BAB IV

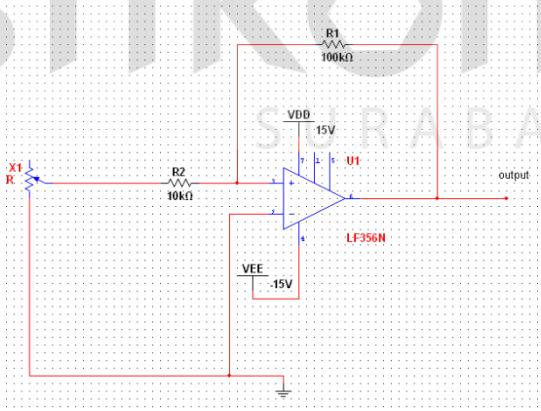
PEMBAHASAN DAN HASIL PENGUJIAN

4.1 *Operational Amplifier*

Operational Amplifier atau yang lebih dikenal dengan OpAmp, adalah penguat operasional yang sangat penting dalam instrumentasi elektronika. OpAmp tidak lain adalah penguat differensial dengan dua masukan dan satu keluaran yang mempunyai penguat tegangan yang sangat tinggi. Rangkaian penguat operasional dalam aplikasinya menggunakan IC OpAmp yang terdiri dari berbagai macam. Dalam percobaan ini akan digunakan jenis IC LM741 dan LF356.

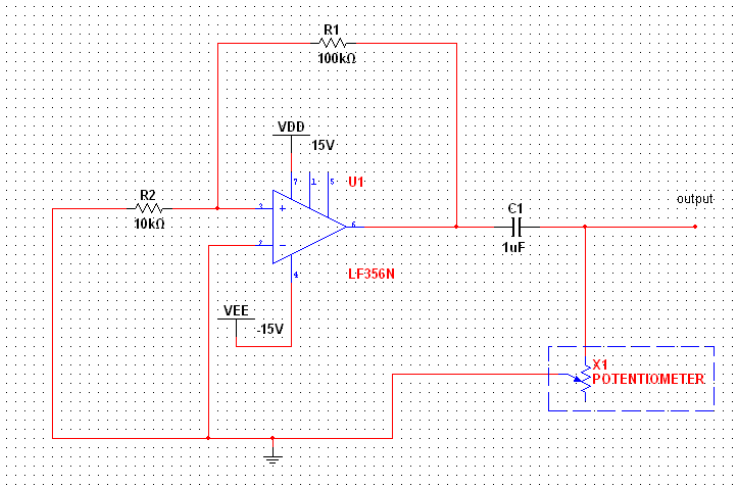
4.1.1 Pengukuran Impedansi

a. Impedansi Masukan



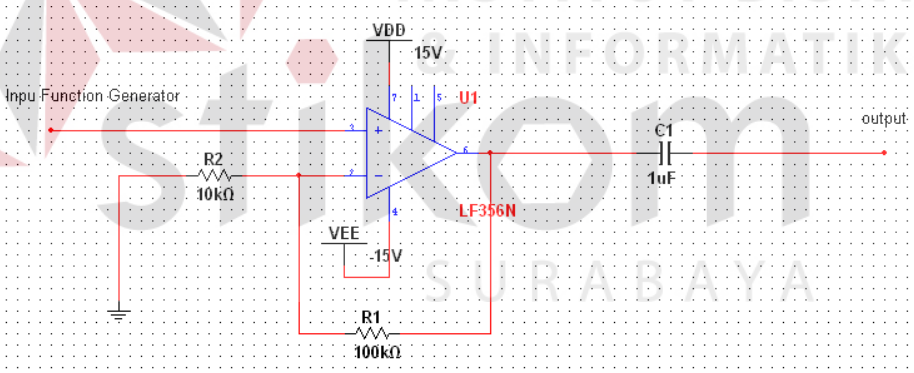
Frekuensi	1 KHz	10 KHz	100 KHz
V in	14 V	14V	14V
½ V in	7 V	7 V	7 V
Rp	30,67 K Ohm	30, 67 K Ohm	37,76 K Ohm

b. Impedansi Keluaran



Frekuensi	1 Khz	10 Khz	100Khz
V in	14v	14v	14v
½ Vin	7v	7v	7v
Rp	29,42 ohm	29,87 ohm	35,54 k ohm

4.1.2 Penguat Tak Membalik



Input 100m Vpp
Volt menurut rumus : 1,1 Volt

Frekuensi Input	V in	V out	Penguatan Tegangan
1 Khz	100,409 mV	1,104 V	10,99 x
10 Khz	100,409 mV	1,101 V	10,96 x
100 Khz	100,408 mV	884,892 mV	8,81 x

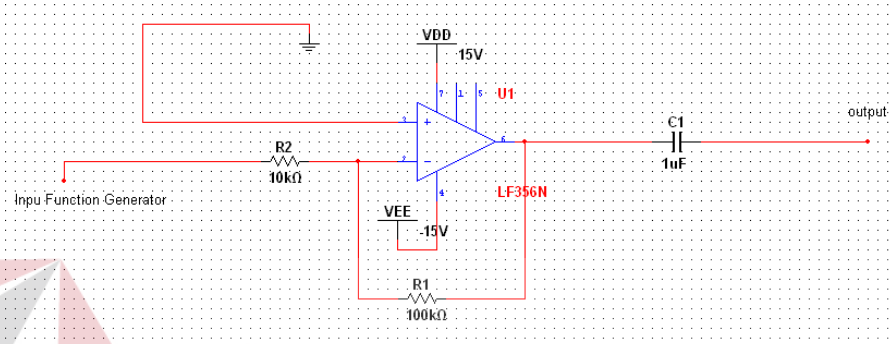
Input 500m Vpp
Volt menurut rumus : 5,5 Volt

Frekuensi Input	V in	V out	Penguatan Tegangan
1 Khz	500,505 mV	5,505 V	10,0997 x
10 Khz	500,467 mV	5,49 V	10,969 x
100 Khz	500,554 mV	4,43 mV	8,85 x

Input 1 Vpp
Volt menurut rumus : 11 Volt

Frekuensi Input	V in	V out	Penguatan Tegangan
1 Khz	1,01 V	11,111 V	11 x
10 Khz	1,01 V	11.081 V	10,971 x
100 Khz	1,01 V	8,942 V	8,853 x

4.1.3 Penguat Membalik



Input 100m Vpp
Volt menurut rumus : -1,1 Volt

Frekuensi Input	V in	V out	Penguatan Tegangan
1 Khz	100,409 mV	-1,104 V	-10,99 x
10 Khz	100,409 mV	-1,101 V	-10,96 x
100 Khz	100,408 mV	-884,892 mV	8,81 x

Input 500m Vpp
Volt menurut rumus : - 5,5 Volt

Frekuensi Input	V in	V out	Penguatan Tegangan
1 Khz	100,409 mV	-5,05 V	-10,099 x
10 Khz	100,409 mV	-5,49 V	-10,969 x
100 Khz	100,408 mV	-4,44 mV	-8,84 x

Input 1 Vpp
Volt menurut rumus : -11 Volt

Frekuensi Input	V in	V out	Penguatan Tegangan
1 Khz	-1,02 V	-11,221 V	10,99 x
10 Khz	-1.02 V	-11,221 V	10,96 x
100 Khz	-1,03V	-8,966V	8,86x

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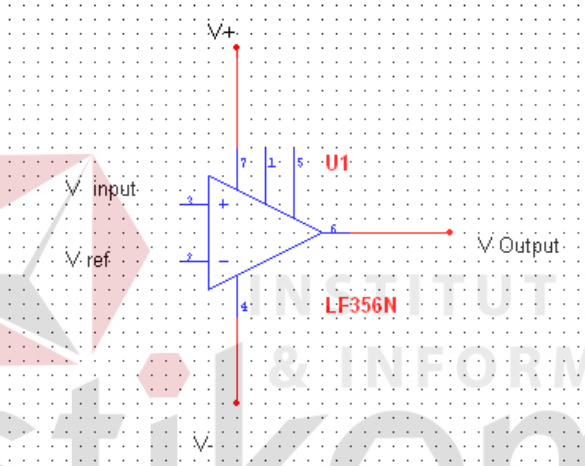
4.2 Komparator

Komparator adalah sebuah rangkaian yang memanfaatkan kelebihan-kelebihan karakteristik penguat operasional. Seperti namanya, komparator adalah rangkaian untuk membandingkan dua buah isyarat masukan.

4.2.1 Rangkaian Komparator



Hasil Percobaan

Tegangan Referensi (v)	Tegangan Masukan (v)	Tegangan Keluaran (v)
2	1	4.86v
	2	4.87v
	3	0v
	4	0v
3	1	4.88v
	2	4.87v
	3	4.86v
	4	0v
5	3	4.88v
	4	4.88v
	5	4.87v
	6	0v

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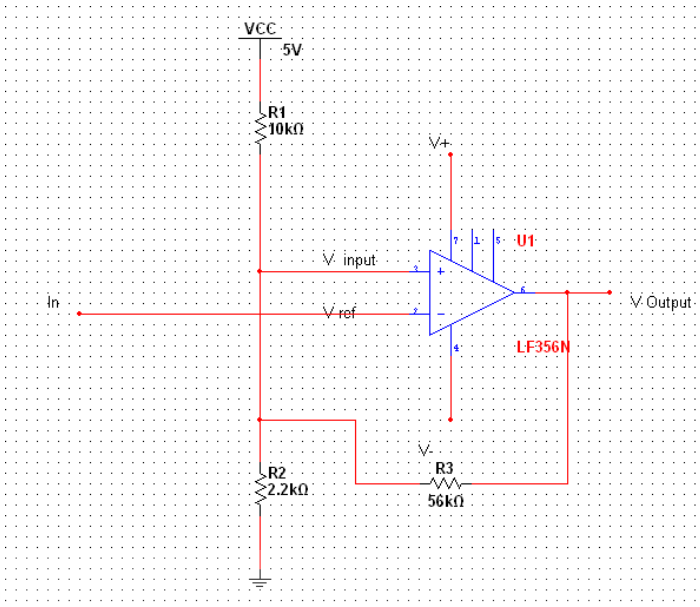
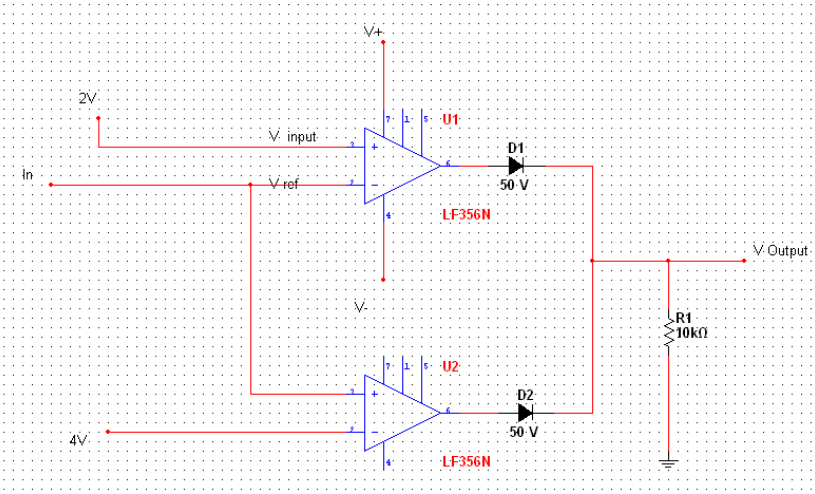
4.2.2 Rangkaian Schmitt Trigger



