

UCC25661x DESIGN CALCULATOR TOOL

TI Literature Number:

Version: 3.3

UCC25661x Enhanced LLC Resonant Controller

Please enter design parameters into the shaded cells

Recommended Component Values will be in RED where manual user input is required

The calculator will choose real component values in the recommended cells. you can override the

Be sure to ENABLE MACROS before attempting to use this design calculator

This spreadsheet guides the user through the design process of an LLC resonant DC/DC CONVERTER using the UCC25661x.

User interaction is required in order to get the best possible results. Enter the desired specification where prompted, the highlighted cells are for user inputs; calculations for the design are based upon the inputs.

WHERE APPLICABLE, A RECOMMENDED VALUE IS GIVEN THAT WILL BE THE BEST CHOICE TO MEET THE GIVEN SPECIFICATION. IT IS IN THE BEST INTEREST OF THE USER TO USE A VALUE AS CLOSE AS POSSIBLE TO THE SUGGESTED RECOMMENDED VALUE. FOR ACCURATE RESULTS, THE USER MUST ENTER THE ACTUAL VALUE USED IN THE APPROPRIATE CELL.

Order-able part number / Feature	UCC256610	UCC256611	UCC256612 UCC256612-Q1	UCC256613 UCC256613-Q1	UCC256614 UCC256614-Q1	UCC256616
High-voltage startup	●	●	●		●	●
X-Capacitor discharge (not supported in -Q1 versions)	●	●			▲	
Extended gain range	●				●	
OVP latch		●				●
T _{SET} enforced burst mode retention	●					
Soft in/out of burst mode	●					
T _{SET} gain simplification	●	●	●	●	●	
PFC on/off control					●	
I _{FB} typical (μA)	80	80	160	160	80	80
R _{IFBINTERNAL} (kΩ)	100	100	50	50	100	100
FB clamp current	87.5	87.5	175	175	175	87.5
Bulk brown-out ISINK (μA)	1	5	5	5	1	5
Bulk brown-out hysteresis (mV)	50	100	100	100	50	100
I _{SENSE} threshold (mV)	150	150	150	150	150	100

Select Which Device You Are Using

UCC256612

Refer datasheet for the difference of UCC25661x devices

OUTPUT

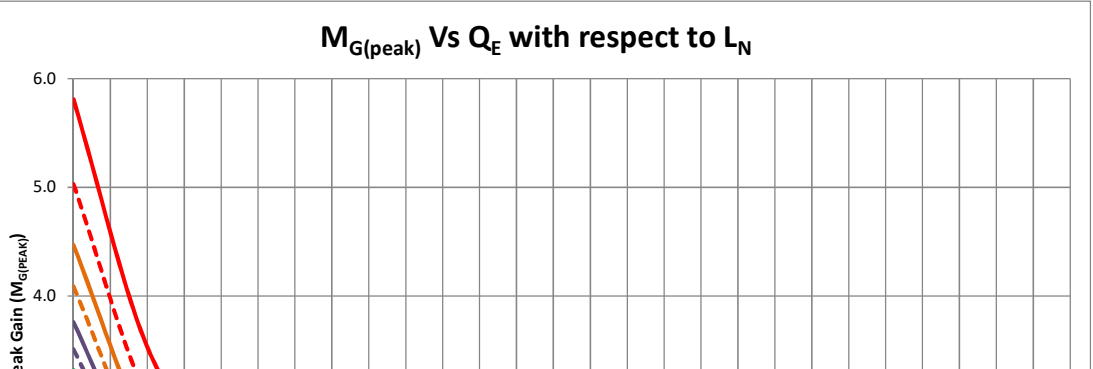
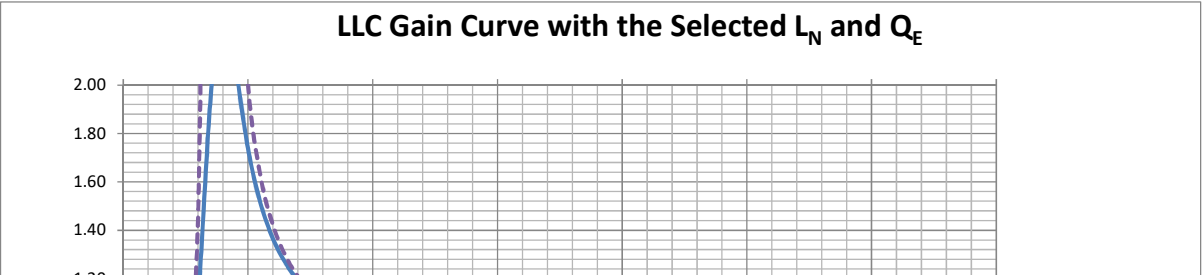
Output Voltage	V _{OUT}	24	V	Enter nominal output voltage
Maximum Output Power	P _{OUT}	300	W	Enter maximum output power
Full Load Output Current	I _{OUT}	12.5	A	
Maximum Output Voltage Ripple	V _{OUT(pk-pk)}	500	mV	Enter the maximum allowable output voltage ripple
Target Efficiency	η	0.85		Enter the overall target efficiency here

