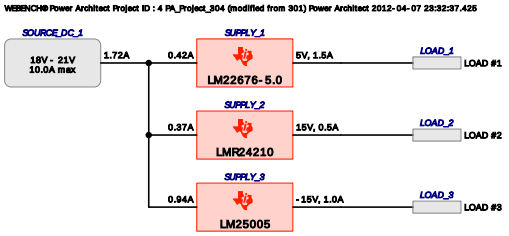
WEBENCH® Power Architect



Project Report

Project : 1245096/4 : PA_Project_304 (modified from 301)
Created : 2012-04-07 23:32:37.425
Optimize project optFactor=3

Project Summary

1.	Total System Efficiency	89.781 %
2.	Total System BOM Count	38.0
3.	Total System Footprint	1.182 kmm2
4.	Total System BOM Cost	$8.58
5.	Total System Power Dissipation	3.415 W

--> Launch WEBENCH Power Architect.

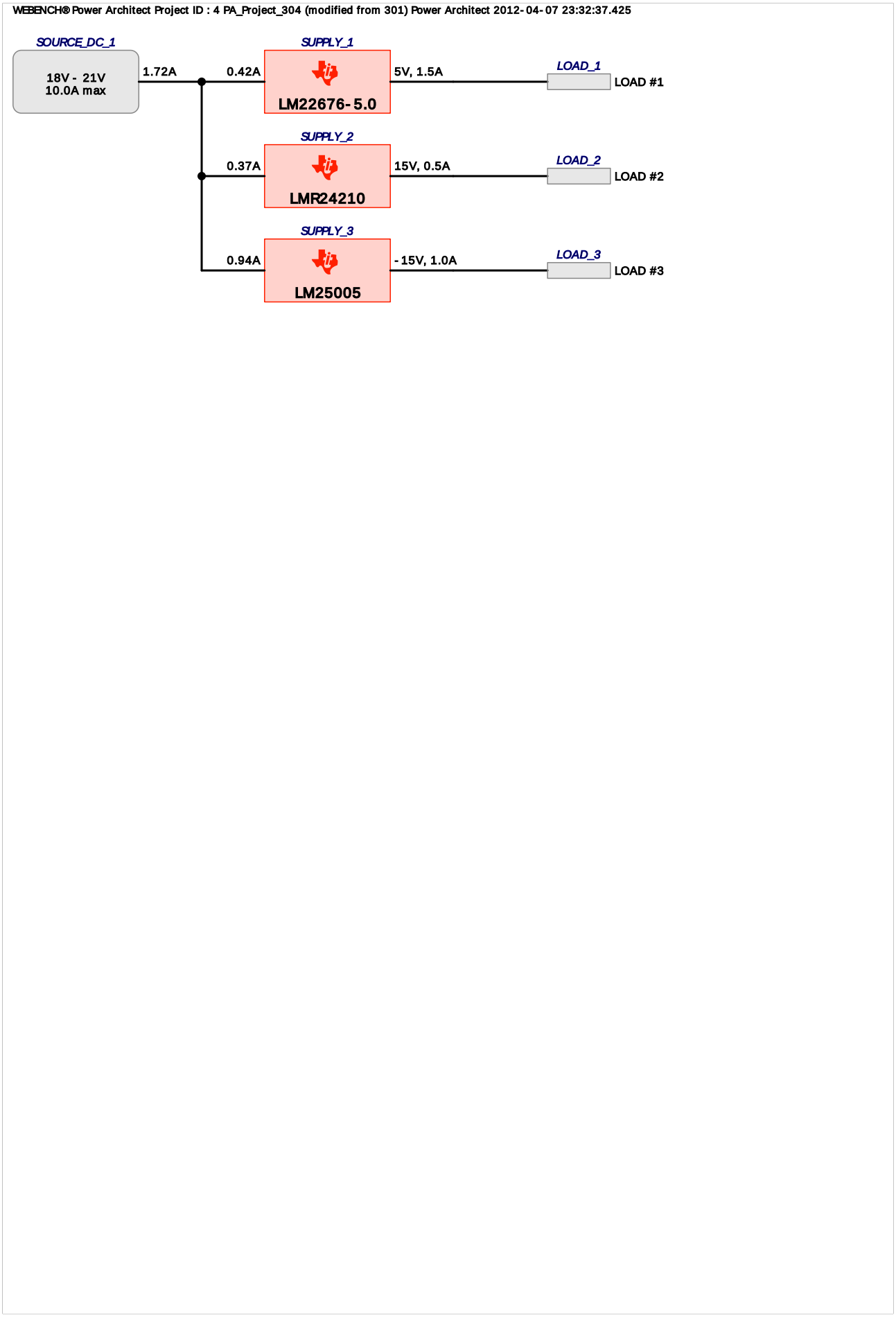
Power Supplies

#	Name	NSID	Description	Vout	Iout	Efficiency	Foot-print	Cost	Design	Page
1.	SUPPLY_1	LM22676-5.0	Switcher : Low Part Count	5 V	1.5 A	86%	372	$3.47	14	4
2.	SUPPLY_2	LMR24210	Switcher : High Efficiency	15 V	0.5 A	95.5%	250	$2.02	15	6
3.	SUPPLY_3	LM25005	Switcher : Positive to negative inverting buck boost converter	-15 V	1.0 A	89.1%	560	$3.09	16	8

Power Loads

#	Name	VLoad	ILoad	Description
1.	LOAD #1	5 V	1.5 A	VoutRipple=10%
2.	LOAD #2	15 V	0.5 A	VoutRipple=10%
3.	LOAD #3	-15 V	1 A	VoutRipple=10%

Project Diagram



Electrical Procurement BOM

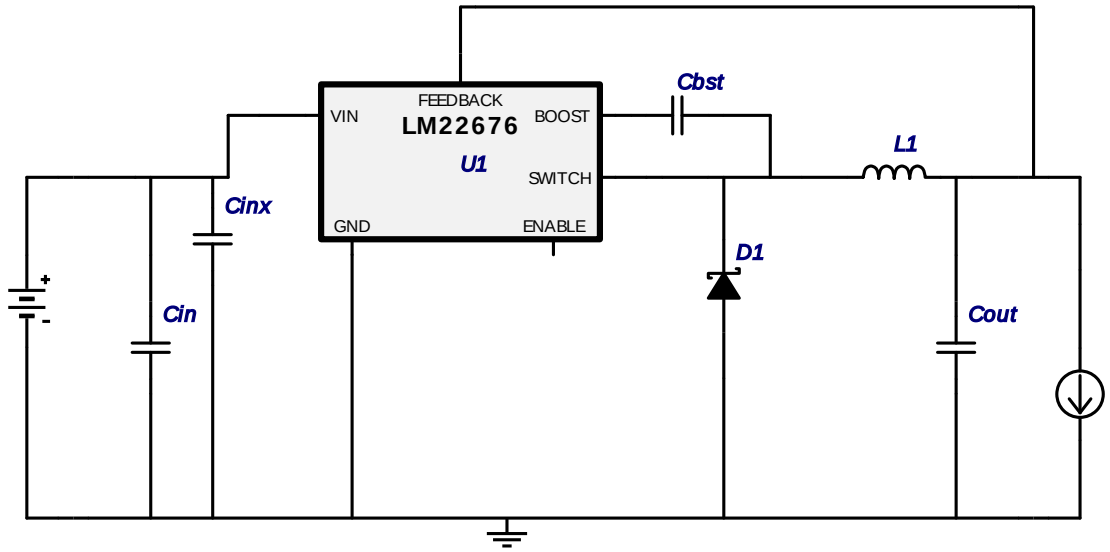
Manufacturer	Part Number	Description	Quantity	Budgetary Price	Footprint (mm^2)
Diodes Inc.	B240A-13-F	SMA	1	$0.09	37
Diodes Inc.	B260A-13-F	SMA	1	$0.11	37
Kemet	C0805C103K5RACTU	0805	1	$0.01	13