Hasil Percobaan

R1 (Ω)	R2 (Ω)	R3 (Ω)	Hasil Perhitungan		Hasil Pengukuran	
			V2 (v)	V'2 (v)	V2 (v)	V'2 (v)
2.2k	10k	56k	3.54v	1.98v	3.4v	1.94v
		68k	2.97v	1.48v	2.95v	1.46v
2.2k	33k	56k	3.01v	2.2v	2.98v	1.97v
	56k		2.88v	1.51v	2.71v	1.49v
3.3k	10k	56k	4.58v	2.3v	4.43v	2.01v
5.6k			4.2v	2.8v	4.01v	2.71v

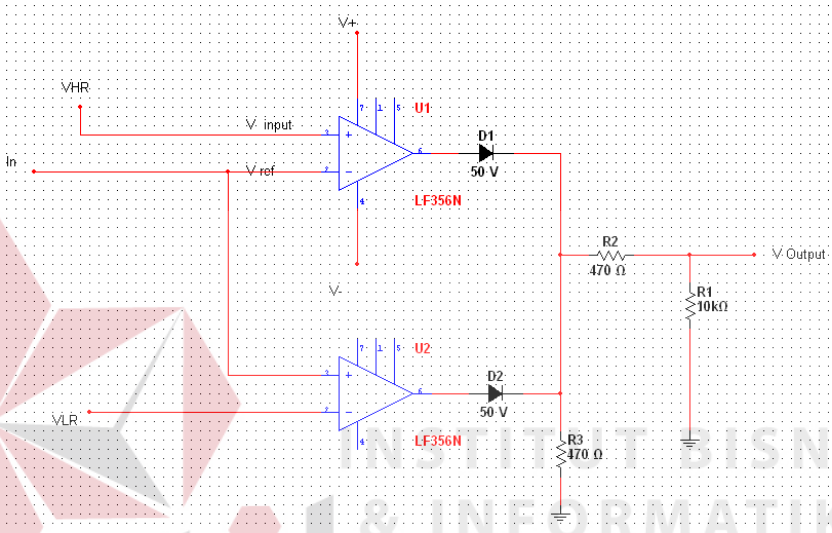
4.2.3 Rangkaian Komparator Jendela Membalik



Hasil Percobaan

Vin (volt)	Vout (volt)
0	2.01v
1	1.99v
2	1.98v
3	0v
4	0v
5	3.98v

4.2.4 Rangkaian Komparator Jendela Tak Membalik



Hasil Percobaan

Vin (volt)	Vout (volt)
0	2.1v
1	1.97v
2	1.98v
3	0v
4	0v
5	4.01v

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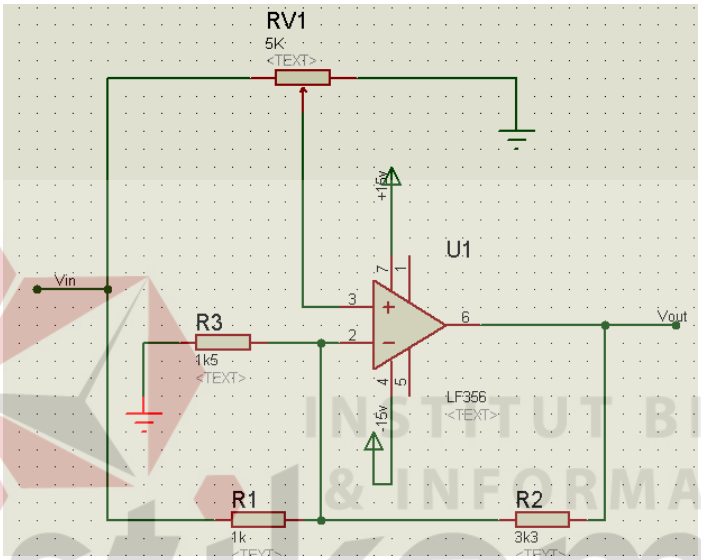
4.3 Rangkaian Aplikasi Sederhana Op-Amp

Merangkai dan menganalisa rangkaian-rangkaian aplikasi sederhana Op-amp (switchable op-amp , penggeser fasa, subtractor, perata-rata tegangan.

4.3.1 Switchable Op-Amp



Hasil Percobaan

Nilai resistanti R4 pada kaki no 1 & 2	Vout (v)	Besar penguatan	Bentuk output Inverting = 1 Non invert = 0
0	3,2	3x	0
1k	1,8	1,8x	0
2k	0	0x	0
3k	-1,4	-1,4x	1
5k	-3,3	-3,3x	1

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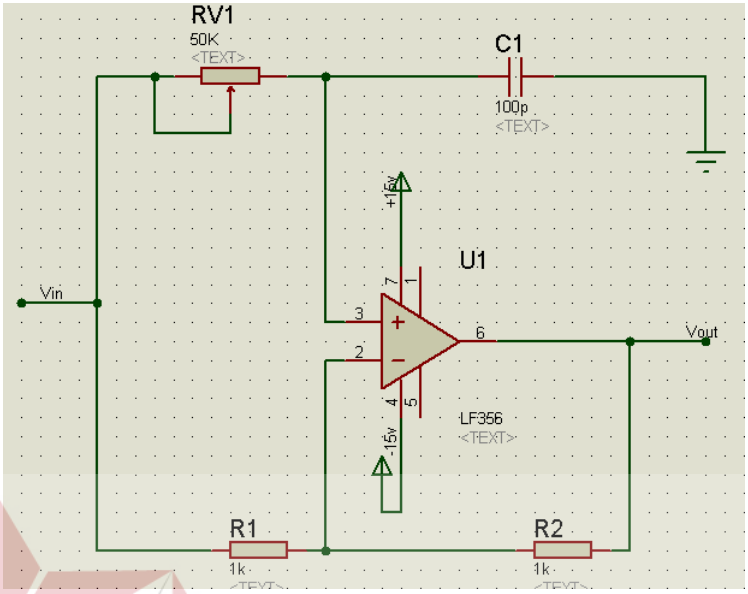
4.3.2 Rangkaian Penggeser Fasa



Hasil percobaan

Nilai R3 pada kaki no.1 dan 2	Beda fasa gelombang input dan output
0	0^o
1k	5^o
5k	15^o
10k	25^o
30k	45^o

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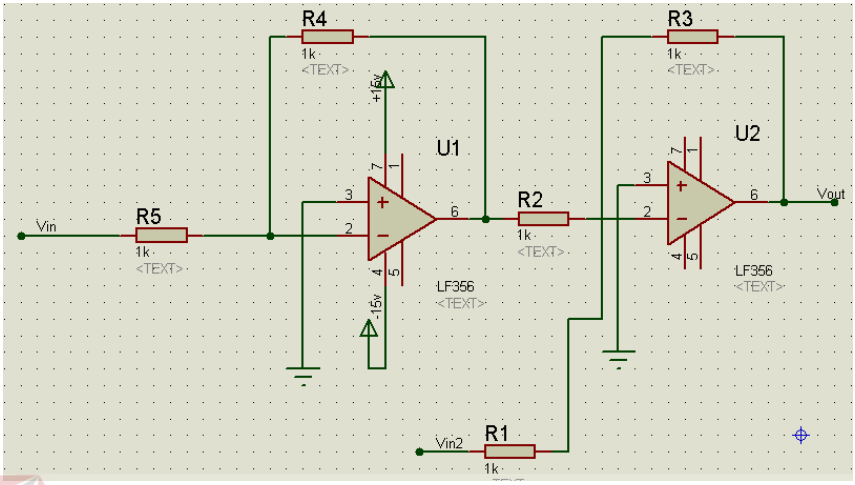
4.3.3 Subtractor



Hasil percobaan

Vin 1 (v)	Vin2 (v)	Vout (v)
1	1	0
2	1	0,98
3	2	0,97
4	2	1,96
5	3	1,97

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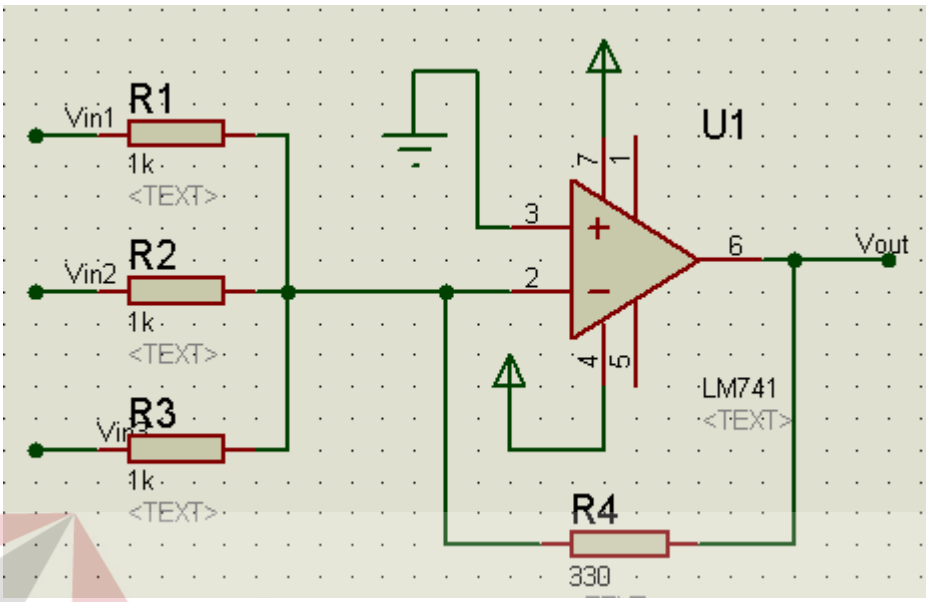
4.3.4 Perata-rata



