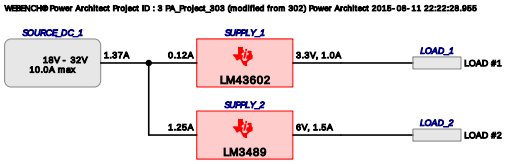
WEBENCH® Power Architect



Project Report

Project : 4320088/3 : PA_Project_303 (modified from 302)
Created : 2015-08-11 22:22:28.955
Optimize project optFactor=3

Project Summary

1.	Total System Efficiency	71.908 %
2.	Total System BOM Count	26.0
3.	Total System Footprint	583.0 mm2
4.	Total System BOM Cost	$4.39
5.	Total System Power Dissipation	4.805 W

--> Launch WEBENCH Power Architect.

Power Supplies

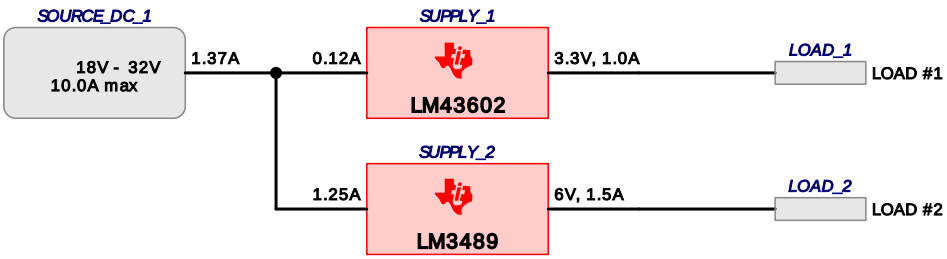
#	Name	NSID	Description	Vout	Iout	Efficiency	Foot-print	Cost	Design	Page
1.	SUPPLY_1	LM43602	Switcher : SIMPLE SWITCHER Buck Regulator	3.3 V	1.0 A	87.9%	196	$2.47	23	4
2.	SUPPLY_2	LM3489	Switcher : Hysteretic controller	6 V	1.5 A	89.1%	387	$1.92	24	9

Power Loads

#	Name	VLoad	ILoad	Description
1.	LOAD #1	3.3 V	1 A	VoutRipple=10%
2.	LOAD #2	6 V	1.5 A	VoutRipple=10%

Project Diagram

WEBENCH® Power Architect Project ID : 3 PA_Project_303 (modified from 302) Power Architect 2015-08-11 22:22:28.955



Electrical Procurement BOM

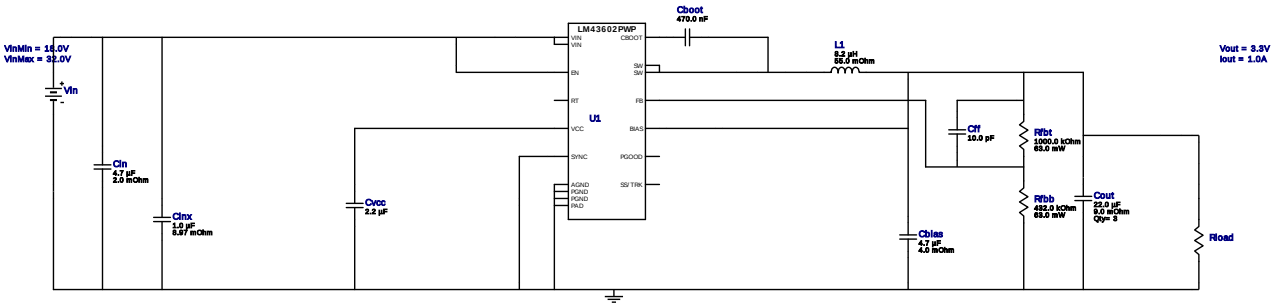
Manufacturer	Part Number	Description	Quantity	Budgetary Price	Footprint (mm^2)
Panasonic	16SVP180M	SM_RADIAL_8MM	1	$0.29	113
Panasonic	35SVPF22M	CAPSMT_62_F61	1	$0.43	74
Diodes Inc.	B260A-13-F	SMA	1	$0.09	37
Kemet	C0603C225K9PACTU	0603	1	$0.02	5
Kemet	C0805C100M4GACTU	0805	1	$0.01	7
Kemet	C0805C104K5RACTU	0805	1	$0.01	7
TDK	C3216X5R1H105K	1206	1	$0.04	11
Yageo America	CC0805JRNPO9BN102	0805	1	$0.01	7
Yageo America	CC0805JRNPO9BN390	0805	1	$0.01	7
Vishay-Dale	CRCW04021M00FKED	0402	1	$0.01	3
Vishay-Dale	CRCW040220K0FKED	0402	1	$0.01	3
Vishay-Dale	CRCW0402267RFKED	0402	1	$0.01	3
Vishay-Dale	CRCW0402432KFKED	0402	1	$0.01	3
Vishay-Dale	CRCW040276K8FKED	0402	1	$0.01	3
Vishay-Dale	CRCW040288K7FKED	0402	1	$0.01	3
MuRata	GRM155C80J474KE19D	0402	1	$0.01	3
MuRata	GRM21BR60J226ME39L	0805	3	$0.05	7
MuRata	GRM32ER71H475KA88L	1210	1	$0.29	15
Taiyo Yuden	JMK212BJ475KG-T	0805	1	$0.02	7
Texas Instruments	LM3489MM/NOPB	mpds028d	1	$0.54	16
Texas Instruments	LM43602PWPR	PWP0016F	1	$1.75	59
Vishay-Siliconix	SI2319DS-T1-E3	SOT-23	1	$0.28	14
Bourns	SRN6045-8R2Y	SRN6045	1	$0.16	64
Bourns	SRN8040-8R2Y	SRN8040	1	$0.22	100
Total			26	$4.39	571

WEBENCH® Design Report

VinMin = 18.0V
VinMax = 32.0V
Vout = 3.3V
Iout = 1.0A

Device = LM43602PWPR
Topology = Buck
Created = 8/11/15 10:22:27 PM
BOM Cost = $2.47
Footprint = 196.0 mm²
BOM Count = 13
Total Pd = 0.45W

Design : 4320088/23 LM43602PWPR
LM43602PWPR 18.0V-32.0V to 3.30V @ 1.0A



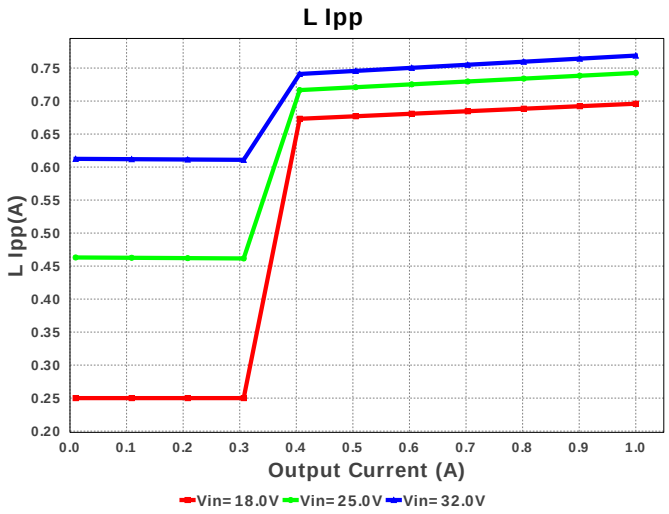
1. The input capacitor included in the BOM only contains a small filter capacitor that should be placed near the IC. Depending on where the power supply is laid out in the system additional bulk capacitance may need to be added to filter the line ripple.

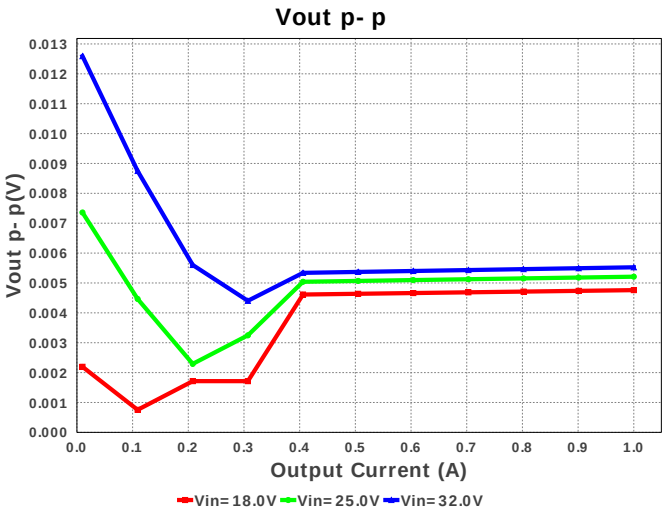
2. If there is no VinTyp specified, WEBENCH will use the VinMax value. To change the VinTyp value, click on the "Change Design Inputs" button under the Optimization Tuning knob. In some applications, while the design requires the input voltage to be a wide range, for a majority of the time, it is operating at a much lower voltage than the maximum input voltage. Sizing the inductor based on the maximum input voltage may yield an inductance much larger than typically needed, causing a larger footprint for the overall design. At the same time, components such as the input capacitor must be rated based on the maximum input voltage. WEBENCH now supports the use of this additional input voltage specification.

