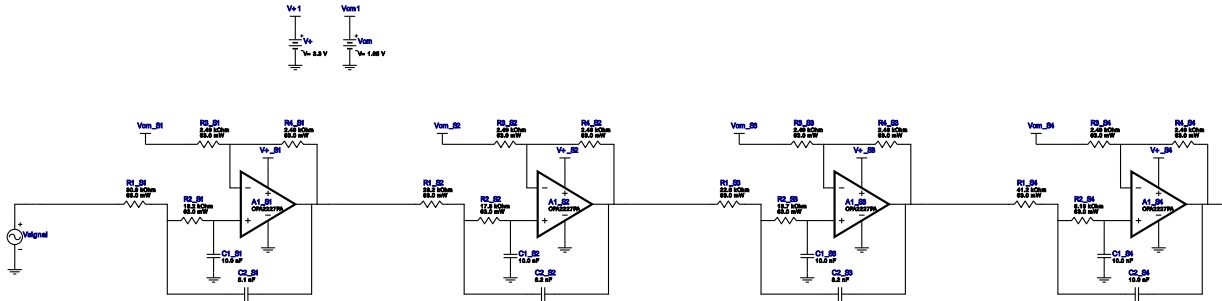


## WEBENCH<sup>®</sup> Design Report

 Design : 4595529/11 OPA2227PA  
 Lowpass, Sallen\_Key, Butterworth


### My Comments

No comments

### Electrical BOM

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	A1_S1	Texas Instruments, Inc.	OPA2227PA	GbwTyp= 8.0MHz VccMin= 5.0 V VccMax= 36.0 V	1	\$2.35	 P0008A 116 mm <sup>2</sup>
2.	A1_S2	Texas Instruments, Inc.	OPA2227PA	GbwTyp= 8.0MHz VccMin= 5.0 V VccMax= 36.0 V	1	\$2.35	 P0008A 116 mm <sup>2</sup>
3.	A1_S3	Texas Instruments, Inc.	OPA2227PA	GbwTyp= 8.0MHz VccMin= 5.0 V VccMax= 36.0 V	1	\$2.35	 P0008A 116 mm <sup>2</sup>
4.	A1_S4	Texas Instruments, Inc.	OPA2227PA	GbwTyp= 8.0MHz VccMin= 5.0 V VccMax= 36.0 V	1	\$2.35	 P0008A 116 mm <sup>2</sup>
5.	C1_S1	Kemet	C0603C103J5RACTU Series= X7R	Cap= 10.0 nF VDC= 50.0 V Tolerance= 5.0 %	1	\$0.01	 0603 5 mm <sup>2</sup>
6.	C1_S2	Kemet	C0603C103J5RACTU Series= X7R	Cap= 10.0 nF VDC= 50.0 V Tolerance= 5.0 %	1	\$0.01	 0603 5 mm <sup>2</sup>
7.	C1_S3	Kemet	C0603C103J5RACTU Series= X7R	Cap= 10.0 nF VDC= 50.0 V Tolerance= 5.0 %	1	\$0.01	 0603 5 mm <sup>2</sup>
8.	C1_S4	Kemet	C0603C103J5RACTU Series= X7R	Cap= 10.0 nF VDC= 50.0 V Tolerance= 5.0 %	1	\$0.01	 0603 5 mm <sup>2</sup>
9.	C2_S1	MuRata	GRM2195C1H512JA01D Series= C0G/NP0	Cap= 5.1 nF VDC= 50.0 V Tolerance= 5.0 %	1	\$0.05	 0805 7 mm <sup>2</sup>