Hasil percobaan

Vin1 (v)	Vin2 (v)	Vin3 (v)	Vout (v)
1	1	1	0
2	1	1	-1,3
3	2	1	-2,06
4	2	1	-2,43
5	3	2	-3,33

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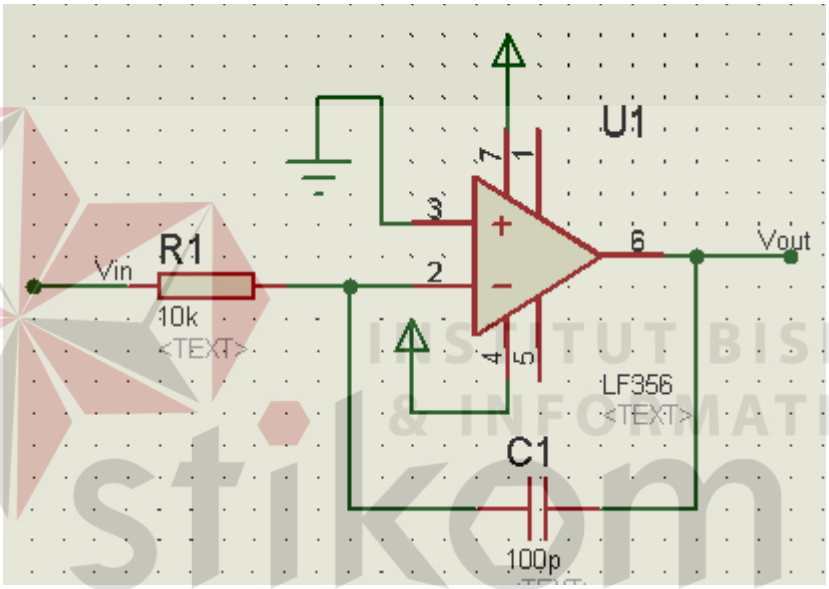
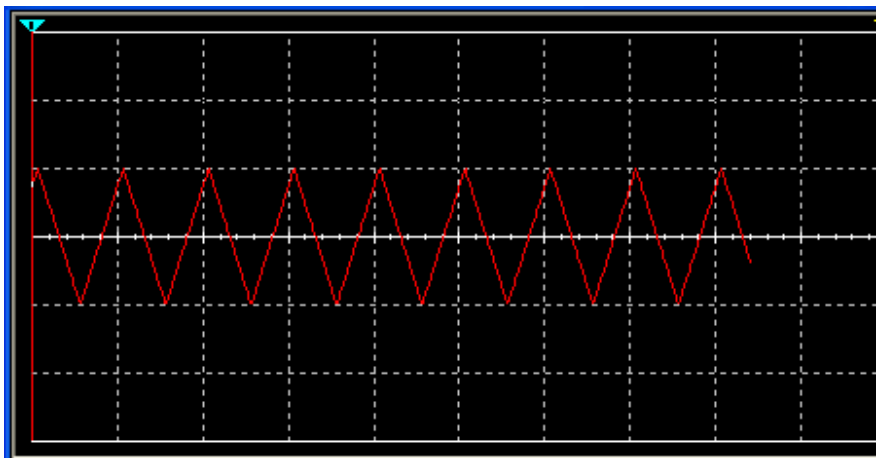
4.4 Integrator, Differensiator, Clipper, dan Clamper

Merangkai dan menganalisa rangkaian integrator, differensiator, clipper dan clamper.

4.4.1 Integrator



Hasil percobaan :



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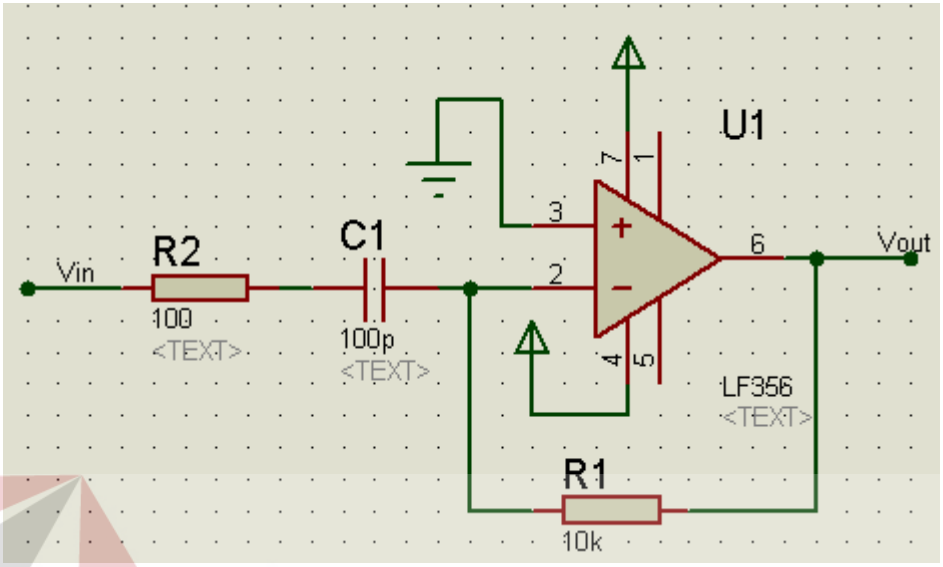
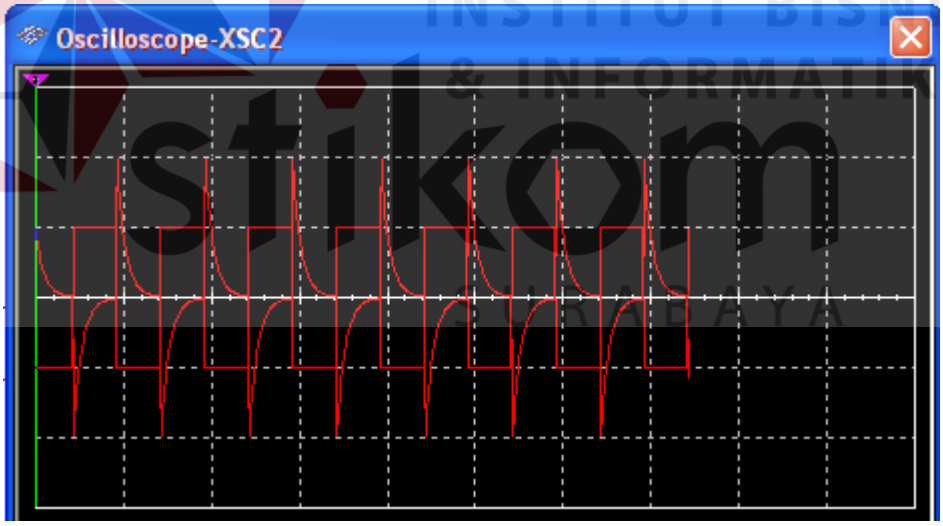
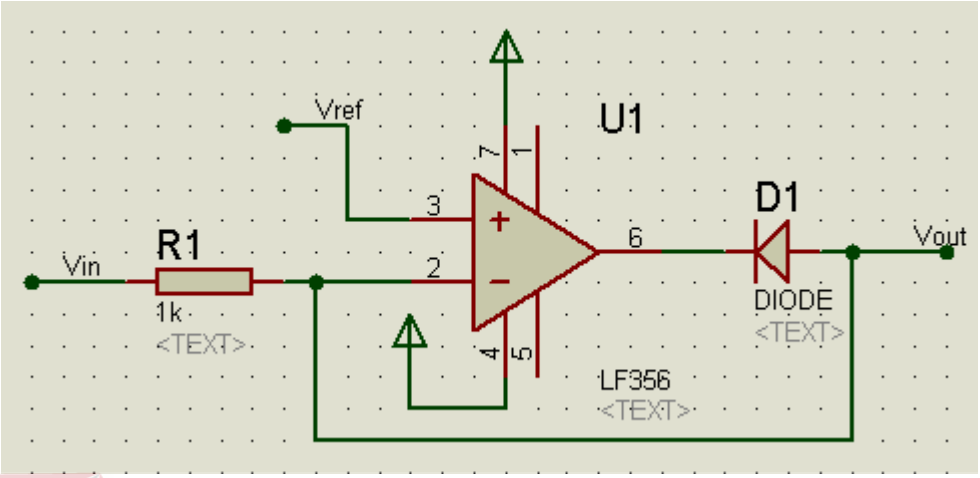
4.4.2 Differensiator



Hasil Percobaan :



