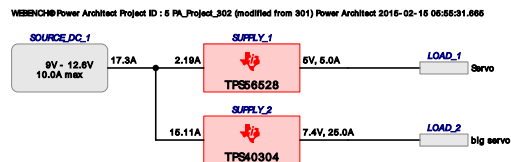


# WEBENCH® Power Architect



## Project Report

Project : 4109962/5 : PA\_Project\_302 (modified from 301)

Created : 2015-02-15 05:55:31.665

Optimize project optFactor=3

### Project Summary

1. Total System Efficiency	96.333 %
2. Total System BOM Count	36.0
3. Total System Footprint	593.0 mm2
4. Total System BOM Cost	\$8.25
5. Total System Power Dissipation	7.994 W

--> Launch WEBENCH Power Architect.

## Power Supplies

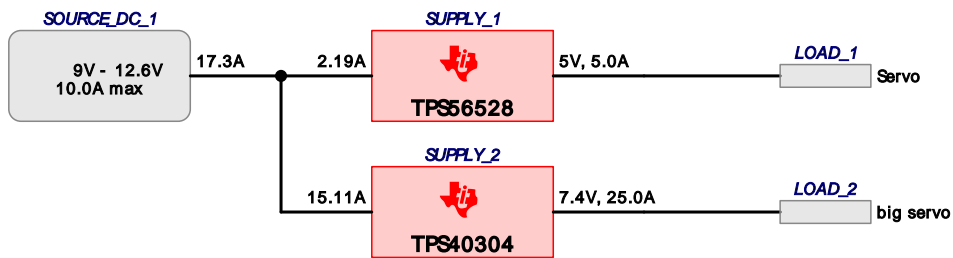
#	Name	NSID	Description	Vout	Iout	Efficiency	Foot-print	Cost	Design	Page
1.	SUPPLY_1	TPS56528	Switcher : 5A Synchronous Buck Converter with EcoMode	5 V	5.0 A	90.5%	216	\$2.57	15	4
2.	SUPPLY_2	TPS40304	Switcher : Synchronous Buck Controller	7.4 V	25.0 A	97.2%	377	\$5.68	16	9

## Power Loads

#	Name	VLoad	ILoad	Description
1.	Servo	5 V	5 A	VoutRipple=10%
2.	big servo	7.4 V	25 A	VoutRipple=10%

## Project Diagram

WEBENCH® Power Architect Project ID : 5\_PA\_Project\_302 (modified from 301) Power Architect 2015-02-15 05:55:31.665



## Electrical Procurement BOM

Manufacturer	Part Number	Description	Quantity	Budgetary Price	Footprint (mm <sup>2</sup> )
AVX	08053C104KAT2A	0805	1	\$0.01	7
Infineon Technologies	BSZ050N03MS G	PG-TSDSON-8	1	\$0.30	19
TDK	C1005X5R1A104K	0402	1	\$0.01	3
TDK	C3216X6S1A476M	1206	2	\$0.26	22
Yageo America	CC0805KRX7R9BB153	0805	1	\$0.01	7
Vishay-Dale	CRCW0402100KFKED	0402	2	\$0.01	6
Vishay-Dale	CRCW040210K0FKED	0402	2	\$0.01	6
Vishay-Dale	CRCW04021K21FKED	0402	1	\$0.01	3
Vishay-Dale	CRCW0402261RFKED	0402	1	\$0.01	3
Vishay-Dale	CRCW0402365KFKED	0402	1	\$0.01	3
Vishay-Dale	CRCW040249K9FKED	0402	1	\$0.01	3
Vishay-Dale	CRCW04024K42FKED	0402	1	\$0.01	3
Vishay-Dale	CRCW0402887RFKED	0402	1	\$0.01	3
Texas Instruments	CSD16340Q3	TRANS_NexFET_Q3	2	\$0.44	19
MuRata	GRM033R71C332KA88D	0201	1	\$0.01	2
MuRata	GRM1555C1E5R1CA01D	0402	1	\$0.01	3
MuRata	GRM1555C1H361JA01D	0402	1	\$0.01	3
MuRata	GRM155R61A474KE15D	0402	1	\$0.01	3
MuRata	GRM155R71H182KA01D	0402	1	\$0.01	3
MuRata	GRM188R61A225KE34D	0603	1	\$0.02	5
MuRata	GRM188R61E105KA12D	0603	1	\$0.01	5
MuRata	GRM32ER61E226KE15L	1210	2	\$0.28	29
Vishay-Dale	IHLP3232DZER3R3M01	IHLP-3232DZ	1	\$0.66	112
ON Semiconductor	MBR0540T1G	SOD-123	1	\$0.06	13
Texas Instruments	TPS40304DRCR	S-PVSON-N10	1	\$0.95	17
Texas Instruments	TPS56528DDAR	R-PDSO-G8	1	\$1.30	57
Coilcraft	XAL1010-681MEB	XAL1010	1	\$1.71	160
<b>Total</b>			<b>36</b>	<b>\$8.25</b>	<b>519</b>



VinMin = 9.0V  
 VinMax = 12.6V  
 Vout = 5.0V  
 Iout = 5.0A

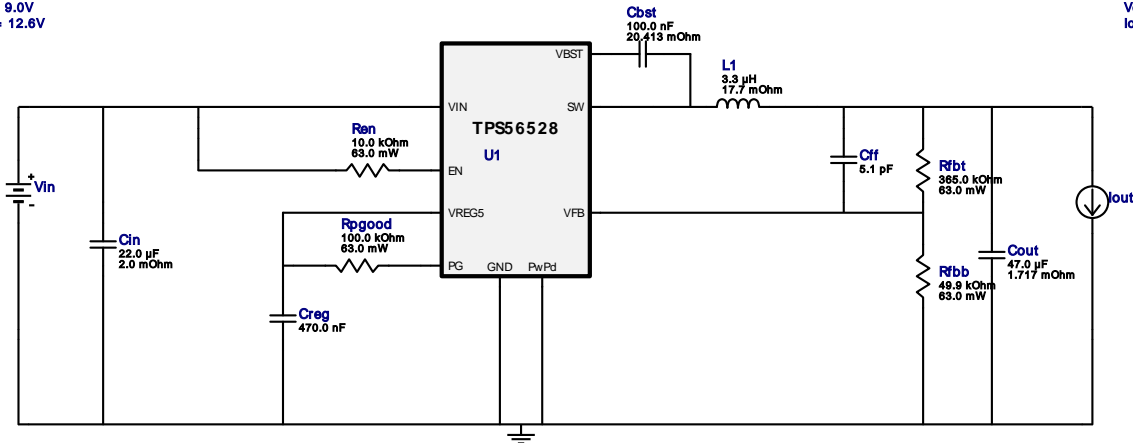
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 Topology = Buck  
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 BOM Cost = \$2.57  
 Footprint = 216.0 mm<sup>2</sup>  
 BOM Count = 11  
 Total Pd = 2.63W

