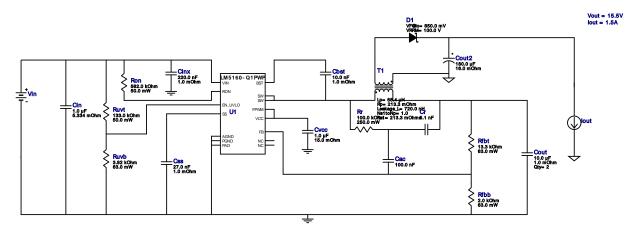


WEBENCH® Design Report

VinMin = 44.0V VinMax = 54.0V Vout = 15.5V lout = 1.5A Device = LM5160QPWPRQ1 Topology = Flybuck Created = 2019-06-19 22:14:53.720 BOM Cost = \$12.67 BOM Count = 19 Total Pd = 4.13W

Design: 42 LM5160QPWPRQ1 LM5160QPWPRQ1 44V-54V to 15.50V @ 1.5A



- 1. Feedback Resistors may need to be further adjusted to get more precise regulation as ripple injection circuit will introduce some amount of DC offset. Use simulation to help adjust.
- 2. This regulator device is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application. View WEBENCH(R) Disclaimer.

Design Alerts

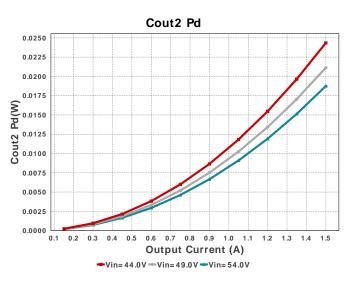
Component Selection Information

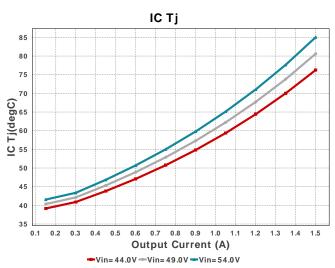
The LM5160-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application.

