuRata	GRM21BR60J226ME39L	0805	4	\$0.05	27
Fairchild Semiconductor	MBR1020VL	SOD-123F	4	\$0.07	47
Kemet	T495B474K035ATE2K2	3528-21	20	\$0.45	34
Texas Instruments	TPS65131TRGERQ1	RGE0024B	3	\$1.40	75
TDK	VLCF4028T-4R7N1R5-2	VLCF4028	4	\$0.36	100
Total			63	\$16.00	408.84

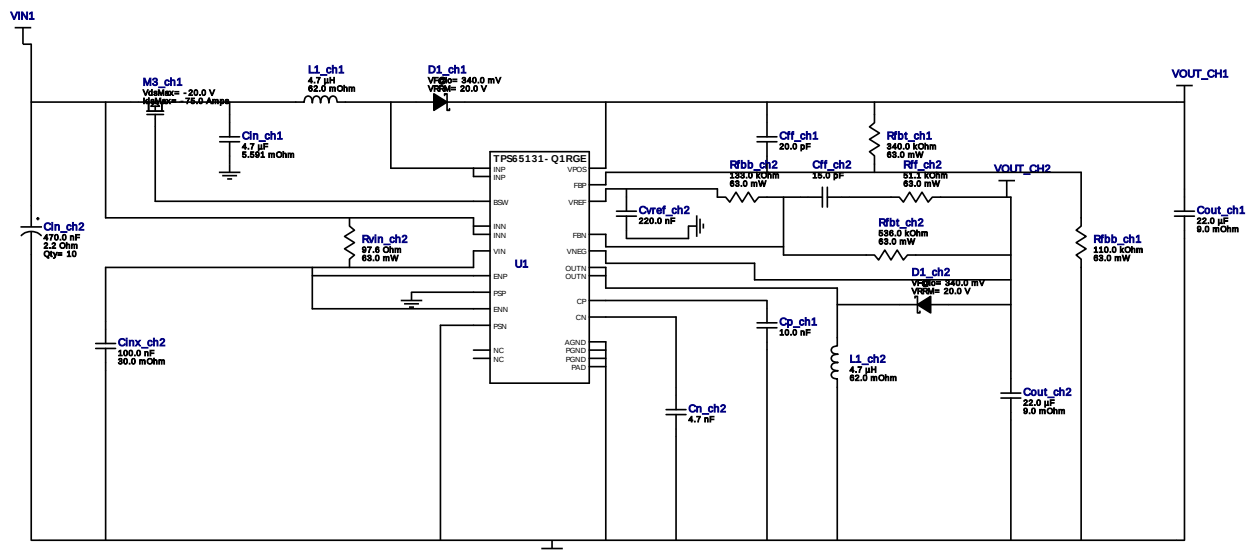


Vout = 5.0V
Iout = 0.3A

Device = TPS65131TRGERQ1
Topology = PMU
Created = 2017-09-17 17:16:02.140
BOM Cost = \$7.38
BOM Count = 31
Total Pd = 0.55W

WEBENCH® Design Report

Design : 811229/52 TPS65131TRGERQ1
Design 52 - TPS65131TRGERQ1

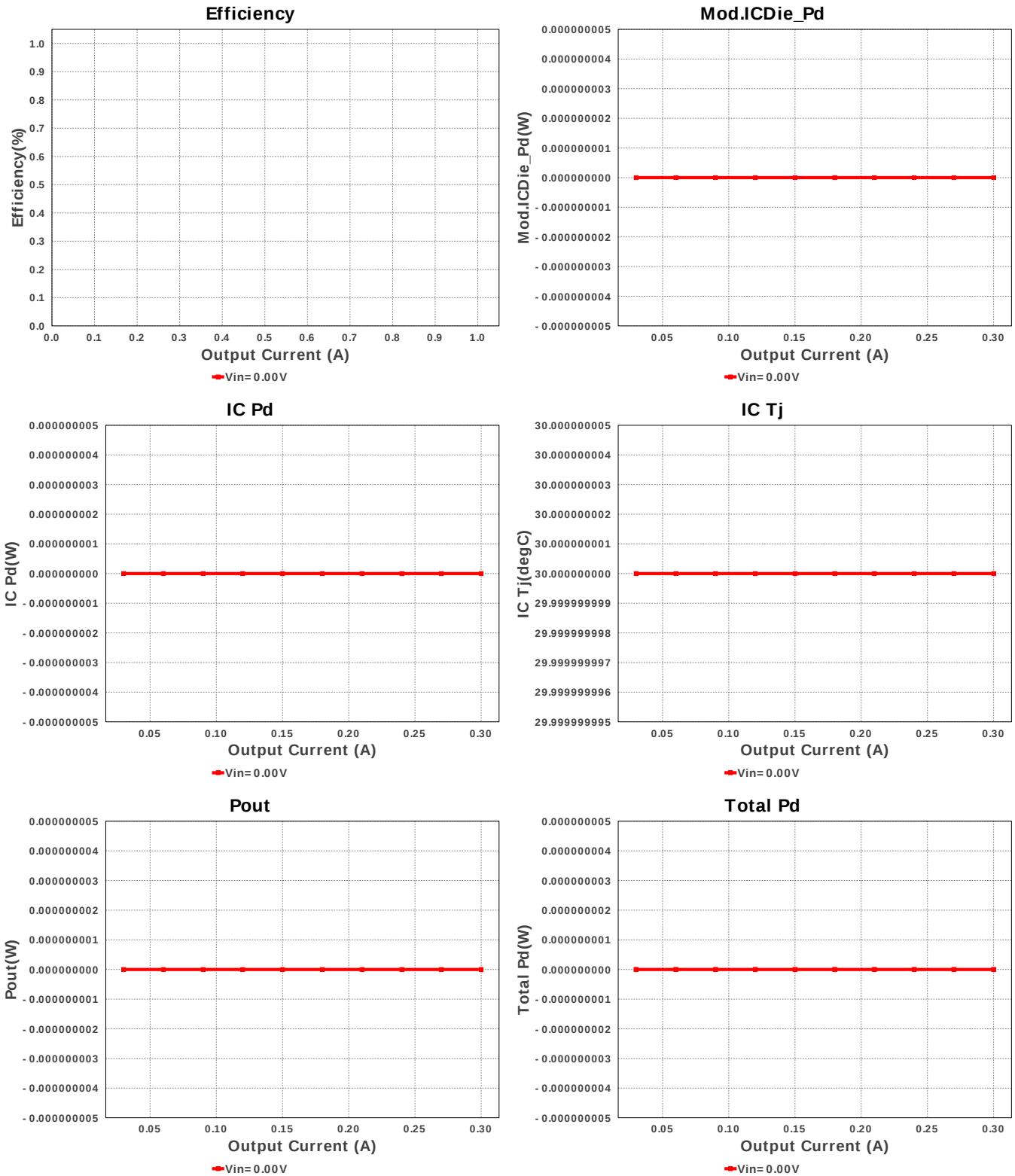


1. This schematic shows all the components for this Power Management Unit. The block diagram on the left shows how the channels are connected. Use the drop down PMU Options selector below the optimization dial on the summary page to get the details for each channel. Or click on the block diagram on the left to select a specific channel.

Electrical BOM

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cff_ch1	Yageo America	CC0402JRNPO9BN200 Series= C0G/NP0	Cap= 20.0 pF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm ²
2.	Cff_ch2	Kemet	C0402C150J4GACTU Series= C0G/NP0	Cap= 15.0 pF VDC= 16.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm ²
3.	Cin_ch1	MuRata	GRM219R61A475KE34D Series= X5R	Cap= 4.7 uF ESR= 5.591 mOhm VDC= 10.0 V IRMS= 1.9219 A	1	\$0.03	0805 7 mm ²
4.	Cin_ch2	Kemet	T495B474K035ATE2K2 Series= T495	Cap= 470.0 nF ESR= 2.2 Ohm VDC= 35.0 V IRMS= 177.0 mA	10	\$0.45	3528-21 17 mm ²
5.	Cinx_ch2	MuRata	GRM188R70J104KA01D Series= X7R	Cap= 100.0 nF ESR= 30.0 mOhm VDC= 6.3 V IRMS= 1.75 A	1	\$0.01	0603 5 mm ²
6.	Cn_ch2	AVX	04025A471JAT2A Series= C0G/NP0	Cap= 4.7 nF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm ²
7.	Cout_ch1	MuRata	GRM21BR60J226ME39L Series= X5R	Cap= 22.0 uF ESR= 9.0 mOhm VDC= 6.3 V IRMS= 3.5 A	1	\$0.05	0805 7 mm ²

