UCC28740 DESIGN CALCUL

TI Literature Number: SLUC487B

Disclaimer

This product is designed as an aid for customers of Texas Instruments. No warranties, either e
fitness for any particular purpose, are claimed by Texas Instruments or the author. The software
to its quality and performance is with the cust

UCC28740 CONSTANT-VOLTAGE, CONSTANT-CURRENT F

CLEAR ALL USER INPUT CELLS BEFORE START

ALL GREEN CELLS ARE USER INP

WHERE APPLICABLE, A RECOMMENDED VALUE IS GIVEN THAT WILL BE THE BEST CHO
THE BEST INTEREST OF THE USER TO USE A VALUE AS CLOSE AS POSSIBLE TO TH
ACCURATE RESULTS, THE USER MUST ENTER THE ACTUAL VALUE U

DESIGN REQUIREMENTS

INPUT SPECIFICATIONS

Input Voltage Type, AC or DC:	AC	
Minimum Input Voltage, $V_{INPUTmin}$ =	85	VAC
Maximum Input Voltage, $V_{INPUTmax}$ =	265	VAC
Nominal Input Voltage, $V_{INPUTnom}$ =	230	VAC
Minimum Line Frequency, $f_{LINEmin}$ =	47	Hz
Minimum Input Voltage for Start-Up, $V_{INPUTrun}$ =	80	VAC

OUTPUT SPECIFICATIONS

Regulated Output Voltage, Constant Voltage Mode, V_{OUT_CV} =	12.2	VDC
Full Load Rated Output Current, I_{OUT} =	0.55	A
Target Constant Current Mode Output Load Threshold, I_{OCC} =	0.55	A
Target Minimum Output Voltage During Constant Current Regulation, V_{OUT_CC} =	12.1	VDC
Allowable Output Voltage Drop During Load-Step Transient in Constant Voltage Mode, $V_{OUT\Delta}$ =	0.2	V
Maximum Peak to Peak Output Voltage Ripple, V_{RIPPLE} =	30	mV

Maximum Desired Switching Frequency, User must input value not greater than 100 kHz, f_{max} =	100	kHz
Output Over Voltage Protection, V_{OUT_OVP} =	12.4	V
Required Positive Load Step Transient Current, I_{TRAN} =	0.6	A
Maximum Allowable Response Time to Load Step Transient, t_{RESP} =	20	ms
Target Maximum Stand By Power Dissipation, $P_{SBtarget}$ =	50	mW

COMPONENT SELECTION USER INPU		
COMPONENT	**PARAMETER**	
Input Capacitor, C_{BULK}		
Desired Minimum Valley Voltage, $V_{BULKvalley\_desired}$ =	100	V
Recommended Input Bulk Capacitance, C_{BULK} =	30.68	µF
Actual Input Bulk Capacitance, C_{BULK}, Used =	46.00	µF
Output Rectifier, D_{OUT}		
Forward Voltage Drop of Output Rectifier, V_F =	1.25	V
Output Inductor, L_{OUT}		
DCR of Output Inductor, DCR_{Lout}, if used =	0	mΩ

Flyback Transformer, Primary to Secondary Turns Ratio		
Ideal Primary to Secondary Turns Ratio, $N_{PSideal}$ =	8.856	
Actual Primary to Secondary Turns Ratio Used, N_{PS} =	8.880	Enter Actual N_{PS} of Transformer Used
Current Sense Resistor, R_{CS}		
Recommended Current Sense Resistor, R_{CS} =	2.487	Ω
Actual Current Sense Resistor Used, R_{CS} =	2.650	Ω
Flyback Transformer, T		
Recommended Primary Inductance Value, L_P =	1933.517	µH

Actual Primary Inductance Used, L_P =	1900.000	µH
Recommended Primary to Auxillary Turns Ratio, N_{PA} =	12.611	Suggested N_P
Actual Primary to Auxiliary Turns Ratio, N_{PA} =	9.250	Enter Actual N_{PA} of Transformer Used
MOSFET Switch, Q		
Required Drain to Soure Voltage Rating , $V_{DSrated}$ =	642.463	V
MOSFET Rated Drain to Source Voltage, V_{DS} =	800	V
Output Capacitance of Selected MOSFET, C_{OSS} =	16	pF
Drain to Source On-Resistance of Selected MOSFET, R_{DSon} =	0.36	Ω
MOSFET Fall Time, t_f =	6	ns
MOSFET Turn Off Delay Time, t_{Doff} =	40	ns
MOSFET Total Gate Charge, Q_g =	30	nC