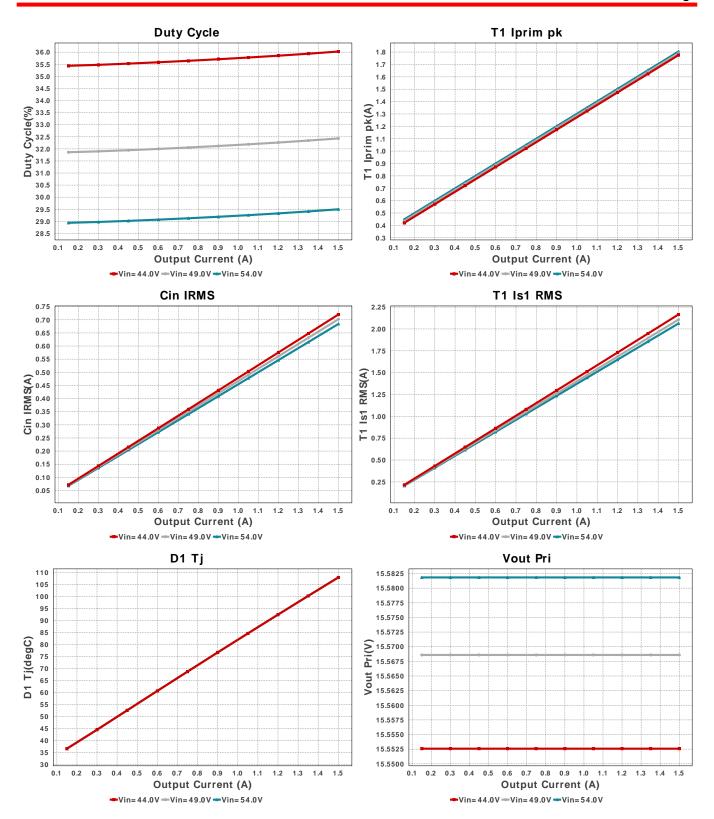
Electrical BOM

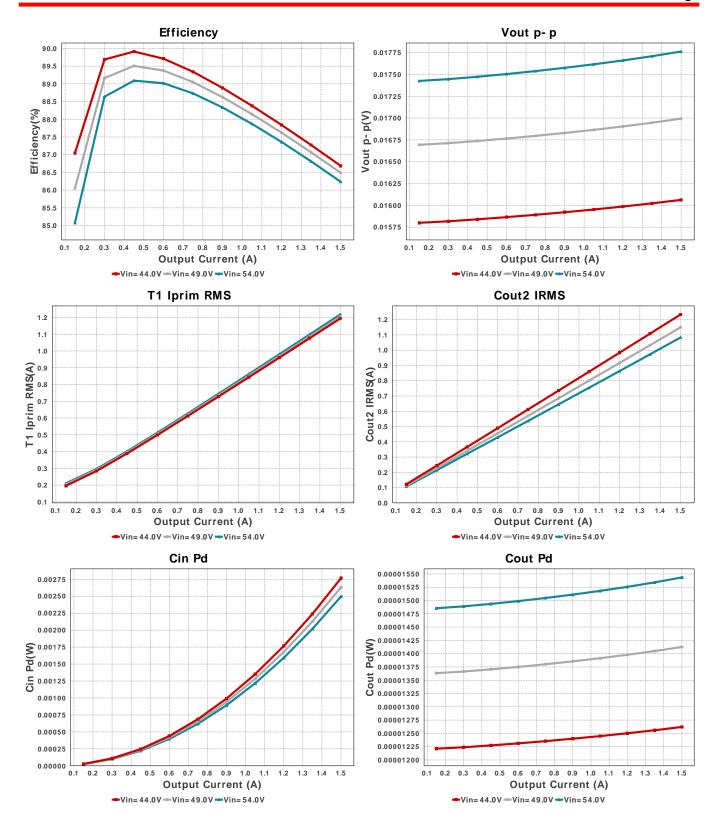
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cac	AVX	08053C104JAZ2A Series= X7R	Cap= 100.0 nF VDC= 25.0 V IRMS= 0.0 A	1	\$0.07	0805 7 mm ²
Cbst	MuRata	GRM155R71H103KA88D Series= X7R	Cap= 10.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm ²
Cin	MuRata	GRM31CR72A105KA01L Series= X7R	Cap= 1.0 uF ESR= 5.334 mOhm VDC= 100.0 V IRMS= 1.55432 A	1	\$0.24	1206_190 11 mm²
Cinx	MuRata	GRM21AR72A224KAC5L Series= X7R	Cap= 220.0 nF ESR= 1.0 mOhm VDC= 100.0 V IRMS= 0.0 A	1	\$0.09	0805 7 mm ²
Cout	MuRata	GRM32ER71J106KA12L Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 63.0 V IRMS= 6.0 A	2	\$0.30	1210_280 15 mm ²
Cout2	Panasonic	25SVPF180M Series= SVPF	Cap= 180.0 uF ESR= 16.0 mOhm VDC= 25.0 V IRMS= 4.65 A	1	\$0.63	CAPSMT 62 E12 106 mm ²

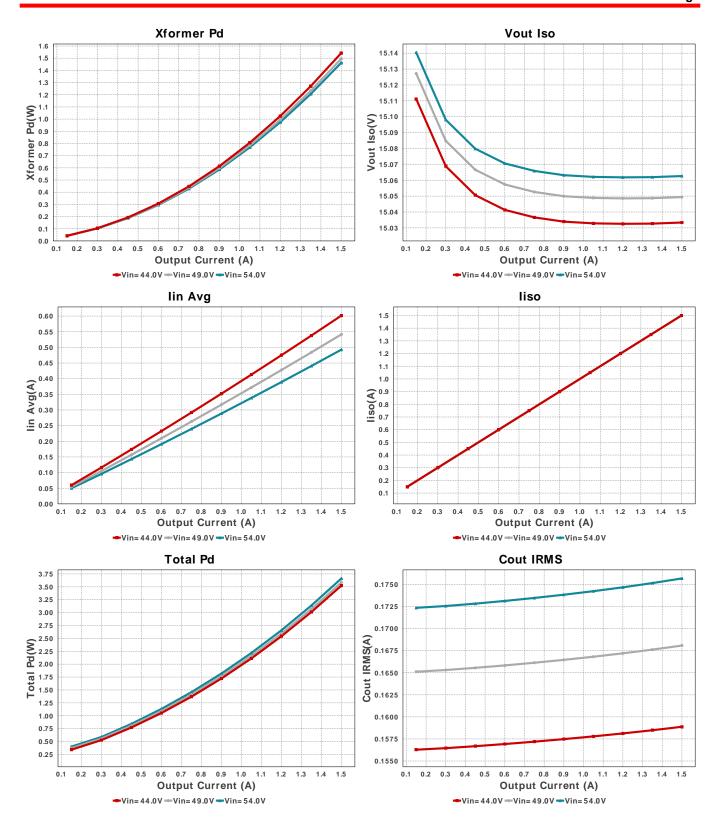
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cr	Kemet	C0603C512J5GAC7867 Series= C0G/NP0	Cap= 5.1 nF VDC= 50.0 V IRMS= 0.0 A	1	\$0.09	0603 5 mm ²
Css	MuRata	GRM155R71C273KA01D Series= X7R	Cap= 27.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm ²