## WEBENCH® Design Report

Design : 4109962/15 TPS56528DDAR  
 TPS56528DDAR 9.0V-12.6V to 5.00V @ 5.0A

VinMin = 9.0V  
 VinMax = 12.6V

Vout = 5.0V  
 Iout = 5.0A



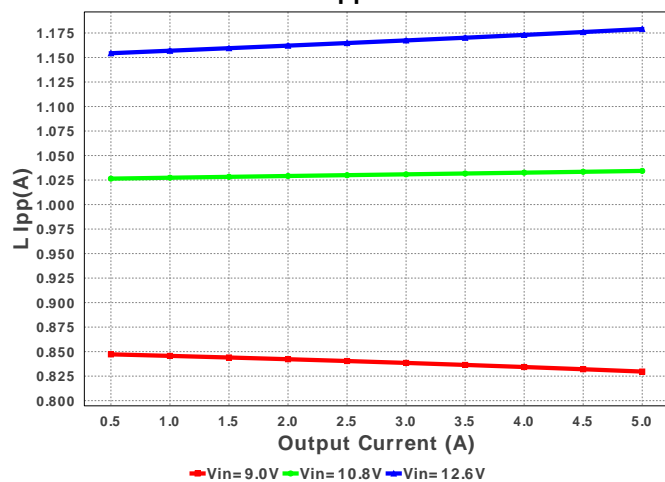
## Electrical BOM

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cbst	TDK	C1005X5R1A104K Series= 285	Cap= 100.0 nF ESR= 20.413 mOhm VDC= 10.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm <sup>2</sup>
2.	Cff	MuRata	GRM1555C1E5R1CA01D Series= C0G/NP0	Cap= 5.1 pF VDC= 25.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm <sup>2</sup>
3.	Cin	MuRata	GRM32ER61E226KE15L Series= X5R	Cap= 22.0 uF ESR= 2.0 mOhm VDC= 25.0 V IRMS= 3.67 A	1	\$0.28	1210 15 mm <sup>2</sup>
4.	Cout	TDK	C3216X6S1A476M Series= 285	Cap= 47.0 uF ESR= 1.717 mOhm VDC= 10.0 V IRMS= 0.0 A	1	\$0.26	1206 11 mm <sup>2</sup>
5.	Creg	MuRata	GRM155R61A474KE15D Series= X5R	Cap= 470.0 nF VDC= 10.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm <sup>2</sup>
6.	L1	Vishay-Dale	IHLP3232DZER3R3M01	L= 3.3 uH DCR= 17.7 mOhm	1	\$0.66	IHLP-3232DZ 112 mm <sup>2</sup>
7.	Ren	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>
8.	Rfbb	Vishay-Dale	CRCW040249K9FKED Series= CRCW..e3	Res= 49.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>
9.	Rfbb	Vishay-Dale	CRCW0402365KFKED Series= CRCW..e3	Res= 365.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>
10.	Rpgood	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>

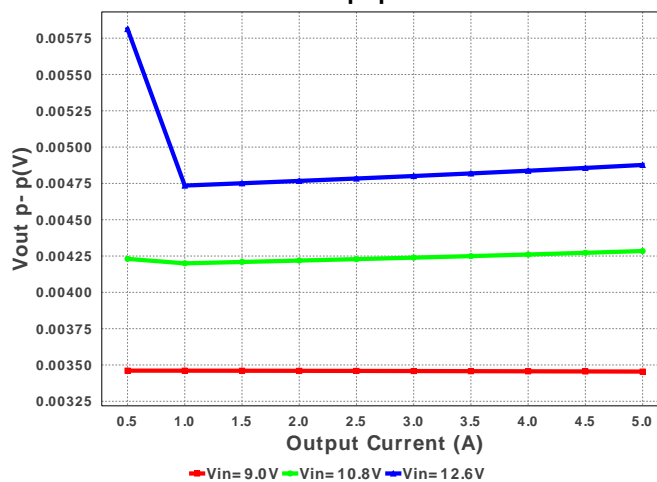
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
11. U1		Texas Instruments	TPS56528DDAR	Switcher	1	\$1.30	

R-PDSO-G8 57 mm<sup>2</sup>

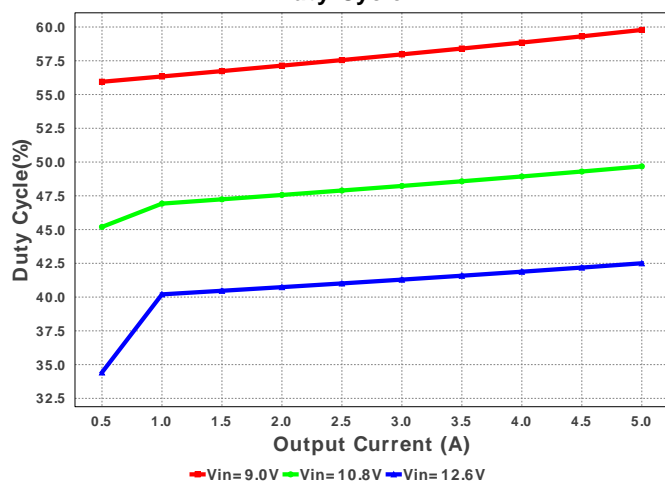
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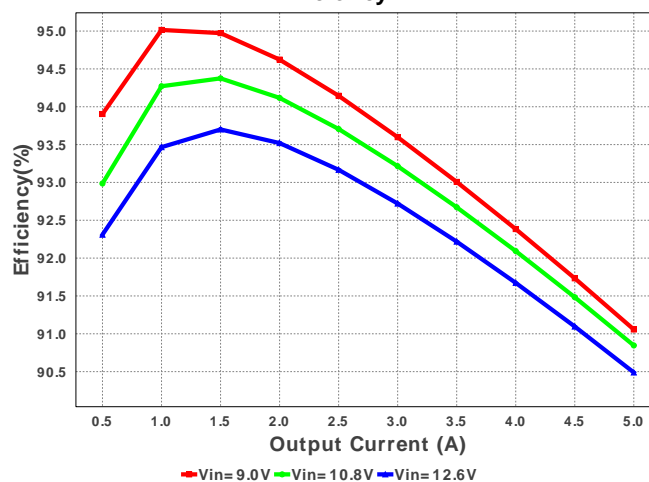
Vout p-p