Output Capacitor, C_{OUT}		
Recommended Minimum Output Capacitance, C_{OUT} =	470.000	µF
Actual Minimum Output Capacitance, C_{OUT} =	540.000	µF
Recommended Maximum ESR, ESR_{Cout} =	11.582	mΩ
Actual ESR of C_{OUT} Used, ESR_{Cout} =	50.000	mΩ
Bridge Rectifier, D_{BRIDGE}		
Forward Voltage Drop, $V_{F\ BRIDGE}$ =	1.1	V
Auxiliary Winding Rectifier, D_{AUX}		
Auxiliary Rectifier Forward Voltage Drop, V_{FA} =	1.25	V
Input Line Voltage Turn On Resistor, R_{VS1}		
Recommended Value for R_{VS1}, R_{VS1} =	44.200	kΩ
Actual Value for R_{VS1}, R_{VS1} =	44.200	kΩ
Output Over Voltage Resistor, R_{VS2}		
Recommended Value for R_{VS2}, R_{VS2} =	33.200	kΩ
Actual Value for R_{VS2}, R_{VS2} =	33.200	kΩ
Line Compensation Resistor, R_{LC}		
Recommended Value for R_{LC}, R_{LC} =	1.270	kΩ
Actual Value for R_{LC}, R_{LC} =	1.270	kΩ
Loop Compensation Components, R_{FB1}, R_{FB2}, R_{TL}, R_{OPT}, C_{FB}, C_{EXT}, R_{FB3}, R_{FB4}, C_Z		
Reference Voltage of Shunt Regulator, i.e. TL431, V_{REF431} =	2.5	V
Maximum Reference Input Current of Shunt Regulator, I_{REF431} =	4	µA
Recommended Value for R_{FB2}, R_{FB2} =	44.2	kΩ

Actual Value for R_{FB2}, R_{FB2} =	44.2	kΩ
Recommended Value for R_{FB1}, R_{FB1} =	169	kΩ
Actual Value for R_{FB1}, R_{FB1} =	169	kΩ
Minimum Current Transfer Ratio of Selected Opto-Coupler, CTR_{min} =	50	%
Response Fall Time of Opto-Coupler, t_{f_opto} =	18	µs
R_L of Specified Opto-Coupler Fall Time, R_{L_opto} =	100	Ω
Cut-Off Frequency of Opto-Coupler, f_{c_opto} =	2	kHz
Input Forward Voltage of Opto-Coupler, V_{F_opto} =	1.2	V
Recommended External Capacitor Across Opto-Coupler Output, C_{EXT} =	0	µF
Actual Value for C_{EXT} Used , C_{EXT} =	0.0015	µF
Recommended Capacitor on Opto_Coupler Emitter, C_{FB} =	0.047	µF
Actual Value for C_{FB} Used, C_{FB} =	0.047	µF
Recommended Value For $R_{FB4,}$ R_{FB4} =	22	kΩ
Actual Value for R_{FB4} Used	22	kΩ
Recommended Value for Shunt Regulator Bias Resistor, R_{TL} =	1.5	kΩ
Actual Value of Shunt Regulator Bias Resistor Used, R_{TL} =	1.5	kΩ
Recommended Value for Compensation Capacitor, C_Z =	1500	pF
Actual Value of Compensation Capacitor Used, C_Z =	1500	pF

ATOR TOOL

xpressed or implied, with respect to this software or its
is licensed solely on an "as is" basis. The entire risk as
omer.

FLYBACK DESIGN CALCULATOR

ING A NEW DESIGN
PUTS

OICE TO MEET THE GIVEN SPECIFICATION. IT IS IN
HE SUGGESTED RECOMMENDED VALUE. FOR
SED IN THE APPROPRIATE CELL.