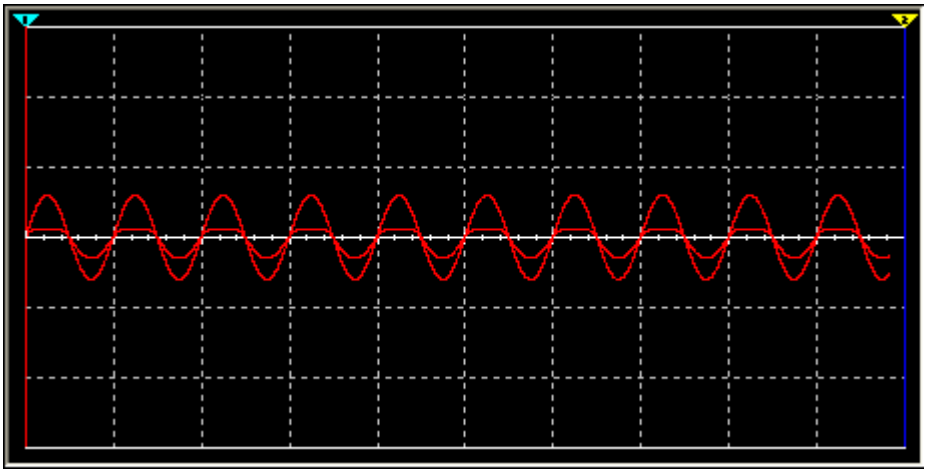
4.4.3 Clipper positif aktif



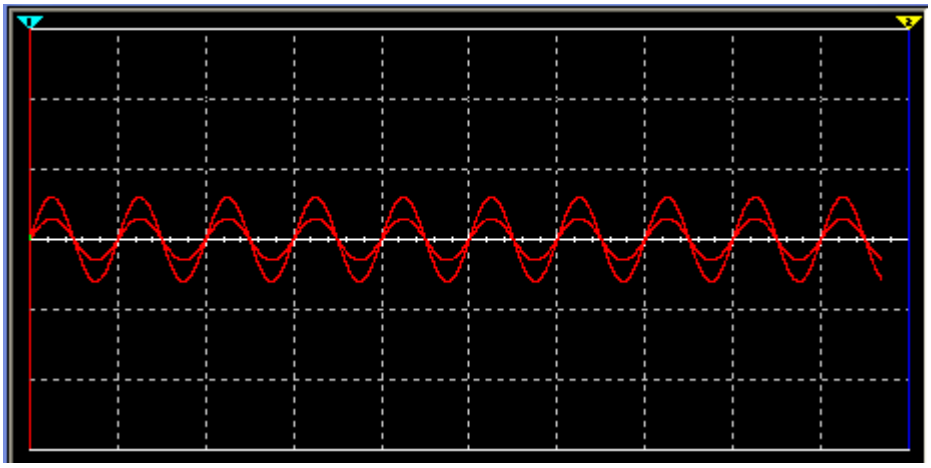
Hasil percobaan

Vref (v)	Vout positif terhadap ground
0	1.2v
1	2.1v
3	2.96v
5	4.2v

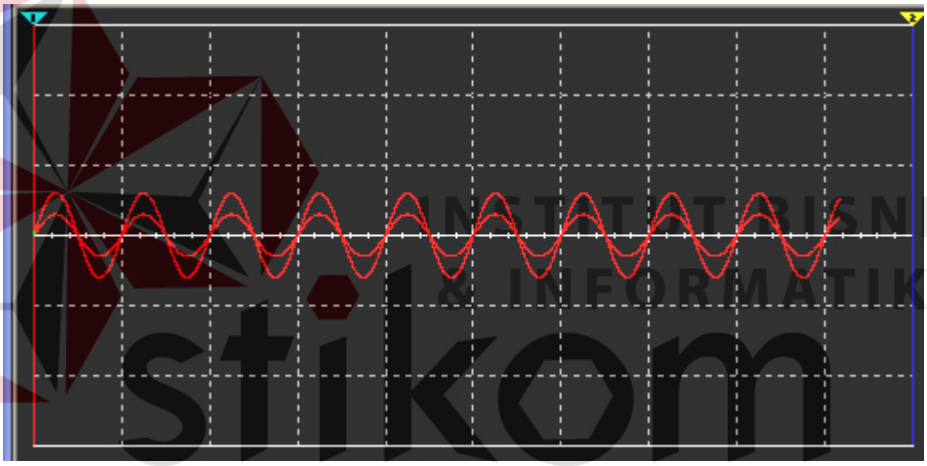
Vreff = 0v



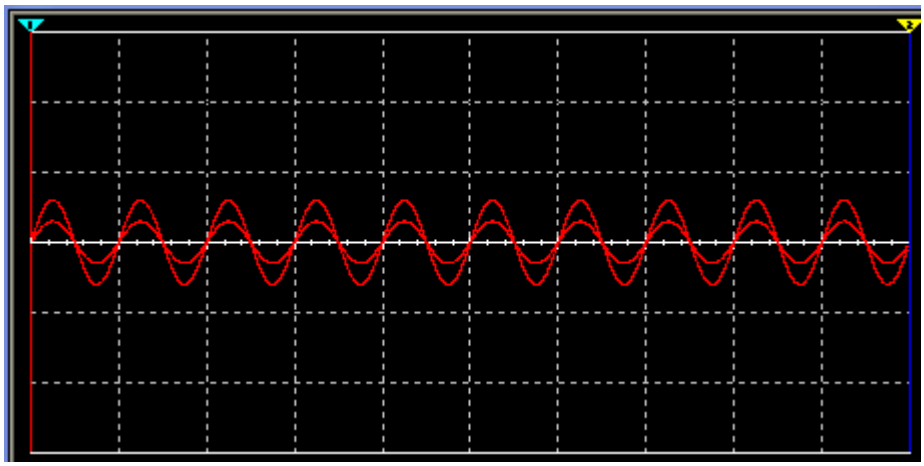
Vreff = 1v



Vreff = 3v



Vreff = 5v



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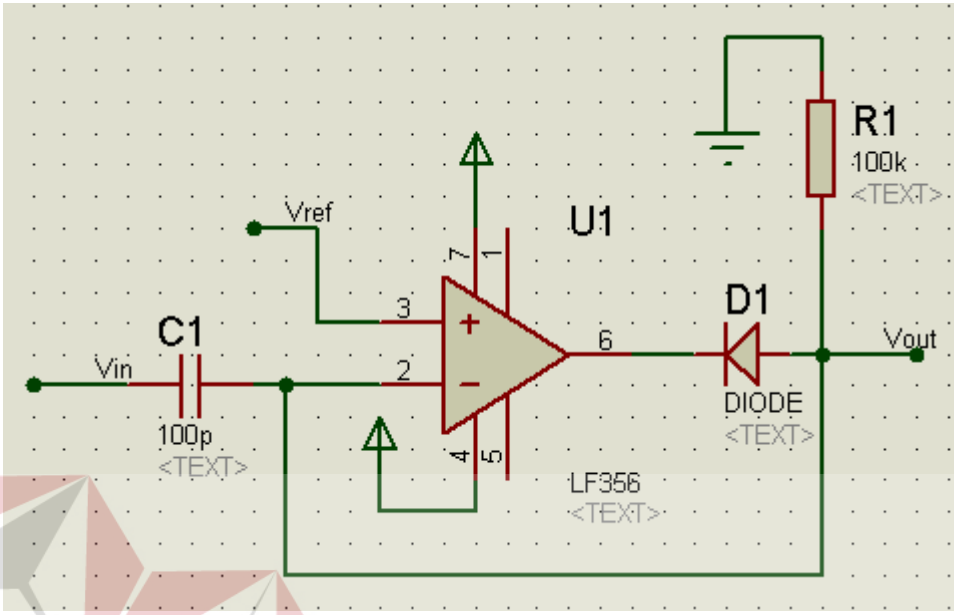
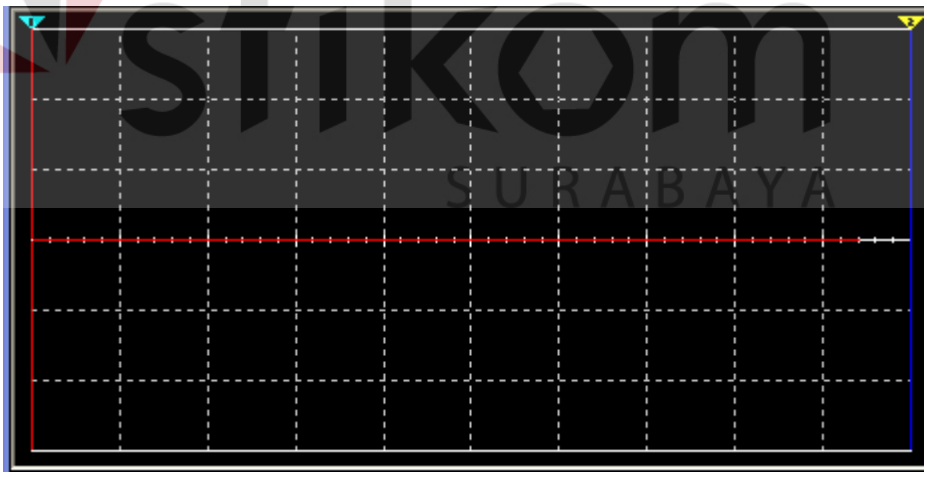
4.4.4 Clamper positif aktif



Hasil percobaan

Vreff = 0v



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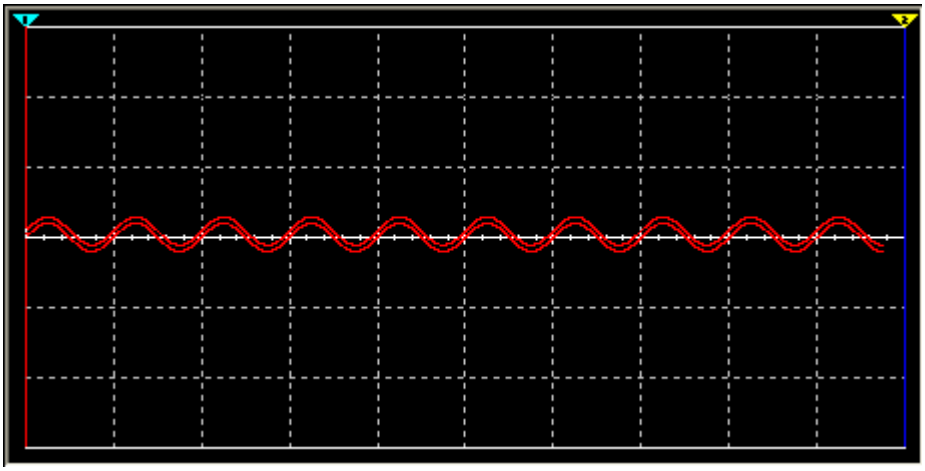
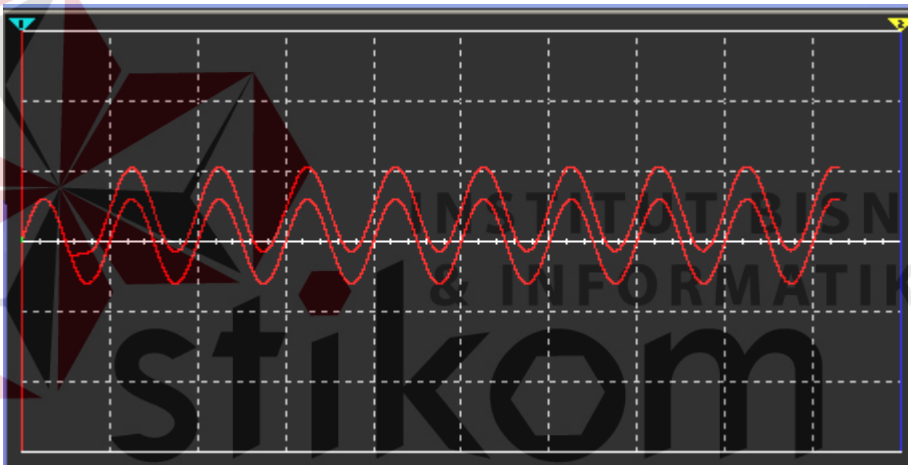
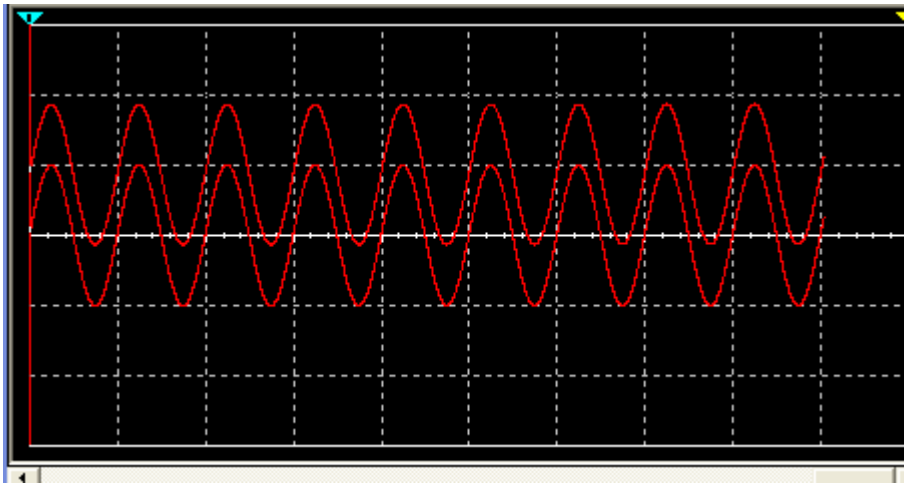
Vreff = 1v