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
8.	Cout_ch2	MuRata	GRM21BR60J226ME39L Series= X5R	Cap= 22.0 uF ESR= 9.0 mOhm VDC= 6.3 V IRMS= 3.5 A	1	\$0.05	 0805 7 mm²
9.	Cp_ch1	MuRata	GRM155R60J103KA01D Series= X5R	Cap= 10.0 nF VDC= 6.3 V IRMS= 0.0 A	1	\$0.01	 0402 3 mm²
10.	Cvref_ch2	MuRata	GRM155C80G224KE01D Series= X6S	Cap= 220.0 nF VDC= 4.0 V IRMS= 0.0 A	1	\$0.01	 0402 3 mm²
11.	D1_ch1	Fairchild Semiconductor	MBR1020VL	VF@Io= 340.0 mV VRRM= 20.0 V	1	\$0.07	 SOD-123F 12 mm²
12.	D1_ch2	Fairchild Semiconductor	MBR1020VL	VF@Io= 340.0 mV VRRM= 20.0 V	1	\$0.07	 SOD-123F 12 mm²
13.	L1_ch1	TDK	VLCF4028T-4R7N1R5-2	L= 4.7 uH DCR= 62.0 mOhm	1	\$0.36	 VLCF4028 25 mm²
14.	L1_ch2	TDK	VLCF4028T-4R7N1R5-2	L= 4.7 uH DCR= 62.0 mOhm	1	\$0.36	 VLCF4028 25 mm²
15.	M3_ch1	Texas Instruments	CSD25402Q3A	VdsMax= -20.0 V IdsMax= -75.0 Amps	1	\$0.29	 DNH0008A 18 mm²
16.	Rfbb_ch1	Vishay-Dale	CRCW0402110KFKED Series= CRCW..e3	Res= 110.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
17.	Rfbb_ch2	Vishay-Dale	CRCW0402133KFKED Series= CRCW..e3	Res= 133.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
18.	Rfbt_ch1	Vishay-Dale	CRCW0402340KFKED Series= CRCW..e3	Res= 340.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
19.	Rfbt_ch2	Vishay-Dale	CRCW0402536KFKED Series= CRCW..e3	Res= 536.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
20.	Rff_ch2	Vishay-Dale	CRCW040251K1FKED Series= CRCW..e3	Res= 51.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
21.	Rvin_ch2	Vishay-Dale	CRCW040297R6FKED Series= CRCW..e3	Res= 97.6 Ohm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
22.	U1	Texas Instruments	TPS65131TRGERQ1	Switcher	1	\$1.40	 RGE0024B 25 mm²



Operating Values

#	Name	Value	Category	Description
1.	BOM Count	31	General	Total Design BOM count
2.	FootPrint	346.0 mm ²	General	Total PMU footprint area of BOM components
3.	Pout	3.0 W	General	Total PMU output power
4.	Total BOM	\$7.38	General	Total BOM Cost
5.	Efficiency	84.513 %	Op_point	PMU steady state efficiency
6.	IC Tj	36.741 degC	Op_point	PMU IC junction temperature
7.	ICThetaJA	34.1 degC/W	Op_point	IC junction-to-ambient thermal resistance
8.	Cin_ch1 Pd	18.627 μ W	Power	Input capacitor power dissipation
9.	Cin_ch2 Pd	28.343 mW	Power	Input capacitor power dissipation
10.	Cout_ch1 Pd	362.995 μ W	Power	Output capacitor power dissipation
11.	Cout_ch2 Pd	1.154 mW	Power	Output capacitor power dissipation

#	Name	Value	Category	Description
12.	D1_ch1 Pd	76.27 mW	Power	Output Diode Power Dissipation
13.	Diode_ch2 Pd	198.643 mW	Power	Diode power dissipation
14.	IC Pd	197.67 mW	Power	IC Pd
15.	L1_ch1 Pd	14.636 mW	Power	Power Dissipation in the Inductor
16.	L1_ch2 Pd	32.606 mW	Power	Inductor power dissipation
17.	L1_ch2 Pd	32.606 mW	Power	Power Dissipation in the Inductor
18.	Module ICPd	197.67 mW	Power	IC Pd
19.	Total Pd	549.765 mW	Power	PMU total power dissipation
20.	Total Pd	549.765 mW	Power	PMU total power dissipation

Design Inputs

#	Name	Value	Description
1.	Iout	300.0 m	Maximum Output Current
2.	Vin1Max	3.3	Maximum Input Voltage #1
3.	Vin1Min	3.3	Minimum Input Voltage #1
4.	Vin2Max	3.3	Maximum Input Voltage #2
5.	Vin2Min	3.3	Minimum Input Voltage #2
6.	Vout	5.0	Output Voltage
7.	base_pn	TPS65131-Q1	Base Product Number
8.	source	DC	Input Source Type
9.	Ta	30.0	Ambient temperature

Design Assistance

1. **TPS65131-Q1** Product Folder : <http://www.ti.com/product/TPS65131-Q1> : contains the data sheet and other resources.

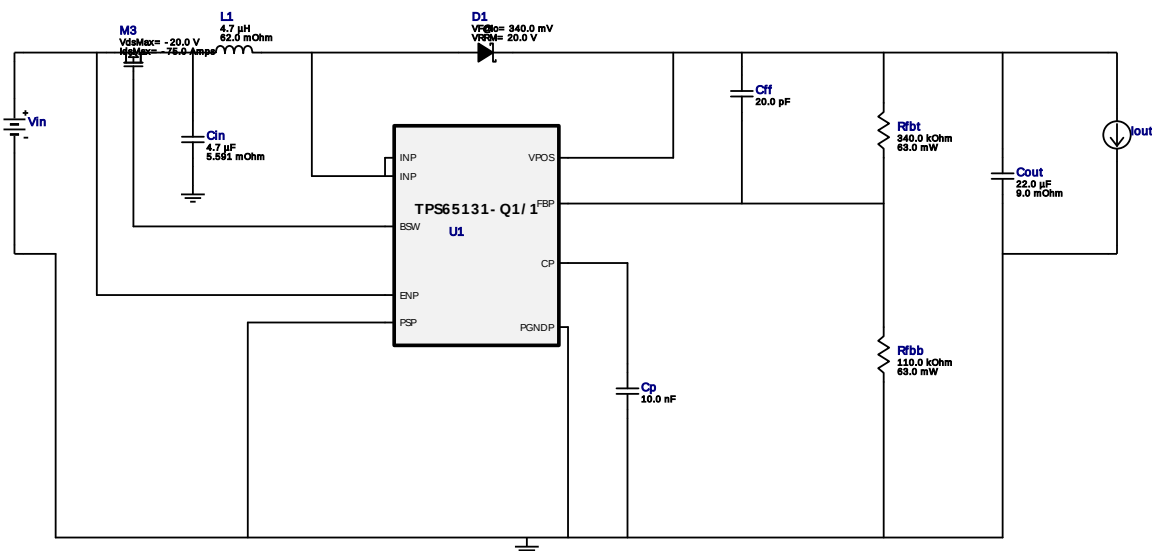


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Iout = 0.3A

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Topology = Boost
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Total Pd = 0.25W

WEBENCH® Design Report

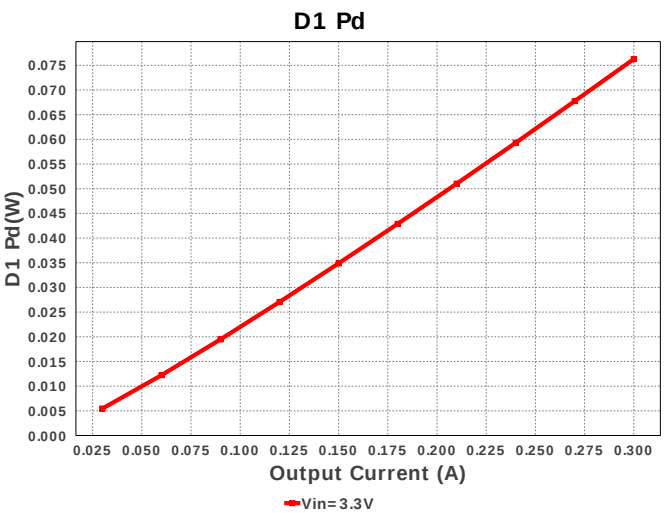
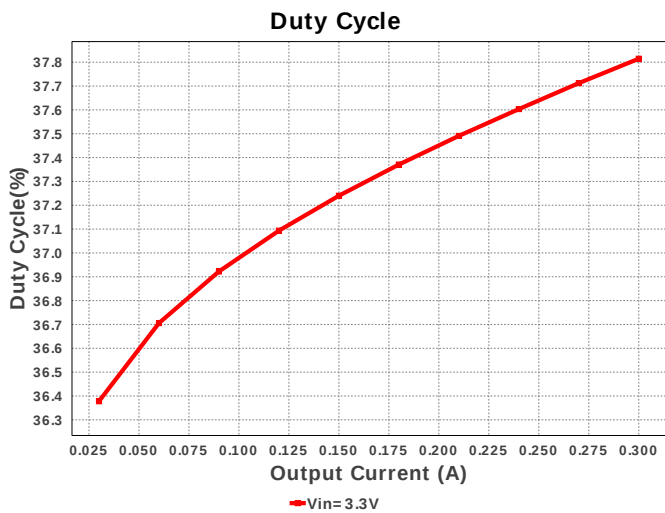
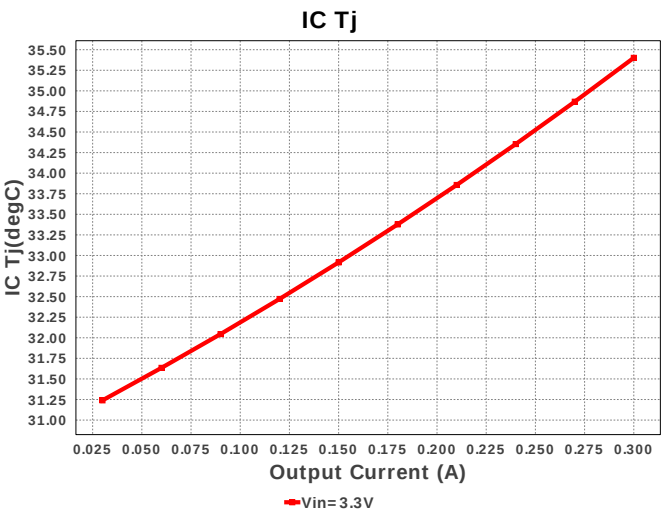
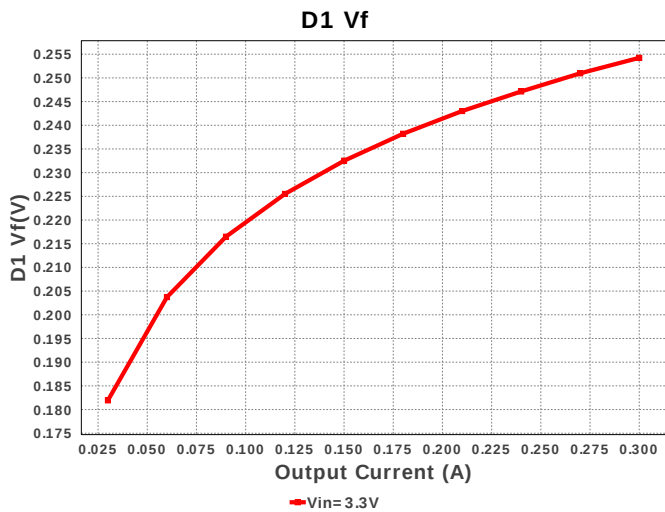
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TPS65131TRGERQ1 3.3V-3.3V to 5.00V @ 0.3A