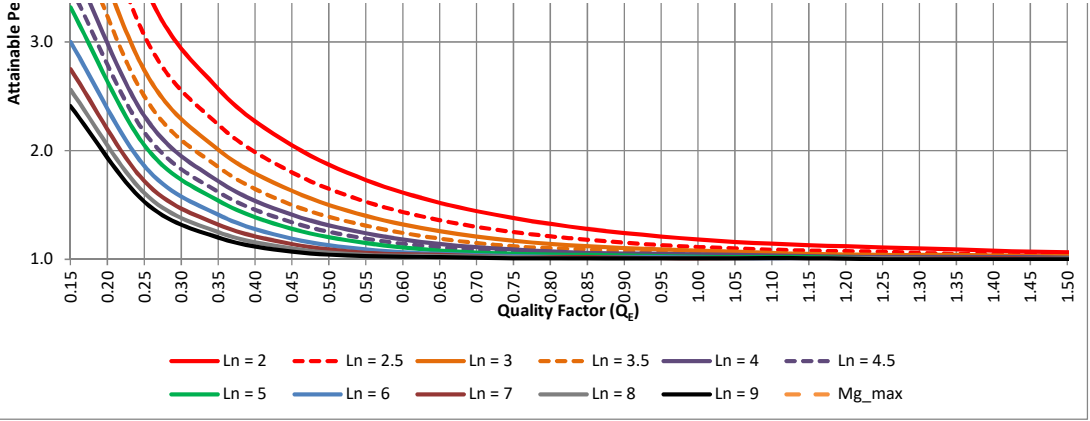
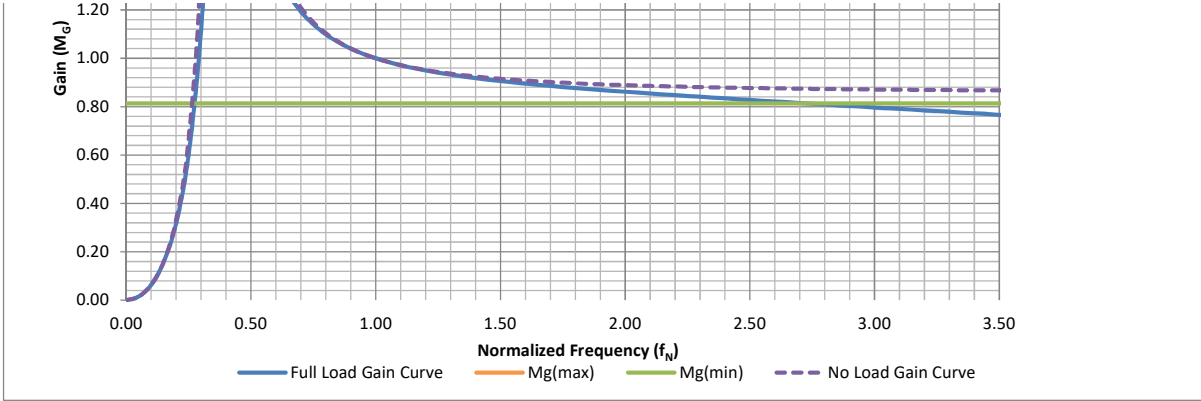
INPUT

Nominal Input Voltage	V _{BLK}	110	V	Enter the nominal input voltage
Maximum DC Input Voltage	V _{BLK(max)}	138	V	10% margin was added by default. You can override this
Minimum DC Input Voltage	V _{BLK(hu)}	55	V	#NAME?