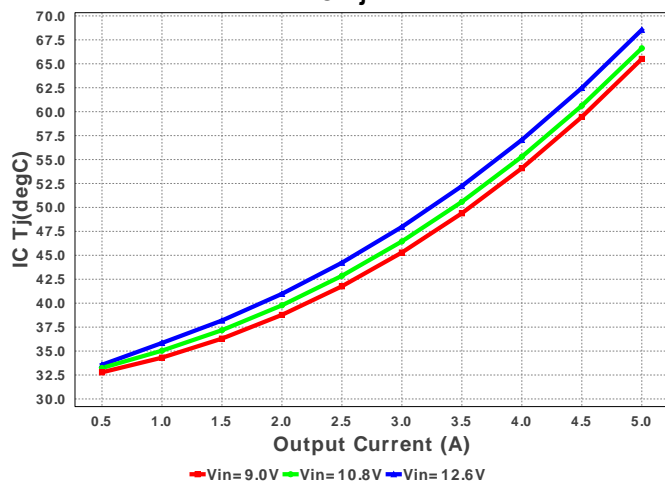
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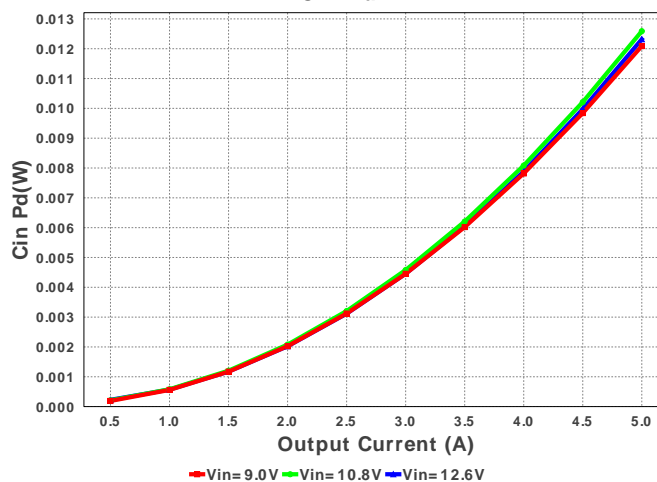
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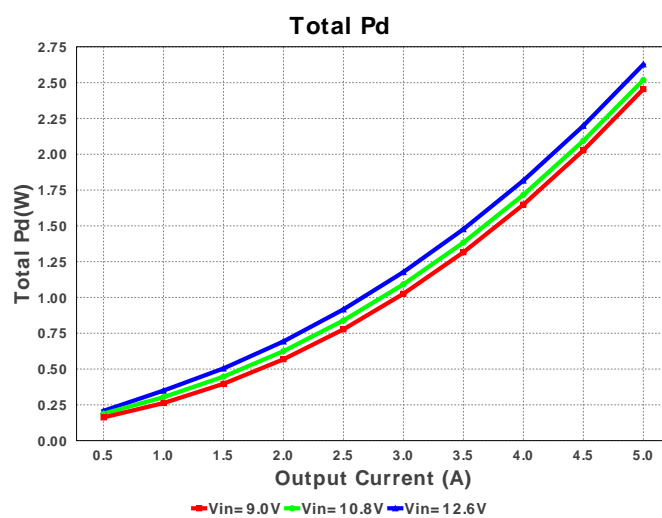
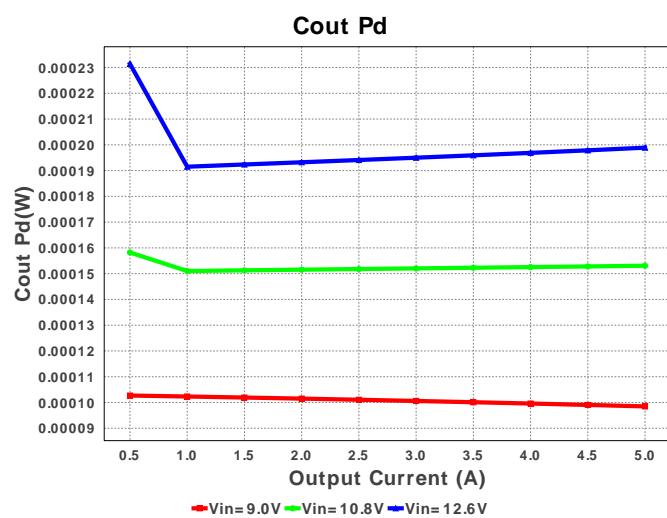
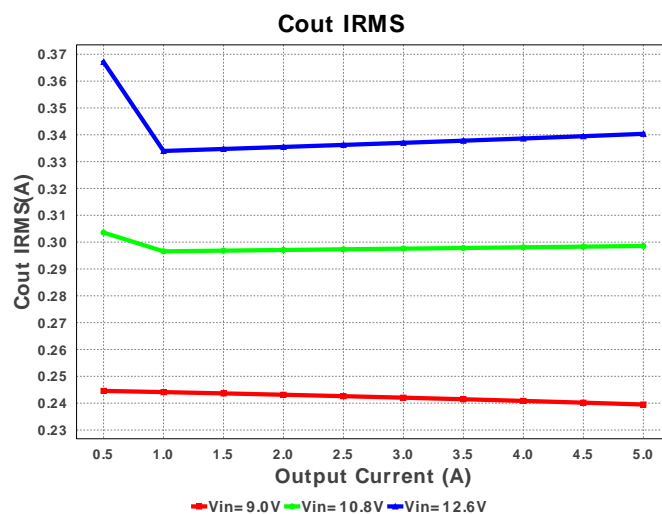
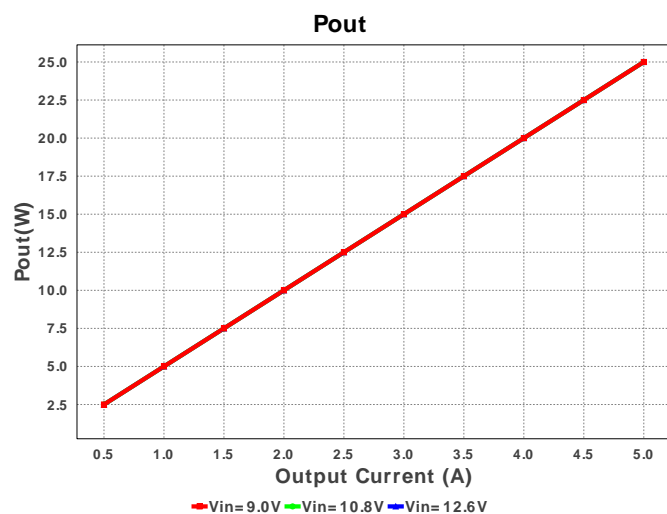
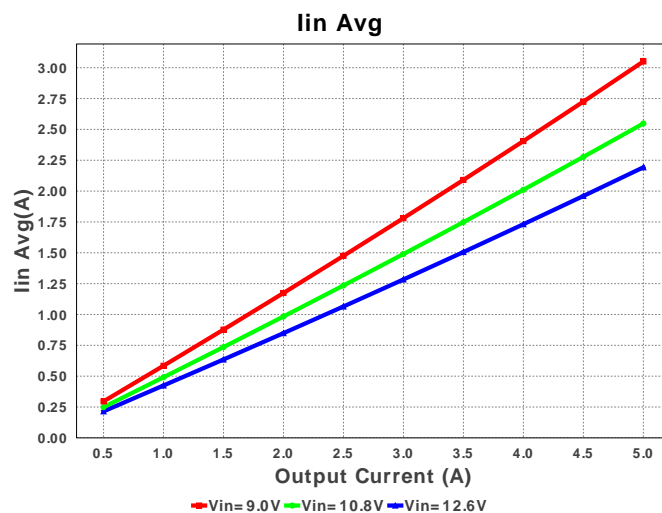
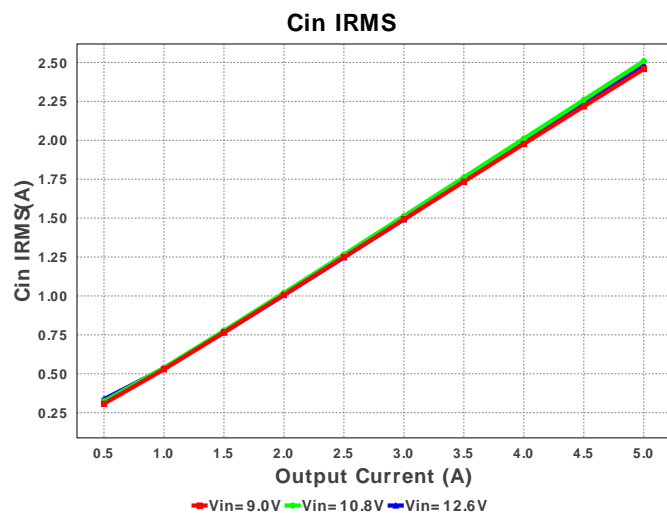


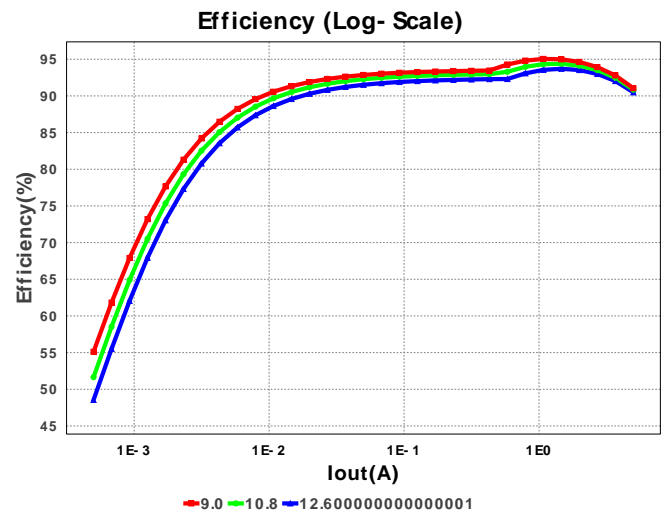
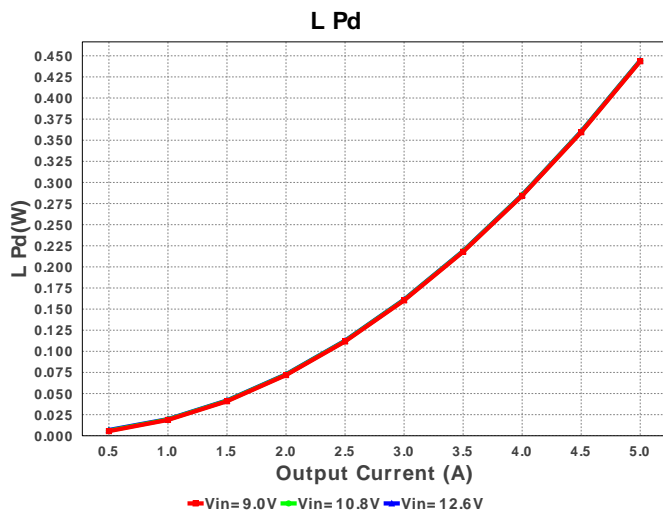
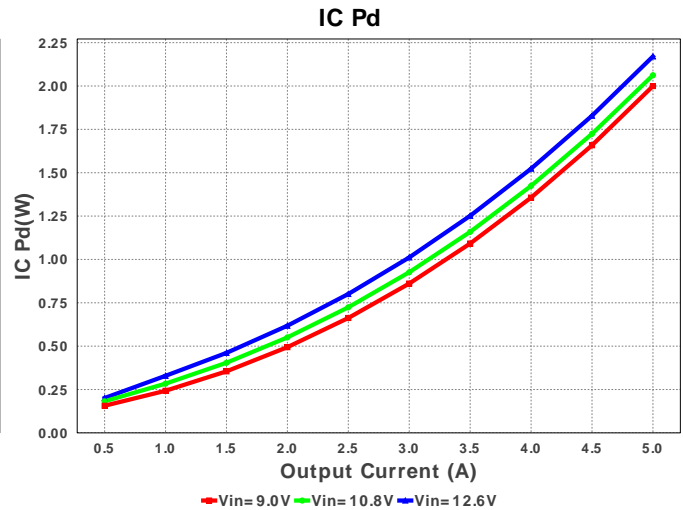
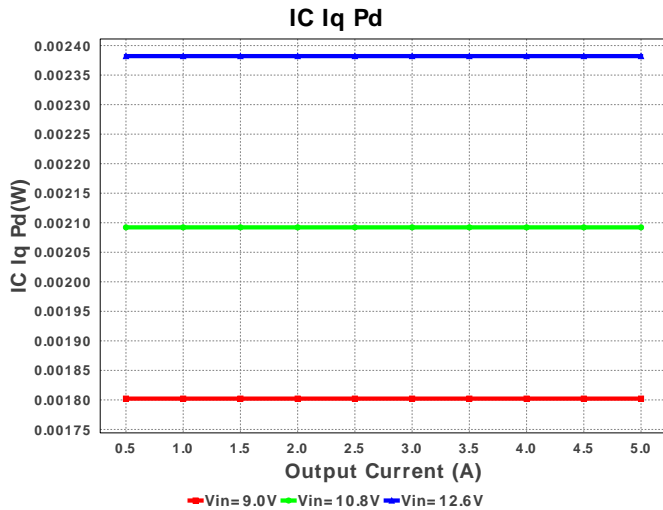
IC Tj