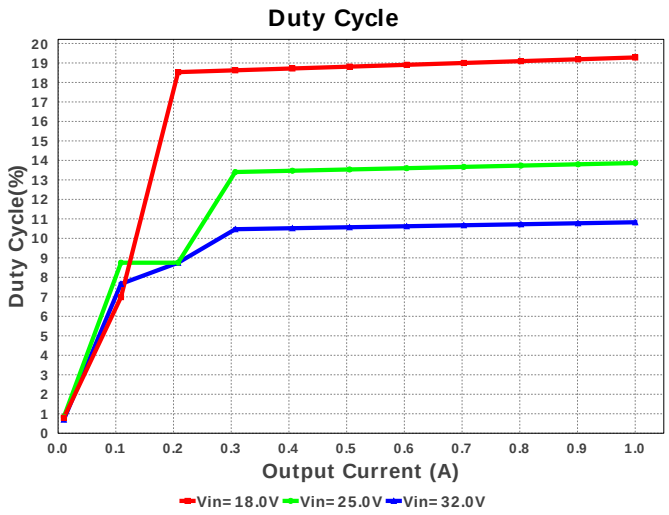
Electrical BOM

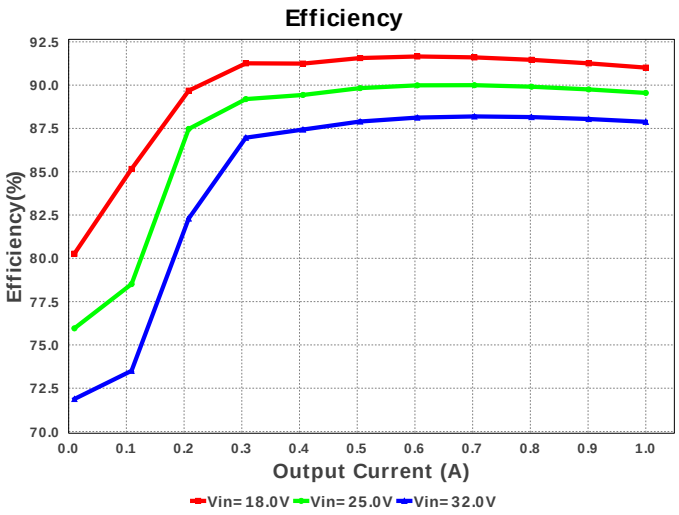
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cbias	Taiyo Yuden	JMK212BJ475KG-T Series= X5R	Cap= 4.7 uF ESR= 4.0 mOhm VDC= 6.3 V IRMS= 0.0 A	1	$0.02	0805 7 mm²
2.	Cboot	MuRata	GRM155C80J474KE19D Series= X6S	Cap= 470.0 nF VDC= 6.3 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
3.	Cff	Kemet	C0805C100M4GACTU Series= C0G/NP0	Cap= 10.0 pF VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
4.	Cin	MuRata	GRM32ER71H475KA88L Series= X7R	Cap= 4.7 uF ESR= 2.0 mOhm VDC= 50.0 V IRMS= 5.35 A	1	$0.29	1210 15 mm²
5.	Cinx	TDK	C3216X5R1H105K Series= X5R	Cap= 1.0 uF ESR= 8.97 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.04	1206 11 mm²
6.	Cout	MuRata	GRM21BR60J226ME39L Series= X5R	Cap= 22.0 uF ESR= 9.0 mOhm VDC= 6.3 V IRMS= 3.5 A	3	$0.05	0805 7 mm²
7.	Cvcc	Kemet	C0603C225K9PACTU Series= X5R	Cap= 2.2 uF VDC= 6.3 V IRMS= 0.0 A	1	$0.02	0603 5 mm²
8.	L1	Bourns	SRN6045-8R2Y	L= 8.2 µH DCR= 55.0 mOhm	1	$0.16	SRN6045 64 mm²
9.	Rfbb	Vishay-Dale	CRCW0402432KFKED Series= CRCW..e3	Res= 432.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²

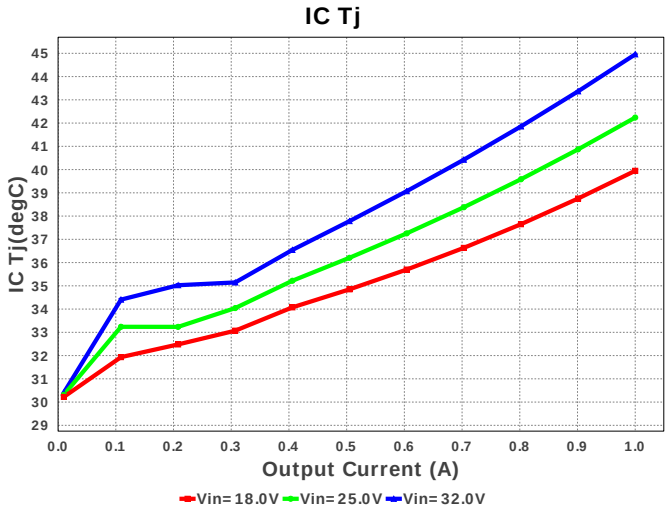
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
10.	Rfbt	Vishay-Dale	CRCW04021M00FKED Series= CRCW..e3	Res= 1000.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
11.	U1	Texas Instruments	LM43602PWPR	Switcher	1	$1.75	PWP0016F 59 mm^2