Cvcc	Kemet	C0805C105K4RACTU Series= X7R	Cap= 1.0 uF ESR= 15.0 mOhm VDC= 16.0 V IRMS= 8.19 A	1	\$0.02	0805 7 mm ²
D1	Micro Commercial Components	SK310A-TP	VF@Io= 850.0 mV VRRM= 100.0 V	1	\$0.11	SMA 37 mm ²
Rfbb	Vishay-Dale	CRCW04022K00FKED Series= CRCWe3	Res= 2.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm ²
Rfbt	Vishay-Dale	CRCW040213K3FKED Series= CRCWe3	Res= 13.3 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm ²
Ron	Yageo	RC0201FR-07562KL Series= ?	Res= 562.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	\$0.01	0201 2 mm ²
Rr	Vishay-Dale	CRCW1206100KFKEA Series= CRCWe3	Res= 100.0 kOhm Power= 250.0 mW Tolerance= 1.0%	1	\$0.01	1206 11 mm ²
Ruvb	Vishay-Dale	CRCW04023K92FKED Series= CRCWe3	Res= 3.92 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm ²
Ruvt	Yageo	RC0201FR-07133KL Series= ?	Res= 133.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	\$0.01	0201 2 mm ²
T1	Wurth Elektronik	749196541	Lp= 68.4 µH Rp= 213.3 mOhm Leakage_L= 720.0 nH Ns1toNp= 1.0 Rs1= 213.3 mOhms	1	\$8.62	EFD20 724 mm ²
U1	Texas Instruments	LM5160QPWPRQ1	Switcher	1	\$2.12	PWP0014A_N 59 mm ²