Vreff = 3v



Vreff = 5v



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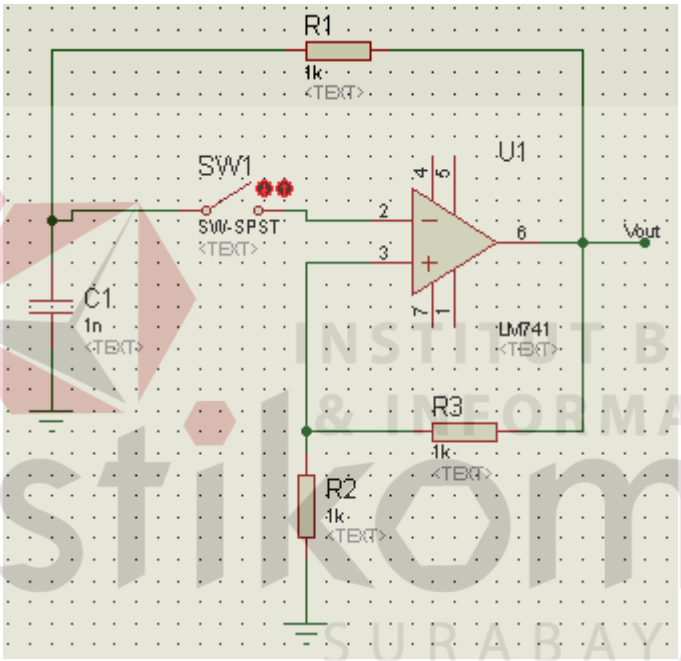
4.5 Pembangkit dan Pengubah Bentuk Gelombang

Merangkai dan menganalisa rangkaian pembangkit dan pengubah bentuk gelombang menggunakan Op-Amp.

4.5.1 Osilator Relaksasi



Hasil percobaan

Nilai Komponen				Frekuansi Output	
R1	R2	R3	C	Perhitungan	Pengukuran
1k	1k	1k	1u	450Hz	447Hz
1k	1k	1k	10u	50Hz	45.4Hz
1k	1k	10k	10u	275Hz	268Hz
1k	10k	10k	10u	50Hz	45.4Hz
10k	1k	10k	10u	30Hz	27.3Hz

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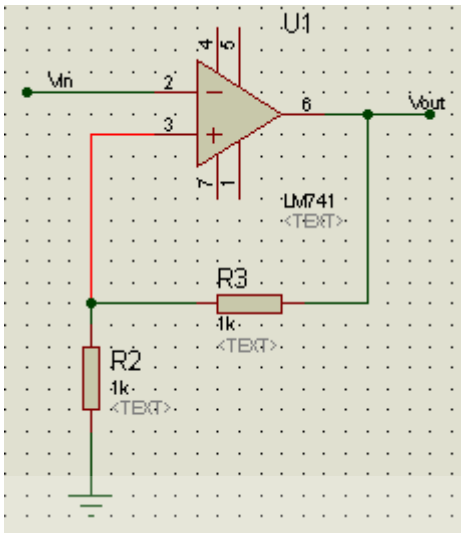
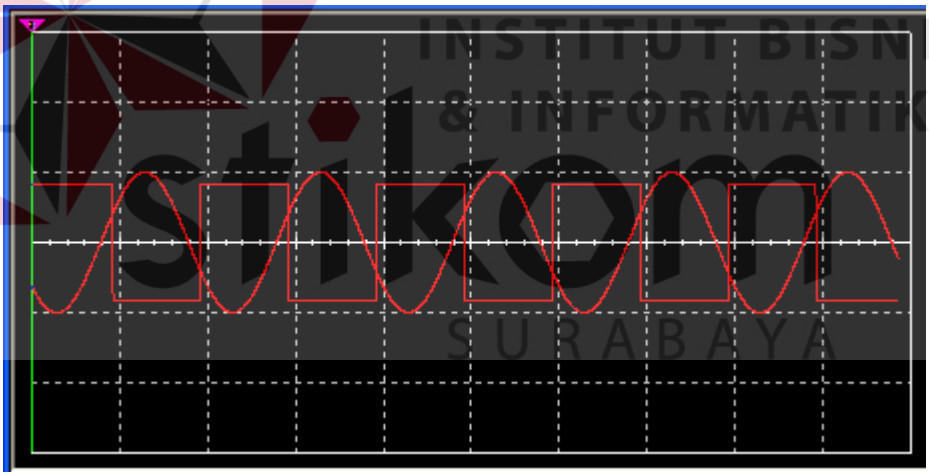
4.5.2 Pengubah Bentuk Gelombang Sinus ke Persegi

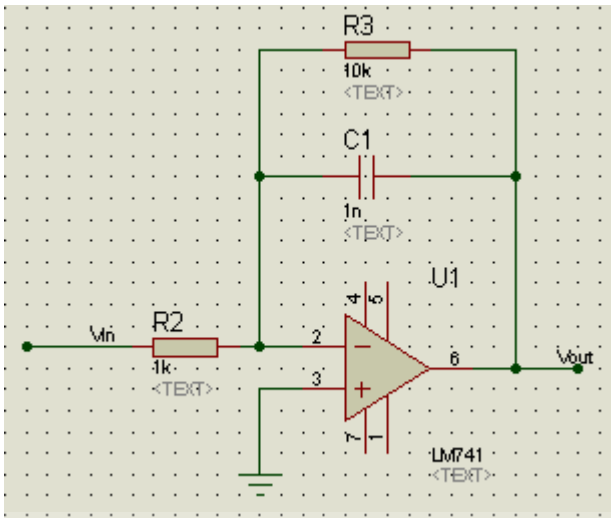


Hasil percobaan

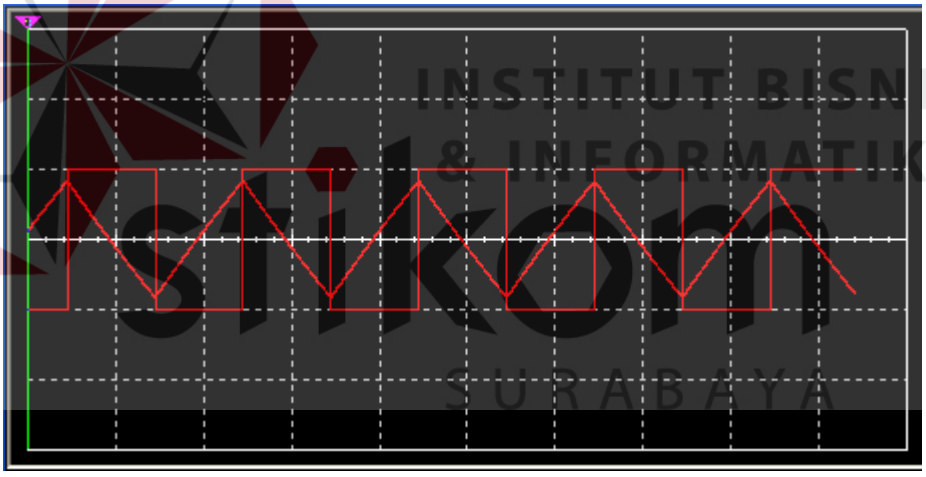


Fin	Fout
100Hz	99Hz
1Khz	997Hz
10Khz	9.95kHz

4.5.3 Pengubah Bentuk Gelombang Persegi ke Segi Tiga



Hasil percobaan



Fin	Fout
100Hz	97Hz
1Khz	998Hz
10Khz	37kHz

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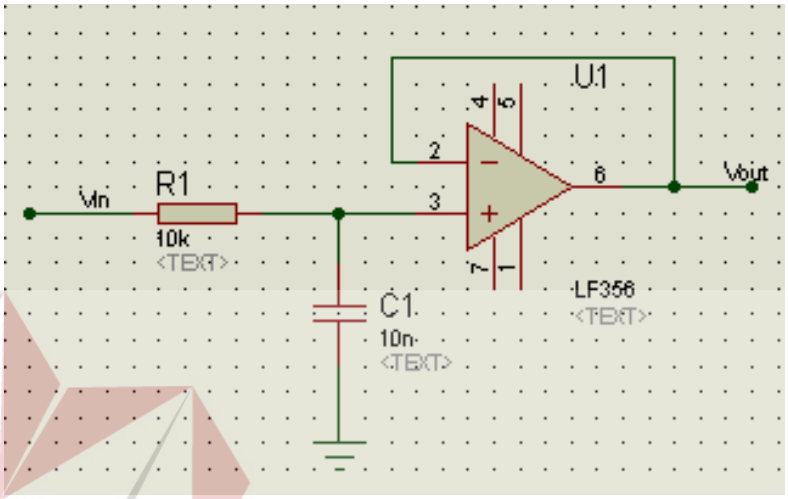
4.6 Rangkaian Filter I

Filter adalah sebuah rangkaian yang dirancang agar melewatkan suatu pita frekuensi tertentu supaya memperlemah semua isyarat diluar pita ini.