Kemet	C0805C104K5RACTU	0805	2	$0.01	26
TDK	C2012Y5V1E105Z/0.85	0805	2	$0.01	26
TDK	C2012Y5V1H105Z	0805	1	$0.02	13
TDK	C3216X7R1H105K	1206	2	$0.04	37
TDK	C3225X5R1E106M	1210	4	$0.14	47
TDK	C5750X7R1E226M	2220	1	$0.84	60
TDK	C5750X7R1H106M	2220	1	$0.68	60
Yageo America	CC0805JRNP09BN820	0805	1	$0.01	13
Vishay-Dale	CRCW0402140KFKED	0402	1	$0.01	8
Vishay-Dale	CRCW040217K8FKED	0402	1	$0.01	8
Vishay-Dale	CRCW040218K7FKED	0402	1	$0.01	8
Vishay-Dale	CRCW04021K00FKED	0402	1	$0.01	8
Vishay-Dale	CRCW04021K65FKED	0402	1	$0.01	8
Vishay-Dale	CRCW040220K5FKED	0402	1	$0.01	8
Vishay-Dale	CRCW040222K6FKED	0402	1	$0.01	8
Vishay-Dale	CRCW0402301KFKED	0402	1	$0.01	8
Nippon Chemi-Con	EMVY350ADA680MF80G	CAPSMT_62_F80	1	$0.13	74
MuRata	GRM155R61C104KA88D	0402	1	$0.01	8
MuRata	GRM155R71C123KA01D	0402	1	$0.01	8
MuRata	GRM155R71E153KA61D	0402	1	$0.01	8
MuRata	GRM155R71E333KA88D	0402	1	$0.01	8
MuRata	GRM155R71H223KA12D	0402	1	$0.01	8
MuRata	GRM1885C2A360JA01D	0603	1	$0.01	10
MuRata	GRM3195C1H133JA01D	1206	1	$0.13	19
Texas Instruments	LM22676MRE-5.0	MRA08B	1	$1.92	56
Texas Instruments	LM25005MHX	MXA20A	1	$1.40	71
Texas Instruments	LMR24210TL	TLC28VFA	1	$1.50	25
Coilcraft	MSS1048-333MLB	MSS1048	1	$0.47	146
Bourns	SDR1307-330KL	SDR1307	1	$0.41	227
Bourns	SRN6045-680M	SRN6045	1	$0.18	64
Total			**38**	**$8.58**	**1,159**