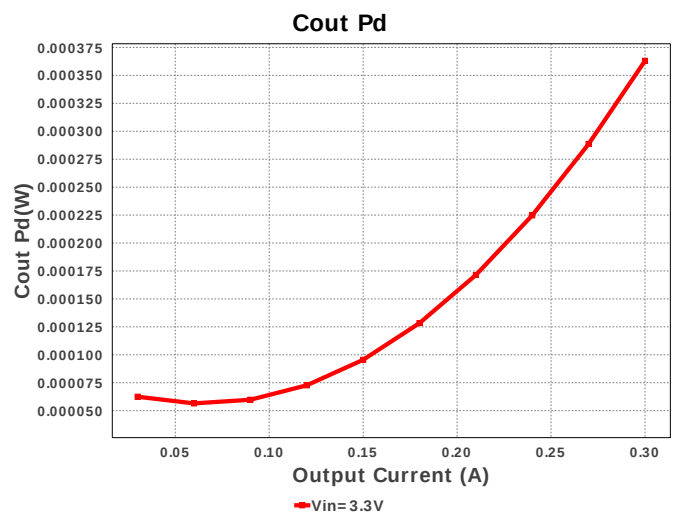
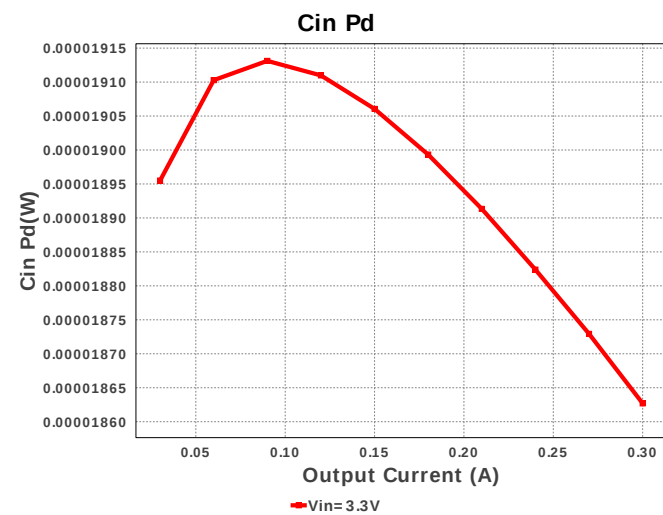
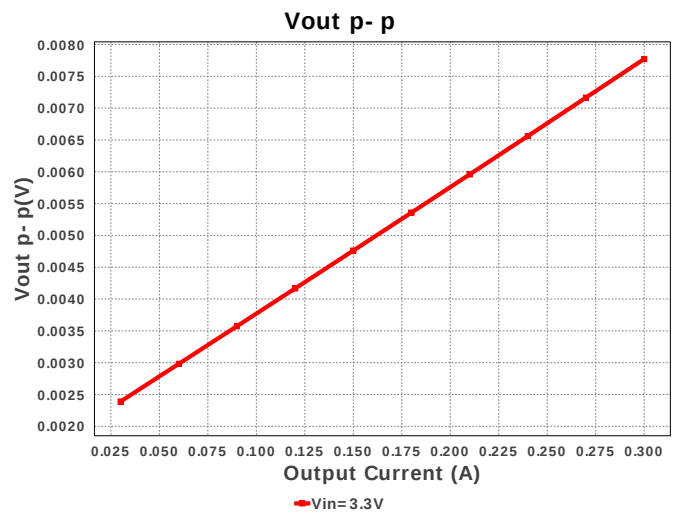
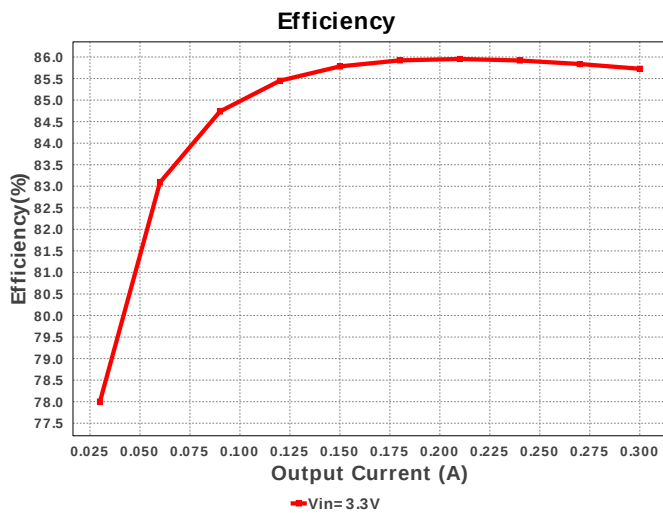
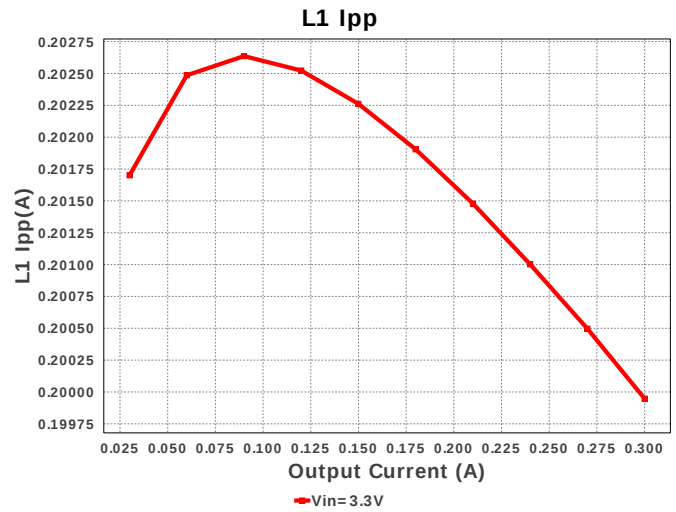
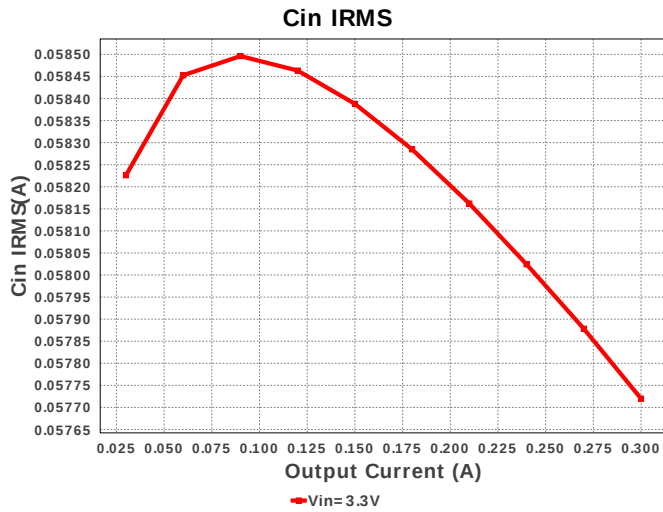