Cin Pd







## Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	2.482 A	Current	Input capacitor RMS ripple current
2.	Cout IRMS	340.354 mA	Current	Output capacitor RMS ripple current
3.	Iin Avg	2.193 A	Current	Average input current
4.	L Ipp	1.179 A	Current	Peak-to-peak inductor ripple current
5.	BOM Count	11	General	Total Design BOM count
6.	FootPrint	216.0 mm <sup>2</sup>	General	Total Foot Print Area of BOM components
7.	Frequency	781.515 kHz	General	Switching frequency
8.	Pout	25.0 W	General	Total output power
9.	Total BOM	\$2.57	General	Total BOM Cost
10.	Vout OP	5.0 V	Op_Point	Operational Output Voltage
11.	Duty Cycle	42.504 %	Op_point	Duty cycle
12.	Efficiency	90.489 %	Op_point	Steady state efficiency
13.	IC Tj	68.548 degC	Op_point	IC junction temperature
14.	ICThetaJA	17.76 degC/W	Op_point	IC junction-to-ambient thermal resistance
15.	IOUT_OP	5.0 A	Op_point	Iout operating point
16.	VIN_OP	12.6 V	Op_point	Vin operating point
17.	Vout p-p	4.877 mV	Op_point	Peak-to-peak output ripple voltage
18.	Cin Pd	12.318 mW	Power	Input capacitor power dissipation
19.	Cout Pd	198.898 μW	Power	Output capacitor power dissipation
20.	IC Iq Pd	2.382 mW	Power	IC Iq Pd
21.	IC Pd	2.17 W	Power	IC power dissipation
22.	L Pd	444.55 mW	Power	Inductor power dissipation
23.	Total Pd	2.628 W	Power	Total Power Dissipation

## Design Inputs

#	Name	Value	Description
1.	Iout	5.0	Maximum Output Current
2.	Iout1	5.0	Output Current #1
3.	VinMax	12.6	Maximum input voltage
4.	VinMin	9.0	Minimum input voltage

#	Name	Value	Description
5.	Vout	5.0	Output Voltage
6.	Vout1	5.0	Output Voltage #1
7.	base_pn	TPS56528	Base Product Number
8.	source	DC	Input Source Type
9.	Ta	30.0	Ambient temperature

## Design Assistance

1. **TPS56528** Product Folder : <http://www.ti.com/product/tps56528> : contains the data sheet and other resources.



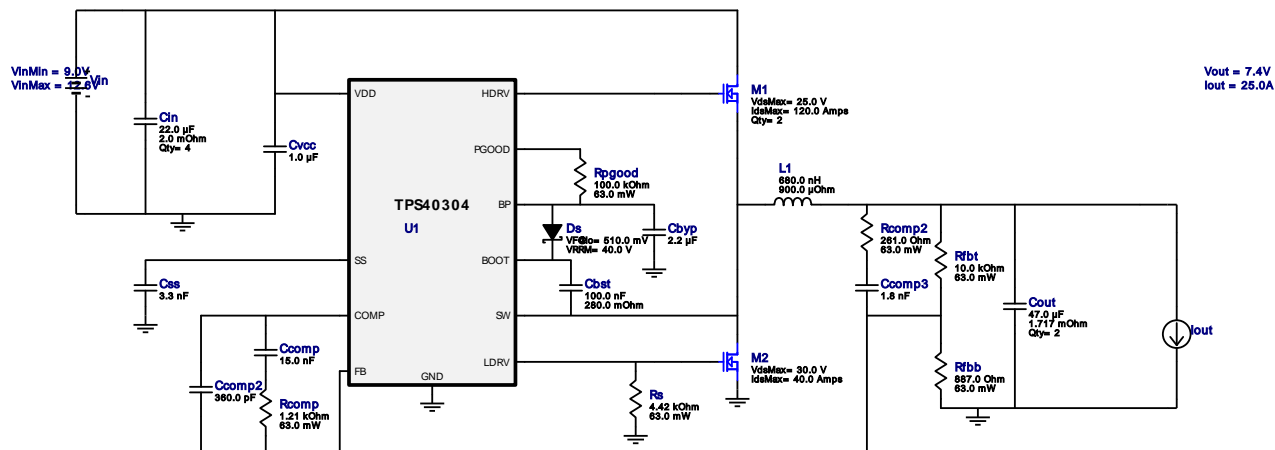


VinMin = 9.0V  
 VinMax = 12.6V  
 Vout = 7.4V  
 Iout = 25.0A

Device = TPS40304DRCR  
 Topology = Buck  
 Created = 2/15/15 5:55:31 AM  
 BOM Cost = \$5.68  
 Footprint = 377.0 mm<sup>2</sup>  
 BOM Count = 25  
 Total Pd = 5.37W

## WEBENCH® Design Report

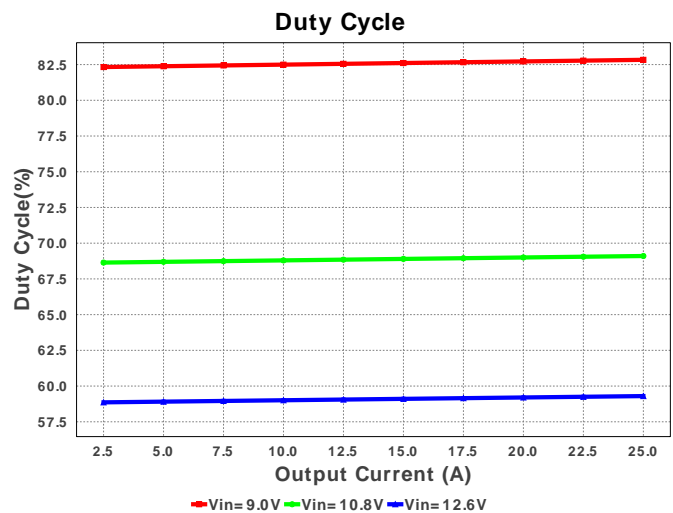
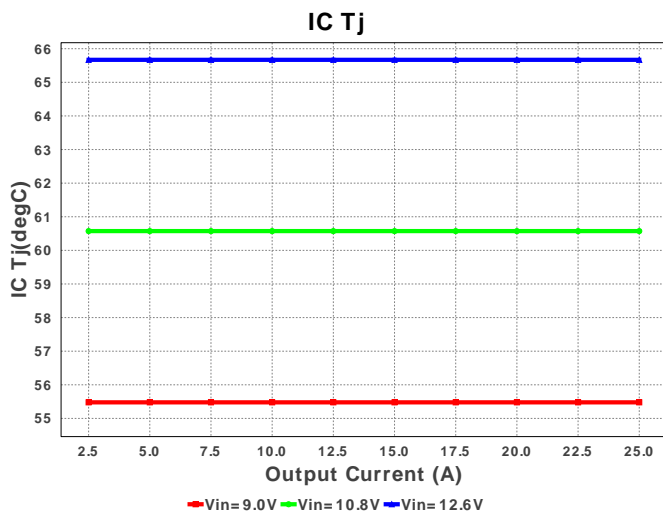
Design : 4109962/16 TPS40304DRCR  
 TPS40304DRCR 9.0V-12.6V to 7.40V @ 25.0A