Choose either AC or DC

For universal line enter 47 Hz

Recommend target to be a minimum of 5% higher than rated Iout

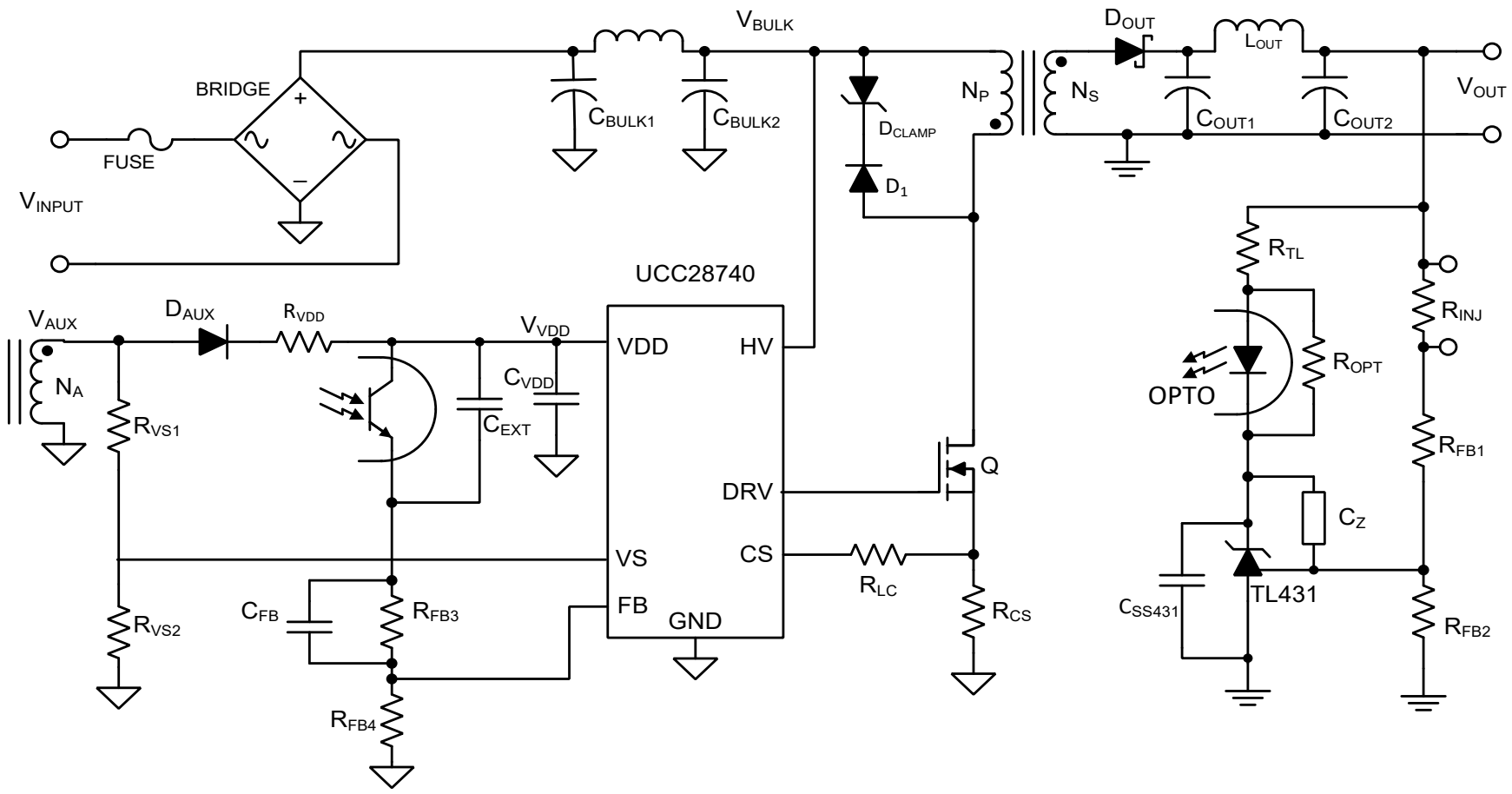
JTS
COMMENT
Used to determine the required input bulk capacitor at minimum line, full load. For DC input, use $V_{INPUTrun}$
Using a value less than recommended will result in a minimum valley voltage less than desired, requiring a larger power stage to accommodate the higher currents due to the lower input rail. Using a value larger than recommended will result in a higher input rail and lower currents on the power stage but higher peak current in the input capacitor itself.
Enter actual input bulk capacitor used
Enter V_F at full load
Enter 0 if no secondary LC filter used

Recommended N_{PS}
Recommended R_{CS}
Enter Actual R_{CS} Used

A

Recommended C_{OUT}
Enter Actual C_{OUT} Used
Recommended ESR
Enter Actual ESR of C_{OUT} Used
At I_{INPEAK} Not Applicable for DC input
Recommended R_{VS1}
Enter Actual R_{VS1} Used
Recommended R_{VS2}
Enter Actual R_{VS2} Used
Recommeded R_{LC}
Enter Actual R_{LC} Used
Enter Nominal V_{REF} Used
Enter Reference Pin Input Current
Recommended R_{FB2}

Enter Actual R_{FB2} Used
Recommended R_{FB1}
Enter Actual R_{FB1} Used
Enter CTR_{min}
Enter Opto-Coupler t_f
Enter R_L from Opto-Coupler t_f spec
Enter Opto-Coupler Cut-Off Frequency
Enter Maximum V_F of Opto-Coupler
Recommended C_{EXT}
Enter Actual C_{EXT} Used
Recommended C_{FB}
Enter Actual C_{FB} Used
Recommended R_{FB4}
Enter Actual R_{FB4} Used
Recommended R_{TL}
Enter Actual R_{TL} Used
Recommended C_Z
Enter Actual C_Z Used



RECOMMENDED BILL OF MATERIALS			
Reference Designator	**Description/Comments**		
BRIDGE RECTIFIER	Minimum DC Blocking Voltage:	400 V	
	Minimum Current Rating:	0.148 A	
	Power Dissipation:	489.336 mW	
$C_{BULKtotal} = C_{BULK1} + C_{BULK2}$	Type:	Aluminum Electrolytic	
	Value:	46 µF	Total Capacitance
	Minimum Voltage Rating:	400 V	
	Minimum Ripple Current Rating:	222.425 mA	
C_{EXT}	Type:	Ceramic	
	Value:	0.0015 µF	±10%
	Minimum Voltage Rating:	50 V	
C_{FB}	Type:	Ceramic	
	Value:	0.047 µF	±10%
	Minimum Voltage Rating:	10 V	
$C_{OUTtotal} = C_{OUT1} + C_{OUT2}$	Type:	Aluminum Electrolytic	
	Minimum Value:	540 µF	Total Capacitance
	Minimum Voltage Rating:	12.200 V	
	Minimum Ripple Current Rating:	0.830 A	
	Maximum ESR Rating:	11.582 mΩ	
C_{SS431}	Type:	Ceramic	
	Value:	1 µF	±10%
	Minimum Voltage Rating:	10 V	
C_{VDD}	Type:	Ceramic	
	Minimum Value:	15 µF	±10%
	Voltage Rating:	50 V	
C_{Z}	Type:	Ceramic	
	Value:	1500 pF	±10%
	Voltage Rating:	10 V	
D_{AUX}	Type:	Switching	
	Minimum Required Blocking Voltage:	63.889 V	
	Minimum Rated Current:	250 mA	

