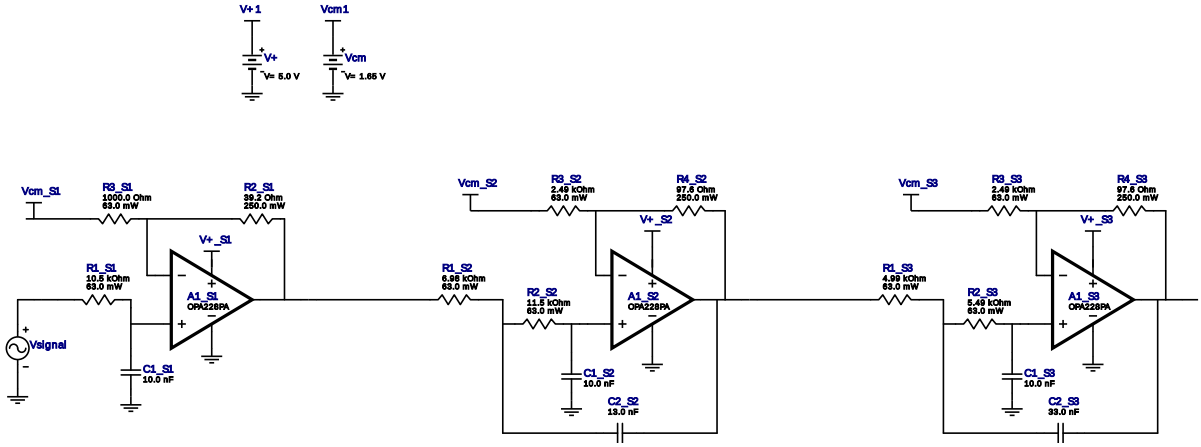
Type : Lowpass
Response : Bessel
Order : 5
Number of Stages : 3

Device = OPA228PA
Created = Jul 24 2016 7:29AM

WEBENCH® Design Report

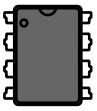
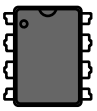
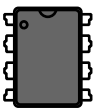
Design : 1194016/2197 OPA228PA
Lowpass, Sallen Key, Bessel



My Comments

No comments

Electrical BOM

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	A1_S1	Texas Instruments, Inc.	OPA228PA	GbwTyp= 33.0MHz VccMin= 5.0 V VccMax= 36.0 V	1	$1.40	 P0008A 116 mm^2
2.	A1_S2	Texas Instruments, Inc.	OPA228PA	GbwTyp= 33.0MHz VccMin= 5.0 V VccMax= 36.0 V	1	$1.40	 P0008A 116 mm^2
3.	A1_S3	Texas Instruments, Inc.	OPA228PA	GbwTyp= 33.0MHz VccMin= 5.0 V VccMax= 36.0 V	1	$1.40	 P0008A 116 mm^2
4.	C1_S1	Kemet	C0603C103J5RACTU Series= X7R	Cap= 10.0 nF VDC= 50.0 V Tolerance= 5.0 %	1	$0.01	 0603 5 mm^2
5.	C1_S2	Kemet	C0603C103J5RACTU Series= X7R	Cap= 10.0 nF VDC= 50.0 V Tolerance= 5.0 %	1	$0.01	 0603 5 mm^2
6.	C1_S3	Kemet	C0603C103J5RACTU Series= X7R	Cap= 10.0 nF VDC= 50.0 V Tolerance= 5.0 %	1	$0.01	 0603 5 mm^2
7.	C2_S2	MuRata	GRM3195C1H133JA01D Series= C0G/NP0	Cap= 13.0 nF VDC= 50.0 V Tolerance= 5.0 %	1	$0.07	 1206 11 mm^2
8.	C2_S3	AVX	08053A332JAT2A Series= C0G/NP0	Cap= 33.0 nF VDC= 25.0 V Tolerance= 5.0 %	1	$0.06	 0805 7 mm^2

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
9.	R1_S1	Vishay-Dale	CRCW040210K5FKED Series= CRCW..e3	Res= 10.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
10.	R1_S2	Vishay-Dale	CRCW04026K98FKED Series= CRCW..e3	Res= 6.98 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
11.	R1_S3	Vishay-Dale	CRCW04024K99FKED Series= CRCW..e3	Res= 4.99 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
12.	R2_S1	Panasonic	ERJ-8ENF39R2V Series= ERJ-8E	Res= 39.2 Ohm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²
13.	R2_S2	Vishay-Dale	CRCW040211K5FKED Series= CRCW..e3	Res= 11.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
14.	R2_S3	Vishay-Dale	CRCW04025K49FKED Series= CRCW..e3	Res= 5.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
15.	R3_S1	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
16.	R3_S2	Vishay-Dale	CRCW04022K49FKED Series= CRCW..e3	Res= 2.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
17.	R3_S3	Vishay-Dale	CRCW04022K49FKED Series= CRCW..e3	Res= 2.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
18.	R4_S2	Panasonic	ERJ-8ENF97R6V Series= ERJ-8E	Res= 97.6 Ohm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²
19.	R4_S3	Panasonic	ERJ-8ENF97R6V Series= ERJ-8E	Res= 97.6 Ohm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²

Design Inputs

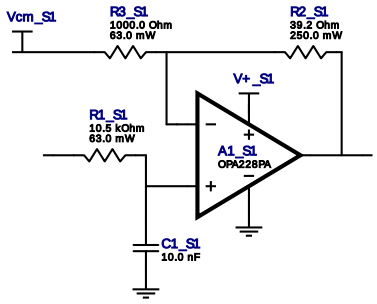
#	Name	Value	Description
1.	FilterType	Lowpass	
2.	FilterResponse	Bessel	
3.	FilterOrder	5.0	
4.	FilterTopology	Sallen_Key	
5.	NumberOfStages	3.0	
6.	PassbandFrequency	1,000.0	
7.	StopbandAttenuation	-45.0	
8.	StopbandFrequency	5.0 k	
9.	Gain	1.122	
10.	SingleSupply	3.3	Power supply(s) to active chips
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

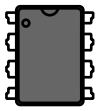
1. **OPA228PA** Product Folder : http://www.ti.com//product/OPA228 : contains the data sheet and other resources.