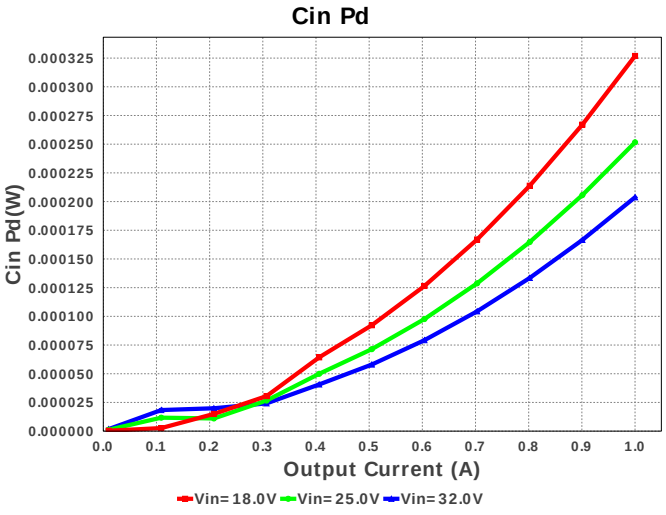


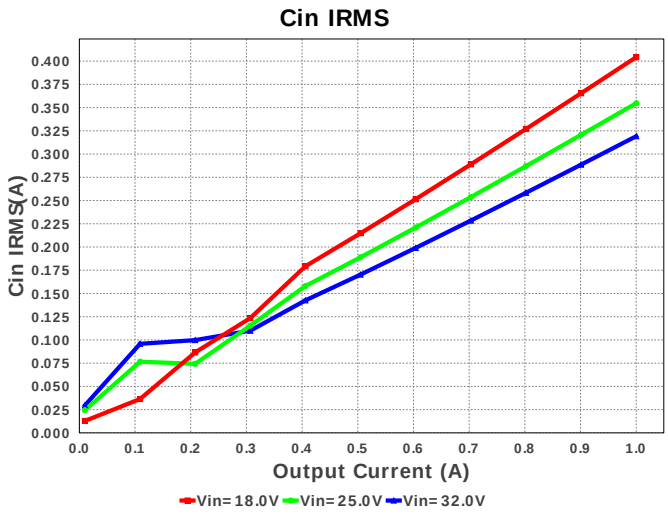


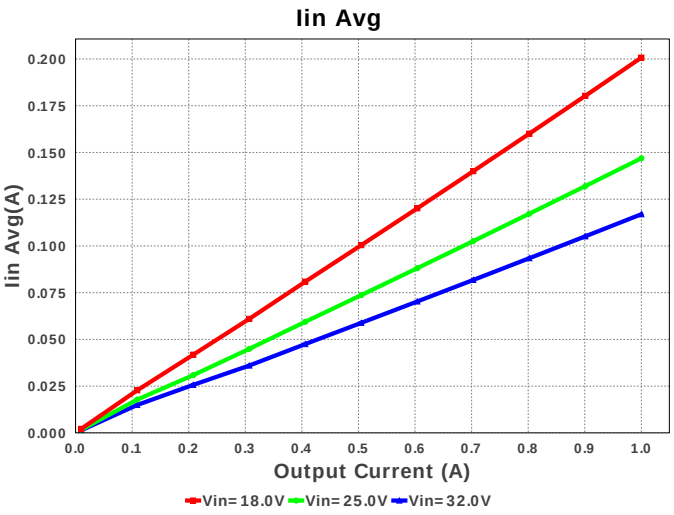


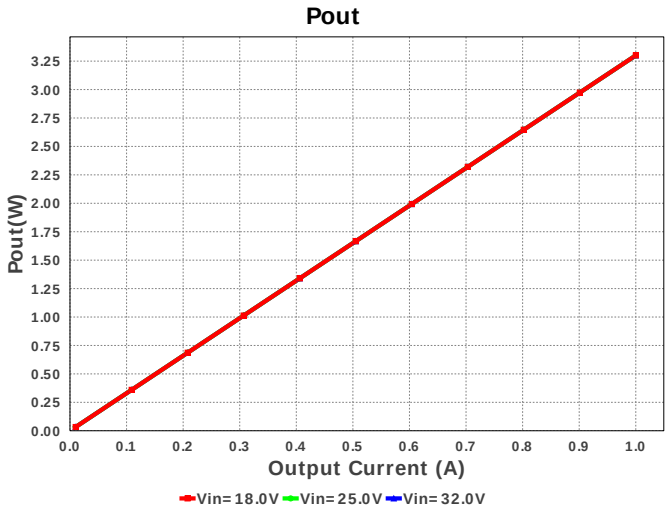


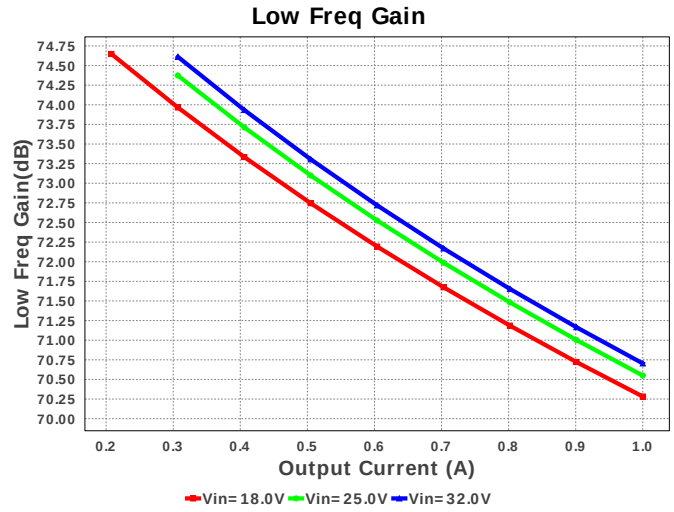


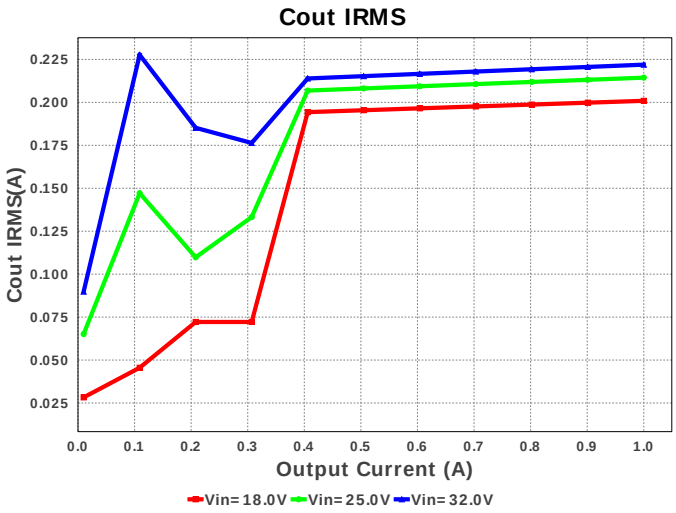


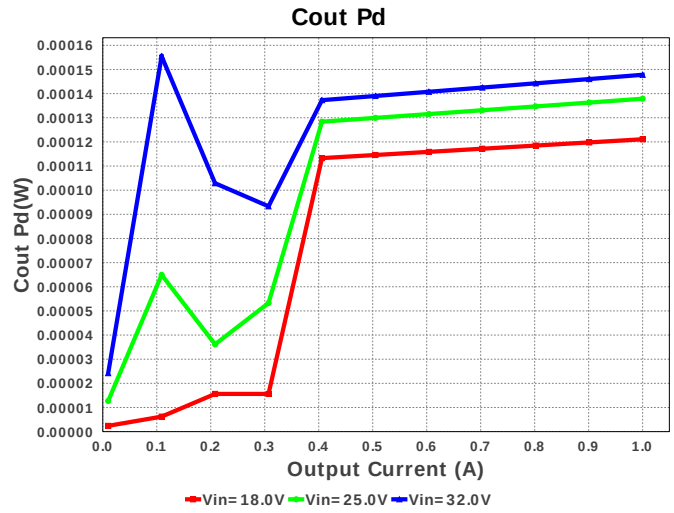


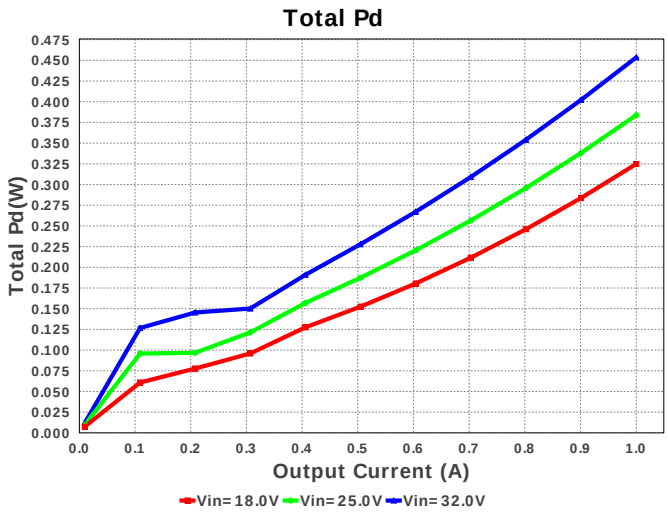


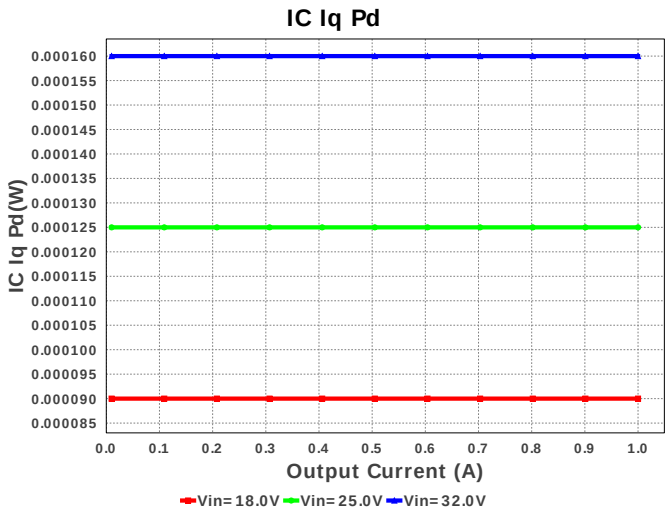


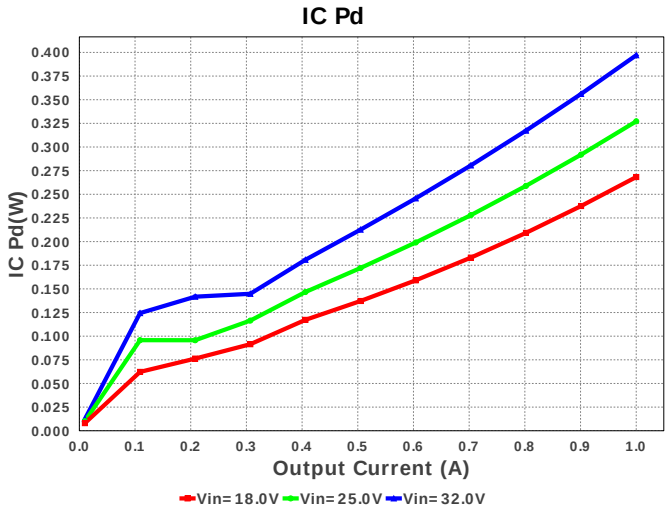


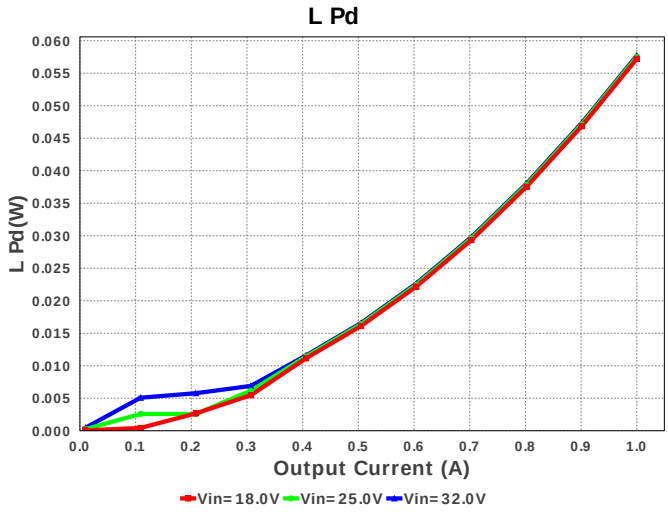


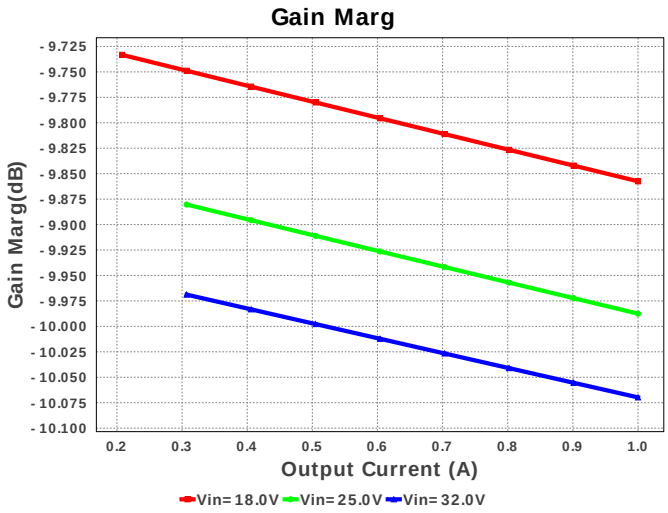


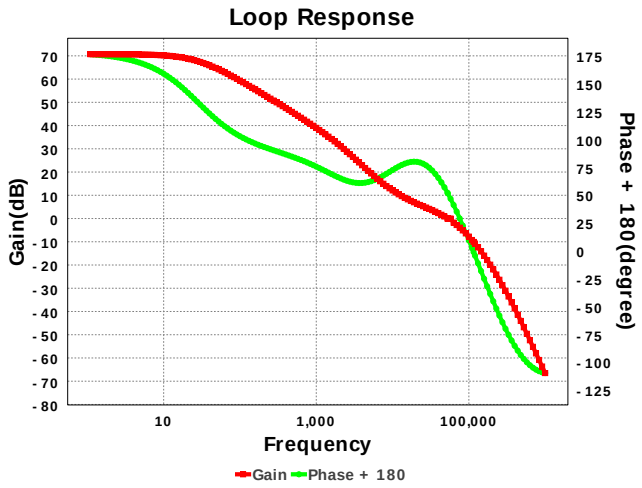

Total Pd
Total Pd(W)
0.475
0.450
0.425
0.400
0.375
0.350
0.325
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin= 18.0V Vin= 25.0V Vin= 32.0V

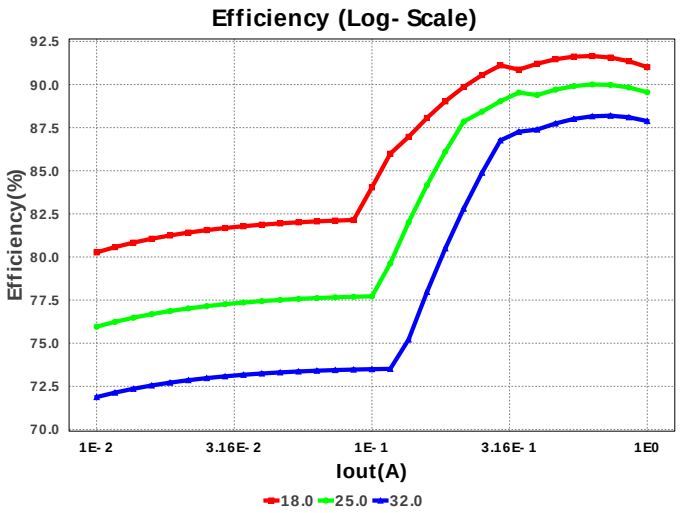

IC Iq Pd
IC Iq Pd(W)
0.000160
0.000155
0.000150
0.000145
0.000140
0.000135
0.000130
0.000125
0.000120
0.000115
0.000110
0.000105
0.000100
0.000095
0.000090
0.000085
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin= 18.0V Vin= 25.0V Vin= 32.0V


IC Pd
IC Pd(W)
0.400
0.375
0.350
0.325
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin= 18.0V Vin= 25.0V Vin= 32.0V


L Pd
L Pd(W)
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin= 18.0V Vin= 25.0V Vin= 32.0V


Gain Marg
Gain Marg(dB)
- 9.725
- 9.750
- 9.775
- 9.800
- 9.825
- 9.850
- 9.875
- 9.900
- 9.925
- 9.950
- 9.975
- 10.000
- 10.025
- 10.050
- 10.075
- 10.100
0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin= 18.0V Vin= 25.0V Vin= 32.0V


Loop Response
Gain(dB)
70
60
50
40
30
20
10
0
- 10
- 20
- 30
- 40
- 50
- 60
- 70
- 80
Phase + 180(degree)
175
150
125
100
75
50
25
0
- 25