D_{CLAMP}	Type:	Transient Voltage Suppressor	
	Voltage:	265.797 V	
	Power Rating:	600.000 W	
D_{OUT}	Type:	Schottky	
	Minimum Blocking Voltage Rating:	84.536 V	
	Minimum Average Current Rating:	0.975 A	
	Power Dissipation:	0.688 W	
D_1	Type:	Ultra Fast	
	Voltage Rating:	1000 V	
	Current Rating:	1 A	
FUSE	Type:	Slow Blow	
	Minimum Voltage Rating:	265 VAC	
	Minimum Peak Current Rating:	0.536 A	
OPTO-COUPLER	CTR_{min}:	50 %	
Q	Minimum V_{DS} Voltage Rating:	800 V	
	Minimum Continuous Current Rating:	1.230 A	
	Minimum Repetitive Peak Current Rating:	3.087 A	
	Power Dissipation:	0.092 W	
R_{CS}	Value:	2.650 Ω	±1%
	Power Dissipation:	35.799 mW	
	Type:	Low Inductance	
R_{FB1}	Value:	169 kΩ	±1%
	Power Rating:	1/10 W	
R_{FB2}	Value:	44.2 kΩ	±1%
	Power Rating:	1/10 W	
R_{FB3}	Value:	100 kΩ	±1%
	Power Rating:	1/10 W	
R_{FB4}	Value:	22 kΩ	±1%
	Power Rating:	1/10 W	
R_{INJ}	Value:	20 Ω	±1%
	Power Rating:	1/10 W	
R_{LC}	Value:	1.27 kΩ	±1%
	Power Rating:	1/10 W	
R_{OPT}	Value:	1 kΩ	±1%
	Power Rating:	1/10 W	
R_{TL}	Value:	1.5 kΩ	±1%
	Power Rating:	1/10 W	
R_{VDD}	Value:	2 to 50 Ω	As Needed for Voltage Spike Smoothing
	Power Rating:	1/10 to 1/2 W	
R_{VS1}	Value:	44.2 kΩ	±1%
	Power Rating:	1/10 W	
R_{VS2}	Value:	33.2 kΩ	±1%
	Power Rating:	1/10 W	
SHUNT REGULATOR	Voltage Reference:	2.5 V	
TRANSFORMER	Primary Inductance:	1900 µH	
	Primary to Secondary Turns Ratio:	8.880	N_{PS}
	Primary to Auxiliary Turns Ratio:	9.250	N_{PA}
	Peak Primary Current:	0.292 A	
	Primary RMS Current:	0.116 A	
	Peak Secondary Current:	2.590 A	

Secondary RMS Current:	0.975	A
Maximum Switching Frequency:	91.588	kHz

UCC28740 DESIGN CALCULATIONS

The Values Entered by the User on the DESIGN INPUT Page are Used in the Design Calculations

INPUT				
Input Voltage Type	AC or DC:	AC		User Input Values From Design Input Page
Minimum Input Voltage	$V_{INPUTmin}$ =	85	VAC	
Maximum Input Voltage	$V_{INPUTmax}$ =	265	VAC	
Nominal Input Voltage	$V_{INPUTnom}$ =	230	VAC	
Minimum Line Frequency	$f_{LINEmin}$ =	47	Hz	
Minimum Input Voltage for Start-Up	$V_{INPUTrun}$ =	80	VAC	
Minimum Peak Bulk Input Voltage	$V_{BULKmin}$ =	120.208	V	
Maximum Peak Bulk Input Voltage	$V_{BULKmax}$ =	374.767	V	
Nominal Peak Bulk Input Voltage	$V_{BULKnom}$ =	325.269	V	
Turn-On Peak Bulk Input Voltage	$V_{BULKstartup}$ =	113.137	V	
Line Cycle Period	t_{LINE} =	21.277	ms	
OUTPUT				
Regulated Output Voltage, Constant Voltage Mode	V_{OUT_CV} =	12.2	V	User Input Values From Design Input Page
Full Load Rated Output Current	I_{OUT} =	0.55	A	
Target Constant Current Mode Output Load Threshold	I_{OCC_target} =	0.55	A	
Target Minimum Output Voltage During Constant Current Regulation	V_{OUT_CC} =	12.1	V	
Allowable Output Voltage Drop During Load-Step Transient in Constant Voltage Mode	$V_{OUT\Delta}$ =	0.2	V	
Maximum Peak to Peak Output Voltage Ripple	V_{RIPPLE} =	30	mV	
Required Positive Load Step Transient Current	I_{TRAN} =	0.6	A	
Maximum Allowable Response Time to Load Step Transient	t_{RESP} =	20	ms	
Output Over Voltage Protection	V_{OUT_OVP} =	12.4	V	
Maximum Stand By Power Dissipation	$P_{SBtarget}$ =	50	mW	
Estimated Efficiency	η =	0.850		
Output Power	P_{OUT} =	6.710	W	
Estimated Input Power	P_{IN} =	7.894	W	