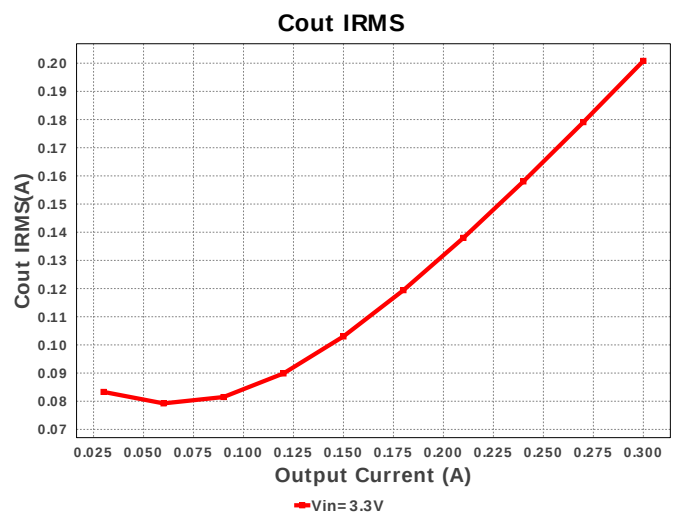
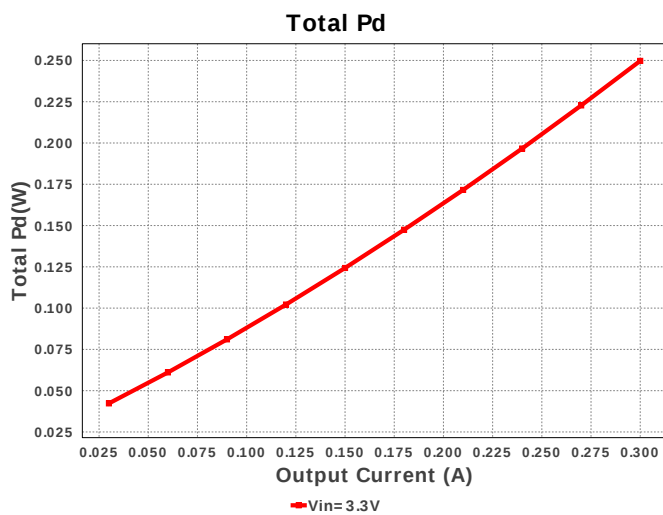
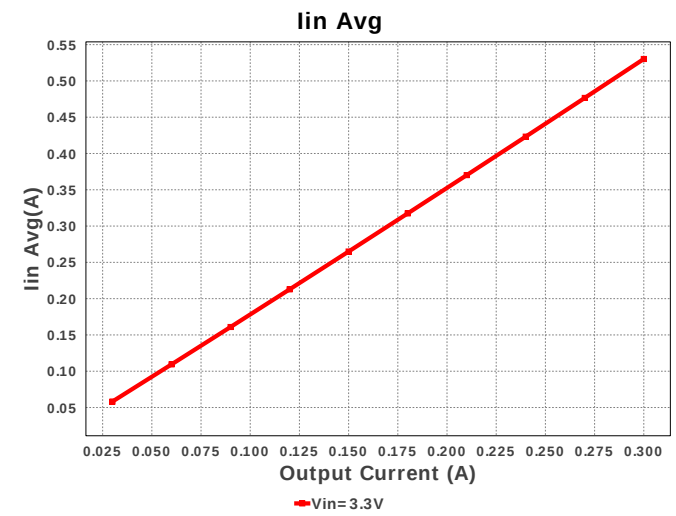
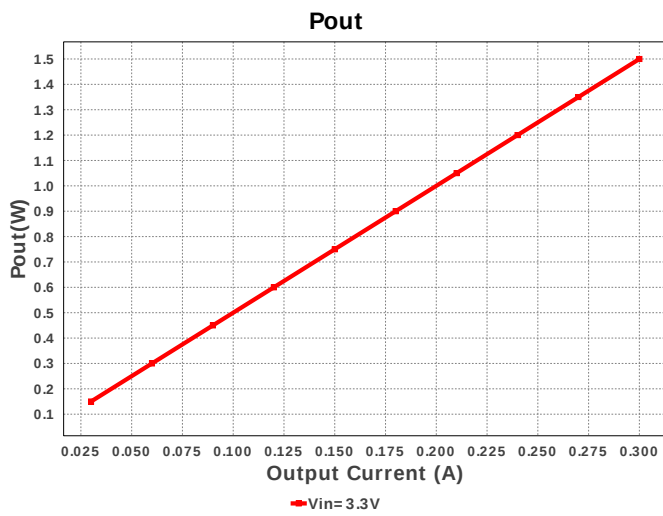
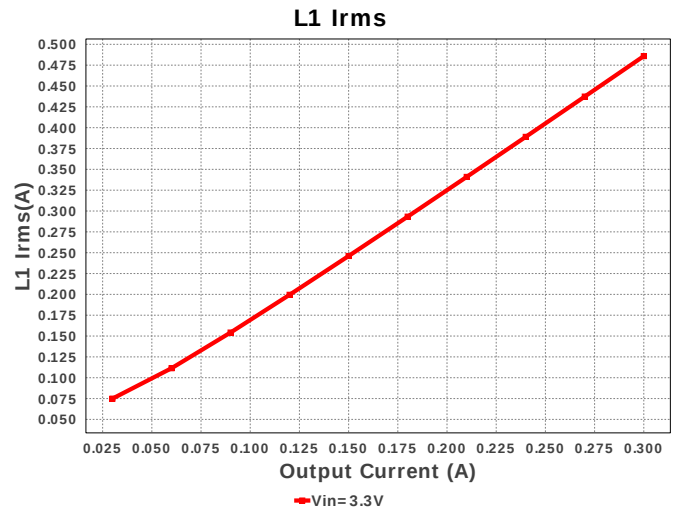
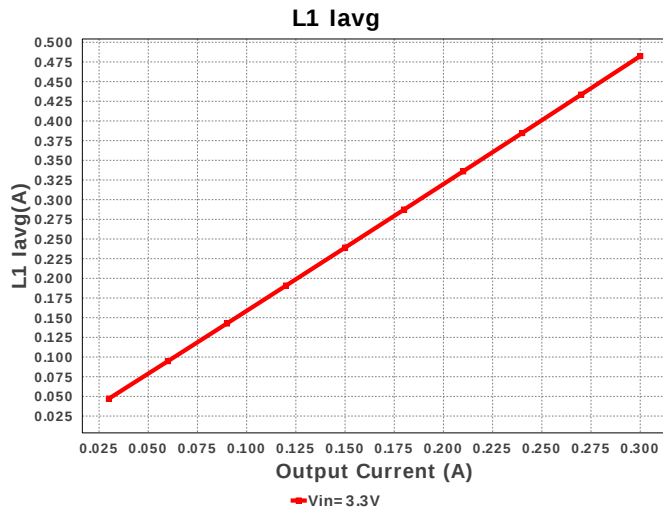
Electrical BOM

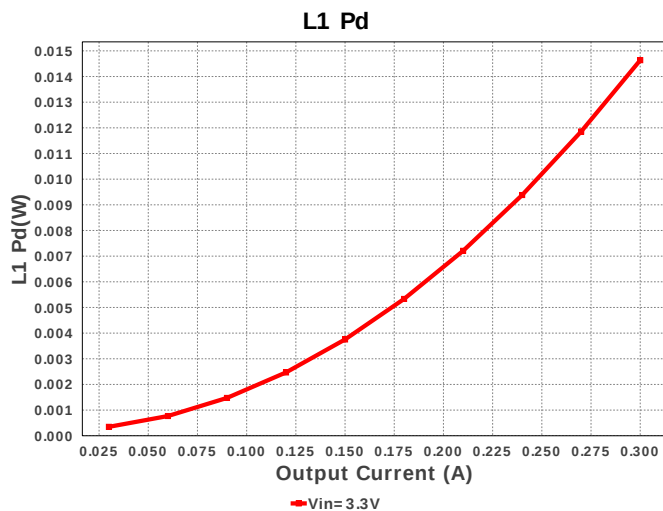
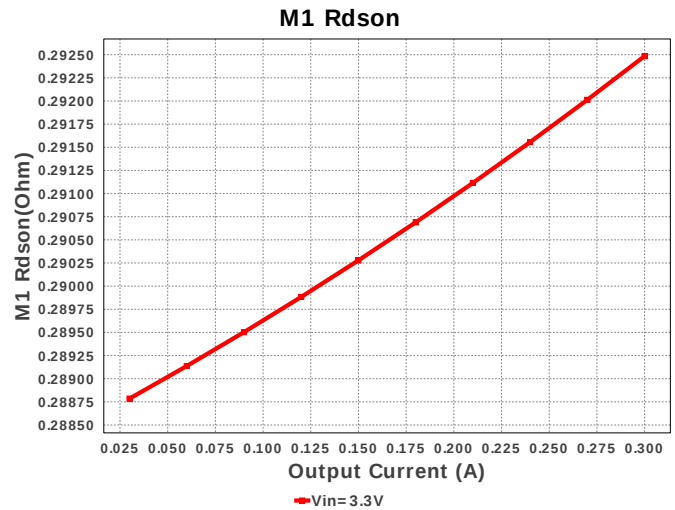
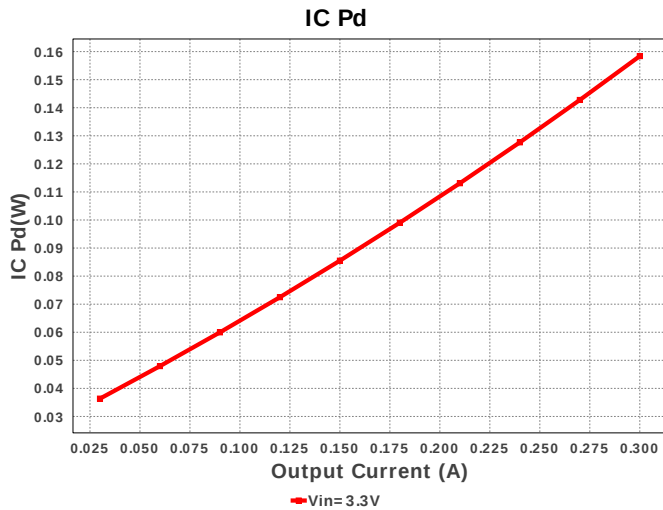
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cff	Yageo America	CC0402JRNPO9BN200 Series= C0G/NP0	Cap= 20.0 pF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm ²
2.	Cin	MuRata	GRM219R61A475KE34D Series= X5R	Cap= 4.7 uF ESR= 5.591 mOhm VDC= 10.0 V IRMS= 1.9219 A	1	\$0.03	0805 7 mm ²
3.	Cout	MuRata	GRM21BR60J226ME39L Series= X5R	Cap= 22.0 uF ESR= 9.0 mOhm VDC= 6.3 V IRMS= 3.5 A	1	\$0.05	0805 7 mm ²
4.	Cp	MuRata	GRM155R60J103KA01D Series= X5R	Cap= 10.0 nF VDC= 6.3 V IRMS= 0.0 A	1	\$0.01	0402 3 mm ²
5.	D1	Fairchild Semiconductor	MBR1020VL	VF@Io= 340.0 mV VRRM= 20.0 V	1	\$0.07	SOD-123F 12 mm ²
6.	L1	TDK	VLCF4028T-4R7N1R5-2	L= 4.7 µH DCR= 62.0 mOhm	1	\$0.36	VLCF4028 25 mm ²
7.	M3	Texas Instruments	CSD25402Q3A	VdsMax= -20.0 V IdsMax= -75.0 Amps	1	\$0.29	DNH0008A 18 mm ²
8.	Rfbb	Vishay-Dale	CRCW0402110KFKED Series= CRCW..e3	Res= 110.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm ²
9.	Rfbb	Vishay-Dale	CRCW0402340KFKED Series= CRCW..e3	Res= 340.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm ²