- 50
- 75
- 100
- 125
10 1,000 100,000
Frequency
Gain Phase + 180



Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	319.173 mA	Current	Input capacitor RMS ripple current
2.	Cout IRMS	221.959 mA	Current	Output capacitor RMS ripple current
3.	Iin Avg	116.95 mA	Current	Average input current
4.	L Ipp	768.89 mA	Current	Peak-to-peak inductor ripple current
5.	BOM Count	13	General	Total Design BOM count
6.	FootPrint	196.0 mm^2	General	Total Foot Print Area of BOM components
7.	Frequency	500.0 kHz	General	Switching frequency
8.	Pout	3.3 W	General	Total output power
9.	Total BOM	$2.47	General	Total BOM Cost
10.	Low Freq Gain	70.704 dB	Op_Point	Gain at 10Hz
11.	Vout OP	3.3 V	Op_Point	Operational Output Voltage
12.	Cross Freq	52.877 kHz	Op_point	Bode plot crossover frequency
13.	Duty Cycle	10.826 %	Op_point	Duty cycle
14.	Efficiency	87.881 %	Op_point	Steady state efficiency
15.	Gain Marg	-10.07 dB	Op_point	Bode Plot Gain Margin
16.	IC Tj	44.956 degC	Op_point	IC junction temperature
17.	ICThetaJA	38.9 degC/W	Op_point	IC junction-to-ambient thermal resistance
18.	IOUT_OP	1.0 A	Op_point	Iout operating point
19.	Phase Marg	52.787 deg	Op_point	Bode Plot Phase Margin
20.	VIN_OP	32.0 V	Op_point	Vin operating point
21.	Vout p-p	5.525 mV	Op_point	Peak-to-peak output ripple voltage
22.	Cin Pd	203.743 µW	Power	Input capacitor power dissipation
23.	Cout Pd	147.797 µW	Power	Output capacitor power dissipation
24.	IC Iq Pd	160.0 µW	Power	IC Iq Pd
25.	IC Pd	397.007 mW	Power	IC power dissipation
26.	L Pd	57.71 mW	Power	Inductor power dissipation
27.	Total Pd	453.541 mW	Power	Total Power Dissipation