COMPONENT PARAMETER CALCULATIONS

INPUT CAPACITOR, C_{BULK}				
Recommended Input Bulk Capacitance	$C_{BULKrecommended}$ =	30.68	µF	
Actual Input Bulk Capacitance	$C_{BULKactual}$ =	46.000	µF	**User Input**
Input Capacitor Value Used in Calculations	C_{BULK} =	46.000	µF	
Minimum Valley Voltage on Input Bulk Capacitors	$V_{BULKvalley}$ =	106.572	V	
Minimum Input Capacitor Ripple Current Rating	$I_{CINripple}$ =	222.425	mA	
Minimum Input Capacitor Voltage Rating	V_{Cin} =	400	V	

INPUT FUSE				
Voltage Rating	V_{FUSE} =	265	VAC	
Peak Input Current	I_{INpeak} =	0.536	A	

BRIDGE RECTIFIER				
Voltage Rating	$V_{BRIDGE\_minrating}$ =	400.000	V	
Current Rating	$I_{BRIDGE\_minrating}$ =	0.148	A	
Forward Voltage Drop	V_{F_BRIDGE} =	1.100	V	**User Input**
Full Load Power Dissipation of Bridge Rectifier	P_{BRIDGE} =	489.336	mW	

TRANSFORMER TURNS-RATIO, N_{PS}				
Demagnetizing Duty Cycle	D_{DEMAG_CC} =	0.425		Device Parameter
Amplitude Modulation Control Ratio	K_{AMnom} =	4		Device Parameter
Maximum Desired Switching Frequency	f_{max_target} =	100.000	kHz	**User Input**
Desired Switching Period	t_{SW_target} =	10.000	µs	
Resonant Frequency During DCM Dead Time	f_{RES} =	0.500	MHz	
Time to First Resonant Valley	t_{RES} =	1.000	µs	
Estimated Maximum Duty Cycle	D_{max_target} =	0.475		

Ideal Primary to Secondary Turns Ratio	$N_{PSideal}$ =	8.8557		Ideal N_{PS}
Actual Primary to Secondary Turns Ratio	$N_{PSactual}$ =	8.880		**User Input**
Primary to Secondary Turns Ratio Used in Calculations	N_{PS} =	8.880		
Actual Flyback Voltage	$V_{FLYBACK}$ =	119.436	V	
Allowable Leakage Inductance Voltage Spike	$V_{LEAKAGE}$ =	305.797	V	
Estimated Maximum On-Time	$t_{ONestimated}$ =	4.756	µs	
Estimated Transformer Efficiency	η_{XFMR} =	0.9		

CURRENT SENSE RESISTOR, R_{CS}, PEAK PRIMARY CURRENT, I_{PP}				
Constant Current Regulation Factor, Minimum	V_{CCR_min} =	318	mV	Device Parameter
Constant Current Regulation Factor, Nominal	V_{CCR_nom} =	330	mV	Device Parameter
Constant Current Regulation Factor, Minimum	V_{CCR_min} =	343	mV	Device Parameter
Initial estimate for L_P	$L_{P\_estimate}$ =	1935.044	µH	
Recommended Current Sense Resistor Value	$R_{CSrecommended}$ =	2.487	Ω	
Actual Current Sense Resistor Used	$R_{CSactual}$ =	2.650	Ω	**User Input**
Current Sense Resistor Value Used in Calculation	R_{CS} =	2.650	Ω	
Power Dissipation of R_{CS}	P_{Rcs} =	35.799	mW	
Maximum Current Sense Threshold Voltage, Minimum	V_{CSTmax_min} =	738	mV	Device Parameter
Maximum Current Sense Threshold Voltage, Nominal	V_{CSTmax_nom} =	773	mV	Device Parameter
Maximum Current Sense Threshold Voltage, Maximum	V_{CSTmax_max} =	810	mV	Device Parameter
Peak Primary Current, Minimum, Full Load	I_{PPmin} =	0.278	A	
Peak Primary Current, Nominal, Full Load	**I_{PPnom} =**	**0.292**	**A**	
Peak Primary Current, Maximum, Full Load	I_{PPmax} =	0.306	A	
Actual Output Current During Constant Current Mode	**I_{OCC_actual} =**	**0.550**	**A**	
Peak Primary Current During Light Load, FM Mode	I_{PP_FM} =	0.073	A	
Worst Case Peak Primary Current	I_{PP_WC} =	0.309	A	Assumes -1%R_{CS} and V_{CSTmax_max}
Maximum Output Current During Constant Current Mode	I_{OCCmax} =	0.583	A	Worst Case Estimate

