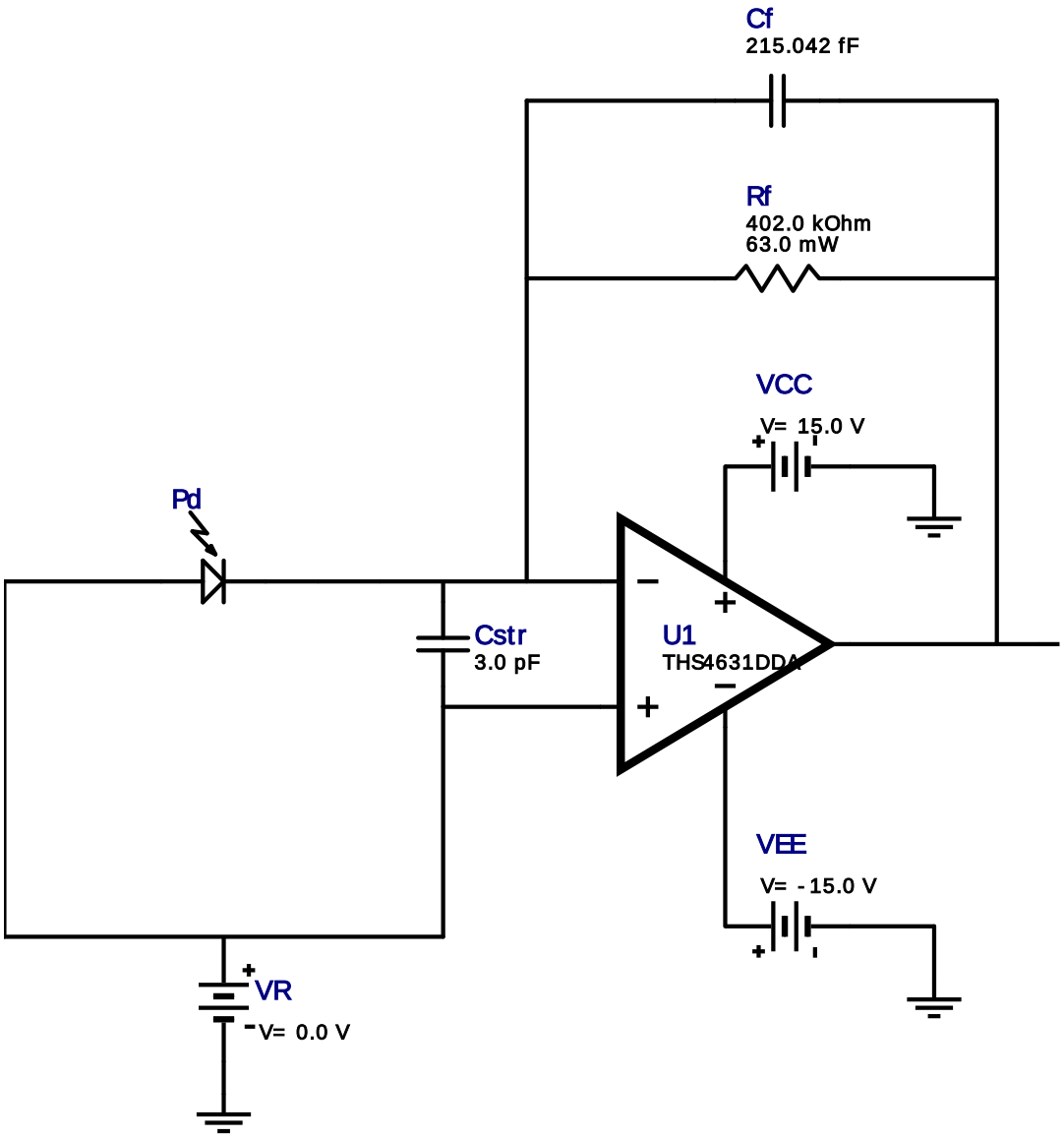
Device = THS4631DDA
Topology = TIA
Created = May 26 2017 11:24AM
BOM Cost = $3.37
Footprint = 82.2 mm^2
BOM Count = 5

WEBENCH® Amplifier Design Report

Design : 4087980/2 THS4631DDA
THS4631DDA TIA Zero Reverse Bias Design



My Comments

No comments

Electrical BOM

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cb	MuRata	GRM31CR71E106KA12L Series= X7R	Cap= 10.0 uF ESR= 4.366 mOhm VDC= 25.0 V IRMS= 2.8022 A	1	$0.05	1206_190 11 mm^2
2.	Cf	CUSTOM	CUSTOM Series= ?	Cap= 215.042 fF VDC= 0.0 V IRMS= 0.0 A	1	NA	CUSTOM 0 mm^2