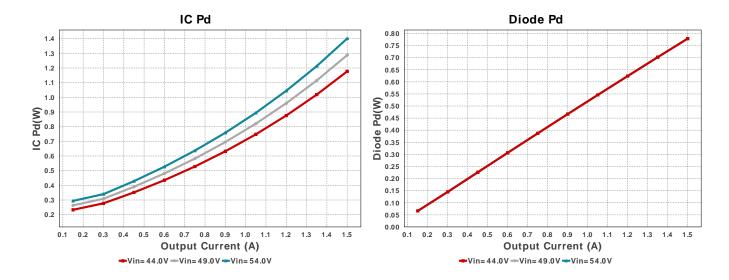












Operating Values

1. Cin IRMS 684.072 mA Capacitor Input capacitor RMS ripple current 2. Cin Pd 2.496 mW Capacitor Capacitor 3. Cout IRMS 173.434 mA Capacitor Output capacitor power dissipation 4. Cout Pd 15.04 µW Capacitor Output capacitor power dissipation 6. Cout2 RMS 1.083 A Capacitor Output capacitor 2RMS ripple current 6. Cout2 Pd 18.75 mW Capacitor Output capacitor 2RMS ripple current 7. Iliso 1.5 A Current Secondary Side Output Current 8. D1 Tj 107.74 degC Dlode Dlode power dissipation 10. IC Pd 1.412 W IC Clower dissipation 11. IC Tj 85.48 degC IC Clower dissipation 12. IC Thets1JA 39.3 degC/W IC IC junction temperature 12. IC Thets1JA 39.3 degC/W IC IC junction temperature 12. IC Thets1JA 39.3 degC/W IC IC junction temperature 12. IC Thets1JA 39.3 degC/W IC IC junction temperature IC junction temperature	#	Name	Value	Category	Description
3. Cout IRMS 173.434 mA Capacitor Output Pd 15.04 µW Capacitor 6. Cout2 RMS 1.083 A Capacitor Output capacitor 2 RMS ripple current 6. Cout2 Pd 18.75 mW Capacitor Output capacitor 2 RMS ripple current 7. Iliso 1.5 A Current Output capacitor 2 power dissipation 8. D1 Tj 100 Report 1.412 W Diode Diode power dissipation 10. IC Pd 1.412 W IC IC power dissipation 11. IC Tj 85.48 degC IC IC power dissipation 12. ICThetaJA 39.3 degCMW IC IC junction temperature 12. ICThetaJA 39.3 degCMW IC IC junction temperature 15. Vout Pri 15.582 V Op Point IC junction-to-ambient thermal resistance 15. Vout Pri 15.582 V Op Point Secondary Side Output Voltage 16. Cin Pd 2.496 mW Power Power Power dissipation 17. Cout Pd 15.04 µW Power Output capacitor power dissipation 19. Lough Pd 4.129 W Power Power	1.	Cin IRMS	684.072 mA	Capacitor	
Cout Pd	2.	Cin Pd	2.496 mW	Capacitor	Input capacitor power dissipation
6. Coulz IRMS 1.083 Å Capacitor Capacitor Cutzu capacitor 2 Most pipel current Output capacitor 2 Most pipel current Output capacitor 2 Most pipel current 7. Iso 1.5 A Carpacitor Output capacitor 2 Most pipel current 8. D1 Tj 107.74 degC Diode Diode Dutput Current 9. Diode Pd 777.36 mW Diode Diode power dissipation 10. Ic Pd 1.412 W IC IC power dissipation 11. Ic Tj 85.48 degC IC IC junction temperature 12. Ic ThetaJA 39.3 degCW IC IC junction temperature 13. Iin Avg 501.46 mA IC Vareage input current 14. Vout Iso 15.064 V Op Point Secondary Side Output Voltage 15. Vout Pi 15.582 V Op Point Power Output capacitor power dissipation 17. Cout Pd 15.04 µW Power Output capacitor power dissipation 18. Cout2 Pd 18.75 mW Power Output capacitor power dissipation 19. Ic Pd 1.412 W Power Output capacitor power dissipation 10. Ic Pd 1.412 W<	3.	Cout IRMS	173.434 mA	Capacitor	Output capacitor RMS ripple current
6. Coulz Pd 18.75 mW Capacitor Diode Output capacitor2 power dissipation 7. Iiso 1.5 A Current Secondary Side Output Current 8. D1 Tj 107.74 degC Diode Diode Diode Diode power dissipation 10. IC Pd 1.412 W IC C power dissipation 11. IC Tj 85.48 degC IC IC jounction-to-ambient thermal resistance 12. ICThetaJA 39.3 degCW IC IC junction-to-ambient thermal resistance 13. Iin Avg 501.46 mA IC Average input current 14. Vout Iso 15.064 V Op Point Average input current 15. Vout Pri 15.582 V Op Point Average input current 16. Cin Pd 2.496 mW Power Input capacitor power dissipation 16. Cout Pd 15.04 µW Power Output capacitor power dissipation 16. Cout Pd 18.75 mW Power Output capacitor power dissipation 16. Cout Pd 1.412 W Power Output capacitor power dissipation 16. Cout Pd 1.412 W Power Total Power Dissipation	4.	Cout Pd	15.04 μW	Capacitor	Output capacitor power dissipation
7. ilso 1.5 A Current Secondary Side Output Current 8. D1 Tj 107.74 degC Diode D1 junction temperature 9. Diode Pd 777.36 mW Diode D1 junction temperature 10. IC Pd 1.412 W IC IC power dissipation 11. IC Tj 85.48 degC IC IC junction-to-ambient thermal resistance 12. ICThetaJA 39.3 degC/W IC IC junction-to-ambient thermal resistance 13. Iin Avg 501.46 m A IC Average input current 14. Vout Iso 15.064 V Op Point Secondary Side Output Voltage 15. Vout Pri 15.582 V Op Point Secondary Side Output Voltage 16. Cin Pd 2.496 mW Power Input capacitor power dissipation 17. Cout Pd 15.04 µW Power Output capacitor power dissipation 18. Cout2 Pd 18.75 nW Power Output capacitor power dissipation 19. Lic Pd 1.412 W Power Dice power dissipation 20. IC Pd 1.412 W Power Total Power Dissipation 21. Total Pd 4.129 W Power	5.	Cout2 IRMS	1.083 A	Capacitor	Output capacitor2 RMS ripple current