Design Inputs

#	Name	Value	Description
1.	Iout	1.0	Maximum Output Current
2.	Iout1	1.0	Output Current #1
3.	VinMax	32.0	Maximum input voltage
4.	VinMin	18.0	Minimum input voltage
5.	Vout	3.3	Output Voltage
6.	Vout1	3.3	Output Voltage #1
7.	base_pn	LM43602	Texas Instruments Base Part Number
8.	source	DC	Input Source Type
9.	ta	30.0	Ambient temperature

Design Assistance

1. LM43602 Product Folder : http://www.ti.com/product/LM43602 : contains the data sheet and other resources.

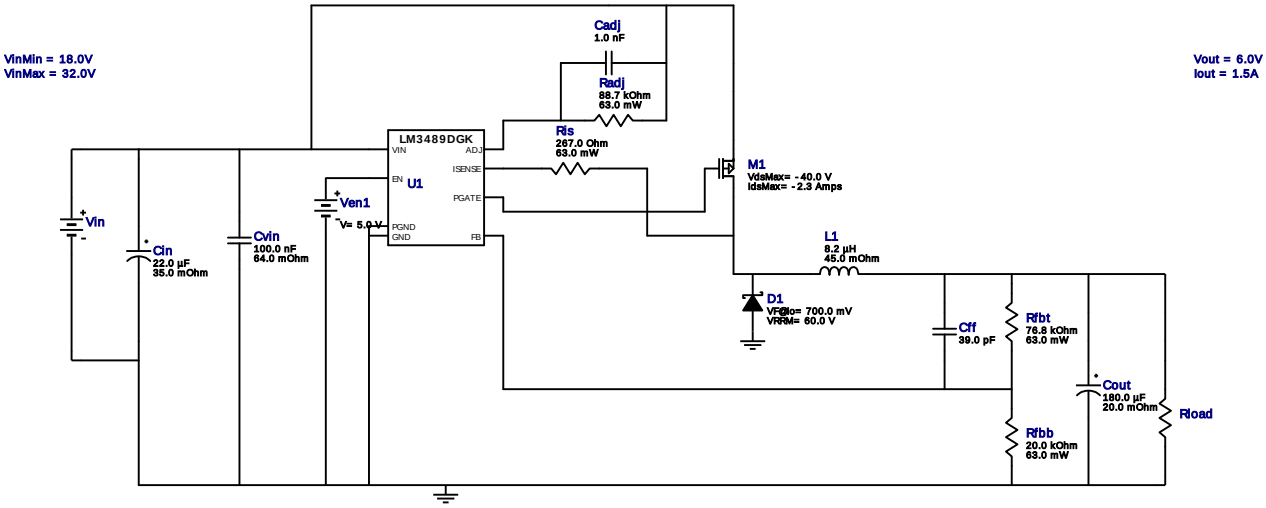
TEXAS INSTRUMENTS

WEBENCH® Design Report

VinMin = 18.0V
VinMax = 32.0V
Vout = 6.0V
Iout = 1.5A

Device = LM3489MM/NOPB
Topology = Buck
Created = 8/11/15 10:22:28 PM
BOM Cost = $1.92
Footprint = 387.0 mm^2
BOM Count = 13
Total Pd = 4.35W

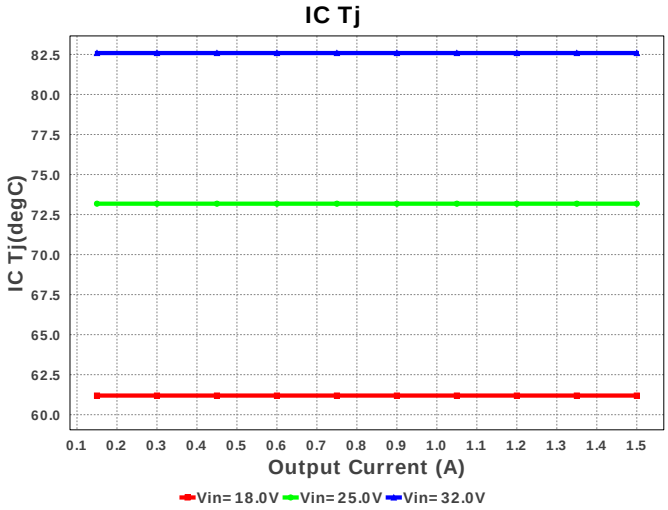
Design : 4320088/24 LM3489MM/NOPB
LM3489MM/NOPB 18.0V-32.0V to 6.00V @ 1.5A

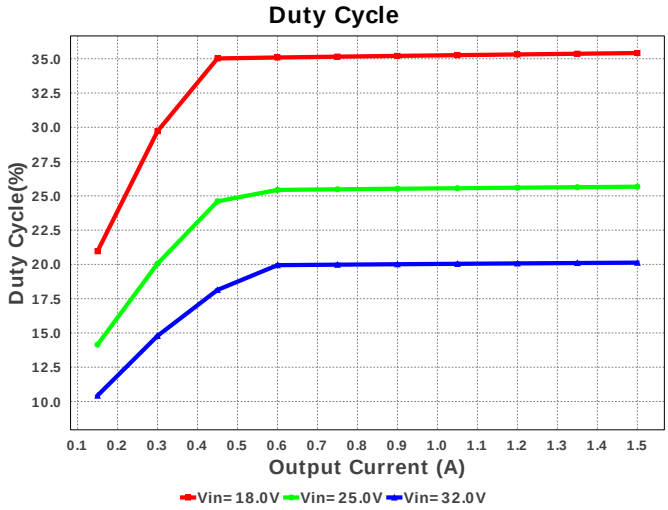


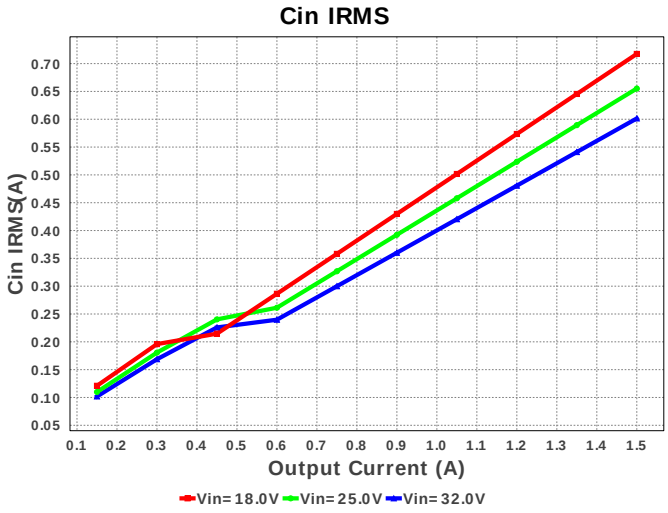
Electrical BOM

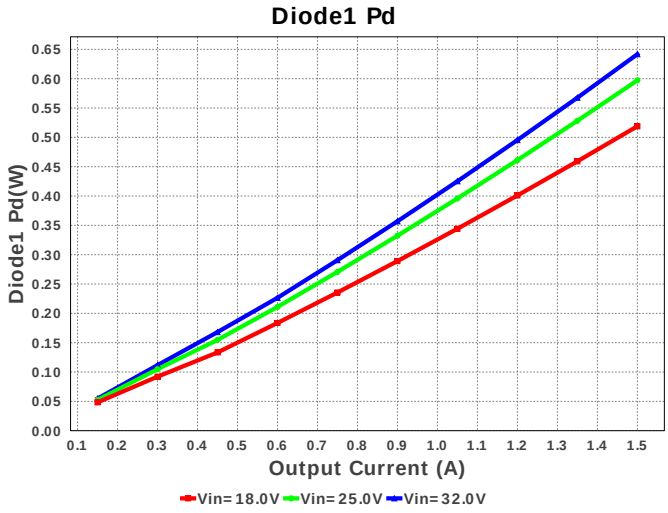
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cadj	Yageo America	CC0805JRNPO9BN102 Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
2.	Cff	Yageo America	CC0805JRNPO9BN390 Series= C0G/NP0	Cap= 39.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
3.	Cin	Panasonic	35SVPF22M Series= SVPF	Cap= 22.0 uF ESR= 35.0 mOhm VDC= 35.0 V IRMS= 2.6 A	1	$0.43	CAPSMT_62_F61 74 mm^2
4.	Cout	Panasonic	16SVP180M Series= SVP	Cap= 180.0 uF ESR= 20.0 mOhm VDC= 16.0 V IRMS= 3.64 A	1	$0.29	SM_RADIAL_8MM 113 mm^2
5.	Cvin	Kemet	C0805C104K5RACTU Series= X7R	Cap= 100.0 nF ESR= 64.0 mOhm VDC= 50.0 V IRMS= 1.64 A	1	$0.01	0805 7 mm^2
6.	D1	Diodes Inc.	B260A-13-F	VF@Io= 700.0 mV VRRM= 60.0 V	1	$0.09	SMA 37 mm^2
7.	L1	Bourns	SRN8040-8R2Y	L= 8.2 µH DCR= 45.0 mOhm	1	$0.22	SRN8040 100 mm^2
8.	M1	Vishay-Siliconix	SI2319DS-T1-E3	VdsMax= -40.0 V IdsMax= -2.3 Amps	1	$0.28	SOT-23 14 mm^2