Filter Stage :1

Cutoff Frequency	1.507 kHz
Min GBW Reqd	78.289 kHz
Stage Gain	1.039 V/V
Stage Q	500.0 m
Stage Topology	Real_Pole

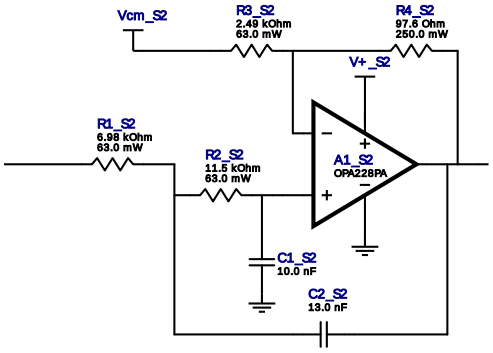


Electrical BOM

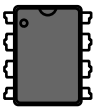
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	A1_S1	Texas Instruments, Inc.	OPA228PA	GbwTyp= 33.0MHz VccMin= 5.0 V VccMax= 36.0 V	1	$1.40	 P0008A 116 mm^2
2.	C1_S1	Kemet	C0603C103J5RACTU Series= X7R	Cap= 10.0 nF VDC= 50.0 V Tolerance= 5.0 %	1	$0.01	 0603 5 mm^2
3.	R1_S1	Vishay-Dale	CRCW040210K5FKED Series= CRCW..e3	Res= 10.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
4.	R2_S1	Panasonic	ERJ-8ENF39R2V Series= ERJ-8E	Res= 39.2 Ohm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	 1206 11 mm^2
5.	R3_S1	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2

Filter Stage :2

Cutoff Frequency	1.561 kHz
Min GBW Reqd	90.825 kHz
Stage Gain	1.039 V/V
Stage Q	560.0 m
Stage Topology	Sallen_Key

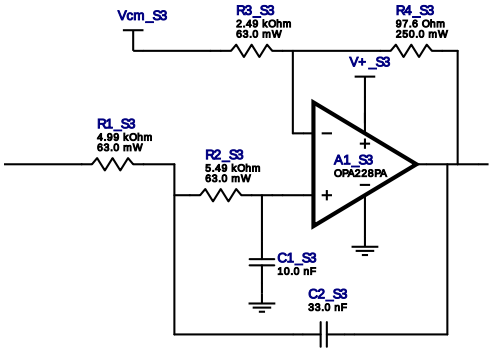


Electrical BOM

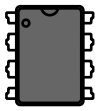
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	A1_S2	Texas Instruments, Inc.	OPA228PA	GbwTyp= 33.0MHz VccMin= 5.0 V VccMax= 36.0 V	1	$1.40	 P0008A 116 mm^2
2.	C1_S2	Kemet	C0603C103J5RACTU Series= X7R	Cap= 10.0 nF VDC= 50.0 V Tolerance= 5.0 %	1	$0.01	 0603 5 mm^2
3.	C2_S2	MuRata	GRM3195C1H133JA01D Series= C0G/NP0	Cap= 13.0 nF VDC= 50.0 V Tolerance= 5.0 %	1	$0.07	 1206 11 mm^2
4.	R1_S2	Vishay-Dale	CRCW04026K98FKED Series= CRCW..e3	Res= 6.98 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
5.	R2_S2	Vishay-Dale	CRCW040211K5FKED Series= CRCW..e3	Res= 11.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
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^2
7.	R4_S2	Panasonic	ERJ-8ENF97R6V Series= ERJ-8E	Res= 97.6 Ohm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	 1206 11 mm^2

Filter Stage :3

Cutoff Frequency	1.761 kHz
Min GBW Reqd	168.33 kHz
Stage Gain	1.039 V/V
Stage Q	920.0 m
Stage Topology	Sallen_Key



Electrical BOM

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	A1_S3	Texas Instruments, Inc.	OPA228PA	GbwTyp= 33.0MHz VccMin= 5.0 V VccMax= 36.0 V	1	$1.40	 P0008A 116 mm^2
2.	C1_S3	Kemet	C0603C103J5RACTU Series= X7R	Cap= 10.0 nF VDC= 50.0 V Tolerance= 5.0 %	1	$0.01	 0603 5 mm^2
3.	C2_S3	AVX	08053A332JAT2A Series= C0G/NP0	Cap= 33.0 nF VDC= 25.0 V Tolerance= 5.0 %	1	$0.06	 0805 7 mm^2
4.	R1_S3	Vishay-Dale	CRCW04024K99FKED Series= CRCW..e3	Res= 4.99 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
5.	R2_S3	Vishay-Dale	CRCW04025K49FKED Series= CRCW..e3	Res= 5.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
6.	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^2

#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
7.	R4_S3	Panasonic	ERJ-8ENF97R6V Series= ERJ-8E	Res= 97.6 Ohm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	 1206 11 mm^2