WEBENCH® Design Report

VinMin = 18.0V
VinMax = 21.0V
Vout = 5.0V
Iout = 1.5A

Device = LM22676MRE-5.0
Topology = Buck
Created = 4/7/12 11:32:33 PM
BOM Cost = $3.47
Total Pd = 1.22 W
Footprint = 372.0 mm2
BOM Count = 8

Design : 1245096/14 LM22676MRE-5.0
LM22676MRE-5.0 18.0V-21.0V to 5.0V @ 1.5A



Electrical BOM

#	Name	Manufacturer	Part Number	Quantity	Price	Properties	Footprint
1.	Cbst	Kemet	C0805C103K5RACTU Series= X7R	1	$0.01	Cap= 10.0 nF ESR= 1.739 Ohm VDC= 50.0 V IRMS= 411.0 mA	0805 13mm2
2.	Cin	TDK	C5750X7R1H106M Series= X7R	1	$0.68	Cap= 10.0 µF ESR= 3.0 mOhm VDC= 50.0 V IRMS= 5.5 A	2220 60mm2
3.	Cinx	TDK	C2012Y5V1H105Z Series= Y5V	1	$0.02	Cap= 1.0 µF ESR= 9.0 mOhm VDC= 50.0 V IRMS= 2.9 A	0805 13mm2
4.	Cout	TDK	C3225X5R1E106M Series= X5R	2	$0.14	Cap= 10.0 µF ESR= 15.0 mOhm VDC= 25.0 V IRMS= 3.0 A	1210 23mm2
5.	D1	Diodes Inc.	B240A-13-F	1	$0.09	VF@Io= 500.0 mV VRRM= 40.0 V	SMA 37mm2
6.	L1	Coilcraft	MSS1048-333MLB	1	$0.47	L= 33.0 µH DCR= 80.0 mOhm	MSS1048 146mm2
7.	U1	Texas Instruments	LM22676MRE-5.0	1	$1.92	Switcher	MRA08B 56mm2

Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	636.743 m A	Current	Input capacitor RMS ripple current
2.	Cout IRMS	71.952 m A	Current	Output capacitor RMS ripple current
3.	IC Ipk	1.625 A	Current	Peak switch current in IC
4.	Iin Avg	415.28 m A	Current	Average input current
5.	L Ipp	249.25 m A	Current	Peak-to-peak inductor ripple current
6.	M1 Irms	760.486 m A	Current	Q Iavg
7.	BOM Count	8.0	General	Total Design BOM count
8.	FootPrint	372.0 mm2	General	Total Foot Print Area of BOM components
9.	Frequency	500.0 k Hz	General	Switching frequency
10.	IC Tolerance	75.0 m V	General	IC Feedback Tolerance
11.	M Vds Act	102.504 m V	General	
12.	Mode	CCM	General	Conduction Mode
13.	Pout	7.5 W	General	Total output power
14.	Total BOM	$3.47	General	Total BOM Cost
15.	D1 Tj	43.931 degC	Op_Point	D1 junction temperature
16.	Vout OP	5.0 V	Op_Point	Operational Output Voltage
17.	Cross Freq	61.657 k Hz	Op_point	Bode plot crossover frequency
18.	Duty Cycle	25.704 %	Op_point	Duty cycle
19.	Efficiency	86.001 %	Op_point	Steady state efficiency
20.	IC Tj	57.861 degC	Op_point	IC junction temperature
21.	ICThetaJA	60.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
22.	IOUT_OP	1.5 A	Op_point	Iout operating point
23.	Phase Marg	44.943 deg	Op_point	Bode Plot Phase Margin
24.	VIN_OP	21.0 V	Op_point	Vin operating point
25.	Vout p-p	3.745 m V	Op_point	Peak-to-peak output ripple voltage
26.	Cin Pd	1.216 m W	Power	Input capacitor power dissipation
27.	Cout Pd	38.829 µ W	Power	Output capacitor power dissipation
28.	Diode Pd	557.22 m W	Power	Diode power dissipation
29.	IC Pd	464.353 m W	Power	IC power dissipation
30.	L Pd	198.0 m W	Power	Inductor power dissipation
31.	Total Pd	1.221 W	Power	Total Power Dissipation
32.	Input Load Capacitance	11.0 µ F	Unknown	Input load capacitance seen by upstream circuit

Design Inputs

#	Name	Value	Description
1.	Iout	1.5 A	Maximum Output Current
2.	Iout1	1.5 Amps	Output Current #1
3.	VinMax	21.0 V	Maximum input voltage
4.	VinMin	18.0 V	Minimum input voltage
5.	Vout	5.0 V	Output Voltage
6.	Vout1	5.0 Volt	Output Voltage #1
7.	base_pn	LM22676	National Based Product Number
8.	Ta	30.0 degC	Ambient temperature

Design Assistance

1. **LM22676** Product Folder : http://www.national.com/pf/LM/LM22676.html : contains the data sheet and other resources.