LLC STAGE

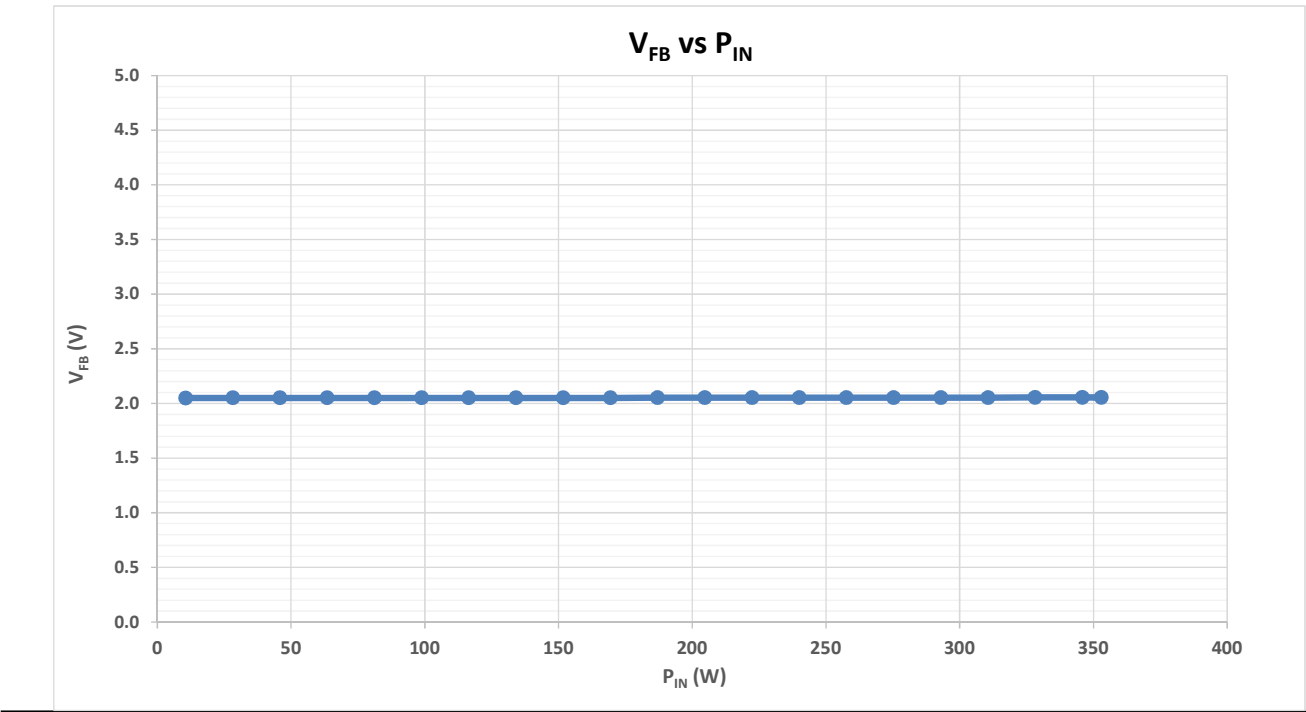
Nominal LLC Switching Frequency	f _{LLC}	100	kHz	Enter desired nominal LLC switching frequency
Primary to Secondary and Primary to Bias Winding turn ratios				
Recommended Primary/Secondary Turns Ratio	N _{PS(recommended)}	2.29		
Actual Primary/Secondary Turns Ratio	N _{PS}	2.29		Enter Actual Primary/Secondary Turns Ratio
Recommended Primary/Bias Turns Ratio	N _{PB(recommended)}	3.67		
Actual Primary/Bias Turns Ratio	N _{PB}	3.67		Enter Actual Turns Ratio
LLC Effective Load Resistance at 110% Full Load	R _E	7.4	Ω	
LLC Effective Load Resistance at Full Load	R _{E(full load)}	8.2	Ω	
LLC Gain Range				
Minimum LLC Gain	M _{G(min)}	0.813		
Maximum LLC Gain Including Losses	M _{G(max)}	2.123		
Predicted Voltage Drop Due to Losses	V _{LOSS}	1.000	V	Enter the predicted voltage drop due to conversion losses in circuit
Select L _N and Q _E				
Selected Primary Inductance Ratio	L _{N(selected)}	6.00		
Selected Quality Factor for Resonant Network	Q _{E(selected)}	0.19		
Gain Required at No-Load	M _{G(noload)}	0.857		
f _N at Maximum Switching Frequency	f _{N(max)}	3.50		