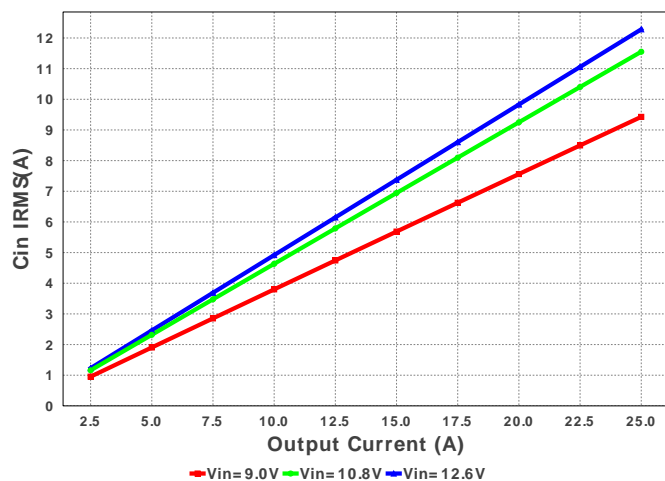
## Electrical BOM

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cbst	AVX	08053C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 280.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	\$0.01	0805 7 mm <sup>2</sup>
2.	Cbyp	MuRata	GRM188R61A225KE34D Series= X5R	Cap= 2.2 uF VDC= 10.0 V IRMS= 0.0 A	1	\$0.02	0603 5 mm <sup>2</sup>
3.	Ccomp	Yageo America	CC0805KRX7R9BB153 Series= X7R	Cap= 15.0 nF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	0805 7 mm <sup>2</sup>
4.	Ccomp2	MuRata	GRM1555C1H361JA01D Series= C0G/NP0	Cap= 360.0 pF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm <sup>2</sup>
5.	Ccomp3	MuRata	GRM155R71H182KA01D Series= X7R	Cap= 1.8 nF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm <sup>2</sup>
6.	Cin	MuRata	GRM32ER61E226KE15L Series= X5R	Cap= 22.0 uF ESR= 2.0 mOhm VDC= 25.0 V IRMS= 3.67 A	4	\$0.28	1210 15 mm <sup>2</sup>
7.	Cout	TDK	C3216X6S1A476M Series= 285	Cap= 47.0 uF ESR= 1.717 mOhm VDC= 10.0 V IRMS= 0.0 A	2	\$0.26	1206 11 mm <sup>2</sup>
8.	Css	MuRata	GRM033R71C332KA88D Series= X7R	Cap= 3.3 nF VDC= 16.0 V IRMS= 0.0 A	1	\$0.01	0201 2 mm <sup>2</sup>
9.	Cvcc	MuRata	GRM188R61E105KA12D Series= X5R	Cap= 1.0 uF VDC= 25.0 V IRMS= 0.0 A	1	\$0.01	0603 5 mm <sup>2</sup>
10.	Ds	ON Semiconductor	MBR0540T1G	VF@Io= 510.0 mV VRRM= 40.0 V	1	\$0.06	SOD-123 13 mm <sup>2</sup>

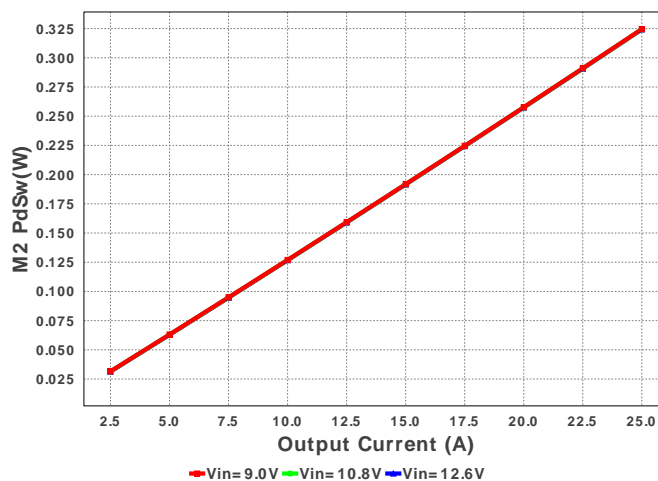
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
11.	L1	Coilcraft	XAL1010-681MEB	L= 680.0 nH DCR= 900.0 $\mu$ Ohm	1	\$1.71	 XAL1010 160 mm <sup>2</sup>
12.	M1	Texas Instruments	CSD16340Q3	VdsMax= 25.0 V IdsMax= 120.0 Amps	2	\$0.44	 TRANS_NexFET_Q3 19 mm <sup>2</sup>
13.	M2	Infineon Technologies	BSZ050N03MS G	VdsMax= 30.0 V IdsMax= 40.0 Amps	1	\$0.30	 PG-TSDSON-8 19 mm <sup>2</sup>
14.	Rcomp	Vishay-Dale	CRCW04021K21FKED Series= CRCW..e3	Res= 1.21 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>
15.	Rcomp2	Vishay-Dale	CRCW0402261RFKED Series= CRCW..e3	Res= 261.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>
16.	Rfbb	Vishay-Dale	CRCW0402887RFKED Series= CRCW..e3	Res= 887.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>
17.	Rfbt	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>
18.	Rpgood	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>
19.	Rs	Vishay-Dale	CRCW04024K42FKED Series= CRCW..e3	Res= 4.42 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>
20.	U1	Texas Instruments	TPS40304DRCR	Switcher	1	\$0.95	 S-PVSON-N10 17 mm <sup>2</sup>