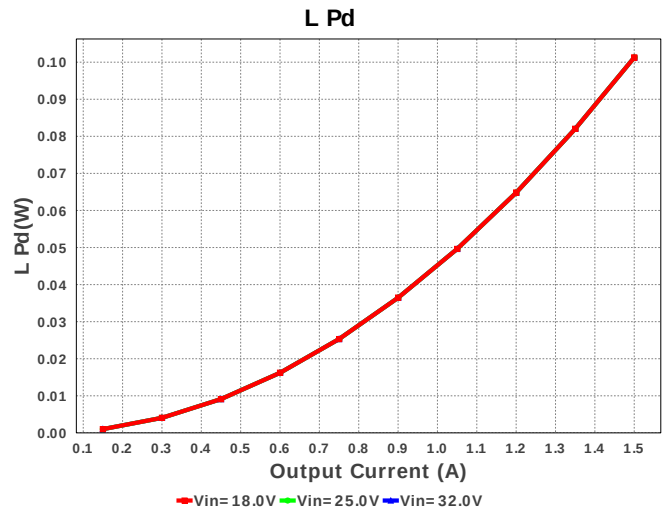
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
9.	Radj	Vishay-Dale	CRCW040288K7FKED Series= CRCW..e3	Res= 88.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
10.	Rfbb	Vishay-Dale	CRCW040220K0FKED Series= CRCW..e3	Res= 20.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
11.	Rfbt	Vishay-Dale	CRCW040276K8FKED Series= CRCW..e3	Res= 76.8 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
12.	Ris	Vishay-Dale	CRCW0402267RFKED Series= CRCW..e3	Res= 267.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
13.	U1	Texas Instruments	LM3489MM/NOPB	Switcher	1	$0.54	mpds028d 16 mm^2