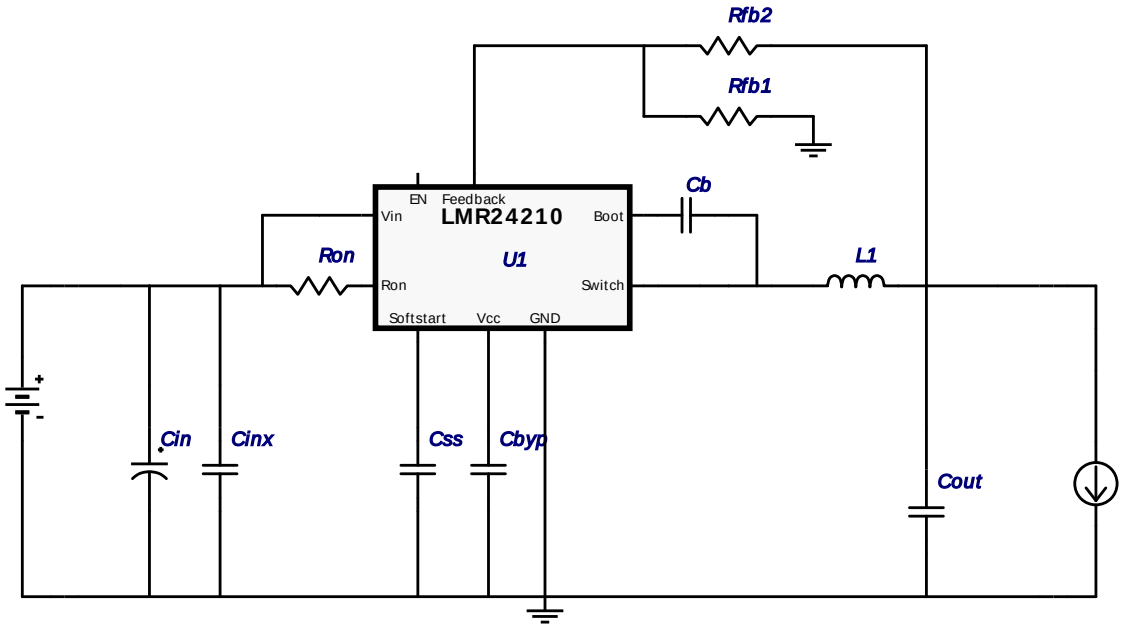
TEXAS INSTRUMENTS

WEBENCH® Design Report

VinMin = 18.0V
VinMax = 21.0V
Vout = 15.0V
Iout = 0.5A

Device = LMR24210TL
Topology = Buck
Created = 4/7/12 11:32:34 PM
BOM Cost = $2.02
Total Pd = 0.35 W
Footprint = 250.0 mm2
BOM Count = 11

Design : 1245096/15 LMR24210TL
LMR24210TL 18.0V-21.0V to 15.0V @ 0.5A



Electrical BOM

#	Name	Manufacturer	Part Number	Quantity	Price	Properties	Footprint
1.	Cb	MuRata	GRM155R71E333KA88D Series= X7R	1	$0.01	Cap= 33.0 nF ESR= 0.0 Ohm VDC= 25.0 V IRMS= 0.0 A	0402 8mm2
2.	Cbyp	TDK	C2012Y5V1E105Z/0.85 Series= Y5V	1	$0.01	Cap= 1.0 µF ESR= 9.0 mOhm VDC= 25.0 V IRMS= 0.0 A	0805 13mm2
3.	Cin	Nippon Chemi-Con	EMVY350ADA680MF80G Series= MVY	1	$0.13	Cap= 68.0 µF ESR= 340.0 mOhm VDC= 35.0 V IRMS= 280.0 mA	CAPSMT_62_F80 74mm2
4.	Cinx	Kemet	C0805C104K5RACTU Series= X7R	1	$0.01	Cap= 100.0 nF ESR= 64.0 mOhm VDC= 50.0 V IRMS= 1.64 A	0805 13mm2
5.	Cout	TDK	C3225X5R1E106M Series= X5R	1	$0.14	Cap= 10.0 µF ESR= 15.0 mOhm VDC= 25.0 V IRMS= 3.0 A	1210 23mm2
6.	Css	MuRata	GRM155R71E153KA61D Series= X7R	1	$0.01	Cap= 15.0 nF ESR= 0.0 Ohm VDC= 25.0 V IRMS= 0.0 A	0402 8mm2
7.	L1	Bourns	SRN6045-680M	1	$0.18	L= 68.0 µH DCR= 351.0 mOhm	SRN6045 64mm2

#	Name	Manufacturer	Part Number	Quantity	Price	Properties	Footprint
8.	Rfb1	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	1	$0.01	Res= 1,000 Ohm Power= 63.0 mW Tolerance= 1.0%	0402 8mm2
9.	Rfb2	Vishay-Dale	CRCW040217K8FKED Series= CRCW..e3	1	$0.01	Res= 17.8 kOhm Power= 63.0 mW Tolerance= 1.0%	0402 8mm2
10.	Ron	Vishay-Dale	CRCW0402301KFKED Series= CRCW..e3	1	$0.01	Res= 301.0 kOhm Power= 63.0 mW Tolerance= 1.0%	0402 8mm2
11.	U1	Texas Instruments	LMR24210TL	1	$1.50	Switcher	TLC28VFA 25mm2

Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	222.824 m A	Current	Input capacitor RMS ripple current
2.	Cout IRMS	48.548 m A	Current	Output capacitor RMS ripple current
3.	IC Ipk	584.087 m A	Current	Peak switch current in IC
4.	Iin Avg	373.93 m A	Current	Average input current
5.	L Ipp	168.174 m A	Current	Peak-to-peak inductor ripple current
6.	M1 Irms	447.402 m A	Current	Q Iavg
7.	BOM Count	11.0	General	Total Design BOM count
8.	FootPrint	250.0 mm2	General	Total Foot Print Area of BOM components
9.	Frequency	375.562 k Hz	General	Switching frequency
10.	IC Tolerance	16.0 m V	General	IC Feedback Tolerance
11.	M Vds Act	90.0 m V	General	
12.	Mode	CCM	General	Conduction Mode
13.	Pout	7.5 W	General	Total output power
14.	Total BOM	$2.02	General	Total BOM Cost
15.	Vout OP	15.0 V	Op_Point	Operational Output Voltage
16.	Duty Cycle	72.671 %	Op_point	Duty cycle
17.	Efficiency	95.511 %	Op_point	Steady state efficiency
18.	IC Tj	41.295 degC	Op_point	IC junction temperature
19.	ICThetaJA	50.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
20.	IOUT_OP	500.0 m A	Op_point	Iout operating point
21.	VIN_OP	21.0 V	Op_point	Vin operating point
22.	Vout p-p	2.523 m V	Op_point	Peak-to-peak output ripple voltage
23.	Cin Pd	16.881 m W	Power	Input capacitor power dissipation
24.	Cout Pd	35.353 µ W	Power	Output capacitor power dissipation
25.	IC Pd	225.907 m W	Power	IC power dissipation
26.	L Pd	109.688 m W	Power	Inductor power dissipation
27.	Total Pd	352.5 m W	Power	Total Power Dissipation
28.	Input Load Capacitance	68.1 µ F	Unknown	Input load capacitance seen by upstream circuit

Design Inputs

#	Name	Value	Description
1.	Iout	500.0 mA	Maximum Output Current
2.	Iout1	500.0 mAmps	Output Current #1
3.	VinMax	21.0 V	Maximum input voltage
4.	VinMin	18.0 V	Minimum input voltage
5.	Vout	15.0 V	Output Voltage
6.	Vout1	15.0 Volt	Output Voltage #1
7.	base_pn	LMR24210	National Based Product Number
8.	Ta	30.0 degC	Ambient temperature

Design Assistance

1. **LMR24210** Product Folder : http://www.national.com/pf/LM/LMR24210.html : contains the data sheet and other resources.

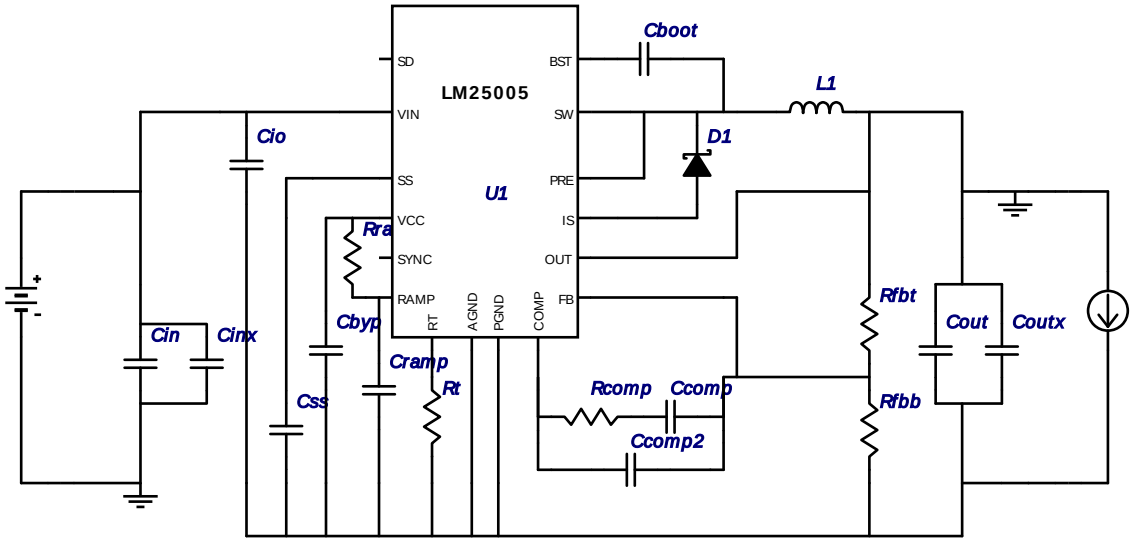
TEXAS INSTRUMENTS

WEBENCH® Design Report

VinMin = 18.0V
VinMax = 21.0V
Vout = -15.0V
Iout = 1.0A

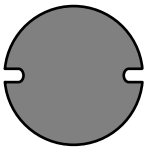
Device = LM25005MHX
Topology = Inverting_Buck_Boost
Created = 4/7/12 11:32:36 PM
BOM Cost = $3.09
Total Pd = 1.84 W
Footprint = 560.0 mm2
BOM Count = 19