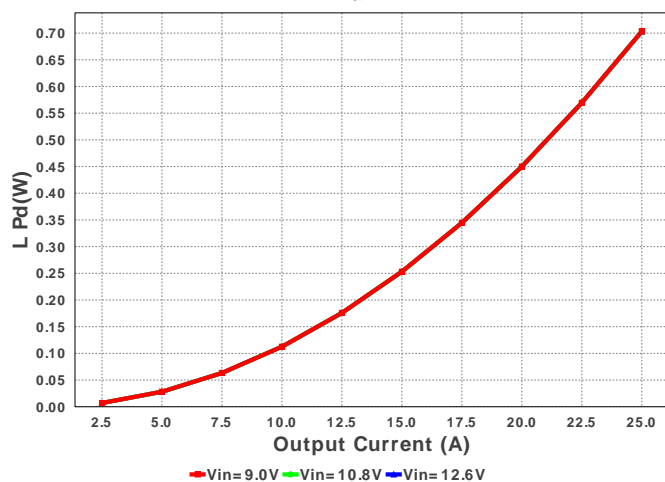
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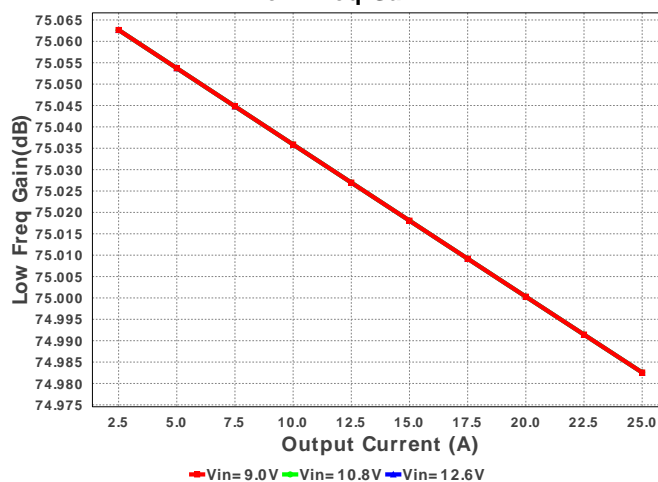
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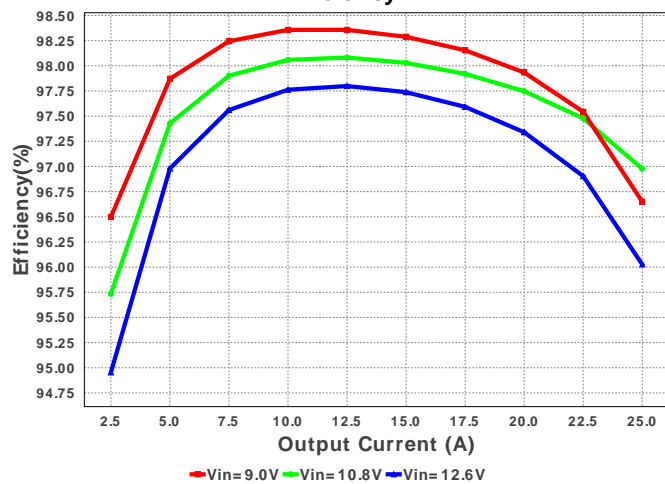
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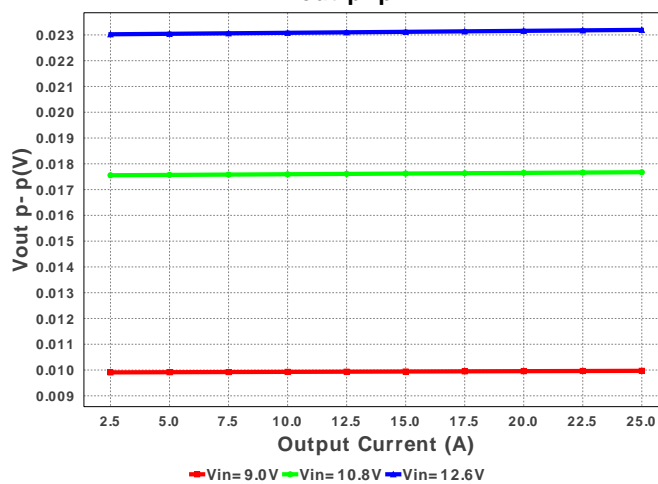
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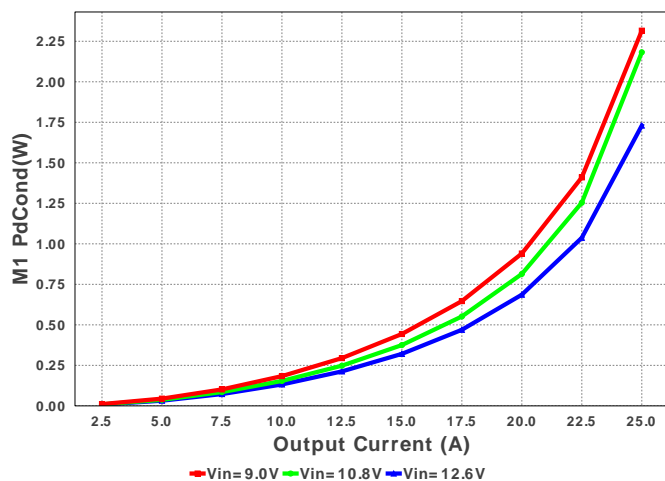
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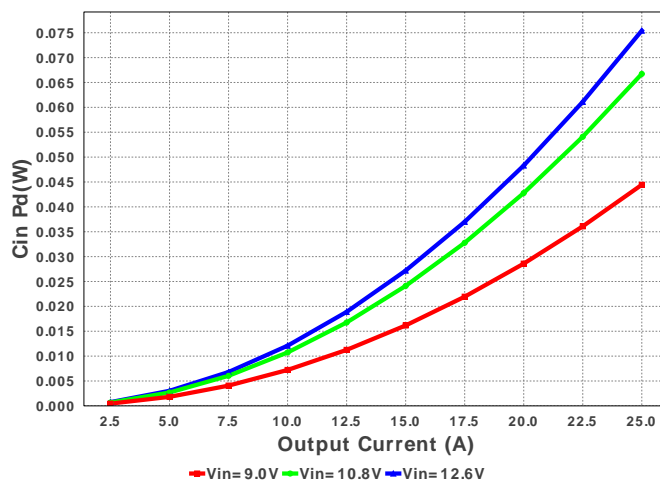
Vout p-p



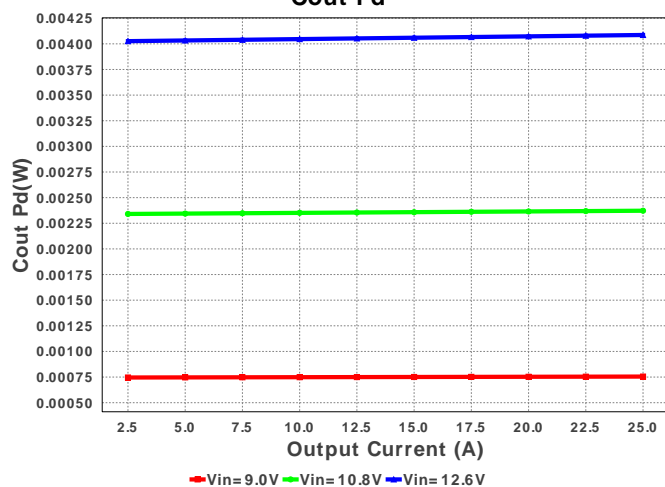
M1 PdCond



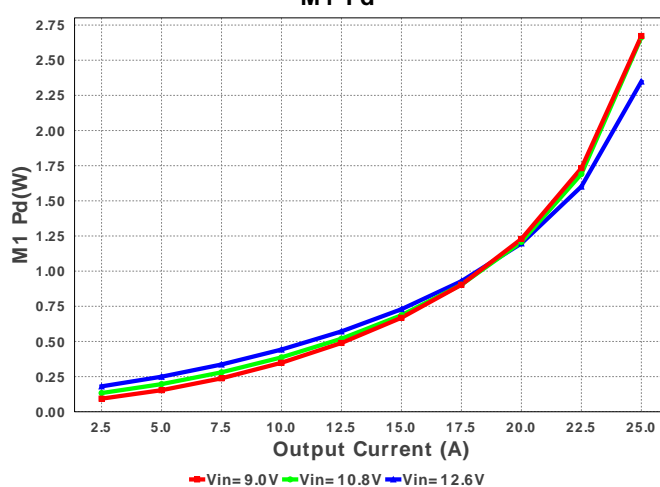
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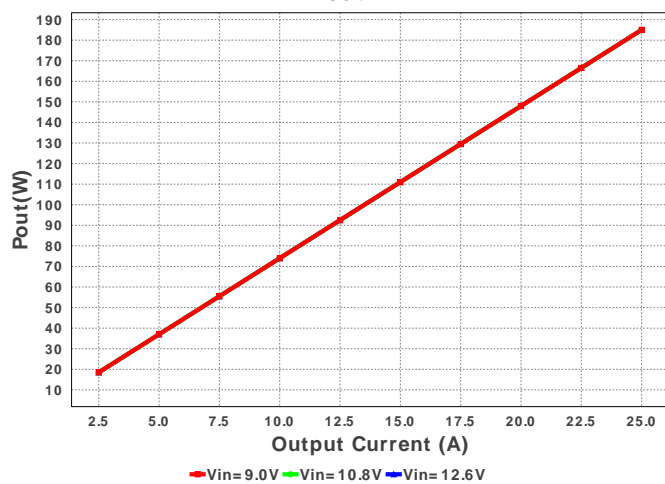
Cout Pd