8. D1 Tj 107.74 degC Diode D1 jode power dissipation 10. IC Pd 1.412 W IC IC power dissipation 11. IC Tj 85.48 degC IC IC junction temperature 12. ICThetaJA 39.3 degCM IC IC junction temperature 13. Iin Avg 501.46 mA IC Average input current 14. Vout Iso 15.064 V OP Point Power Average input current 15. Vout Pri 15.582 V OP Point Primary Side Output Voltage 16. Cin Pd 2.496 mW Power Power Input current 17. Cout Pd 15.04 µW Power Output capacitor power dissipation 18. Cout2 Pd 18.75 mW Power Output capacitor power dissipation 19. Diode Pd 777.36 mW Power Output capacitor power dissipation 10. IC Pd 1.412 W Power Total Power Dissipation 12. Total Pd 4.129 W Power Total Power Dissipation 12. Total Pd 1.919 W System Information 12. Efficiency 84.752 % System	6.	Cout2 Pd	18.75 mW	Capacitor	Output capacitor2 power dissipation
9. Diode Pd 777.36 mW Diode Diode power dissipation 10. IC Pd 1.412 W IC IC power dissipation 11. IC Tj 85.48 degC IC IC power dissipation 12. ICThetaJA 39.3 degC/W IC IC junction-to-ambient thermal resistance 13. Iin Avg 501.46 mA IC Average input current 14. Vout Iso 15.064 V Op Point Secondary Side Output Voltage 15. Vout Pri 15.582 V Op Point Primary Side Output Voltage 16. Cin Pd 2.496 mW Power Primary Side Output Voltage 17. Cout Pd 15.04 µW Power Input capacitor power dissipation 18. Cout2 Pd 18.75 mW Power Output capacitor power dissipation 19. Diode Pd 777.36 mW Power Diode power dissipation 20. IC Pd 1.412 W Power Diode power dissipation 21. Total Pd 4.129 W Power Total Power Dissipation 22. Xformer Pd 1.919 W Power Total Power Dissipation 23. Efficiency 84.752 % Syst	7.	liso	1.5 A	Current	Secondary Side Output Current
10. C Pd	8.	D1 Tj	107.74 degC	Diode	D1 junction temperature
11. IC Tj 85.48 degC IC IC junction temperature 12. ICThetaJA 39.3 degC/W IC IC junction-to-ambeint thermal resistance 13. Iin Avg 501.46 mA IC Average input current 14. Vout Iso 15.064 V Op Point Secondary Side Output Voltage 16. Cin Pd 2.496 mW Power Input capacitor power dissipation 17. Cout Pd 15.04 μW Power Output capacitor power dissipation 18. Cout2 Pd 18.75 mW Power Output capacitor power dissipation 19. Diode Pd 777.36 mW Power Diode power dissipation 19. IC Pd 1.412 W Power Total Power Dissipation 21. Total Pd 4.129 W Power Total Power Dissipation 22. Xformer Pd 1.919 W Power Total Power Dissipation 23. BOM Count 19 System Information 24. Duty Cycle 29.501 % System Information 25. Efficiency 84.752 % System Information 26. FootPrint 1.022 k mm² System Information 2	9.	Diode Pd	777.36 mW	Diode	Diode power dissipation
12. ICThetaJA 39.3 degCW IC IC junction-to-ambient thermal resistance 13. lin Avg 501.46 mA IC Average input current 14. Vout Iso 15.064 V Op Point Secondary Side Output Voltage 15. Vout Pri 15.582 V Op Point Primary Side Output Voltage 16. Cin Pd 2.496 mW Power Input capacitor power dissipation 17. Cout Pd 15.04 μW Power Output capacitor power dissipation 18. Coul2 Pd 18.75 mW Power Output capacitor? power dissipation 19. Diode Pd 777.36 mW Power IC power dissipation 20. IC Pd 1.412 W Power Total Power Dissipation 21. Total Pd 4.129 W Power Total Power Dissipation 23. BOM Count 19 System Duty cycle 24. Duty Cycle 29.501 % System Duty cycle 25. Efficiency 84.752 % System System	10.	IC Pd	1.412 W	IC	IC power dissipation
13. lin Avg 501.46 mA IC Average input current 14. Vout Iso 15.064 V Op Point Secondary Side Output Voltage 15. Vout Pri 15.582 V Op Point Primary Side Output Voltage 16. Cin Pd 2.496 mW Power Input capacitor power dissipation 17. Cout Pd 15.04 µW Power Output capacitor power dissipation 18. Cout2 Pd 18.75 mW Power Output capacitor power dissipation 19. Diode Pd 777.36 mW Power Diode power dissipation 19. Diode Pd 777.36 mW Power Total Power dissipation 21. Total Pd 4.129 W Power Total Power Dissipation 22. Xformer Pd 1.919 W Power Total Design BOM count 23. BOM Count 19 System Duty cycle 24. Duty Cycle 29.501 % System System Information 25. Efficiency 48.752 % System Information System Information	11.	IC Tj	85.48 degC	IC	IC junction temperature
14. Vout Iso 15.064 V Op Point 15.582 V Op Point 15.582 V Op Point Primary Side Output Voltage 16. Cin Pd 2.496 mW Power Input capacitor power dissipation 17. Cout Pd 15.04 μW Power Input capacitor power dissipation 18. Cout2 Pd 18.75 mW Power Output capacitor 2 power dissipation 19. Diode Pd 777.36 mW Power Diode power dissipation 20. IC Pd 1.412 W Power Diode power dissipation 21. Total Pd 4.129 W Power Total Power Dissipation 22. Xformer Pd 1.919 W Power Transformer power dissipation 23. BOM Count 19 System Information 24. Duty Cycle 29.501 % System Information 25. Efficiency 84.752 % System Information 26. FootPrint 1.022 k mm² System Information 27. Frequency 275.801 kHz System Information 28. Total BOM \$12.67 System Information 30. Vout Actual 15.3 V System Information 31. Vout Tolerance 3.028 % System Information Information 32. Vout p-p	12.	ICThetaJA	39.3 degC/W	IC	IC junction-to-ambient thermal resistance