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
10.	C2_S2	MuRata	GRM2195C1H622JA01D Series= C0G/NP0	Cap= 6.2 nF VDC= 50.0 V Tolerance= 5.0 %	1	\$0.05	■ 0805 7 mm <sup>2</sup>
11.	C2_S3	Samsung Electro-Mechanics	CL21C822JBFNNE Series= C0G/NP0	Cap= 8.2 nF VDC= 50.0 V Tolerance= 5.0 %	1	\$0.02	■ 0805 7 mm <sup>2</sup>
12.	C2_S4	Kemet	C0603C103J5RACTU Series= X7R	Cap= 10.0 nF VDC= 50.0 V Tolerance= 5.0 %	1	\$0.01	■ 0603 5 mm <sup>2</sup>
13.	R1_S1	Vishay-Dale	CRCW040230K9FKED Series= CRCW..e3	Res= 30.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	■ 0402 3 mm <sup>2</sup>
14.	R1_S2	Vishay-Dale	CRCW040223K2FKED Series= CRCW..e3	Res= 23.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	■ 0402 3 mm <sup>2</sup>
15.	R1_S3	Vishay-Dale	CRCW040222K6FKED Series= CRCW..e3	Res= 22.6 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	■ 0402 3 mm <sup>2</sup>
16.	R1_S4	Vishay-Dale	CRCW040241K2FKED Series= CRCW..e3	Res= 41.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	■ 0402 3 mm <sup>2</sup>
17.	R2_S1	Vishay-Dale	CRCW040216K2FKED Series= CRCW..e3	Res= 16.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	■ 0402 3 mm <sup>2</sup>
18.	R2_S2	Vishay-Dale	CRCW040217K8FKED Series= CRCW..e3	Res= 17.8 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	■ 0402 3 mm <sup>2</sup>
19.	R2_S3	Vishay-Dale	CRCW040213K7FKED Series= CRCW..e3	Res= 13.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	■ 0402 3 mm <sup>2</sup>
20.	R2_S4	Vishay-Dale	CRCW04026K19FKED Series= CRCW..e3	Res= 6.19 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	■ 0402 3 mm <sup>2</sup>
21.	R3_S1	Vishay-Dale	CRCW04022K49FKED Series= CRCW..e3	Res= 2.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	■ 0402 3 mm <sup>2</sup>
22.	R3_S2	Vishay-Dale	CRCW04022K49FKED Series= CRCW..e3	Res= 2.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	■ 0402 3 mm <sup>2</sup>
23.	R3_S3	Vishay-Dale	CRCW04022K49FKED Series= CRCW..e3	Res= 2.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	■ 0402 3 mm <sup>2</sup>
24.	R3_S4	Vishay-Dale	CRCW04022K49FKED Series= CRCW..e3	Res= 2.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	■ 0402 3 mm <sup>2</sup>
25.	R4_S1	Vishay-Dale	CRCW04022K49FKED Series= CRCW..e3	Res= 2.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	■ 0402 3 mm <sup>2</sup>
26.	R4_S2	Vishay-Dale	CRCW04022K49FKED Series= CRCW..e3	Res= 2.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	■ 0402 3 mm <sup>2</sup>
27.	R4_S3	Vishay-Dale	CRCW04022K49FKED Series= CRCW..e3	Res= 2.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	■ 0402 3 mm <sup>2</sup>
28.	R4_S4	Vishay-Dale	CRCW04022K49FKED Series= CRCW..e3	Res= 2.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	■ 0402 3 mm <sup>2</sup>

## Design Inputs

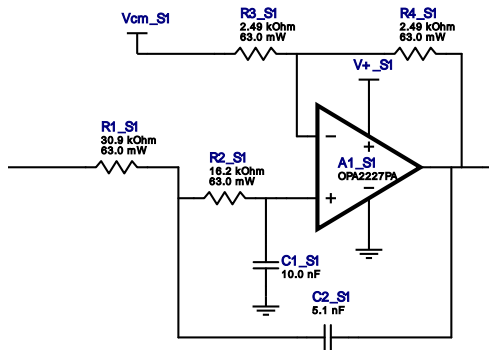
#	Name	Value	Description
1.	FilterType	Lowpass	
2.	FilterResponse	Butterworth	
3.	FilterOrder	8.0	
4.	FilterTopology	Sallen_Key	
5.	NumberOfStages	4.0	
6.	PassbandFrequency	1,000.0	
7.	StopbandAttenuation	-45.0	
8.	StopbandFrequency	2.0 k	
9.	Gain	16.0	
10.	SingleSupply	3.3	Power supply(s) to active chips
11.	ResistorTolerance	E96	Resistor series - 1% Passive resistor tolerance
12.	CapacitorTolerance	E24	Capacitor series - 5% Passive capacitance tolerance
13.	SeedCapacitance	10.0 n	Seed Capacitance to start design of filter

## Design Assistance

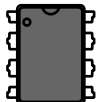






1. **OPA2227PA** Product Folder : <http://www.ti.com//product/OPA2227> : contains the data sheet and other resources.