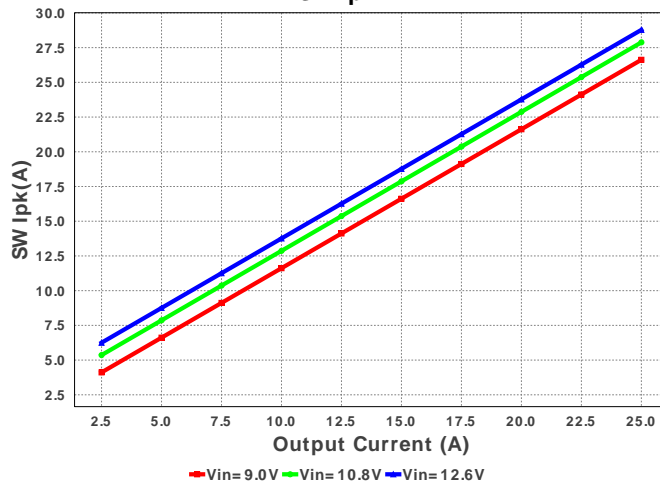
M1 Pd

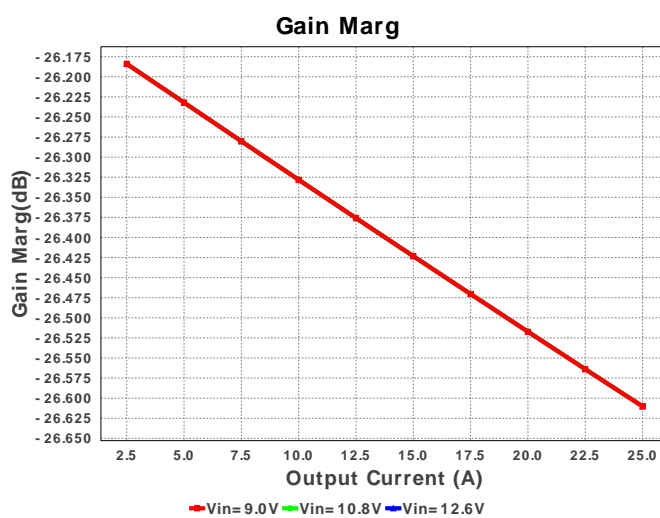
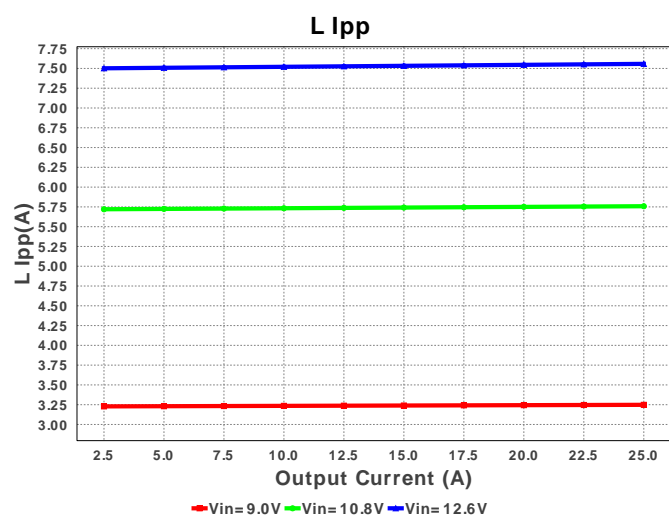
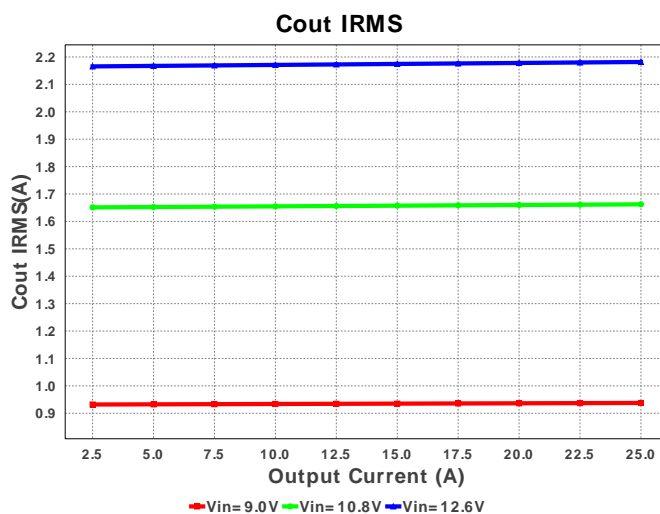
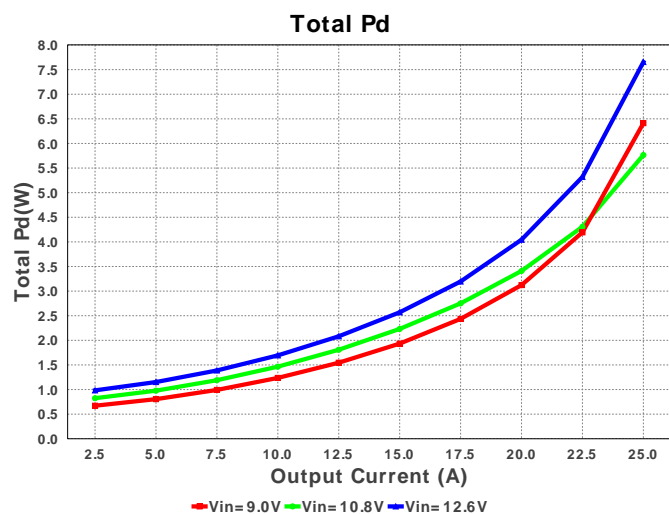
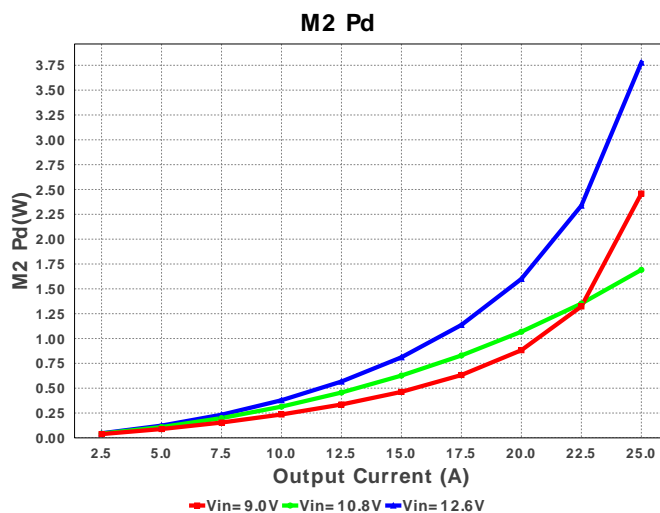
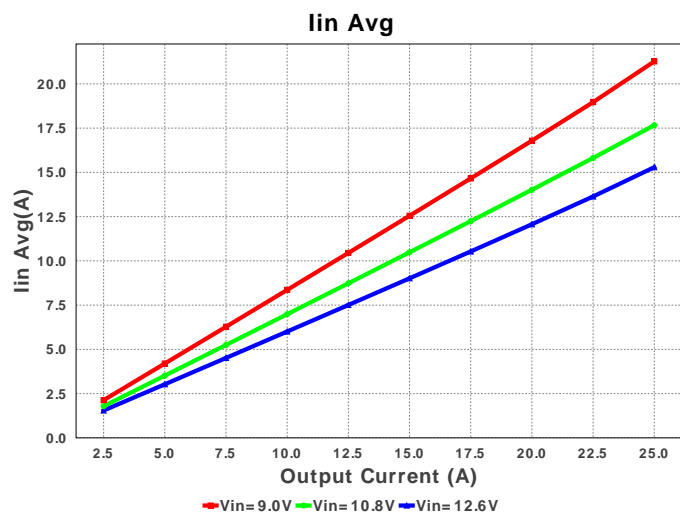