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
3.	Cstr	CUSTOM	CUSTOM Series= ?	Cap= 3.0 pF VDC= 0.0 V IRMS= 0.0 A	0	NA	0 mm²
4.	Pd	CUSTOM	CUSTOM	PhotoDiode	0	NA	0 mm²
5.	Rb	Panasonic	ERJ-8ENF10R0V Series= ERJ-8E	Res= 10.0 Ohm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²
6.	Rf	Vishay-Dale	CRCW0402402KFKED Series= CRCW..e3	Res= 402.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
7.	U1	Texas Instruments, Inc.	THS4631DDA	GbwTyp= 325.0 MHz VccMin= 10.0 V VccMax= 32.0 V	1	$3.30	DDA0008D 57 mm²

Design Inputs

#	Name	Value	Description
1.	Category	Photodiode (Transimpedance) Amplifier	
2.	Topology	Zero Reverse Bias	1DSZ 2DSN 3DSP 4SSZ 5SSN 6SSP
3.	PartNumber	THS4631DDA	
4.	DualSupply	true V	Op Amp power supply type
5.	PositiveSupplyVoltage	15.0 V	Op Amp positive power supply
6.	VoutMax	1.0 V	Amplifier output maximum voltage
7.	VoutMin	0.0 V	Amplifier output minimum voltage
8.	Vref	0.0 V	Voltage Reference applied to the amplifier non-inverting input
9.	CcmTyp	3.9E-12 F	Amplifier input common-mode capacitance
10.	Cdmtyp	3.9E-12 F	Amplifier input difference-mode capacitance
11.	Cpd	1.0E-11 F	Photo diode junction capacitance
12.	Cin	2.0800000000000002E-11 F	system input capacitance = Cstr+CcmTyp+CdmTyp+Cpd
13.	Vp	0.75 V	Peak voltage for step response
14.	Rf	398406.3745019921 OHM	Feedback resistor
15.	Cf	2.1504200381393382E-13 F	Feedback capacitor
16.	Aol	10000.0 V/V	amplfier open loop gain
17.	BroadBandNoise	1.0000000000000001E-7 V/rtHz	Amplifier broadband Noise
18.	fi	3325648.8960071877 Hz	Intercept frequency between amplifier Aol curve and system noise gain
19.	fa	204203.52350435418 Hz	dominant pole of amplifier
20.	fz	19009.23957806562 Hz	Noise Gain zero
21.	fp	1857678.5003654838 Hz	Noise Gain Pole
22.	fc	3.25E8 Hz	amplifier cross over frequency for Gain = AvclTyp
23.	f3db	5.62916512459885E8 Hz	frequency used to create a 60 degree phase margin at fc
24.	TempMin	0.0 C	Amplifier miminum temperature specification
25.	TempMax	50.0 C	Amplifier Maximum temperature specification
26.	SSBandwidth	1000000.0 Hz	small signal bandwidth = 1 / (2 I Rf * Cf)
27.	RiseFallTime	3.5000000000000004E-7 sec	Rise time = fall time = 0.35/(small signal bandwidth)
28.	PhaseMargin	65.0 degrees	Phase margin on entire circuit or at the fi frequency
29.	Overshoot	4.71609570961367 %	Overshoot of the step response
30.	VBias	0.0 V	Reverse bias voltage across the photo diode
31.	SSBandwidth_Computed	1857678.5003654838 Hz	
32.	RiseFallTime_Computed	1.8840719744085977E-7 sec	
33.	PhaseMargin_Computed	64.3153568147877 degrees	
34.	Overshoot_Computed	5.2377701287501965 %	
35.	Q	0.7305254208498424	
36.	IbiasRoomTyp	5.0E-11	
37.	IbiasRoomMax	1.0E-10	
38.	VosRoomMax	5.0E-4	
39.	TCVosTyp	2.5	
40.	InoiseTyp	2.0E-15	
41.	OneHzNoise	9.000000000000001E-8	
42.	VnAtFlatband	0.0	
43.	AmplifierVsupplyMin	10.0	
44.	AmplifierVsupplyMax	32.0	
45.	PhotodiodePartNumber	CUSTOM	Photo diode part number
46.	PhotodiodeManufacturer	CUSTOM	Photo diode manufacturer
47.	CPD	1.0E-11 F	Capacitance(CPD)
48.	Cstr	3.0E-12 F	PCB stray capacitance around the input pins
49.	RSH	1.5E11 OHM	photodiode shunt resistor
50.	IpdMax	2.5099999999999997E-6 A	photodiode max current(IpdMax)
51.	ResistorTolerance	1.0 %	resistance tolerance of Rf
52.	CapacitorTolerance	5.0 %	capacitive tolerance of Cf