Parameters of the LLC Resonant Circuit			
Discrete resonant inductor or transformer leakage inductance used for L _r ?		Discrete Inductor	
Recommended Resonant Capacitor Value	CR(recommended)	1.026	uF
Actual Total Value of Resonant Capacitor Used	CR	1	uF
Recommended Resonant Inductor Value	LR(recommended)	2.500	uH
Actual Resonant Inductor Value Used	LR	2.50	uH
Recommended Transformer Magnetizing Inductance	LM(recommended)	15.00	uH
Actual Transformer Magnetizing Inductance Used	LM	15.0	uH
Resultant Series Resonant Frequency	f ₀	100.7	kHz
No Load Resonant Frequency	f _p	38.0	kHz
Resultant Inductance Ratio	L _N	6.00	You may need to re-enter this in C55
Resultant Quality Factor at Full Load	Q _E	0.19	
Gain Curve Graph Up to Date?		Yes	Re-enter this value in the Q _{E(selected)} cell above to see the actual normalized frequency at M _{G(max)} and M _{G(min)}
f _N at M _{G(max)}	f _{N(MG_max)}	0.45	0.45
f _N at M _{G(min)}	f _{N(MG_min)}	2.75	
Maximum Switching Frequency	f _{SW(max)}	276.8	0.45
Minimum Switching Frequency	f _{SW(min)}	45.3	0.45
LLC Primary Side Currents			
Primary Side RMS Load Current	I _{OE}	6.669	A
RMS Magnetizing Current at f _{SW(min)}	I _M	11.591	A
Total Current in Resonant Circuit	I _R	13.372	A
LLC Secondary Side Currents			
Secondary RMS Current	I _{OE(S)}	15.272	A
Current in Each Center Tapped Winding	I _{WS}	10.799	A
LLC Resonant Inductor			
Terminal AC Voltage Across Resonant Inductor	V _{Lr}	9.515	V
Inductance	L _R	2.500	uH
Rated Current	I _R	13.372	A
LLC Resonant Capacitor			
AC Voltage Across Resonant Capacitor	V _{CR}	47.0	V
RMS Voltage Across Resonant Capacitor	V _{CR(rms)}	83.5	V
Peak Voltage AC Voltage Rating for Resonant Capacitor	V _{CR(peak)}	135.4	V
Valley Voltage on Resonant Capacitor	V _{Cr(valley)}	2.6	V
Rated Current of Resonant Capacitor	I _R	13.372	A
If Using Split Resonant Capacitors			
Value of EACH Resonant Capacitor If Using Split Resonant Capacitors	C _{R(split)}	0.500	uF
LLC Primary Side MOSFETs			
Minimum Voltage Rating of LLC MOSFETs	V _{QLLC(peak)}	207.0	V
RMS Current Rating of LLC MOSFETs	I _{QLLC}	14.710	A
LLC Output Rectifier Diodes/Synchronous rectifiers			
Minimum Voltage Rating for LLC Output Diodes	V _{DB}	72.314	V
Minimum Current Rating for LLC Output Diodes	I _{SAV}	6.875	A
LLC Output Capacitors, C _{OUT}			
Rectifier's full wave output current	I _{RECT}	13.884	A
C _{OUT} Minimum Voltage Rating	V _{LLCcap}	30	V
C _{OUT} RMS Ripple Current Rating at resonant frequency	I _{C(out)}	6.043	A
C _{OUT} Maximum ESR	ESR _{max}	25.465	mΩ