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
10.	U1	Texas Instruments	TPS65131TRGERQ1	Switcher	0	\$1.40	 RGE0024B 25 mm²









Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	57.72 mA	Current	Input capacitor RMS ripple current
2.	Cout IRMS	200.83 mA	Current	Output capacitor RMS ripple current
3.	Iin Avg	530.22 mA	Current	Average input current
4.	L1 Iavg	482.429 mA	Current	Inductor average current
5.	L Ipp	199.948 mA	Current	
6.	L1 Irms	485.869 mA	Current	Inductor ripple current
7.	Frequency	1.26 MHz	General	Switching frequency
8.	M1 Rdson	292.485 mOhm	General	
9.	Mode	PWM CCM	General	PWM/PFM Mode
10.	Pout	1.5 W	General	Total output power
11.	Vout Actual	4.962 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
12.	Duty Cycle	37.815 %	Op_point	Duty cycle
13.	Efficiency	85.727 %	Op_point	PMU channel steady state efficiency
14.	ICThetaJA	34.1 degC/W	Op_point	IC junction-to-ambient thermal resistance
15.	IOUT_OP	300.0 mA	Op_point	Iout operating point
16.	VIN_OP	3.3 V	Op_point	Vin operating point
17.	Vout p-p	4.22 mV	Op_point	Peak-to-peak output ripple voltage
18.	Cin Pd	18.627 μW	Power	Input capacitor power dissipation
19.	Cout Pd	362.995 μW	Power	Output capacitor power dissipation
20.	D1 Pd	76.27 mW	Power	Output Diode Power Dissipation
21.	IC Pd	158.393 mW	Power	IC power dissipation
22.	L Pd	14.636 mW	Power	Power Dissipation in the Inductor
23.	Total Pd	249.738 mW	Power	PMU channel power dissipation
24.	D1 Vf	254.233 mV		
25.	Vout Tolerance	3.535 %		Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable

Design Inputs

#	Name	Value	Description
1.	Iout	300.0 m	Maximum Output Current

#	Name	Value	Description
2.	VinMax	3.3	Maximum input voltage
3.	VinMin	3.3	Minimum input voltage
4.	Vout	5.0	Output Voltage
5.	base_pn	TPS65131-Q1/1	Base Product Number
6.	source	DC	Input Source Type
7.	Ta	30.0	Ambient temperature

Design Assistance

1. **TPS65131-Q1/1** Product Folder : <http://www.ti.com/product/tps65131%2DQ1> : contains the data sheet and other resources.

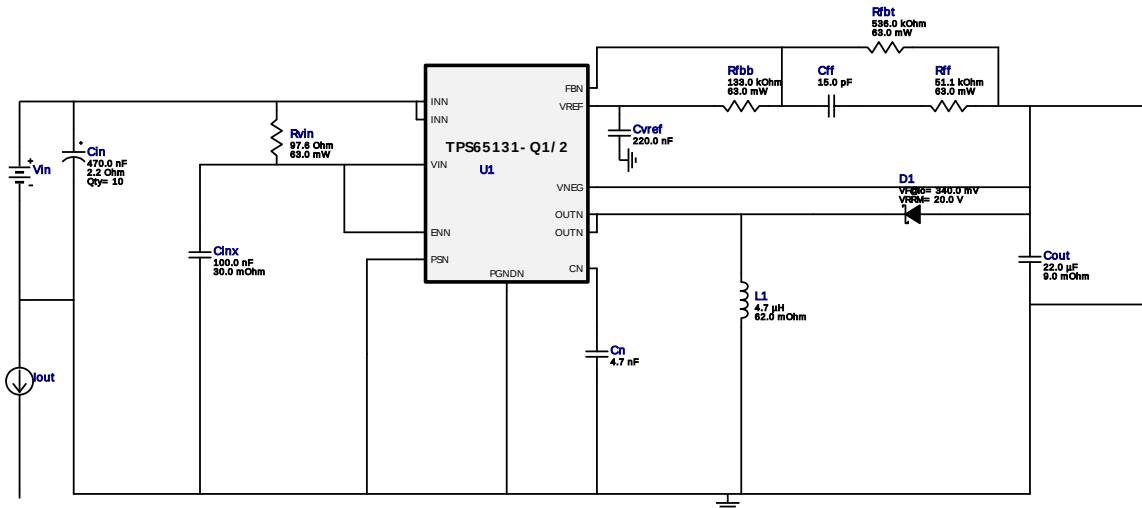


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Iout = 0.3A

Device = TPS65131TRGERQ1
Topology = Inverting_Buck_Boost
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BOM Cost = \$NaN
BOM Count = NaN
Total Pd = 0.3W