4.6.1 Rangkaian Filter Low-pass Dasar



F in (Hz)	Vin (Vpp)	Vout (Vpp)	Gelombang
100	30v	8.23v	membalik
1k	30v	8.22v	membalik
1,5k	30v	8.22v	membalik
3k	30v	8.19v	Tak membalik
5k	30v	8.22v	membalik

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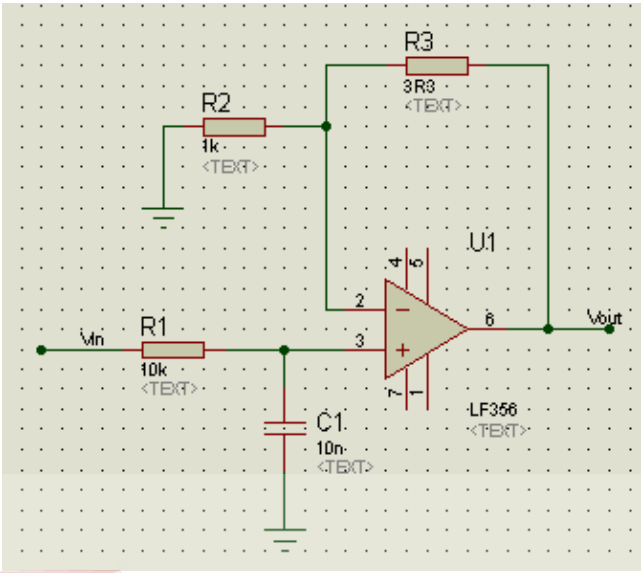
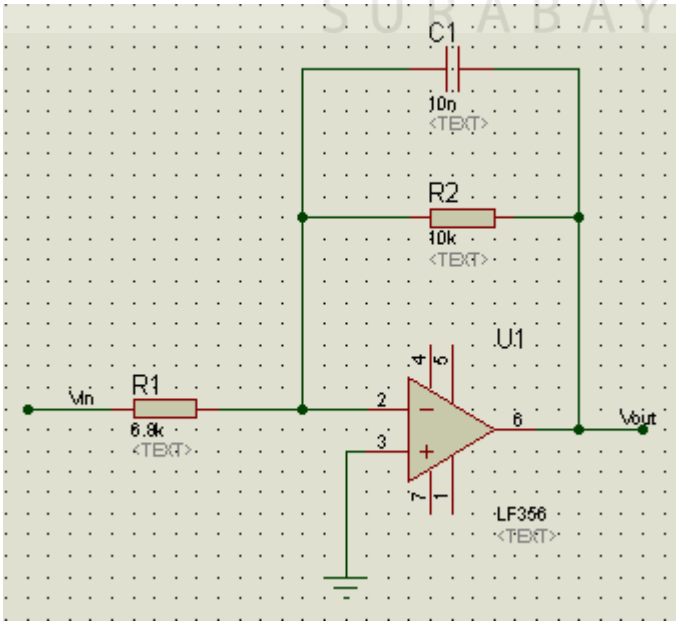
4.6.2 Rangkaian Filter Low-pass Tak Membalik



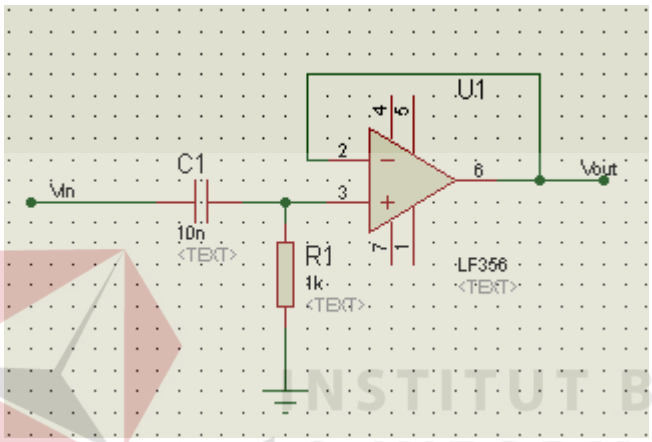
F in (Hz)	Vin (Vpp)	Vout (Vpp)	Gelombang
100	20v	21.3v	Tak membalik
1k	20v	28.2v	Tak membalik
1,5k	20v	28.2v	Tak membalik
3k	20v	28.2v	Tak membalik
5k	20v	28.2v	Tak membalik

4.6.3 Rangkaian Filter Low-pass Membalik



F in (Hz)	Vin (Vpp)	Vout (Vpp)	Gelombang
100	30v	8.21v	membalik
1k	30v	8.24v	Membalik
1,5k	30v	8.22v	Membalik
3k	30v	8.21v	Membalik
5k	30v	8.22v	Membalik

4.6.4 Rangkaian Filter High-pass Dasar



F in (Hz)	Vin (Vpp)	Vout (Vpp)
1k	30v	1.88v
8k	30v	2.3v
15k	30v	3.28v
20k	30v	1.62v
30k	30v	142mV

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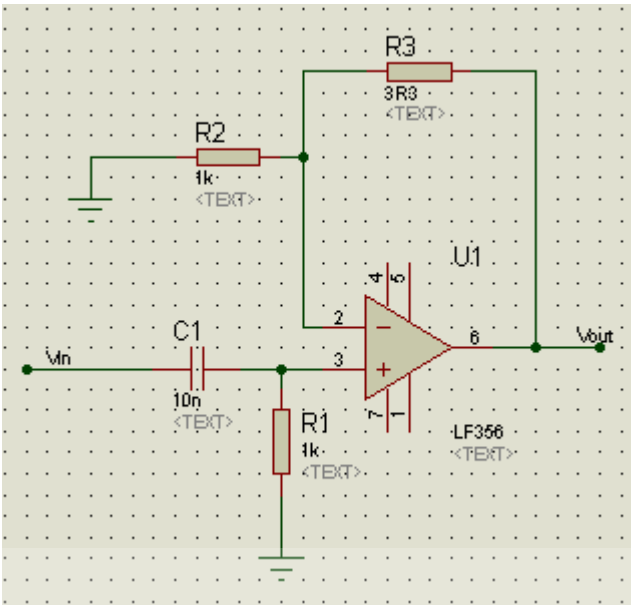
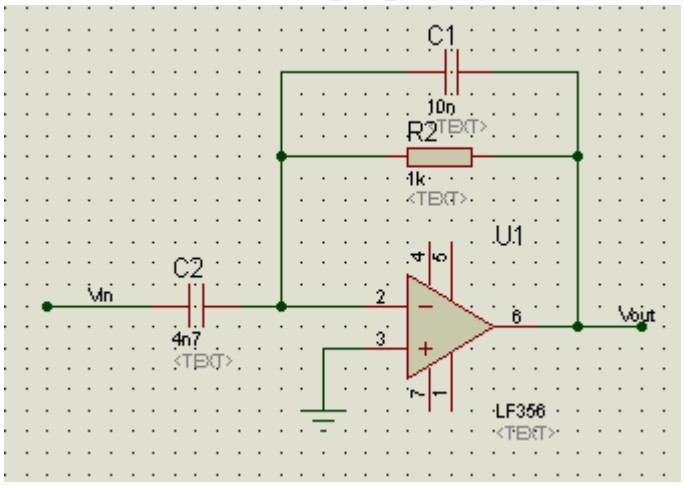
4.6.5 Rangkaian Filter High-pass Tak Membalik



F in (Hz)	Vin (Vpp)	Vout (Vpp)
1k	30v	8.09v
8k	30v	8.22v
15k	30v	1.78v
20k	30v	543mV
30k	30v	33.1mV

4.6.6 Rangkaian Filter High-pass Membalik



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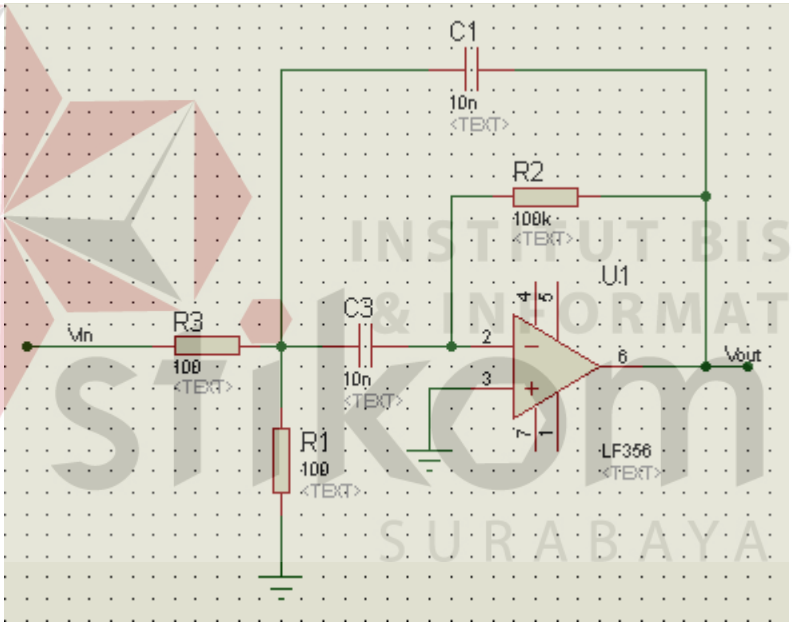
F in (Hz)	Vin (Vpp)	Vout (Vpp)
1k	30v	8.25v
8k	30v	1.13v
15k	30v	8.11v
20k	30v	4.4v
30k	30v	421mV

4.7 Rangkaian Filter II

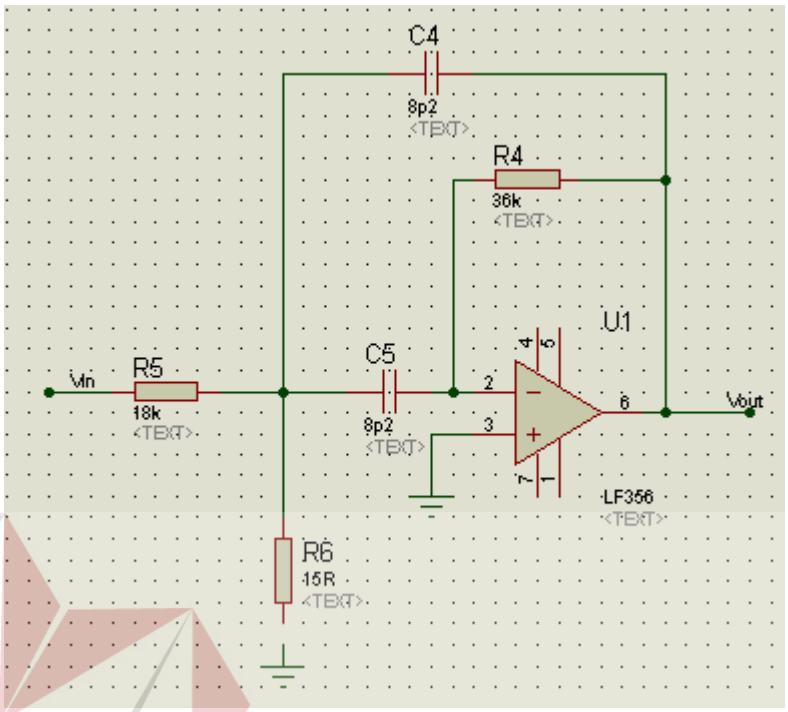
Memahami aplikasi OpAmp sebagai filter.