#	Name	Value	Description
53.	TotalOutputNoise	0.002328057232808741 V/rtHz	total output noise including amplifier and Rf noise
54.	DcPrecision	2.6076268558889327E-4 V	dc precision including offset voltage, input bias current, offset current and CMRR
55.	SlewRate	1000.0 V/sec	slew rate
56.	QuiescentCurrent	11.5 A	static quiescent current of amplifier
57.	Cost	3.3 $	amplifier cost in USD
58.	GbwTyp	3.25E8	
59.	SlewTyp	0.0	
60.	NG_DC	1.0000026560424966	
61.	NG_AC	97.72528915791403	
62.	CMRR	86.0	
63.	VosRoomTyp	2.6000000000000003E-4	
64.	Stage	1	
65.	PosVcm	-3.5	
66.	NegVcm	2.5	
67.	MinAvolTyp	80.0	
68.	AvclMin	1.0	
69.	Rb	10.0	
70.	Cb	9.999999999999999E-6	
71.	Damping	0.68443887882551	

Performance Values - Design Criteria

#	Name	Value	Description
Amplifier			
1.	Op Amp Part Number	Ideal Amplifier	Circuit's Operational Amplifier
2.	Vcc	15V	Positive power supply
3.	Vee	-15V	Negative power supply
4.	Vref = Vout Min	0V	Voltage reference which equals the Op Amp minimum output voltage
5.	Vout Max	1V	Op Amp maximum output voltage
PhotoDiode			
1.	Photodiode Part Number	CUSTOM	
2.	Photodiode Manufacturer	CUSTOM	
3.	Cpd	10pF	Photodiode capacitance
4.	RSH	150GOhms	Photodiode shunt resistance
5.	IpdMax	2.51uA	Maximum photodiode light generated current
TIA Circuit			
1.	Bias Voltage	0V	Reverse bias voltage. The photodiode's junction capacitance is the largest when this voltage is equal to Vref,
2.	Feedback Resistor (Rf)	398.406kOhms	Feedback resistor, Rf
3.	Feedback Resistor Tolerance	1%	Feedback resistor tolerance
4.	Feedback Capacitor (Cf)	0.215pF	Feedback capacitance, Cf
5.	Feedback Capacitor Tolerance	5%	Feedback capacitance tolerance
6.	Stray PCB Capacitance	3pF	Stray PCB capacitance due to trace, via, and planes layout
7.	Minimum Temperature	0deg C	Minimum system temperature
8.	Maximum temperature	50deg C	Maximum system temperature
Frequency Response			
1.	Small Signal Bandwidth	1MHz	Small signal bandwidth = 0.35 / tRise
2.	Rise (Fall) Time	350ns	System rise time = fall time = 0.35 / small signal bandwidth
3.	Phase Margin	65deg	System phase margin
4.	Overshoot	4.716%	Signal overshoot percentage
5.	Small Signal Bandwidth	1.858MHz	Small signal bandwidth = 0.35 / tRise

Performance Values - Actual Design

#	Name	Value	Description
Amplifier			
1.	Op Amp Part Number	THS4631DDA	Circuit's Operational Amplifier
2.	Vcc	15V	Positive power supply
3.	Vee	-15V	Negative power supply
4.	Vref = Vout Min	0V	Voltage reference which equals the Op Amp minimum output voltage
5.	Vout Max	1V	Op Amp maximum output voltage
PhotoDiode			
1.	Photodiode Part Number	CUSTOM	
2.	Photodiode Manufacturer	CUSTOM	
3.	Cpd	10pF	Photodiode capacitance
4.	RSH	150GOhms	Photodiode shunt resistance
5.	IpdMax	2.51uA	Maximum photodiode light generated current
TIA Circuit			
1.	Bias Voltage	0V	Reverse bias voltage. The photodiode's junction capacitance is the largest when this voltage is equal to Vref,
2.	Feedback Resistor (Rf)	402kOhms	Feedback resistor, Rf
3.	Feedback Resistor Tolerance	1%	Feedback resistor tolerance

#	Name	Value	Description
4.	Feedback Capacitor (Cf)	0.215pF	Feedback capacitance, Cf
5.	Feedback Capacitor Tolerance	0%	Feedback capacitance tolerance
6.	Stray PCB Capacitance	3pF	Stray PCB capacitance due to trace, via, and planes layout
7.	Minimum Temperature	0deg C	Minimum system temperature
8.	Maximum temperature	50deg C	Maximum system temperature
Frequency Response			
1.	Rise (Fall) Time	188.407ns	System rise time = fall time = 0.35 / small signal bandwidth
2.	Phase Margin	64.315deg	System phase margin
3.	Overshoot	5.238%	Signal overshoot percentage