TRANSFORMER PRIMARY INDUCTANCE, L_P				
Calculated L_P to meet f_{max_target} with chosen R_{CS}	L_{Pcalc} =	1933.517	µH	
Recommended Primary Inductance to meet t_{CSLEB} with chosen R_{CS}	$L_{Precommended}$ =	1933.517	µH	Ideal L_P
Actual Primary Inductance	$L_{Pactual}$ =	1900.000	µH	**User Input**
Primary Inductance Used in Calculations	L_P =	1900.000	µH	
Actual Maximum Nominal Switching Frequency	**f_{max} =**	**91.588**	**kHz**	
Actual Switching Period	$t_{SWactual}$ =	10.919	µs	
Actual Maximum On-Time	t_{ONmax} =	5.201	µs	
Maximum Duty Cycle	D_{MAX} =	0.476		
Demagnetization Time	t_{DEMAG} =	4.640	µs	
Primary RMS Current	I_{PRI_RMS} =	0.116	A	
Secondary Peak Current	I_{SPmax} =	2.590	A	
Secondary RMS Current	I_{SEC_RMS} =	0.975	A	
VDD Under Voltage Lock Out (UVLO) Voltage, Maximum	VDD_{OFF_max} =	8.150	V	Device Parameter
VDD Under Voltage Lock Out (UVLO) Voltage, Minimum	VDD_{OFF_min} =	7.350	V	Device Parameter
Recommended Auxiliary to Secondary Turns Ratio	$N_{ASrecommended}$ =	0.704		
Recommended Primary to Auxilliary Turns Ratio	$N_{PArecommended}$ =	12.611		
Actual Primary to Auxiliary Turns Ratio	$N_{PAactual}$ =	9.250		**User Input**
Primary to Auxiliary Turns Ratio Used in Calculations	N_{PA} =	9.250		
Nominal VDD Voltage	**VDD =**	**11.662**	**V**	
Actual Auxiliary to Secondary Turns Ratio	N_{AS} =	0.960		
Minimum On-Time, t_{CSLEB}	$t_{ONmin(limit)}$ =	280.000	ns	
Actual Minimum On-Time	$t_{ONmin(actual)}$ =	369.714	ns	
Minimum Demagnetizing Time	$t_{DEMAGmin}$ =	1.160	µs	
Minimum Output Voltage During Constant Current Mode	**V_{OUT_CCmin} =**	**7.708**	**V**	

MOSFET, Q				
Required Drain to Soure Voltage Rating , $V_{DSrated}$ =	V_{DSmin_rating} =	642.463	V	
MOSFET Rated Drain to Source Voltage	V_{DS} =	800.000	V	**User Input Values From Design Input**
Output Capacitance of Selected MOSFET	C_{OSS} =	16	pF	
Drain to Source On-Resistance of Selected MOSFET	R_{DSon} =	0.360	Ω	

MOSFET Fall Time	t_f =	6.000	ns	**Page**
MOSFET Turn Off Delay Time	t_{Doff} =	40	ns	
MOSFET Total Gate Charge	Q_g =	30.000	nC	
Actual Resonant Frequency During DCM Dead Time	f_{RES_actual} =	0.645	MHz	
Actual Estimated Time to First Resonant Valley	t_{RES_actual} =	0.775	µs	
Valley Switching Achieved?	YES or NO	YES		
MOSFET V_{DS} Derating	$V_{DSderated}$ =	0.803		
MOSFET Continuous Current Rating	I_{DRAIN} =	1.230	A	
MOSFET Pulsed Current Rating	I_{PULSED} =	3.087	A	
Estimated MOSFET Conduction Losses	$P_{FETconduction}$ =	0.005	W	
Estimated MOSFET Switching Losses	$P_{FETswitching}$ =	0.087	W	
Total Estimated MOSFET Power Loss	P_{FET} =	0.092	W	
Recommended Clamping Voltage on Drain	$V_{DRAINclamp}$ =	265.797	V	

OUTPUT DIODE, D_{OUT}				
Forward Voltage Drop of Output Rectifier, V_F =	V_F =	1.250	V	**User Input**
Minimum Required Blocking Voltage Rating	$V_{DOUT\_blocking}$ =	84.536	V	
Required Minimum Average Rectified Output Current	I_{Dout} =	0.975	A	
Power Dissipation of D_{OUT}	P_{Dout} =	0.688	W	

AUXILIARY WINDING DIODE, D_{AUX}				
Auxiliary Rectifier Forward Voltage Drop	V_{FA} =	1.250	V	**User Input**
Minimum Required Blocking Voltage Rating	$V_{DBIAS\_blocking}$ =	63.889	V	

OUTPUT INDUCTOR, L_{OUT}				
DCR of Output Inductor	DCR_{Lout} =	0	mΩ	**User Input**