WEBENCH[®] Design Report

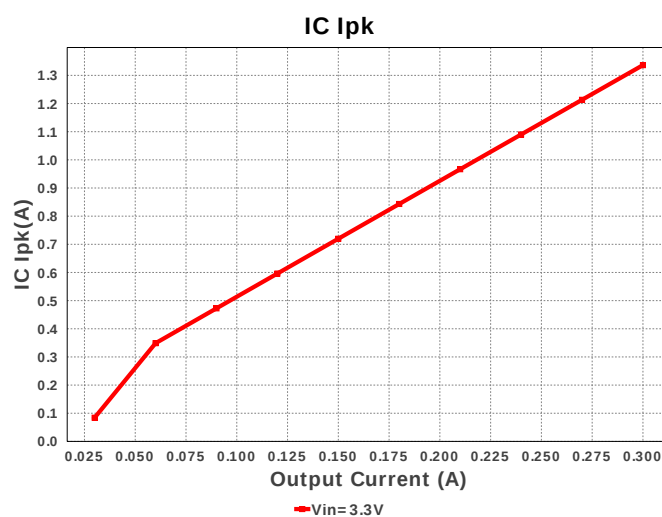
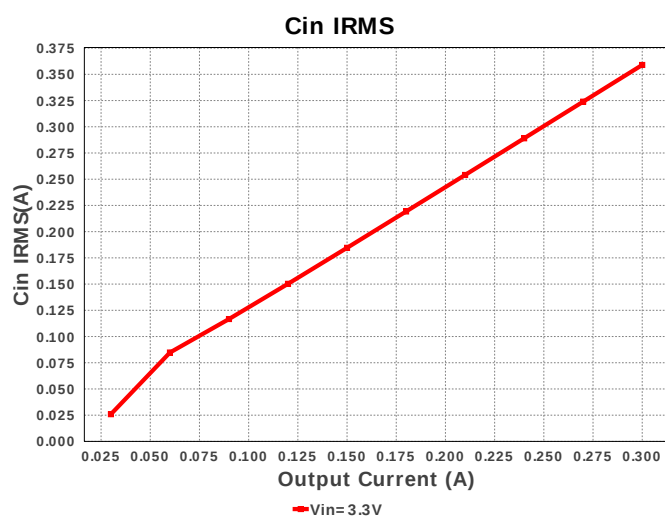
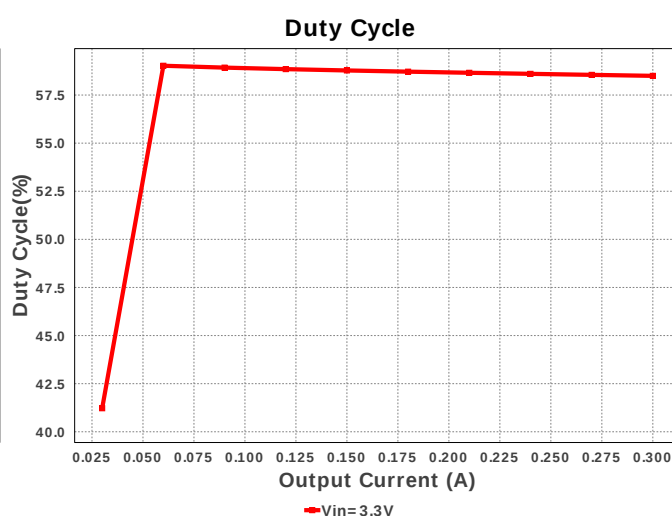
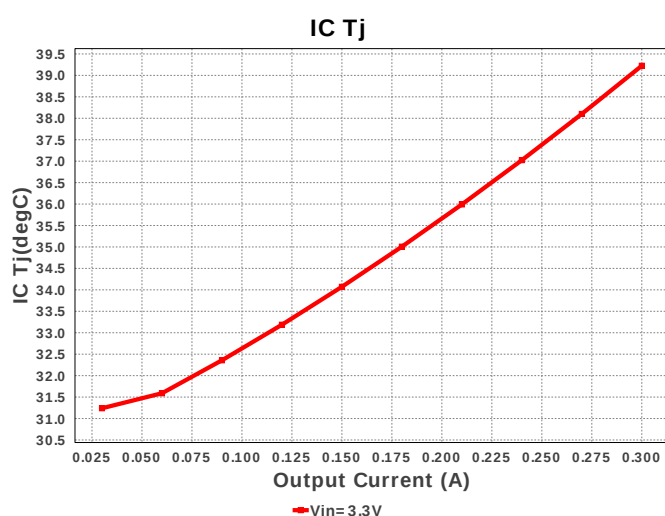
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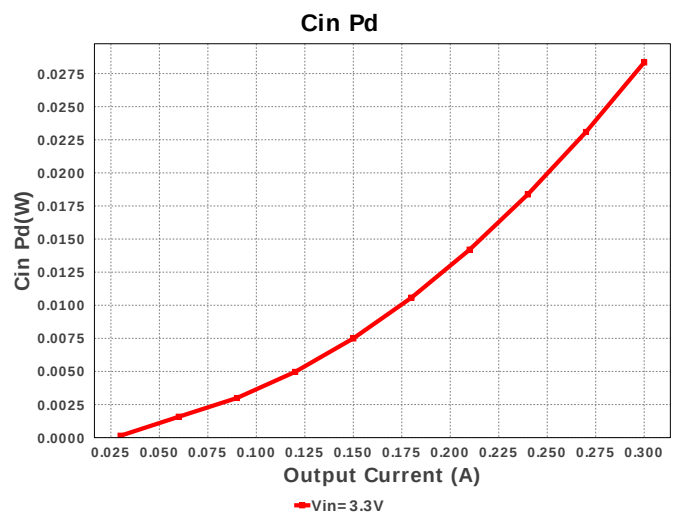
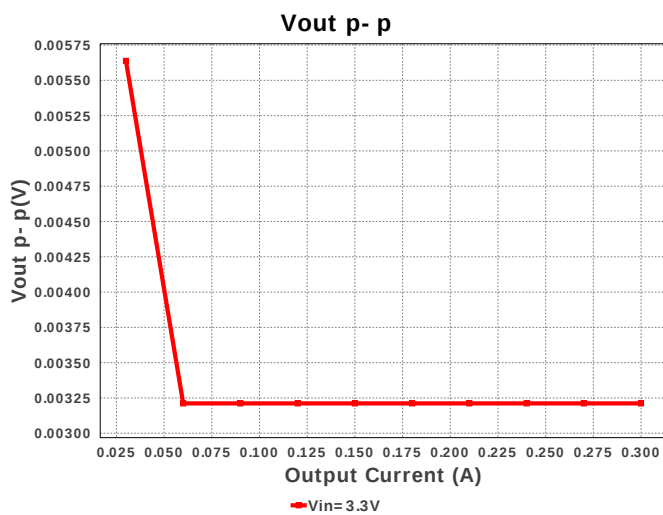
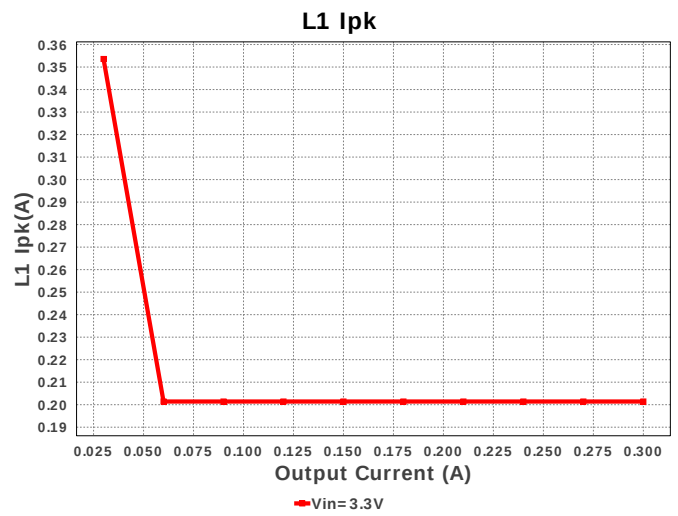
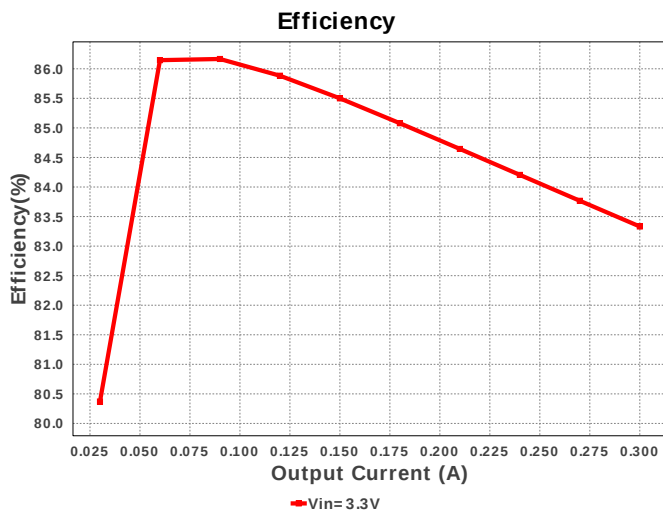
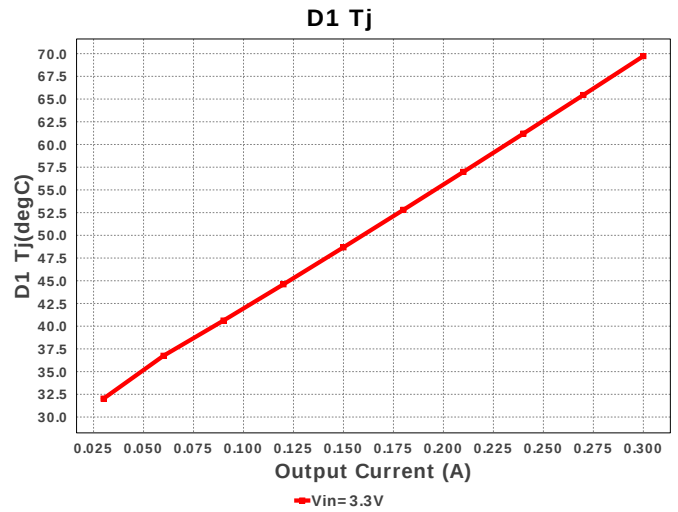
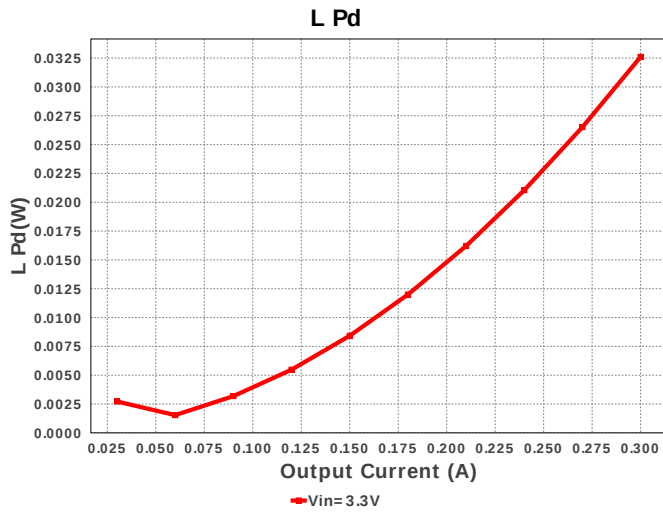