4.7.1 Rangkaian Filter Band-pass



F in (KHz)	Vin (Vpp)	Vout (Vpp)
1	2v	6.42v
5	2v	26v
7	2v	26v
9	2v	26v
15	2v	25.3v

4.7.2 Rangkaian Filter Band-pass Dengan Frekuensi Tengah Variabel



F in (KHz)	Vin (Vpp)	Vout (Vpp)
10	2v	37.7mV
20	2v	221mV
26	2v	359mV
28	2v	207mV
35	2v	89.2mV

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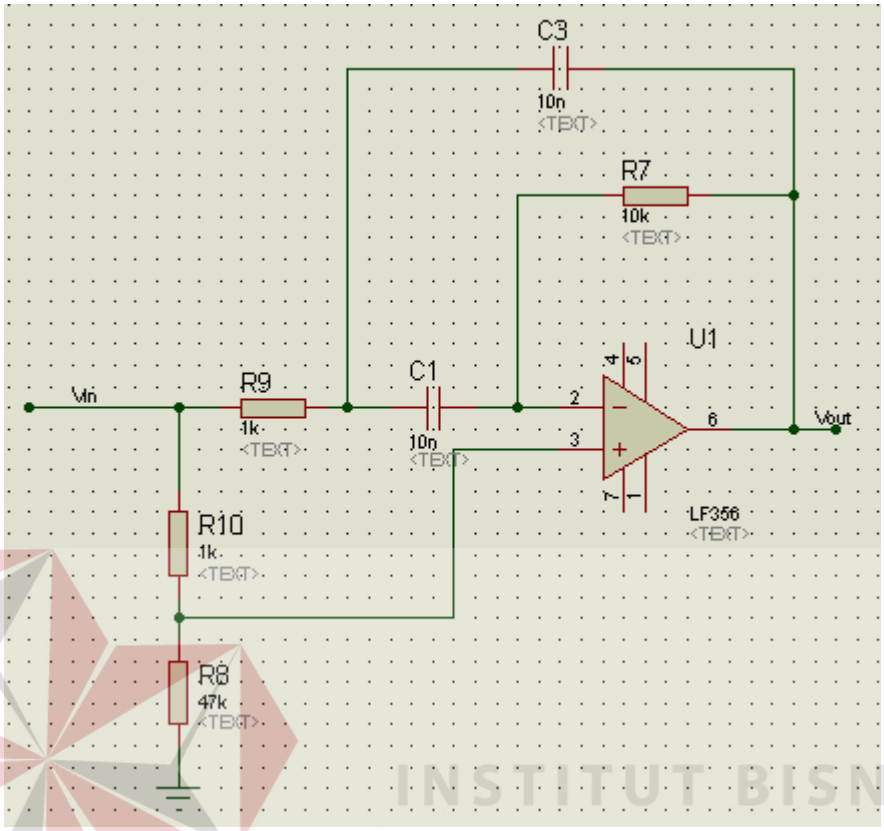
4.7.3 Rangkaian Filter Band-elimination



F in (KHz)	Vin (Vpp)	Vout (Vpp)
0,5	2v	1.96v
1	2v	1.95v
5	2v	1.75v
9	2v	1.91v
15	2v	1.94v

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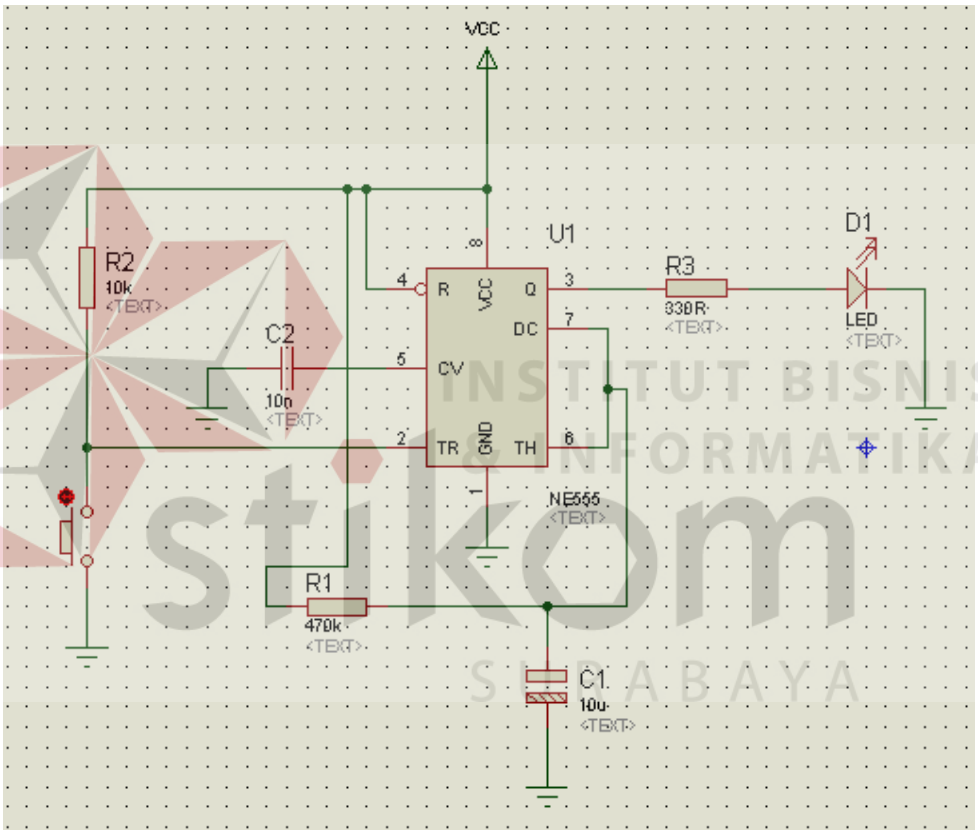
4.8 Rangkaian Timer

Kebanyakan rangkaian pewaktu (timer) adalah variasi dari multivibrator.Multivibrator adalah suatu rangkaian yang mempunyai dua kemungkinan keadaan pada keluarannya. Keluarannya tersebut dapat level rendah atau tinggi.

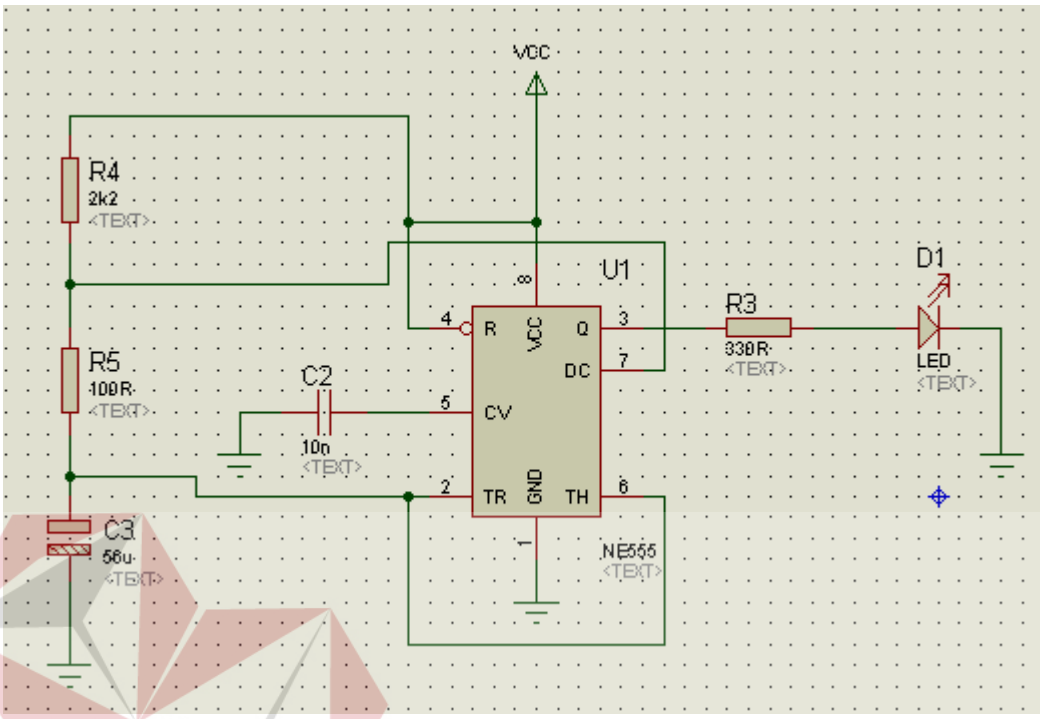
4.8.1 Multivibrator Monostabil 555



Hasil percobaan :

R1 …k	C1 … uf	T (terukur)	T (terhitung)
100	47	501ms	517ms
	100	0.97s	1,1s
200	47	1.01s	1,034s
	100	1.99s	2,2s
330	47	1.6s	1,7s
	100	3.59s	3,63s

4.8.2 Multivibrator Tak Stabil



Hasil percobaan :

R1 … k	R2 … k	C1 … uf	Waktu siklus	
			terukur	terhitung
33	47	25	129.5ms	138,6ms
33	47	50	267.8ms	277,2ms
33	47	100	548.3ms	554,4ms
47	100	25	671.2ms	679.1ms
47	100	50	821.4ms	824.2ms
47	100	100	1.1s	1.2s

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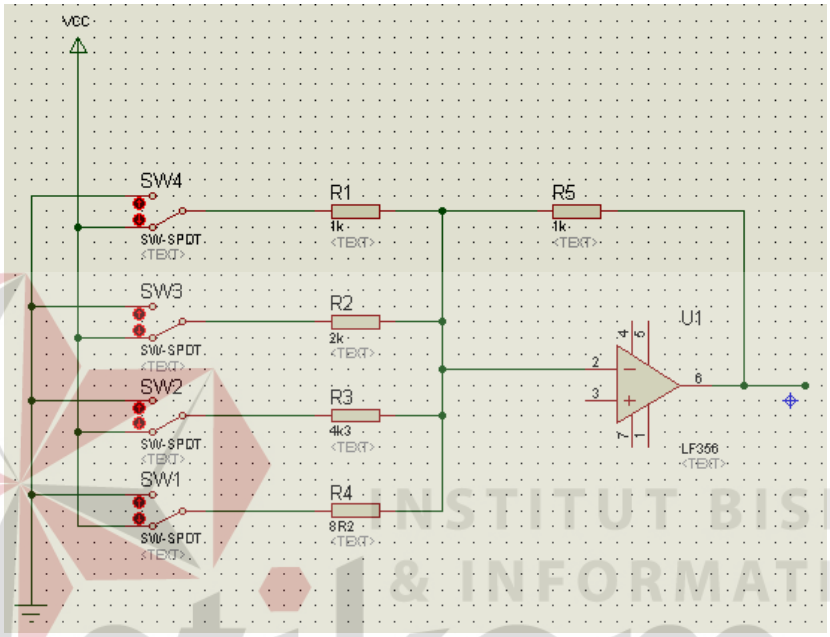
4.9 Digital To Analog Converter

Digital to Analog Converter (DAC) merupakan suatu rangkaian yang mempunyai fungsi untuk mengubah atau mengkonversi signal digital menjadi analog.