## Filter Stage :1

Cutoff Frequency 1.0 kHz  
 Min GBW Req'd 101.961 kHz  
 Stage Gain 2.0 V/V  
 Stage Q 509.796 m  
 Stage Topology Sallen\_Key

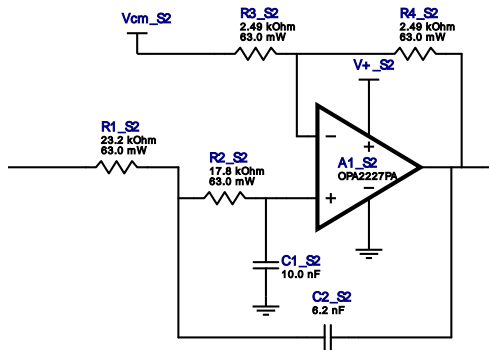


### Electrical BOM

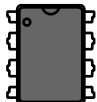






#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	A1_S1	Texas Instruments, Inc.	OPA2227PA	GbwTyp= 8.0MHz VccMin= 5.0 V VccMax= 36.0 V	1	\$2.35	 P0008A 116 mm <sup>2</sup>
2.	C1_S1	Kemet	C0603C103J5RACTU Series= X7R	Cap= 10.0 nF VDC= 50.0 V Tolerance= 5.0 %	1	\$0.01	 0603 5 mm <sup>2</sup>
3.	C2_S1	MuRata	GRM2195C1H512JA01D Series= C0G/NP0	Cap= 5.1 nF VDC= 50.0 V Tolerance= 5.0 %	1	\$0.05	 0805 7 mm <sup>2</sup>
4.	R1_S1	Vishay-Dale	CRCW040230K9FKED Series= CRCW..e3	Res= 30.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>
5.	R2_S1	Vishay-Dale	CRCW040216K2FKED Series= CRCW..e3	Res= 16.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>
6.	R3_S1	Vishay-Dale	CRCW04022K49FKED Series= CRCW..e3	Res= 2.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>
7.	R4_S1	Vishay-Dale	CRCW04022K49FKED Series= CRCW..e3	Res= 2.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>

## Filter Stage :2

Cutoff Frequency 1.0 kHz  
 Min GBW Req'd 120.275 kHz  
 Stage Gain 2.0 V/V  
 Stage Q 601.348 m  
 Stage Topology Sallen\_Key

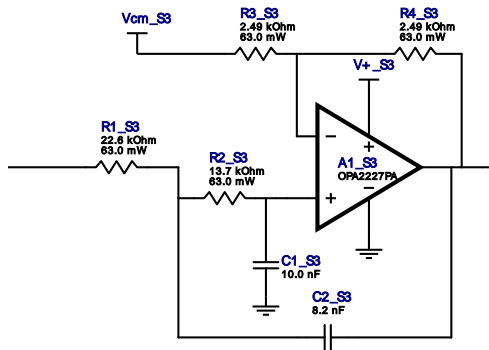


### Electrical BOM

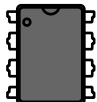






#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	A1_S2	Texas Instruments, Inc.	OPA2227PA	GbwTyp= 8.0MHz VccMin= 5.0 V VccMax= 36.0 V	1	\$2.35	 P0008A 116 mm <sup>2</sup>
2.	C1_S2	Kemet	C0603C103J5RACTU Series= X7R	Cap= 10.0 nF VDC= 50.0 V Tolerance= 5.0 %	1	\$0.01	 0603 5 mm <sup>2</sup>
3.	C2_S2	MuRata	GRM2195C1H622JA01D Series= C0G/NP0	Cap= 6.2 nF VDC= 50.0 V Tolerance= 5.0 %	1	\$0.05	 0805 7 mm <sup>2</sup>
4.	R1_S2	Vishay-Dale	CRCW040223K2FKED Series= CRCW..e3	Res= 23.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>
5.	R2_S2	Vishay-Dale	CRCW040217K8FKED Series= CRCW..e3	Res= 17.8 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>
6.	R3_S2	Vishay-Dale	CRCW04022K49FKED Series= CRCW..e3	Res= 2.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>
7.	R4_S2	Vishay-Dale	CRCW04022K49FKED Series= CRCW..e3	Res= 2.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>