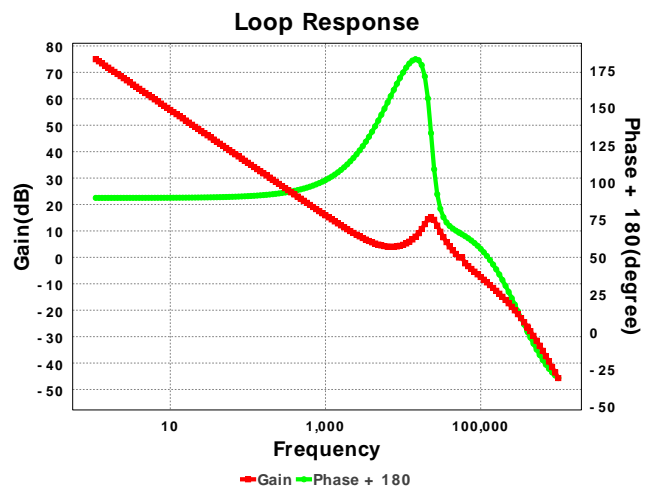
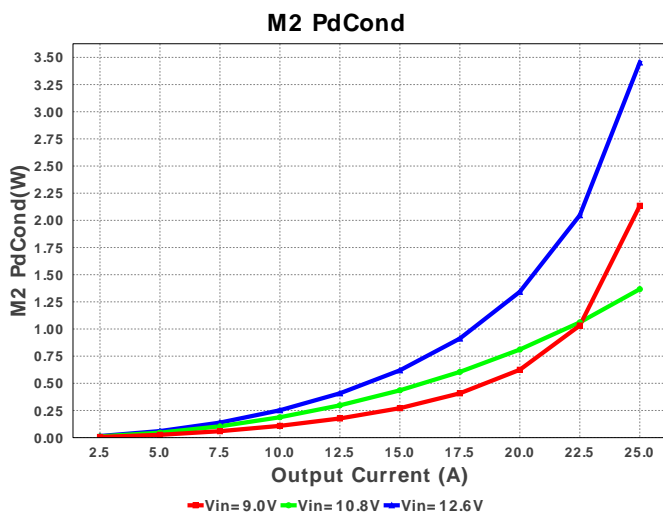
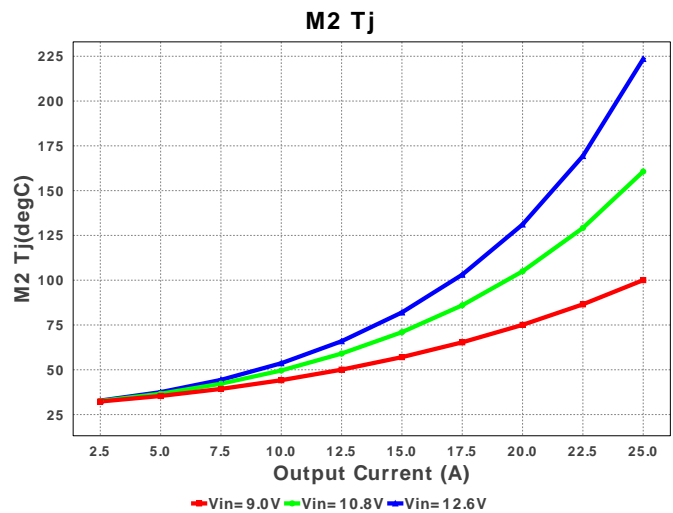
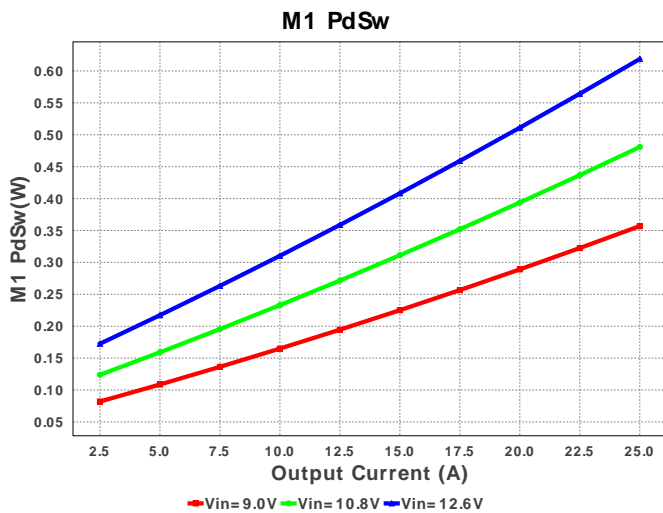
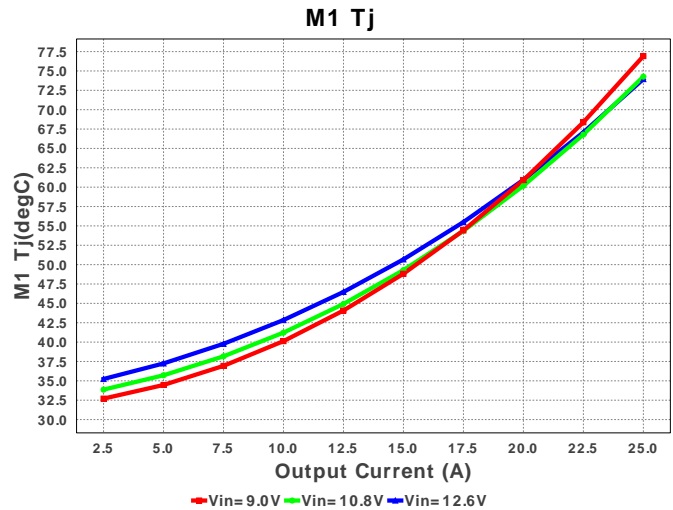
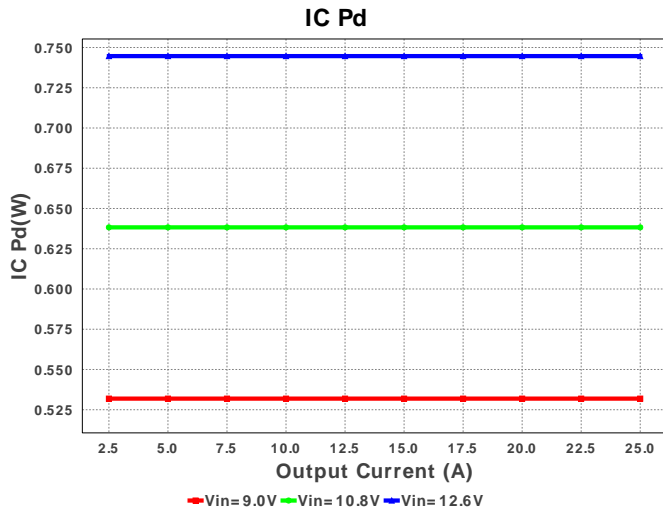
Pout



SW Ipk







## Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	12.282 A	Current	Input capacitor RMS ripple current
2.	Cout IRMS	2.182 A	Current	Output capacitor RMS ripple current
3.	Iin Avg	15.108 A	Current	Average input current
4.	L Ipp	7.558 A	Current	Peak-to-peak inductor ripple current
5.	SW Ipk	28.779 A	Current	Peak switch current
6.	BOM Count	25	General	Total Design BOM count
7.	FootPrint	377.0 mm <sup>2</sup>	General	Total Foot Print Area of BOM components
8.	Frequency	600.0 kHz	General	Switching frequency
9.	IC Tolerance	10.0 mV	General	IC Feedback Tolerance
10.	Pout	185.0 W	General	Total output power
11.	Total BOM	\$5.68	General	Total BOM Cost

#	Name	Value	Category	Description
12.	Cross Freq	52.723 kHz	Op_point	Bode plot crossover frequency
13.	Duty Cycle	59.299 %	Op_point	Duty cycle
14.	Efficiency	97.181 %	Op_point	Steady state efficiency
15.	Gain Marg	-26.581 dB	Op_point	Bode Plot Gain Margin
16.	IC Tj	65.669 degC	Op_point	IC junction temperature
17.	IOUT_OP	25.0 A	Op_point	Iout operating point
18.	M1 Tj	73.949 degC	Op_point	M1 MOSFET junction temperature
19.	M2 Tj	223.482 degC	Op_point	M2 MOSFET junction temperature
20.	Phase Marg	66.156 deg	Op_point	Bode Plot Phase Margin
21.	VIN_OP	12.6 V	Op_point	Vin operating point
22.	Vout p-p	23.196 mV	Op_point	Peak-to-peak output ripple voltage
23.	Cin Pd	75.423 mW	Power	Input capacitor power dissipation
24.	Cout Pd	4.086 mW	Power	Output capacitor power dissipation
25.	IC Pd	744.66 mW	Power	IC power dissipation
26.	L Pd	703.125 mW	Power	Inductor power dissipation
27.	M1 Pd	1.538 W	Power	M1 MOSFET total power dissipation
28.	M1 PdCond	919.477 mW	Power	M1 MOSFET conduction losses
29.	M1 PdSw	618.8 mW	Power	M1 MOSFET switching losses
30.	M2 Pd	2.301 W	Power	M2 MOSFET total power dissipation
31.	M2 PdCond	1.977 W	Power	M2 MOSFET conduction losses
32.	M2 PdSw	324.252 mW	Power	M2 MOSFET switching losses
33.	Total Pd	5.366 W	Power	Total Power Dissipation
34.	Low Freq Gain	75.045 dB	Unknown	Gain at 10Hz

## Design Inputs

#	Name	Value	Description
1.	Iout	25.0	Maximum Output Current
2.	Iout1	25.0	Output Current #1
3.	VinMax	12.6	Maximum input voltage
4.	VinMin	9.0	Minimum input voltage
5.	Vout	7.4	Output Voltage
6.	Vout1	7.4	Output Voltage #1
7.	base_pn	TPS40304	Base Product Number
8.	source	DC	Input Source Type
9.	Ta	30.0	Ambient temperature

## Design Assistance

1. **TPS40304** Product Folder : <http://www.ti.com/product/tps40304> : contains the data sheet and other resources.

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