This is the minimum recommended output capacitance	C _{OUT_MIN}	1,046	μF	Make sure the capacitors chosen meet this minimum capacitance and ESR recommendation
BLK				
BLK Pin Stop Threshold	V _{BLKstop}	1.00	V	
BLK Pin Start Hysteresis	V _{BLKstarthys}	0.10	V	
BLK Pin Current Sink	I _{BLKsink}	5.00	μA	
Desired Bulk Start Voltage	V _{BLKstart}	55	V	
Nominal Bulk Voltage	V _{BLK}	110	V	
Resistor Divider Power Consumption Budget	P _{BLKsns}	15	mW	Enter the desired power consumption for resistor divider
Total BLK Sense Resistor Value	R _{BLKsns}	0.8067	MΩ	
Recommended Lower BLK Sense Resistor Value	R _{BLKlower}	17.36	kΩ	The recommended resistor is a standard 1% resistor
Actual Lower BLK Sense Resistor Value	R _{BLKlower}	19.00	kΩ	Enter the actual value of the lower BLK sense resistor used
Recommended Upper BLK Sense Resistor Value	R _{BLKupper}	786.74	kΩ	The recommended resistor is a standard 1% resistor
Actual Upper BLK Sense Resistor Value	R _{BLKupper}	780.00	kΩ	Enter the actual value of the upper BLK sense resistors used
Actual BLK pin voltage corresponding to maximum input voltage		3.28	V	
Calculated BLK pin voltage below 5 V for the specified input voltage range?		Yes		
Actual Bulk Start Voltage	V _{BLKstart}	49.1	V	
Actual Bulk Stop Voltage	V _{BLKstop}	41.1	V	
Actual BLK divider power consumption	P _{BLKsns}	0.016	mW	
Option 2 ("TSET Gain Set by Diff Voltage Calculation" option is enabled)				
Select TSET option corresponding to required minimum switching frequency fsw	Option #	2		Minimum IPPC frequency 133kHz, Integrator time constant 359ns Maximum dead time 1us
OCP limit [V]	OCP1_Threshold	3.5	V	
Nominal TSET Pin Voltage for the above selected TSET option #	V _{TSETB}	0.547	V	
Select TSET option based on intergrator time constant	Option #	3		Choose an integrator value where Vfbmax is <4.75V
Nominal Diff Voltage for the above selected TSET options # (TSETA - TSETB)	V _{TSETA} - V _{TSETB}	0.644	V	
Recommended TSET Pin Upper Resistance Value	R _{TSET_upper}	590.0	kΩ	
Recommended TSET Pin Lower Resistance Value	R _{TSET_lower}	71.5	kΩ	
Actual TSET Pin Upper Resistance Value	R _{TSET_upper}	590.0	kΩ	Enter the selected TSET pin upper resistance value
Actual TSET Pin Lower Resistance Value	R _{TSET_lower}	72.0	kΩ	Enter the selected TSET pin lower resistance value
Actual TSET Pin Voltage	V _{TSETB}	0.544	V	Maximum and minimum range that can be used for each TSET setting is within +/- 48mV of nominal value.
Selected TSET pin voltage in the specified range?		Yes		
Actual TSET Pin Diff Voltage	V _{TSETA} - V _{TSETB}	0.642	V	Maximum and minimum range that can be used for each TSET setting is within +/- 48mV of nominal value.
Selected TSET pin Diff voltage in the specified range?		Yes		
Integrator time constant for the above selected TSET option #	R _{VCR} * C _{VCR}	694.30	ns	
R _{RAMP} for the above selected TSET option #	R _{RAMP}	3600	kΩ	
Timer gain constant for the above selected TSET option #	k _T	1.1810	1/s	



ISNS				
Peak Resonant Current at Full Load	I _{res(peak)}	18.91	A	
Selected OCP limit [V]	OCP1_Threshold	3.50	V	
Select a Current Sense Capacitor	C _{ISNS}	150	pF	Choose the current sense capacitor value
Recommended Current Sense Resistor	R _{ISNS}	< 1233.6	Ω	986.9
Actual Current Sense Resistor	R _{ISNS}	1500.0	Ω	Enter the actual current sense resistor value.

LL				
Select the difference in voltage between VLLA and VLLB	(VLLA-VLLB)	1.391	V	Select the difference in voltage between VLLA and VLLB from drop down list;If the difference is more than 2.41V,Burst mode is disabled
HFBurstEntry to VLLB ratio for the selected difference in voltage between VLLA and VLLB	HFBurstEntry/VLLB	1.818	V	
LFBurstEntry to VLLB ratio	LFBurstEntry/VLLB	1.667	V	
LL pin Voltage	VLLB	1.20	V	Enter the desired voltage at the LL pin
Recommended LL pin Upper Resistance Value	R _{LLupper}	536.0	kΩ	
Recommended LL pin Lower Resistance Value	R _{LLlower}	169.5	kΩ	
Actual LL pin Upper Resistance Value	R _{LLupper}	536.0	kΩ	Enter the actual LL pin upper resistance value
Actual LL pin Lower Resistance Value	R _{LLlower}	170.0	kΩ	Enter the actual LL pin lower resistance value
Actual LL pin voltage	VLLB	1.204	V	
Actual VLLA voltage	VLLA	2.495	V	
Actual difference in voltage between VLLA and VLLB	(VLLA-VLLB)	1.291	V	
Actual difference in voltage between VLLA and VLLB in the acceptable range?		Yes		
Actual HFBurstEntry threshold	HFBurstEntry	2.189	V	
Actual LFBurstEntry threshold	LFBurstEntry	2.007	V	