15. Vout Pri 15.582 V Op Point Primary Side Output Voltage 16. Cin Pd 2.496 mW Power Input capacitor power dissipation 17. Cout Pd 15.04 µW Power Output capacitor power dissipation 18. Cout2 Pd 18.75 mW Power Output capacitor? power dissipation 19. Diode Pd 777.36 mW Power Diode power dissipation 10. IC Pd 1.412 W Power IC power dissipation 21. Total Pd 4.129 W Power Total Power Dissipation 22. Xformer Pd 1.919 W Power Transformer power dissipation 23. BOM Count 19 System Total Dower Dissipation 24. Duty Cycle 29.501 % System Duty cycle 25. Efficiency 84.752 % System System Information System Information 27. Frequency 275.801 kHz System Information System Information <td>13.</td> <td>lin Avg</td> <td>501.46 mA</td> <td>IC</td> <td></td>	13.	lin Avg	501.46 mA	IC	
16. Cin Pd	14.	Vout Iso	15.064 V	Op Point	Secondary Side Output Voltage
17. Cout Pd 15.04 µW Power Output capacitor power dissipation 18. Cout2 Pd 18.75 mW Power Output capacitor2 power dissipation 19. Diode Pd 777.36 mW Power Diode power dissipation 20. IC Pd 1.412 W Power IC power dissipation 21. Total Pd 4.129 W Power Total Power Dissipation 22. Xformer Pd 1.919 W Power Transformer power dissipation 23. BOM Count 19 System Information Total Power Dissipation 24. Duty Cycle 29.501 % System Information Duty cycle 25. Efficiency 84.752 % System Information System Information 26. FootPrint 1.022 k mm² System Information Switching frequency 27. Frequency 275.801 kHz System Information Switching frequency 28. Total BOM \$12.67 System Information Total BOM Cost 29. Vin 54.0 V System Information Vout Actual calculated based on selected voltage divider resistors information 31. Vout Tolerance 3.028 % System Information Information Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable 32. Vout p-p 17.308 mV Transformer Information Information Information Information Information Information I	15.	Vout Pri	15.582 V	Op Point	Primary Side Output Voltage
18. Cout2 Pd 18.75 mW Power Output capacitor2 power dissipation 19. Diode Pd 777.36 mW Power Diode power dissipation 20. IC Pd 1.412 W Power IC power dissipation 21. Total Pd 4.129 W Power Total Power Dissipation 22. Xformer Pd 1.919 W Power Total Power Dissipation 23. BOM Count 19 System Information 24. Duty Cycle 29.501 % System Information 25. Efficiency 84.752 % System Information 26. FootPrint 1.022 k mm² System Information 27. Frequency 275.801 kHz System Information 28. Total BOM \$12.67 System Information 29. Vin 54.0 V System Information 30. Vout Actual 15.3 V System Information 31. Vout Tolerance 3.028 % System Information 32. Vout p-p 17.308 mV System Information Information 33. T1 Iprim RMS 1.217 A Transformer Informer 34. T1 Iprim pk 1.8 A Transformer	16.	Cin Pd	2.496 mW	Power	Input capacitor power dissipation
19. Diode Pd 777.36 mW Power 10 de power dissipation 10 power dissipatio	17.	Cout Pd	15.04 μW	Power	Output capacitor power dissipation
20. IC Pd	18.	Cout2 Pd	18.75 mW	Power	Output capacitor2 power dissipation
21. Total Pd 4.129 W Power Total Power Dissipation 22. Xformer Pd 1.919 W Power Transformer power dissipation 23. BOM Count 19 System Information 24. Duty Cycle 29.501 % System Information 25. Efficiency 84.752 % System Information 26. FootPrint 1.022 k mm² System Information 27. Frequency 275.801 kHz System Information 28. Total BOM \$12.67 System Information 29. Vin 54.0 V System Information 30. Vout Actual 15.3 V System Information 31. Vout Tolerance 3.028 % System Information 32. Vout p-p 17.308 mV System Information 33. T1 Iprim RMS 1.217 A Transformer Transformer Primary Pask Current 34. T1 Iprim RMS 1.263 A Transformer Transformer Primary Pask Current 35. T1 Is1 RMS 2.063 A Transformer Transformer Secondary1 RMS Current 36. T1 Is1 RMS 2.063 A Transformer Transformer Secondary1 RMS Current	19.	Diode Pd	777.36 mW	Power	
22. Xformer Pd 1.919 W Power Transformer power dissipation 23. BOM Count 19 System Information 24. Duty Cycle 29.501 % System Duty cycle 25. Efficiency 84.752 % System Information 26. FootPrint 1.022 k mm² System Information 27. Frequency 275.801 kHz System Information 28. Total BOM \$12.67 System Information 29. Vin 54.0 V System Information 30. Vout Actual 15.3 V System Information 31. Vout Tolerance 3.028 % System Information 32. Vout p-p 17.308 mV System Information 33. T1 Iprim RMS 1.217 A Transformer Transformer Primary Peak Current 34. T1 Iprim RMS 1.217 A Transformer Transformer Primary Peak Current 35. T1 Is1 RMS 2.063 A Transformer Transformer Secondary1 RMS Current 34. T1 Is1 RMS 2.063 A Transformer Transformer Secondary1 RMS Current	20.	IC Pd	1.412 W	Power	IC power dissipation