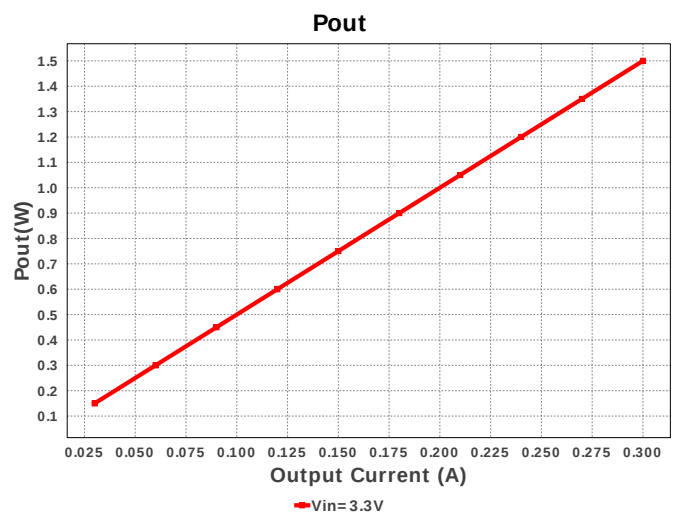
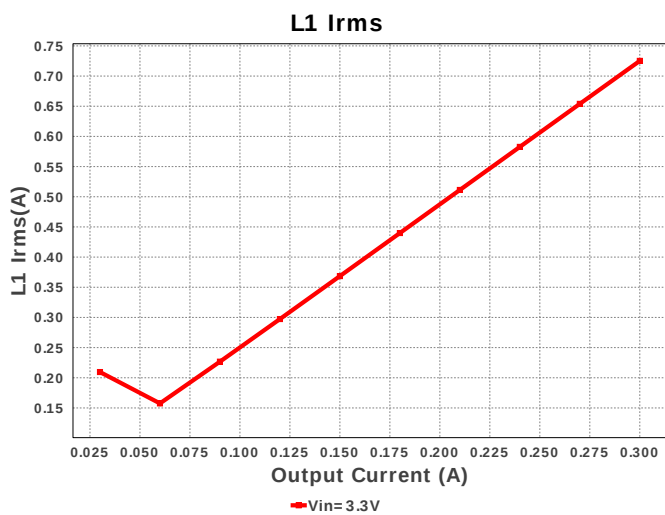
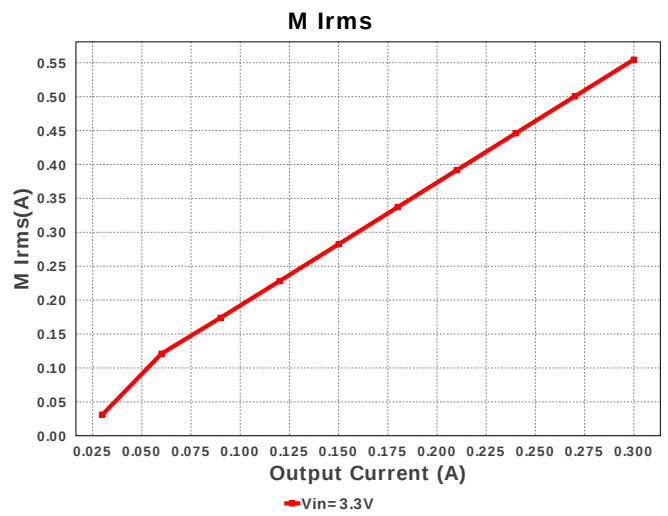
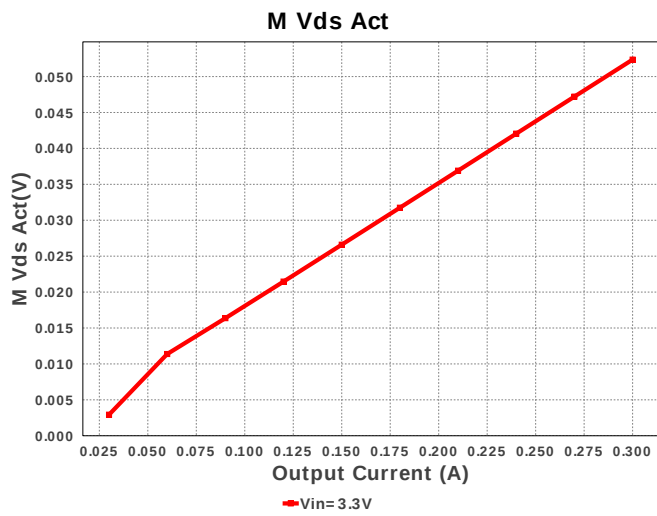
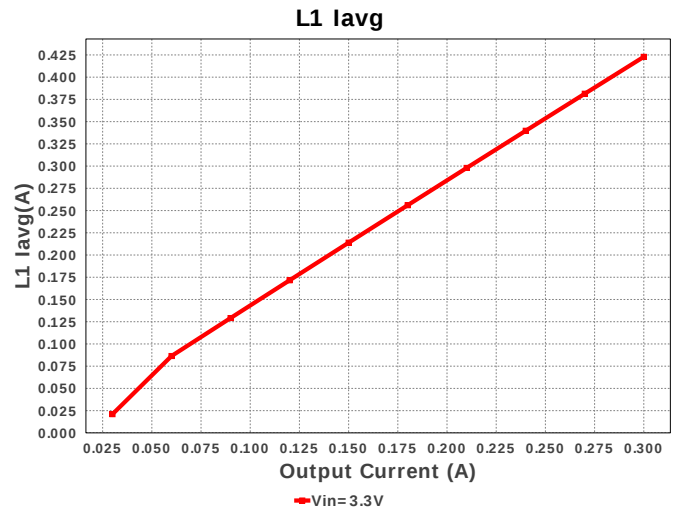
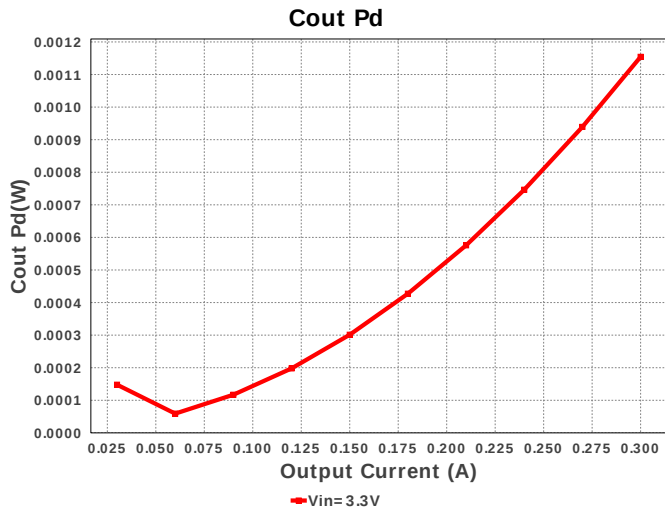
Electrical BOM