OVP/OTP				
Desired OVP Threshold Percentage of Nominal V _{out}	η _{OVP}	130	%	Enter the OVP threshold (percentage)
OVP Threshold Adjustment to Account for Rectifying Element, Transformer Leakage, Resistive Losses In Power Stage, etc.	V _{Drop}	1	V	Enter estimation for voltage drop within power stage (rectifying element, resistive losses, transformer leakage, etc).
Bias Winding Nominal Voltage	V _{BiasWindingNom}	15.6	V	
OVP Threshold	V _{OVPpos}	3.5	V	
Recommended zener diode voltage for over voltage protection	V _Z	16.6	V	
Actual zener diode voltage used	V _Z	15	V	Enter the actual zener diode voltage rating
Actual output voltage at which OVP will be triggered	V _{out_OVP}	28.6	V	
Actual OVP Threshold Percentage of Nominal Vout	η _{OVP}	119	%	
OTP Threshold	V _{OTPNeg}	0.8	V	
OVP/OTP pin sourcing current	I _{OVP_OTP}	100.0	uA	
Desired over temperature protection limit in degC	T	110	degC	Enter the desired over temperature protection limit in degC
NTC resistance ratio for the above desired temperature limit to room temperature	R _T /R ₂₅	0.035263		Enter the (RT/R25) ratio from the selected thermistor datasheet. Refer application section from UCC25661x datasheet.
OVP/OTP pin voltage at room temperature		1.4	V	Enter a value between 0.8 to 3.5 V to avoid fault triggering
Selected OVP/OTP pin voltage at room temperature in the specified range?		Yes		
Recommended Thermistor resistance at room temperature	R ₂₅	470.0	kΩ	
Recommended resistor value that is in parallel with the thermistor	R _{ext}	14.0	kΩ	
Actual Thermistor resistance at room temperature	R ₂₅	470.0	kΩ	Enter the actual Thermistor resistance at room temperature
Actual External resistor value that is in parallel with the thermistor	R _{ext}	14.0	kΩ	Enter the actual External resistor value that is in parallel with the thermistor
Actual OVP/OTP pin voltage at room temperature		1.359	V	
Selected OVP/OTP pin voltage at room temperature in the specified range?		Yes		
Actual OVP/OTP pin voltage at selected over temperature protection limit (T)		0.759	V	
Selected OVP/OTP pin voltage at room temperature in the specified range?		Yes		

Secondary-side Regulation				
Shunt Regulator Voltage	V _{REF}	2.5	V	Enter the reference voltage for the shunt regulator
Output voltage upper resistor value R _{431_Upper}	R _{431_Upper}	147	kΩ	Enter the pull-up resistor for the shunt regulator
Calculated lower resistor voltage	R _{431_lower_calc}	13.36	kΩ	Calculated Resistor
Output voltage lower resistor value R _{431_Lower}	R _{431_Lower}	13.3	kΩ	Enter the actual lower resistor used
Optocoupler body diode forward voltage	V _{FO}	1	V	Optocoupler VF
Minimum Current Transfer Ratio of Optocoupler	CTR _{MIN}	100	%	Enter CTR Min
Minimum TL43x current for regulation	IK _{MIN}	0.1	mA	Enter TL431/2 IK _{MIN}
I _{BLEED} to keep opto from cutting off	I _{BLEED}	1	mA	This is the minimum forward current through the diode
Collector Emitter Saturation Voltage	V _{CESAT}	0.4	V	The is the maximum saturation voltage of the optocoupler
This is the total current flowing through the diode	IK _{TOTAL}	0.26	mA	This is the total IK current
Calculated series resistor	R _{SERIESMAX}	20.50	kΩ	This is the maximum resistor value, the actual value should be far less than this
First pass guess at recommended Rseries	R _{SERIESSUGGESTED}	16.40	kΩ	
This is the series resistor limiting the current through the diode	R _{SERIES}	13.02	kΩ	#NAME?
Calculated bleed resistor	R _{BLEED}	9.09	kΩ	This is the calculated bleed resistance
This is the bleed resistance to ensure the optocoupler performs well at no load	R _{BLEED}	9.09	kΩ	This is the recommened 1% reistor