23. BOM Count 19 System Information 24. Duty Cycle 29.501 % System Duty cycle Information 25. Efficiency 84.752 % System Information 26. FootPrint 1.022 k mm² System Information 27. Frequency 275.801 kHz System Information 28. Total BOM \$12.67 System Information 29. Vin 54.0 V System Information 30. Vout Actual 15.3 V System Information 31. Vout Tolerance 3.028 % System Vout Actual Calculated based on selected voltage divider resistors Information 32. Vout p-p 17.308 mV System Peak-to-peak output ripple voltage Information 33. T1 Iprim RMS 1.217 A Transformer 34. T1 Iprim RMS 1.218 A Transformer 35. T1 Ist RMS 2.063 A Transformer Transformer Frimary Pask Current	21.	Total Pd	4.129 W	Power	Total Power Dissipation
Information System Duty cycle 29.501 % System Information System Information System Information System Steady state efficiency Information System Information System Total Foot Print Area of BOM components Information System Information System Switching frequency Information System Information System Total BOM Cost Information System Information System Information System Information System Information System Vin operating point Information System Vout Actual calculated based on selected voltage divider resistors information System Information Information Information System Peak-to-peak output ripple voltage System Peak-to-peak output ripple voltage System Transformer Transformer Primary RMS Current Transformer Primary Peak Current Transformer Primary Peak Current Transformer Secondary 1 RMS Current Transformer Transformer Transformer Transformer Transformer Transformer Transformer Transformer Transfo			1.919 W	Power	
24. Duty Cycle 29.501 % System Information 25. Efficiency 84.752 % System System Information 26. FootPrint 1.022 k mm² System Information 27. Frequency 275.801 kHz System Information 28. Total BOM \$12.67 System Information 29. Vin 54.0 V System Information 30. Vout Actual 15.3 V System Information 31. Vout Tolerance 3.028 % System Vout Tolerance Information 32. Vout p-p 17.308 mV System Information 33. T1 Iprim RMS 1.217 A Transformer 34. T1 Iprim pk 1.8 A Transformer Transformer Frimary Peak Current Transformer Secondary1 RMS Current Transformer Secondary1 RMS Current Transformer Secondary1 RMS Current Transformer Secondary1 RMS Current	23.	BOM Count	19	System	Total Design BOM count
Information System Steady state efficiency System Information System Switching frequency System Information System Information System Information System				Information	
25. Efficiency 84.752 % System Information 26. FootPrint 1.022 k mm² System Information 27. Frequency 275.801 kHz System Information 28. Total BOM \$12.67 System Information 29. Vin 54.0 V System Information 30. Vout Actual 15.3 V System Information 31. Vout Tolerance 3.028 % System Information 32. Vout p-p 17.308 mV System Information 33. T1 Iprim RMS 1.217 A Transformer Transformer Transformer Primary Peak Current 35. T1 Is1 RMS 2.063 A Transformer Transformer Secondary1 RMS Current Total Foot Print Area of BOM components Total Foot Print Area of BOM contact Total BoM cost Tot	24.	Duty Cycle	29.501 %	System	Duty cycle
Information System System Total Foot Print Area of BOM components Information System Information System Switching frequency Information System Information System Information Information System Information Information System Information Information Information System Vin operating point Information System Vout Actual System Vout Actual System Vout Actual System Information System Information System System Information System System System System Peak-to-peak output ripple voltage Information Information System Information System Peak-to-peak output ripple voltage Information Inform					
26. FootPrint 1.022 k mm² System Information 27. Frequency 275.801 kHz System Switching frequency Information 28. Total BOM \$12.67 System Information 29. Vin 54.0 V System Vin operating point Information 30. Vout Actual 15.3 V System Information Information 31. Vout Tolerance 3.028 % System Vout Actual calculated based on selected voltage divider resistors Information 32. Vout p-p 17.308 mV System Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable Peak-to-peak output ripple voltage 17.208 mV Transformer Transformer Primary RMS Current Transformer Primary Peak Current Transformer Primary Peak Current Transformer Primary Peak Current Transformer Secondary1 RMS Current Transformer Secondary1 RMS Current	25.	Efficiency	84.752 %	•	Steady state efficiency