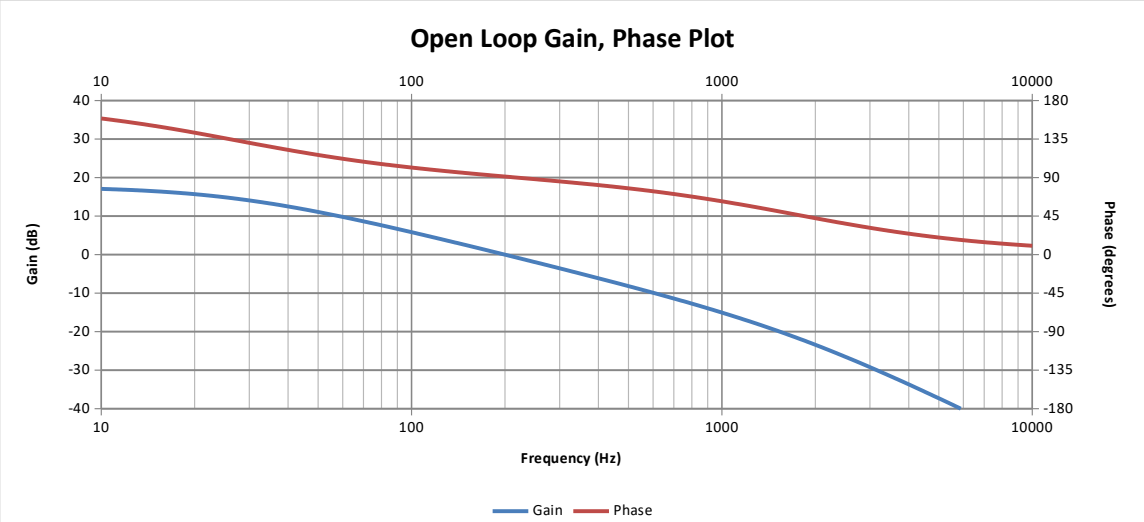
OUTPUT CAPACITOR, C_{OUT}				
Minimum Required C_{OUT} Without Opto-Coupled FeedBack	$C_{OUT\_no\_opto}$ =	60000.000	µF	The importance of using opto feedback should be noted here!
Recommended Minimum Required Output Capacitor With Opto-Coupled FeedBack	$C_{OUTrecommended}$ =	470.000	µF	
Actual Output Capacitance Used	$C_{OUTactual}$ =	540.000	µF	**User Input**
C_{OUT} Used in Calculations	C_{OUT} =	540.000	µF	
Required Minimum Ripple Current Rating	$I_{COUTrms}$ =	0.830	A	
Recommended Maximum ESR	$ESR_{Coutrecommended}$ =	11.582	mΩ	
Actual ESR of C_{OUT} Used	$ESR_{Coutactual}$ =	50.000	mΩ	**User Input**
ESR Used in Calculations	ESR_{Cout} =	50.000	mΩ	
Resultant Output Voltage Peak to Peak Ripple	**$V_{OUTripple}$ =**	**129.622**	**mV**	

VOLTAGE SENSE DIVIDER, R_{VS1}, R_{VS2}				
VS Line Sense Run Current, Minimum	I_{VSLrun_min} =	190	µA	Device Parameter
VS Line Sense Run Current, Nominal	I_{VSLrun_nom} =	225	µA	Device Parameter
VS Line Sense Run Current, Maximum	I_{VSLrun_max} =	275	µA	Device Parameter
VS Line Sense Stop Current, Minimum	$I_{VSLstop\_min}$ =	70	µA	Device Parameter
VS Line Sense Stop Current, Nominal	$I_{VSLstop\_nom}$ =	80	µA	Device Parameter
VS Line Sense Stop Current, Maximum	$I_{VSLstop\_max}$ =	100	µA	Device Parameter
Recommended Resistor Value for Minimum Start Up Line Voltage	$R_{VS1recommended}$ =	44.200	kΩ	
Actual Resistor Value Used for Minimum Start Up Line Voltage	$R_{VS1actual}$ =	44.2	kΩ	**User Input**
R_{VS1} Value Used in Calculations	R_{VS1} =	44.2	kΩ	
Resultant Turn On Voltage, Minimum	$V_{TURNONmin}$ =	54.929	VAC	
Resultant Turn On Voltage, Nominal	**$V_{TURNONnom}$ =**	**65.048**	**VAC**	
Resultant Turn On Voltage, Maximum	$V_{TURNONmax}$ =	79.503	VAC	
Resultant Input Brown Out Voltage, Minimum	$V_{BROWNOUTmin}$ =	29.879	VAC	
Resultant Input Brown Out Voltage, Nominal	**$V_{BROWNOUTnom}$ =**	**32.770**	**VAC**	
Resultant Input Brown Out Voltage, Maximum	$V_{BROWNOUTmax}$ =	38.552	VAC	
Internal VS Over Voltage Threshold, Minimum	V_{OVPmin} =	4.52	V	Device Parameter
Internal VS Over Voltage Threshold, Nominal	V_{OVPnom} =	4.600	V	Device Parameter
Internal VS Over Voltage Threshold, Maximum	V_{OVPmax} =	4.710	V	Device Parameter
Recommended Resistor Value for Desired Output Over Voltage Limit	$R_{VS2recommended}$ =	33.200	kΩ	
Actual Resistor Value Used for Desired Output Over Voltage Limit	$R_{VS2actual}$ =	33.200	kΩ	**User Input**
R_{VS2} Used in Calculations	R_{VS2} =	33.200	kΩ	
Resultant Output Over Voltage Threshold, Minimum	V_{OUT_OVPmin} =	12.227	V	
Resultant Output Over Voltage Threshold, Nominal	**V_{OUT_OVPnom} =**	**12.421**	**V**	**Actual Output Over Voltage**
Resultant Output Over Voltage Threshold, Maximum	V_{OUT_OVPmax} =	12.688	V	

LINE COMPENSATION, R_{LC}				
Line Compensation Current Ratio, Nominal	K_{LCnom} =	25	A/A	Device Parameter
Total Estimated Current Sense Delay	t_{DELAY} =	90	ns	
Recommended Resistor Value for Line Compensation	$R_{LCrecommended}$ =	1.270	kΩ	
Actual Resistor Value Used for Line Compensation	$R_{LCactual}$ =	1.270	kΩ	**User Input**
R_{LC} Used in Calculations	R_{LC} =	1.270	kΩ	
Result of R_{LC} selection	**Output Constant Current will have minimal deviation over input line voltage range.**			