Design : 1245096/16 LM25005MHX
LM25005MHX 18.0V-21.0V to -15.0V @ 1.0A



Electrical BOM

#	Name	Manufacturer	Part Number	Quantity	Price	Properties	Footprint
1.	Cboot	MuRata	GRM155R71H223KA12D Series= X7R	1	$0.01	Cap= 22.0 nF ESR= 0.0 Ohm VDC= 50.0 V IRMS= 0.0 A	0402 8mm2
2.	Cbyp	MuRata	GRM155R61C104KA88D Series= X5R	1	$0.01	Cap= 100.0 nF ESR= 0.0 Ohm VDC= 16.0 V IRMS= 0.0 A	0402 8mm2
3.	Ccomp	MuRata	GRM3195C1H133JA01D Series= C0G/NP0	1	$0.13	Cap= 13.0 nF ESR= 0.0 Ohm VDC= 50.0 V IRMS= 0.0 A	1206 19mm2
4.	Ccomp2	MuRata	GRM1885C2A360JA01D Series= C0G/NP0	1	$0.01	Cap= 36.0 pF ESR= 0.0 Ohm VDC= 100.0 V IRMS= 0.0 A	0603 10mm2
5.	Cin	TDK	C3216X7R1H105K Series= X7R	1	$0.04	Cap= 1.0 µF ESR= 10.0 mOhm VDC= 50.0 V IRMS= 3.2 A	1206 19mm2
6.	Cinx	Kemet	C0805C104K5RACTU Series= X7R	1	$0.01	Cap= 100.0 nF ESR= 64.0 mOhm VDC= 50.0 V IRMS= 1.64 A	0805 13mm2
7.	Cio	TDK	C3216X7R1H105K Series= X7R	1	$0.04	Cap= 1.0 µF ESR= 10.0 mOhm VDC= 50.0 V IRMS= 3.2 A	1206 19mm2
8.	Cout	TDK	C5750X7R1E226M Series= X7R	1	$0.84	Cap= 22.0 µF ESR= 1.9 mOhm VDC= 25.0 V IRMS= 3.6 A	2220 60mm2

#	Name	Manufacturer	Part Number	Quantity	Price	Properties	Footprint
9.	Coutx	TDK	C2012Y5V1E105Z/0.85 Series= Y5V	1	$0.01	Cap= 1.0 µF ESR= 9.0 mOhm VDC= 25.0 V IRMS= 0.0 A	 0805 13mm2
10.	Cramp	Yageo America	CC0805JRNP09BN820 Series= C0G/NP0	1	$0.01	Cap= 82.0 pF ESR= 0.0 Ohm VDC= 50.0 V IRMS= 0.0 A	 0805 13mm2
11.	Css	MuRata	GRM155R71C123KA01D Series= X7R	1	$0.01	Cap= 12.0 nF ESR= 0.0 Ohm VDC= 16.0 V IRMS= 0.0 A	 0402 8mm2
12.	D1	Diodes Inc.	B260A-13-F	1	$0.11	VF@Io= 700.0 mV VRRM= 60.0 V	 SMA 37mm2
13.	L1	Bourns	SDR1307-330KL	1	$0.41	L= 33.0 µH DCR= 65.0 mOhm	 SDR1307 227mm2
14.	Rcomp	Vishay-Dale	CRCW040222K6FKED Series= CRCW..e3	1	$0.01	Res= 22.6 kOhm Power= 63.0 mW Tolerance= 1.0%	 0402 8mm2
15.	Rfbb	Vishay-Dale	CRCW04021K65FKED Series= CRCW..e3	1	$0.01	Res= 1.65 kOhm Power= 63.0 mW Tolerance= 1.0%	 0402 8mm2
16.	Rfbt	Vishay-Dale	CRCW040218K7FKED Series= CRCW..e3	1	$0.01	Res= 18.7 kOhm Power= 63.0 mW Tolerance= 1.0%	 0402 8mm2
17.	Rramp	Vishay-Dale	CRCW0402140KFKED Series= CRCW..e3	1	$0.01	Res= 140.0 kOhm Power= 63.0 mW Tolerance= 1.0%	 0402 8mm2
18.	Rt	Vishay-Dale	CRCW040220K5FKED Series= CRCW..e3	1	$0.01	Res= 20.5 kOhm Power= 63.0 mW Tolerance= 1.0%	 0402 8mm2
19.	U1	Texas Instruments	LM25005MHX	1	$1.40	Switcher	 MXA20A 71mm2

Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	426.697 m A	Current	Input capacitor RMS ripple current
2.	Cio IRMS	507.759 m A	Current	Input to output capacitor RMS ripple current
3.	Cout IRMS	426.643 m A	Current	Output capacitor RMS ripple current
4.	D1 Irms	1.363 A	Current	D1 Irms
5.	IC Ipk	6.35 m A	Current	Peak switch current in IC
6.	Iin Avg	935.64 m A	Current	Average input current
7.	L Ipp	0.0 A	Current	Peak-to-peak output inductor ripple current
8.	L1 Ipk	1.863 A	Current	Inductor peak current
9.	L1 Irms	1.872 A	Current	Inductor ripple current
10.	BOM Count	19.0	General	Total Design BOM count
11.	FootPrint	560.0 mm2	General	Total Foot Print Area of BOM components
12.	Frequency	300.0 k Hz	General	Switching frequency
13.	IC Tolerance	18.0 m V	General	IC Feedback Tolerance
14.	Mode	CCM	General	Conduction Mode
15.	Total BOM	$3.09	General	Total BOM Cost
16.	D1 Tj	48.367 degC	Op_Point	D1 junction temperature
17.	Vin p-p	8.549 m V	Op_Point	Peak-to-peak input voltage
18.	Cross Freq	9.222 k Hz	Op_point	Bode plot crossover frequency
19.	Duty Cycle	46.588 %	Op_point	Duty cycle
20.	Efficiency	89.066 %	Op_point	Steady state efficiency
21.	Gain Marg	10.25 db	Op_point	Bode Plot Gain Margin
22.	IC Tj	60.947 degC	Op_point	IC junction temperature
23.	IOUT_OP	1.0 A	Op_point	Iout operating point
24.	Phase Marg	55.021 deg	Op_point	Bode Plot Phase Margin

#	Name	Value	Category	Description
25.	Phase Shift	57.489 deg	Op_point	Bode Plot Phase Shift
26.	VIN_OP	18.0 V	Op_point	Vin operating point
27.	Vout p-p	1.624 m V	Op_point	Peak-to-peak output ripple voltage
28.	Cin Pd	1.821 m W	Power	Input capacitor power dissipation
29.	Cio Pd	2.578 m W	Power	Input to output capacitor power dissipation
30.	Cout Pd	345.846 µ W	Power	Output capacitor power dissipation
31.	D1 Pd	734.68 m W	Power	Diode power dissipation
32.	D1 PdCond	700.0 m W	Power	Diode conduction losses
33.	D1 PdSw	34.68 m W	Power	Diode switching losses
34.	IC Pd	773.677 m W	Power	IC power dissipation
35.	L Pd	227.839 m W	Power	Inductor power dissipation
36.	Rsense Pd	92.888 m W	Power	LED Current Rsns Power Dissipation
37.	Total Pd	1.841 W	Power	Total Power Dissipation

Design Inputs

#	Name	Value	Description
1.	Iout	1.0 A	Maximum Output Current
2.	Iout1	1.0 Amps	Output Current #1
3.	VinMax	21.0 V	Maximum input voltage
4.	VinMin	18.0 V	Minimum input voltage
5.	Vout	-15.0 V	Output Voltage
6.	Vout1	-15.0 Volt	Output Voltage #1
7.	base_pn	LM25005	National Based Product Number
8.	Ta	30.0 degC	Ambient temperature

Design Assistance

1. **LM25005** Product Folder : http://www.national.com/pf/LM/LM25005.html : contains the data sheet and other resources.