Information System Switching frequency System Information System Information System Information System Information System Information System Information System Vin operating point System Vout Actual calculated based on selected voltage divider resistors Information System Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable System Information System Sy					
27. Frequency 275.801 kHz System Information Switching frequency Information System Total BOM Cost 28. Total BOM \$12.67 System Total BOM Cost Information System Vin operating point 30. Vout Actual 15.3 V System Vout Actual calculated based on selected voltage divider resistors Information 31. Vout Tolerance 3.028 % System Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable 32. Vout p-p 17.308 mV System Peak-to-peak output ripple voltage 33. T1 Iprim RMS 1.217 A Transformer Transformer Primary RMS Current 34. T1 Iprim pk 1.8 A Transformer Transformer Primary Peak Current 35. T1 Is1 RMS 2.063 A Transformer Transformer Secondary1 RMS Current	26.	FootPrint	1.022 k mm²	•	Total Foot Print Area of BOM components
Information 28. Total BOM \$12.67 System Total BOM Cost 29. Vin 54.0 V System Information 30. Vout Actual 15.3 V System Vout Actual calculated based on selected voltage divider resistors 31. Vout Tolerance 3.028 % System Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable 32. Vout p-p 17.308 mV System Peak-to-peak output ripple voltage 33. T1 Iprim RMS 1.217 A Transformer Transformer Primary RMS Current 34. T1 Iprim pk 1.8 A Transformer Transformer Primary Peak Current 35. T1 Is1 RMS 2.063 A Transformer Transformer Secondary1 RMS Current					
28. Total BOM \$12.67 System Information 29. Vin 54.0 V System Vin operating point 30. Vout Actual 15.3 V System Information 31. Vout Tolerance 3.028 % System Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable 32. Vout p-p 17.308 mV System Peak-to-peak output ripple voltage 33. T1 Iprim RMS 1.217 A Transformer Transformer Primary RMS Current 34. T1 Iprim pk 1.8 A Transformer Transformer Primary Peak Current 35. T1 Is1 RMS 2.063 A Transformer Transformer Secondary1 RMS Current	27.	Frequency	275.801 kHz	•	Switching frequency
Information System Vin operating point			_		
29. Vin 54.0 V System Information 30. Vout Actual 15.3 V System Vout Actual calculated based on selected voltage divider resistors 31. Vout Tolerance 3.028 % System Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable 32. Vout p-p 17.308 mV System Peak-to-peak output ripple voltage Information 1.217 A Transformer Transformer Primary RMS Current 34. T1 Iprim pk 1.8 A Transformer Transformer Primary Peak Current 35. T1 Is1 RMS 2.063 A Transformer Transformer Secondary1 RMS Current	28.	Total BOM	\$12.67	•	Total BOM Cost
Information System Vout Actual calculated based on selected voltage divider resistors					
30. Vout Actual 15.3 V System Information 31. Vout Tolerance 3.028 % System Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable 32. Vout p-p 17.308 mV System Peak-to-peak output ripple voltage Information 15.3 V System Peak-to-peak output ripple voltage 33. T1 Iprim RMS 1.217 A Transformer Transformer Primary RMS Current 34. T1 Iprim pk 1.8 A Transformer Transformer Primary Peak Current 35. T1 Is1 RMS 2.063 A Transformer Transformer Secondary1 RMS Current	29.	Vin	54.0 V		Vin operating point
Information 31. Vout Tolerance 3.028 % System Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable 32. Vout p-p 17.308 mV System Peak-to-peak output ripple voltage Information 33. T1 Iprim RMS 1.217 A Transformer Transformer Primary RMS Current 34. T1 Iprim pk 1.8 A Transformer Transformer Primary Peak Current Transformer Secondary1 RMS Current Transformer Secondary1 RMS Current					
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Design Inputs

Name	Value	Description
lout	1.5	Maximum Output Current
VinMax	54.0	Maximum input voltage

Name	Value	Description
VinMin	44.0	Minimum input voltage
Vout	15.5	Output Voltage
base_pn	LM5160-Q1	Base Product Number
source	DC	Input Source Type
Та	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

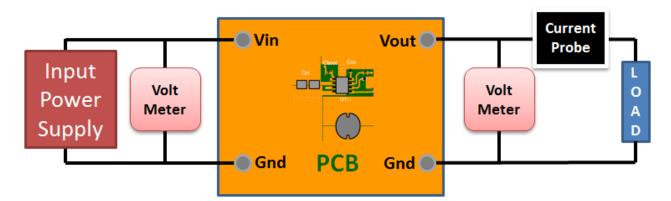
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 44.0V 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 lout 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.



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. The LM5160-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application
- 3. Master key: 367A9DEDF30391D0[v1]
- 4. LM5160-Q1 Product Folder: http://www.ti.com/product/LM5160%2DQ1: contains the data sheet and other resources.

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