VDD CAPACITOR, C_{VDD}				
Device Supply Current During Run Mode, Maximum	I_{RUNmax} =	2.65	mA	Device Parameter
VDD_{ON} Voltage, Maximum	VDD_{ONmax} =	23	V	Device Parameter
VDD_{OFF} Voltage, Maximum	VDD_{OFFmax} =	8.15	V	Device Parameter
Estimated Minimum Switching Frequency at No-Load	f_{SWmin} =	7.918	kHz	
Estimated Over Voltage Charge Duration	t_{OV} =	20.000	ms	
Minimum VDD Capacitor for Start UP	C_{VDD1} =	4.700	µF	
Minimum VDD Capacitor for Load Transient	C_{VDD2} =	15.000	µF	
Minimum VDD Capacitor for Target Ripple on VDD	C_{VDD3} =	0.330	µF	
Recommended Capacitor on VDD	$C_{VDDrecommended}$ =	15.000	µF	

OPTO-COUPLED FEEDBACK				
Reference Voltage of TL431 Shunt Regulator	$VREF_{431}$ =	2.5	V	**User Input**
Shunt Regulator Reference Input Current, Maximum	I_{REF431} =	4	µA	**User Input**
Recommended Bottom Resistor Value for Output Voltage Set Point	$R_{FB2recommended}$ =	44.2	kΩ	
Actual Bottom Resistor Value Used for Output Voltage Set Point	$R_{FB2actual}$ =	44.2	kΩ	**User Input**
R_{FB2} Used in Calculations	R_{FB2} =	44.2	kΩ	
Recommended Top Resistor Value for Output Voltage Set Point	$R_{FB1recommended}$ =	169	kΩ	
Actual Top Resistor Value Used for Output Voltage Set Point	$R_{FB1actual}$ =	169	kΩ	**User Input**
R_{FB1} Used in Calculations	R_{FB1} =	169.02	kΩ	
Noise Injection Resistor For Loop Analysis	R_{INJ} =	20	Ω	**May be changed by User here**
Resultant Nominal Constant Voltage Output Voltage	**V_{OUT_CV} =**	**12.060**	**V**	
Minimum Current Transfer Ratio of Selected Opto-Coupler	CTR_{min} =	50	%	**User Input**
Response Fall Time of Opto-Coupler	t_{f_opto} =	3	µs	**User Input**
R_L of Specified Opto-Coupler Fall Time	R_{L_opto} =	100	Ω	**User Input**
Cut-Off Frequency of Opto-Coupler	f_{c_opto} =	80	kHz	**User Input**
Input Forward Voltage of Opto-Coupler	V_{F_opto} =	1.4	V	**User Input**
Equivalent Opto-Coupler Output Capacitance	C_{OPTO} =	4.775	nF	
Equivalent Internal UCC28740 Dynamic Reistance	R_{EQU} =	40	kΩ	
Recommended Value for External Capacitor on Opto-Coupler	$C_{EXTrecommended}$ =	0	µF	
Actual Value of External Capacitor on Opto-Coupler Used	$C_{EXTactual}$ =	0.0015	µF	**User Input**
C_{EXT} Used in Calculations	C_{EXT} =	0.0015	µF	
Recommended C_{FB}	$C_{FBrecommended}$ =	0.047	µF	
Actual C_{FB} Used	$C_{FBactual}$ =	0.047	µF	**User Input**
C_{FB} Used in Calculations	C_{FB} =	0.047		
Recommended Value For R_{FB4}	$R_{FB4recommended}$ =	22	kΩ	
Actual Value for R_{FB4} Used	$R_{FB4actual}$ =	22	kΩ	**User Input**
R_{FB4} Used in Calculations	R_{FB4} =	22	kΩ	
Opto-Coupler Emitter Current to FB Pin Current Gain	G_{FB1} =	0.355		
FB Pin Current to Control Law Voltage Gain, Full Load	G_{FB2} =	-192	kΩ	
Control Law Voltage to Power Stage Modulation Gain, FM Mode	K_{FM4} =	50.4	kHz/V	
Power Stage Modulation (FM) to Average Current Gain	G_{P4} =	6.005	µC	
Recommeded Value for Shunt Regulator Bias Resistor	$R_{TLrecommended}$ =	1.5	kΩ	
Actual Value of Shunt Regulator Bias Resistor Used	$R_{TLactual}$ =	1.5	kΩ	**User Input**
R_{TL} Used in Calculations	R_{TL} =	1.5	kΩ	
Recommended Value for Compensation Capacitor	$C_{Zrecommended}$ =	1500	pF	
Actual Value Used C_Z	$C_{Zactual}$ =	1500	pF	**User Input**
C_Z Used in Calculations	C_Z =	1500	pF	


Open Loop Gain, Phase Plot
10
100
1000
10000
40
30
20
10
0
-10
-20
-30
-40
180
135
90
45
0
-45
-90
-135
-180
Gain (dB)
Phase (degrees)
Frequency (Hz)
Gain
Phase