## Filter Stage :3

Cutoff Frequency	1.0 kHz
Min GBW Req'd	180.001 kHz
Stage Gain	2.0 V/V
Stage Q	899.966 m
Stage Topology	Sallen_Key

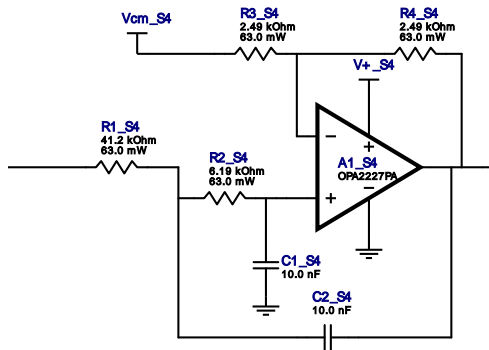


## Electrical BOM

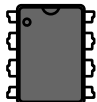





#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	A1_S3	Texas Instruments, Inc.	OPA2227PA	GbwTyp= 8.0MHz VccMin= 5.0 V VccMax= 36.0 V	1	\$2.35	 P0008A 116 mm <sup>2</sup>
2.	C1_S3	Kemet	C0603C103J5RACTU Series= X7R	Cap= 10.0 nF VDC= 50.0 V Tolerance= 5.0 %	1	\$0.01	 0603 5 mm <sup>2</sup>
3.	C2_S3	Samsung Electro-Mechanics	CL21C822JBFNNE Series= C0G/NP0	Cap= 8.2 nF VDC= 50.0 V Tolerance= 5.0 %	1	\$0.02	 0805 7 mm <sup>2</sup>
4.	R1_S3	Vishay-Dale	CRCW040222K6FKED Series= CRCW..e3	Res= 22.6 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>
5.	R2_S3	Vishay-Dale	CRCW040213K7FKED Series= CRCW..e3	Res= 13.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>
6.	R3_S3	Vishay-Dale	CRCW040222K49FKED Series= CRCW..e3	Res= 2.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>
7.	R4_S3	Vishay-Dale	CRCW040222K49FKED Series= CRCW..e3	Res= 2.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>

## Filter Stage :4

Cutoff Frequency 1.0 kHz  
 Min GBW Req'd 512.574 kHz  
 Stage Gain 2.0 V/V  
 Stage Q 2.563  
 Stage Topology Sallen\_Key



## Electrical BOM

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	A1_S4	Texas Instruments, Inc.	OPA2227PA	GbwTyp= 8.0MHz VccMin= 5.0 V VccMax= 36.0 V	1	\$2.35	 P0008A 116 mm <sup>2</sup>
2.	C1_S4	Kemet	C0603C103J5RACTU Series= X7R	Cap= 10.0 nF VDC= 50.0 V Tolerance= 5.0 %	1	\$0.01	 0603 5 mm <sup>2</sup>
3.	C2_S4	Kemet	C0603C103J5RACTU Series= X7R	Cap= 10.0 nF VDC= 50.0 V Tolerance= 5.0 %	1	\$0.01	 0603 5 mm <sup>2</sup>
4.	R1_S4	Vishay-Dale	CRCW040241K2FKED Series= CRCW..e3	Res= 41.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>
5.	R2_S4	Vishay-Dale	CRCW04026K19FKED Series= CRCW..e3	Res= 6.19 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>
6.	R3_S4	Vishay-Dale	CRCW04022K49FKED Series= CRCW..e3	Res= 2.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm <sup>2</sup>

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
7.	R4_S4	Vishay-Dale	CRCW04022K49FKED Series= CRCW..e3	Res= 2.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm <sup>2</sup>

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