4.9.1 Rangakaian DAC Binary Weighted Resistor



Hasil percobaan :

S1 S2 S3 S4	Vout	
	Pengukuran	Perhitungan
0000	2,01v	3.54v
0001	2,04v	1.24v
0010	2,052v	1.22v
0011	2,072v	1.99v
0100	2,911v	1.26v
0101	2,911v	2.01v
0110	2,878v	2v
0111	2,452v	2.81v
1000	2,109v	3.5v
1001	2,072v	3.4v
1010	2,05v	1.99v
1011	2,031v	1.59v
1100	2,014v	3.41v
1101	2,004v	1.62v
1110	1,997v	2v
1111	1,993v	2.38v

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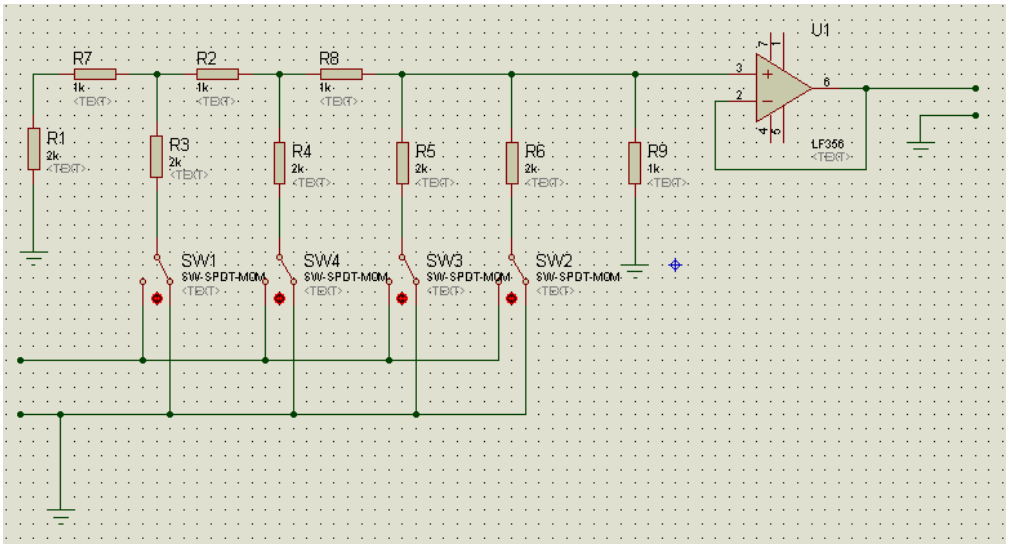
4.9.2 Rangkaian DAC R-2R Ladder Resistor



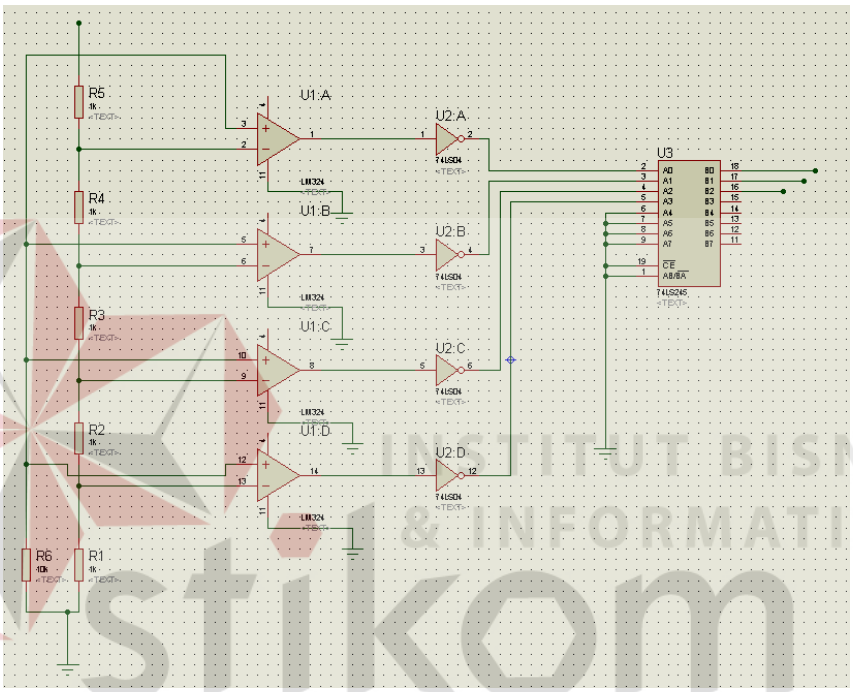
Hasil percobaan :

S1 S2 S3 S4	Vout	
	Pengukuran	Perhitungan
0000	3.5v	2,01v
0001	3.4v	2,04v
0010	1.99v	2,052v
0011	1.59v	2,072v
0100	3.41v	2,911v
0101	1.62v	2,911v
0110	2v	2,878v
0111	2.38v	2,452v
1000	3.54v	2,109v
1001	1.24v	2,072v
1010	1.22v	2,05v
1011	1.99v	2,031v
1100	1.26v	2,014v
1101	2.01v	2,004v
1110	2v	1,997v
1111	2.81v	1,993v

4.10 Analog To Digital Converter

Analog to Digital Converter (ADC) merupakan kebalikan dari rangkaian DAC.Fungsi dari rangkaian ADC sesuai namanya adalah untuk meng-konversi data analog yang berbentuk voltage menjadi data digital.

4.10.1 Flash ADC



Percobaan 1 :
Vref = 2,5v

Besar nilai vref pada tiap –tiap op-amp

Berdasarkan Perhitungan				Berdasarkan Pengukuran			
OpAm1	OpAm2	OpAm3	OpAm4	OpAm1	OpAm2	OpAm3	OpAm4
2v	1,5v	1v	0,5v	2.02v	1,52v	1,02v	0,51v

Vin (V)	Vout OpAmp (V)				Vout IC 7438 (0/1)		
	OpAmp1	OpAmp2	OpAmp3	OpAmp4	Out1	Out2	Out3
0	3,75v	3,75v	3,75v	3,75v	0	0	0
0.5	3,75v	3,75v	3,75v	0v	0	0	1
1	3,75v	0v	3,75v	0v	0	0	1
1,5	3,75v	0v	0v	0v	0	1	1
2	0v	0v	0v	0v	1	0	0
2,5	0v	0v	0v	0v	1	0	0

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Percobaan 2 :
Vref = 5V

Besar nilai vref pada tiap –tiap op-amp

Berdasarkan Perhitungan				Berdasarkan Pengukuran			
OpAm1	OpAm2	OpAm3	OpAm4	OpAm1	OpAm2	OpAm3	OpAm4
4v	3	2v	1v	4,09v	3,07v	2,05v	1,01v

Vin (V)	Vout OpAmp (V)				Vout IC 7438 (0/1)		
	OpAmp1	OpAmp2	OpAmp3	OpAmp4	Out1	Out2	Out3
0	3,75v	3,75v	3,75v	3,75v	0	0	0
0.5	3,75v	3,75v	3,75v	0v	0	0	0
1	3,75v	0v	3,75v	0v	0	0	1
1,5	3,75v	3,75v	3,75v	0v	0	0	1
2	3,75v	3,75v	0v	0v	0	0	1
2,5	3,75v	3,75v	0v	0v	0	0	1
3	3,75v	0v	0v	0v	0	1	1
3,5	3,75v	0v	0v	0v	0	1	1
4	0v	0v	0v	0v	0	1	1
4,5	0v	0v	0v	0v	0	1	1
5	0v	0v	0 v	0v	0	1	1

Percobaan 3 :
Vref = 10v
Besar nilai vref pada tiap –tiap op-amp

Berdasarkan Perhitungan				Berdasarkan Pengukuran			
OpAm1	OpAm2	OpAm3	OpAm4	OpAm1	OpAm2	OpAm3	OpAm4
8v	6	4v	2v	8,06v	6,04 v	4,03v	12,01v

Vin (V)	Vout OpAmp (V)				Vout IC 7438 (0/1)		
	OpAmp1	OpAmp2	OpAmp3	OpAmp4	Out1	Out2	Out3
0	3,75v	3,75v	3,75v	3,75v	0	0	0
0.5	3,75v	3,75v	3,75v	3,75v	0	0	0
1	3,75v	3,75v	3,75v	3,75v	0	0	0
1,5	3,75v	3,75v	3,75v	3,75v	0	0	0
2	3,75v	3,75v	3,75v	0v	0	0	1
2,5	3,75v	3,75v	3,75v	0v	0	0	1
3	3,75v	3,75v	3,75v	0v	0	0	1
3,5	3,75v	3,75v	3,75v	0v	0	0	1
4	3,75v	3,75v	0v	0v	0	0	1
4,5	3,75v	3,75v	0v	0v	0	0	1
5	3,75v	3,75v	0v	0v	0	0	1
5,5	3,75v	3,75v	0v	0v	0	0	1
6	3,75v	0v	0v	0v	0	0	1
6,5	3,75v	0v	0v	0v	0	0	1
7	3,75v	0v	0v	0v	0	0	1

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