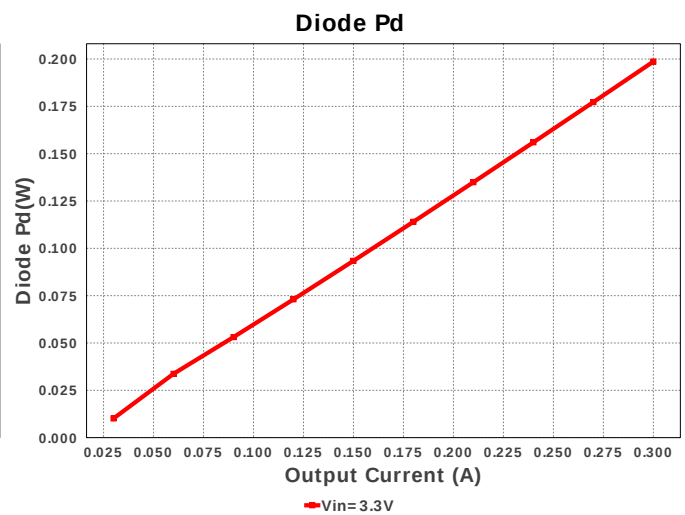
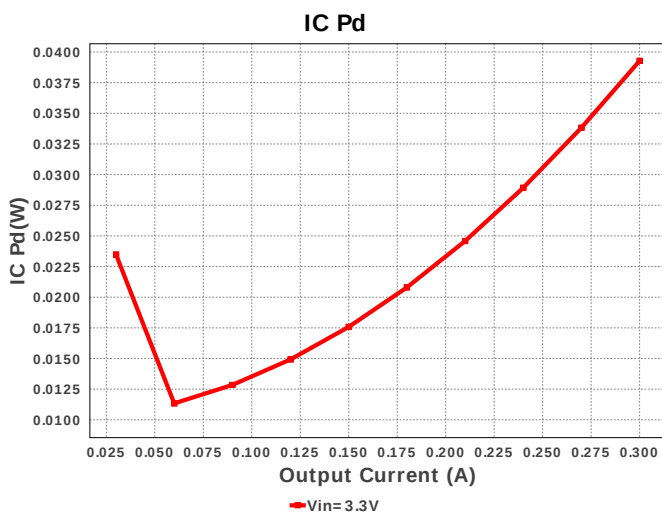
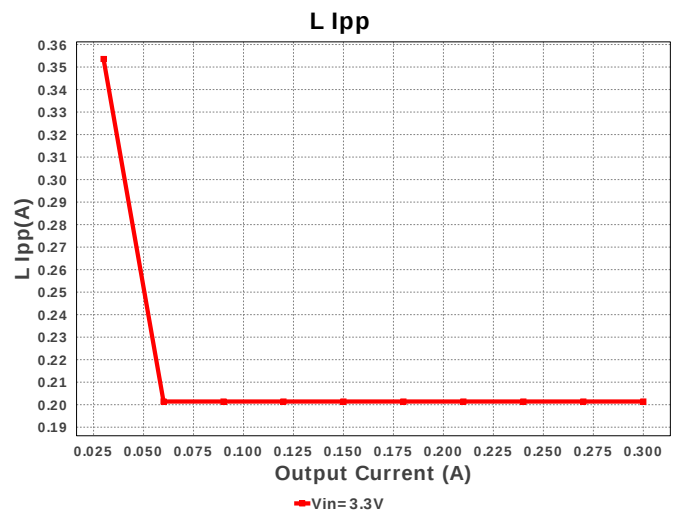
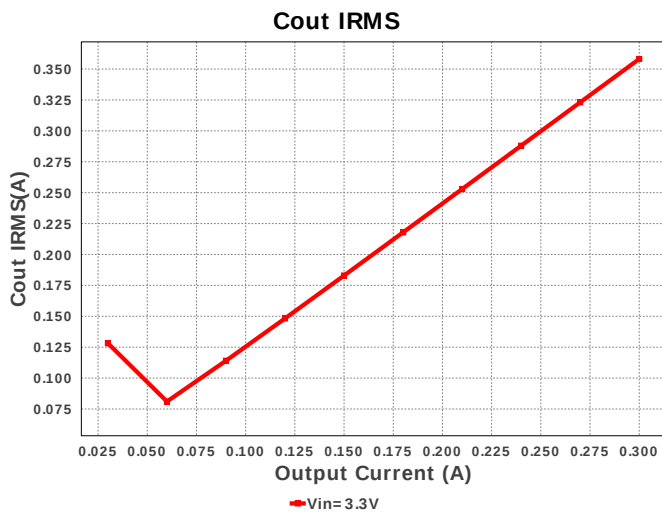
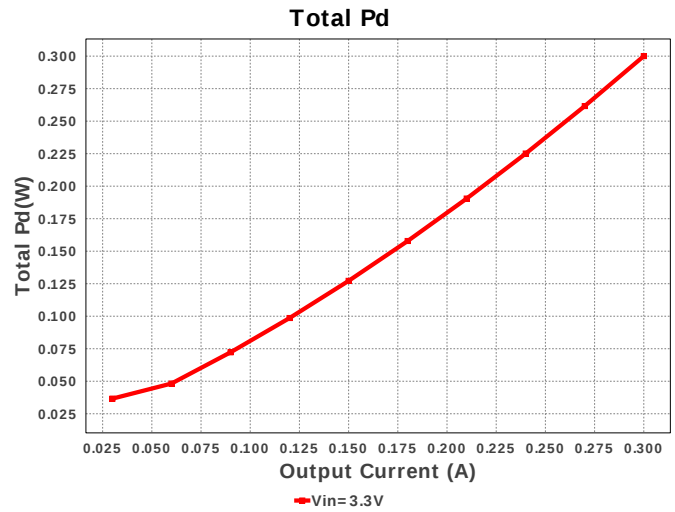
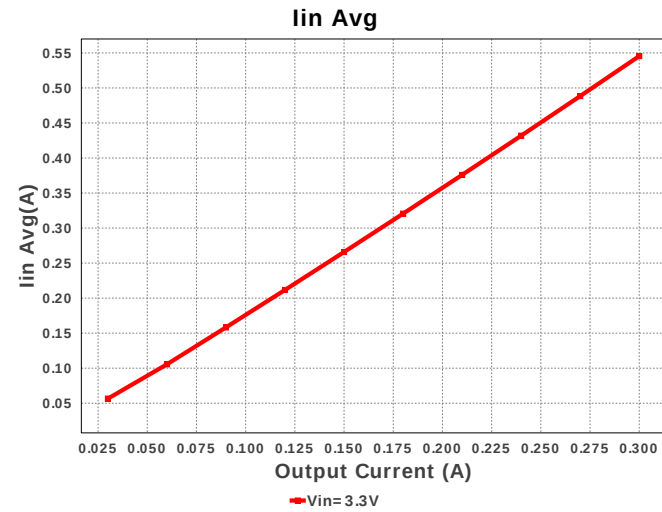
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cff	Kemet	C0402C150J4GACTU Series= C0G/NP0	Cap= 15.0 pF VDC= 16.0 V IRMS= 0.0 A	1	\$0.01	 0402 3 mm ²
2.	Cin	Kemet	T495B474K035ATE2K2 Series= T495	Cap= 470.0 nF ESR= 2.2 Ohm VDC= 35.0 V IRMS= 177.0 mA	10	\$0.45	 3528-21 17 mm ²
3.	Cinx	MuRata	GRM188R70J104KA01D Series= X7R	Cap= 100.0 nF ESR= 30.0 mOhm VDC= 6.3 V IRMS= 1.75 A	1	\$0.01	 0603 5 mm ²
4.	Cn	AVX	04025A471JAT2A Series= C0G/NP0	Cap= 4.7 nF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	 0402 3 mm ²
5.	Cout	MuRata	GRM21BR60J226ME39L Series= X5R	Cap= 22.0 uF ESR= 9.0 mOhm VDC= 6.3 V IRMS= 3.5 A	1	\$0.05	 0805 7 mm ²
6.	Cvref	MuRata	GRM155C80G224KE01D Series= X6S	Cap= 220.0 nF VDC= 4.0 V IRMS= 0.0 A	1	\$0.01	 0402 3 mm ²
7.	D1	Fairchild Semiconductor	MBR1020VL	VF@Io= 340.0 mV VRRM= 20.0 V	1	\$0.07	 SOD-123F 12 mm ²
8.	L1	TDK	VLCF4028T-4R7N1R5-2	L= 4.7 µH DCR= 62.0 mOhm	1	\$0.36	 VLCF4028 25 mm ²
9.	Rfbb	Vishay-Dale	CRCW0402133KFKED Series= CRCW..e3	Res= 133.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
10.	Rfbt	Vishay-Dale	CRCW0402536KFKED Series= CRCW..e3	Res= 536.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²

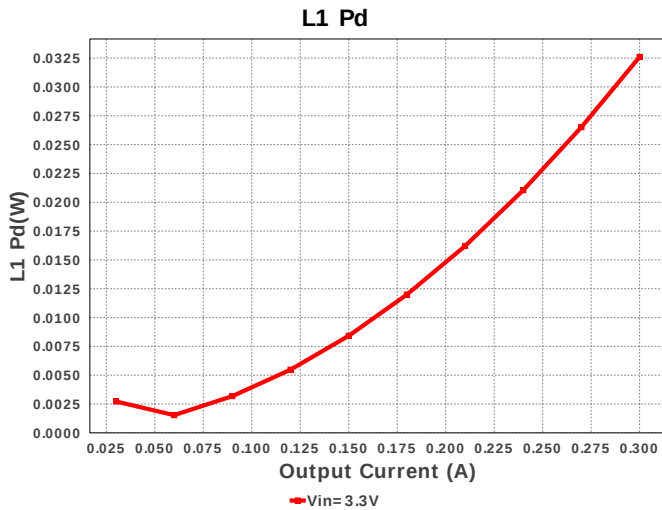
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
11.	Rff	Vishay-Dale	CRCW040251K1FKED Series= CRCW..e3	Res= 51.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
12.	Rvin	Vishay-Dale	CRCW040297R6FKED Series= CRCW..e3	Res= 97.6 Ohm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
13.	U1	Texas Instruments	TPS65131TRGERQ1	Switcher	0	\$1.40	 RGE0024B 25 mm²











Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	358.934 mA	Current	Input capacitor RMS ripple current
2.	Cout IRMS	358.133 mA	Current	Output capacitor RMS ripple current
3.	IC IpK	1.336 A	Current	Peak switch current in IC
4.	Iin Avg	545.46 mA	Current	Average input current
5.	L Ipp	201.41 mA	Current	Peak-to-peak inductor ripple current
6.	L1 Iavg	422.854 mA	Current	Inductor average current
7.	L1 IpK	201.414 mA	Current	Inductor peak current
8.	L1 Irms	725.188 mA	Current	Inductor ripple current
9.	M1 Irms	554.652 mA	Current	Q Iavg
10.	Frequency	1.26 MHz	General	Switching frequency
11.	IC Tolerance	24.0 mV	General	IC Feedback Tolerance
12.	M Vds Act	52.361 mV	General	Voltage drop across the MosFET
13.	Mode	CCM	General	Conduction Mode
14.	Mode	CCM	General	Conduction Mode
15.	Pout	1.5 W	General	Total output power
16.	D1 Tj	69.729 degC	Op_Point	D1 junction temperature
17.	Vout Actual	6.101 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
18.	Vout OP	-5.0 V	Op_Point	Operational Output Voltage
19.	Duty Cycle	58.498 %	Op_point	Duty cycle
20.	Efficiency	83.332 %	Op_point	PMU channel steady state efficiency
21.	ICThetaJA	34.1 degC/W	Op_point	IC junction-to-ambient thermal resistance
22.	IOUT_OP	300.0 mA	Op_point	Iout operating point
23.	VIN_OP	3.3 V	Op_point	Vin operating point
24.	Vout p-p	3.212 mV	Op_point	Peak-to-peak output ripple voltage
25.	Cin Pd	28.343 mW	Power	Input capacitor power dissipation
26.	Cout Pd	1.154 mW	Power	Output capacitor power dissipation
27.	Diode Pd	198.643 mW	Power	Diode power dissipation
28.	IC Pd	39.278 mW	Power	IC power dissipation
29.	IC Pd	39.278 mW	Power	IC power dissipation
30.	L Pd	32.606 mW	Power	Inductor power dissipation
31.	L Pd	32.606 mW	Power	Power Dissipation in the Inductor
32.	Total Pd	300.027 mW	Power	PMU channel power dissipation
33.	Vout Tolerance	3.629 %		Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable

Design Inputs

#	Name	Value	Description
1.	Iout	300.0 m	Maximum Output Current
2.	VinMax	3.3	Maximum input voltage
3.	VinMin	3.3	Minimum input voltage
4.	Vout	-5.0	Output Voltage
5.	base_pn	TPS65131-Q1/2	Base Product Number
6.	source	DC	Input Source Type
7.	Ta	30.0	Ambient temperature

Design Assistance

1. **TPS65131-Q1/2** Product Folder : <http://www.ti.com/product/tps65131%2DQ1> : contains the data sheet and other resources.

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