Performance Values - Input Offset voltage / Input bias current errors

#	Name	Value	Description
Typical			
1.	Offset voltage error at Vout	260.001uV	Typical room temperature input offset voltage times the TIA's DC gain referred to amplifier output
2.	Input bias current error at Vout	20.1uV	Typical room temperature input bias current times Rf referred to amplifier output
Maximum			
1.	Offset voltage error at Vout	500.001uV	Maximum room temperature input offset voltage times the TIA's DC gain referred to amplifier output
2.	Input bias current error at Vout	40.2uV	Maximum room temperature Input bias current times Rf referred to amplifier output
Total Output DC errors			
1.	Typical root-sum-square	260.762uVrms	Total typical DC rms errors equal to the root sum square of Vos Typ and Ib Vout Typ
2.	Maximum root-sum-square	501.585uVrms	Total maximum DC rms errors equal to the root sum square of Vos Max and Ib Vout Max
3.	Worst case	539.841uV	Worst case DC errors equal to the sum of Vos Max and Ib Vout Max

Performance Values - Vout gain/bandwidth vs resistor/capacitance tolerance

#	Name	Value	Description
Feedback Elements			
1.	Rf - nominal	402kOhms	Nominal Feedback resistor
2.	Signal Gain - nominal	402kV/A	Nominal transimpedance (TIA) signal gain
3.	Rf - minimum	397.98kOhms	Minimum feedback resistor (Rf) due to Rf tolerance
4.	Signal Gain - minimum	397.98kV/A	Minimum Transimpedance (TIA) signal gain due to Rf tolerance
5.	Rf - Maximum	406.02kOhms	Maximum feedback resistor (Rf) due to Rf tolerance
6.	Signal Gain - maximum	406.02kV/A	Maximum Transimpedance (TIA) signal gain due to Rf tolerance
7.	Cf - nominal	0.215pF	Nominal feedback capacitance (Cf) value
8.	Cf - minimum	0.204pF	Minimum feedback capacitance (Cf) value due toe Cf tolerance
9.	Cf - maximum	0.226pF	Maximum feedback capacitance (Cf) value due to Cf tolerance
System errors			
1.	TIA Bandwidth - nominal	1.842MHz	Nominal transimpedance amplifier bandwidth
2.	TIA Bandwidth - minimum	1.737MHz	Minimum transimpedance amplifier bandwidth due to Rf and Cf tolerances
3.	TIA Bandwidth - maximum	1.959MHz	Maximum transimpedance amplifier bandwidth due the Rf and Cf tolerances

Performance Values - Operating Frequency Values

#	Name	Value	Description
1.	GBWP	325MHz	Operational amplifier's gain bandwidth product
2.	Slew Rate	1000V/usec	Operational amplifier's slew rate
3.	Small Signal Bandwidth	1.858MHz	Transimpedance (photodiode) amplifier small signal bandwidth
4.	tRise	188.407ns	Transimpedance (photodiode) amplifier rise time where the rise and fall times are assumed to be equal
5.	PM	64.315deg	Phase Margin
6.	OS	5.238%	Overshoot
7.	Q	0.731	Quality factor = 1 / (2 * damping factor)
8.	VbiasFilter	1.592kHz	Low pass filter for the Vbias source

Performance Values - Power Requirements

#	Name	Value	Description
1.	Positive supply voltage (Vcc)	15V	Positive photodiode amplifier power supply
2.	Negative supply voltage (Vee)	-15V	Negative photodiode amplifier power supply
3.	Amplifier Vsupply Max	32V	Amplifier maximum specified power supply range
4.	Amplifier Vsupply Min	10V	Amplifier minimum specified power supply range
5.	IC quiescent current	11.5mA	Operational amplifier's 25 degree C quiescent current (per amplifier)

#	Name	Value	Description
6.	IC Power Dissipation	345mW	Amplifier quiescent power equals (Vcc-Vee)X(IC quiescent current)

Performance Values - Error Over Temperature

#	Name	Value	Description
1.	TC Vos	2.5uV/C	Operational amplifier input offset voltage change with temperature. This drift can be positive or negative
2.	Maximum Temperature	50C	Maximum Amplifier operating temperature
3.	Minimum Temperature	0C	Minimum Amplifier operating temperature

Performance Values - Total Output Noise

#	Name	Value	Description
1.	Rf Noise	138.876uVrms	Total output rms noise due to Rf
2.	OpAmpV	537.877nVrms	Operational amplifier voltage noise referred to the output
3.	OpAmpI	2.345mVrms	Operational amplifier current noise referred to the output
4.	Total Output Noise (rms)	2.349mVrms	Total output rms noise equals the root sum square of Rf Noise, Amp Voltage Noise and Amp Current Noise.
5.	Total Output Noise (peak-to-peak)	15.504mVp-p	Total output peak-to-peak noise equals Noise (rms) times 6.6
6.	SNR	43.551dB	Output Signal-to-noise-ratio
7.	ENOB	6.942bits	Effective Number of Bits

Design Assistance

1. **THS4631** Product Folder : http://www.ti.com//product/THS4631 : contains the data sheet and other resources.