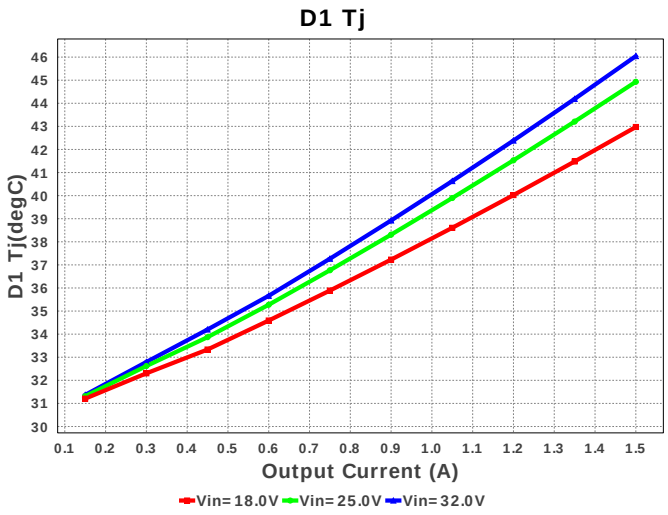


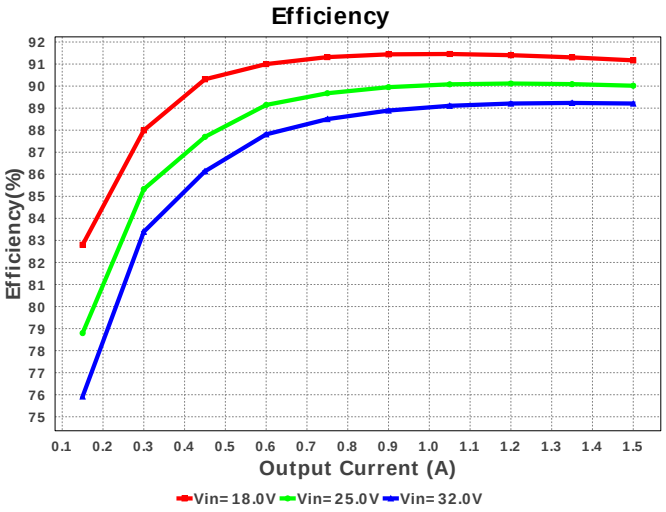


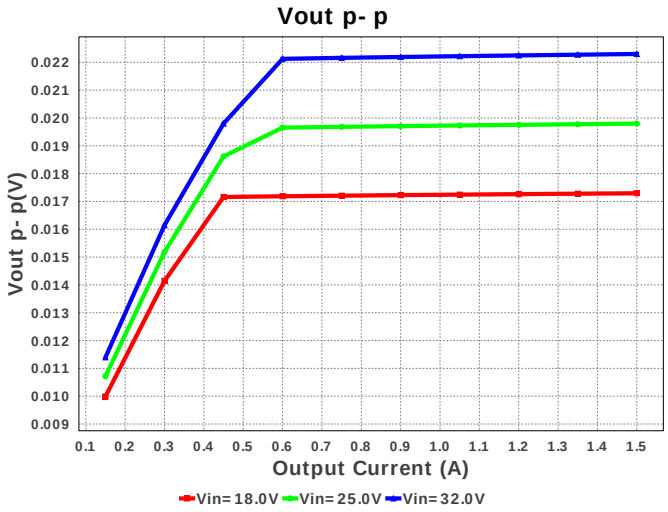


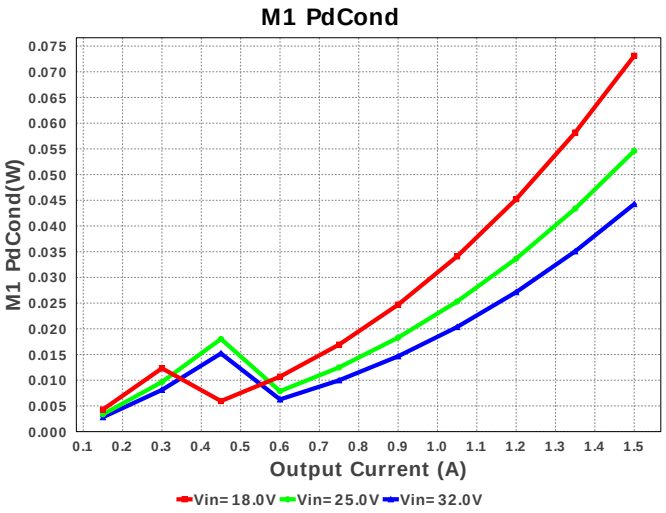


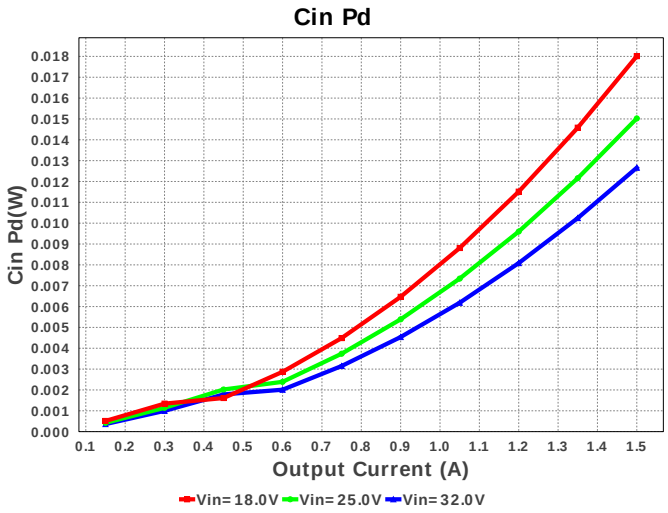


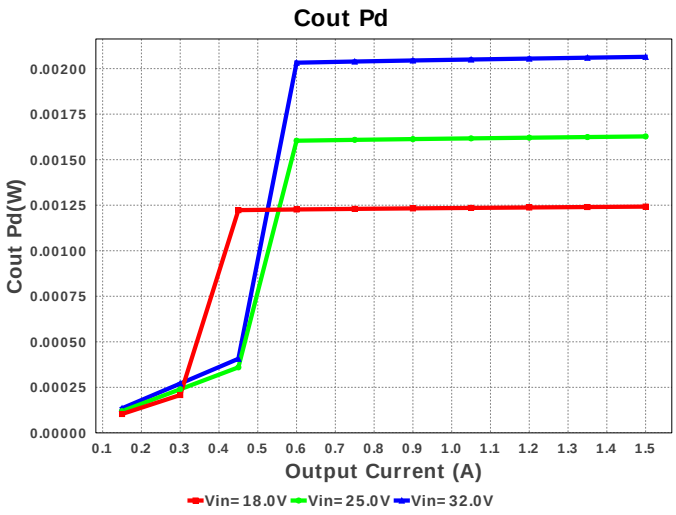


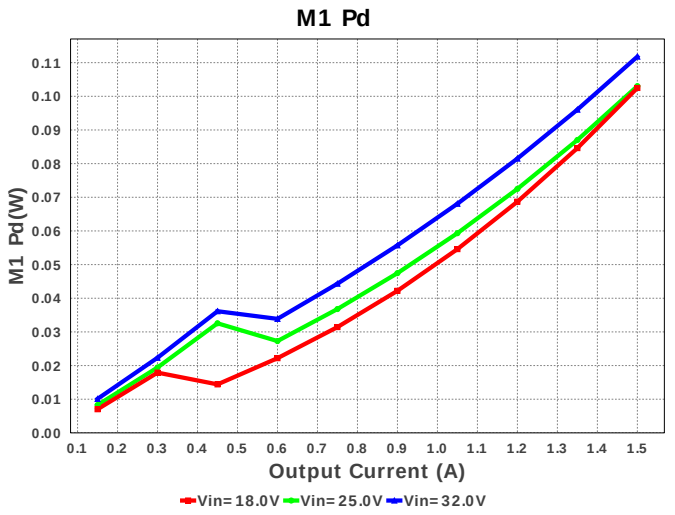


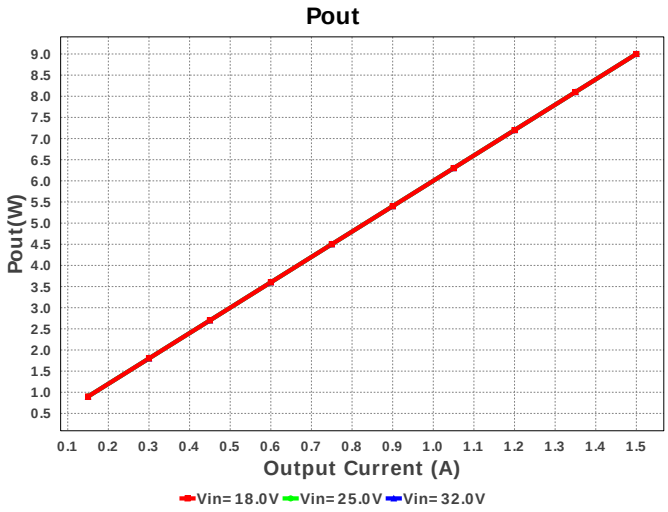


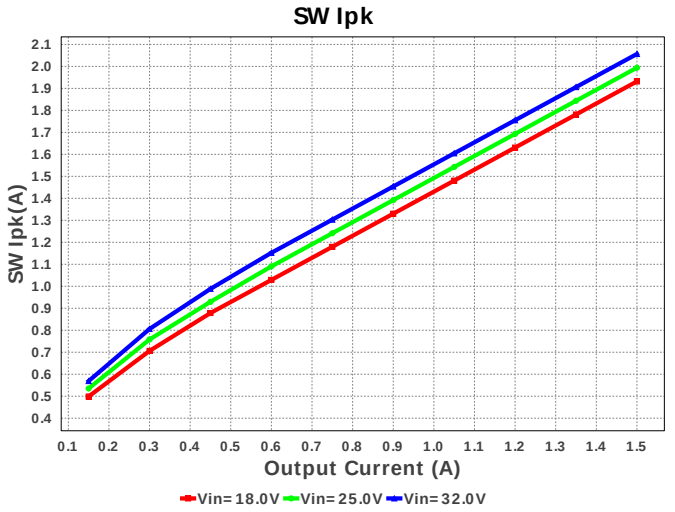


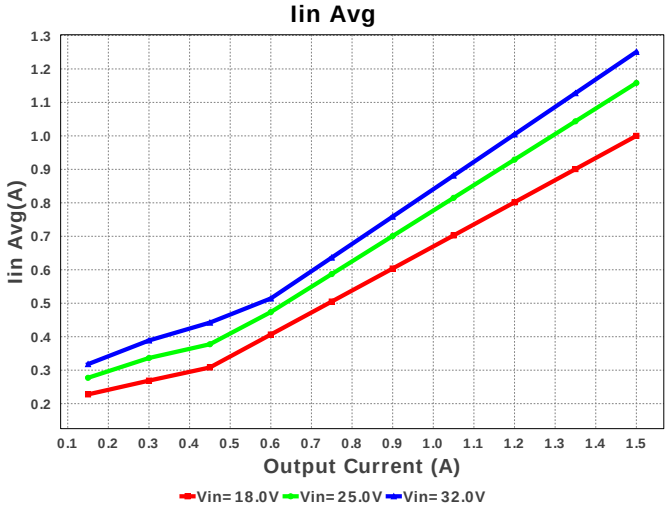


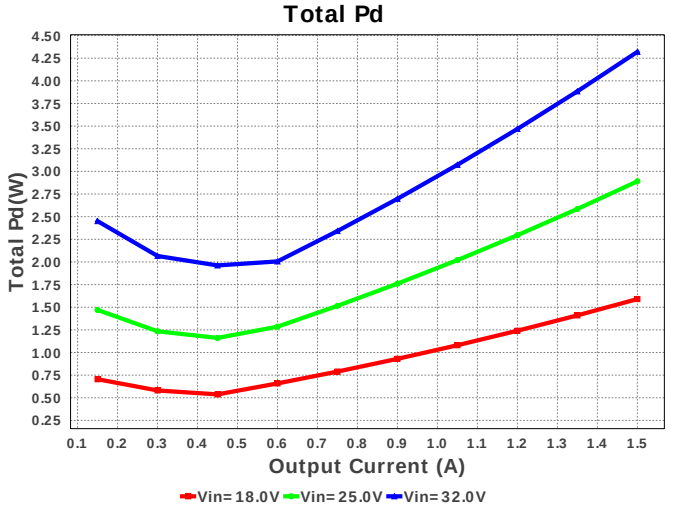


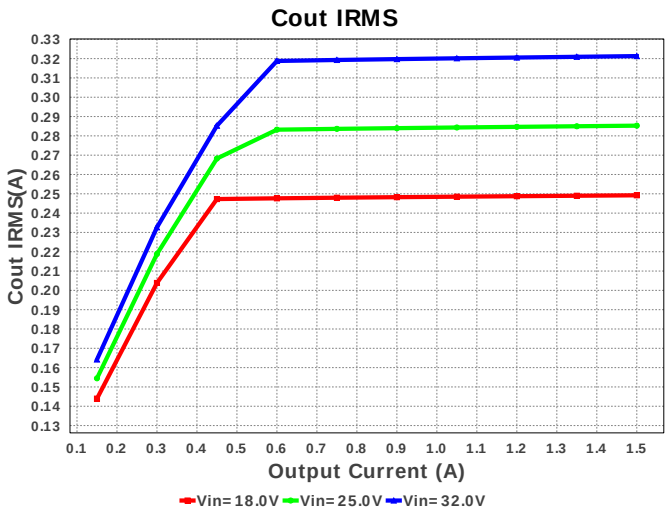


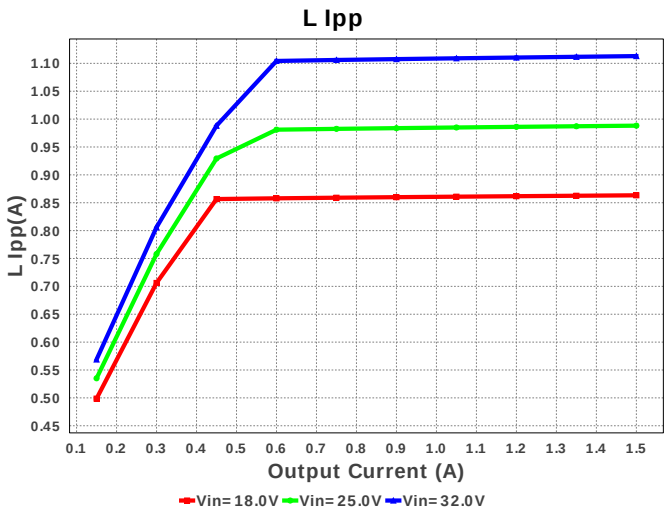


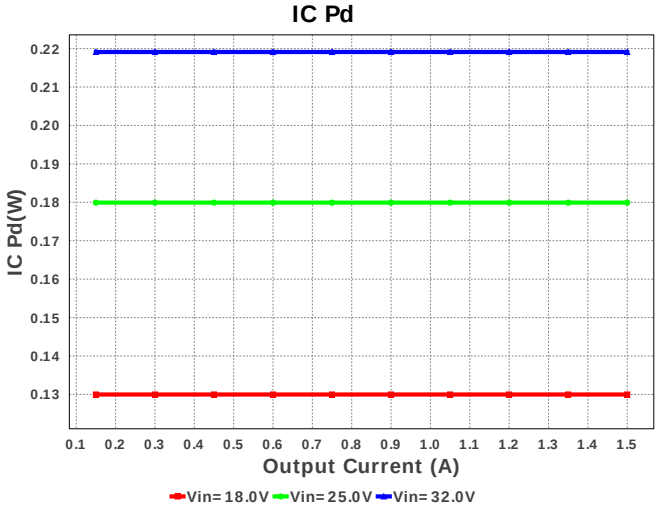


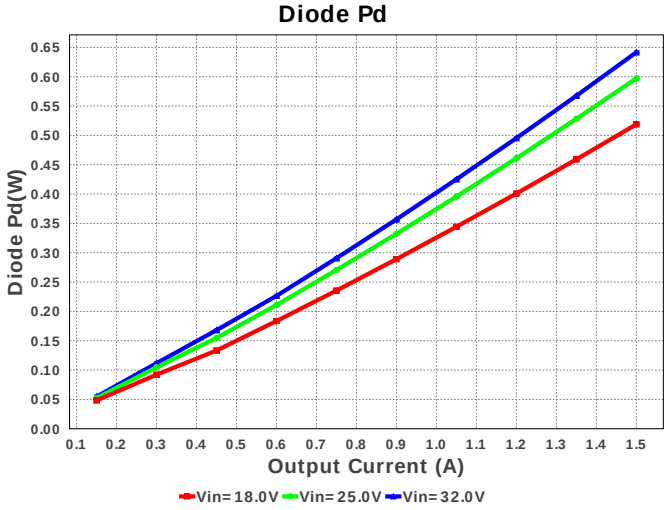


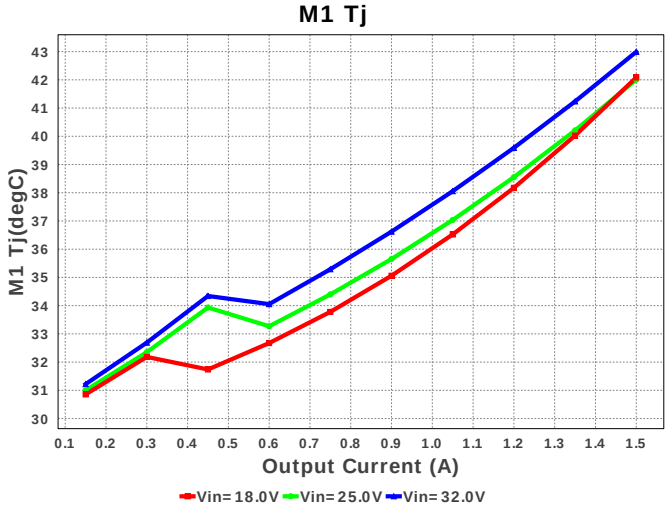


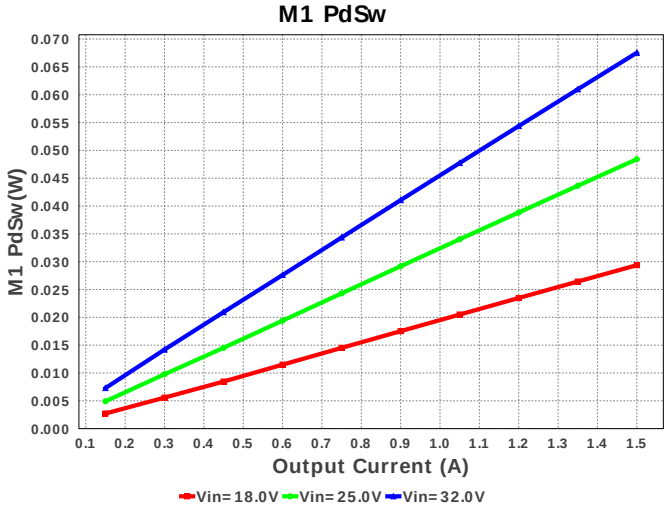












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	601.646 mA	Current	Input capacitor RMS ripple current
2.	Cout IRMS	374.945 mA	Current	Output capacitor RMS ripple current
3.	Iin Avg	1.251 A	Current	Average input current
4.	L Ipp	1.299 A	Current	Peak-to-peak inductor ripple current
5.	SW Ipk	2.149 A	Current	Peak switch current
6.	BOM Count	13	General	Total Design BOM count
7.	FootPrint	387.0 mm^2	General	Total Foot Print Area of BOM components
8.	Frequency	581.187 kHz	General	Switching frequency
9.	IC Tolerance	16.0 mV	General	IC Feedback Tolerance
10.	Pout	9.0 W	General	Total output power
11.	Total BOM	$1.92	General	Total BOM Cost

#	Name	Value	Category	Description
12.	D1 Tj	46.272 degC	Op_Point	D1 junction temperature
13.	Vout OP	6.0 V	Op_Point	Operational Output Voltage
14.	Duty Cycle	20.147 %	Op_point	Duty cycle
15.	Efficiency	89.127 %	Op_point	Steady state efficiency
16.	IC Tj	82.588 degC	Op_point	IC junction temperature
17.	ICThetaJA	240.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
18.	IOUT_OP	1.5 A	Op_point	Iout operating point
19.	M1 Tj	42.997 degC	Op_point	M1 MOSFET junction temperature
20.	VIN_OP	32.0 V	Op_point	Vin operating point
21.	Vout p-p	26.023 mV	Op_point	Peak-to-peak output ripple voltage
22.	Cin Pd	12.669 mW	Power	Input capacitor power dissipation
23.	Cout Pd	2.812 mW	Power	Output capacitor power dissipation
24.	Diode Pd	650.882 mW	Power	Diode power dissipation
25.	Diode Pd	650.882 mW	Power	Diode power dissipation
26.	Diode1 Pd	650.882 mW	Power	Diode1 power dissipation
27.	IC Pd	219.117 mW	Power	IC power dissipation
28.	L Pd	101.25 mW	Power	Inductor power dissipation
29.	L Pd	101.25 mW	Power	Inductor power dissipation
30.	M1 Pd	111.267 mW	Power	M1 MOSFET total power dissipation
31.	M1 PdCond	43.714 mW	Power	M1 MOSFET conduction losses
32.	M1 PdSw	67.553 mW	Power	M1 MOSFET switching losses
33.	Total Pd	4.352 W	Power	Total Power Dissipation

Design Inputs

#	Name	Value	Description
1.	Iout	1.5	Maximum Output Current
2.	Iout1	1.5	Output Current #1
3.	VinMax	32.0	Maximum input voltage
4.	VinMin	18.0	Minimum input voltage
5.	Vout	6.0	Output Voltage
6.	Vout1	6.0	Output Voltage #1
7.	base_pn	LM3489	Texas Instruments Base Part Number
8.	source	DC	Input Source Type
9.	ta	30.0	Ambient temperature

Design Assistance

1. Outline The LM3489 is a hysteretic PFET controller. The hysteretic control architecture provides for a stable design without the use of a control loop. The switching frequency depends on the inductance value, output capacitor ESR, and the input voltage. Therefore depending on the chosen BOM, the frequency at different input voltages would vary.

2. LM3489 Product Folder : http://www.ti.com/product/LM3489 : contains the data sheet and other resources.