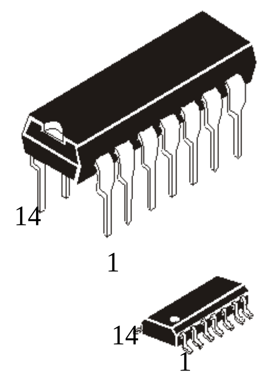
Single Supply Quad Operational Amplifiers

The HT3403 is a low cost, quad operational amplifier with true differential inputs. The device has electrical characteristics similar to the popular MC1741C. However, the HT3403 has several distinct advantages over standard operational amplifier types in single supply applications. The quad amplifier can operate at supply voltages as low as 3.0 V or as high as 36 V with quiescent currents about one third of those associated with the MC1741C (on a per amplifier basis). The common mode input range includes the negative supply, thereby eliminating the necessity for external biasing components in many applications. The output voltage range also includes the negative power supply voltage.



ORDERING INFORMATION

HT3303ANZ DIP

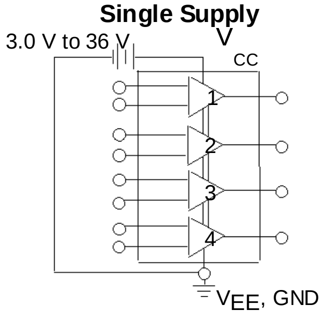
HT3303ARZ SOP

T_A = -40° to 85°C for all packages.

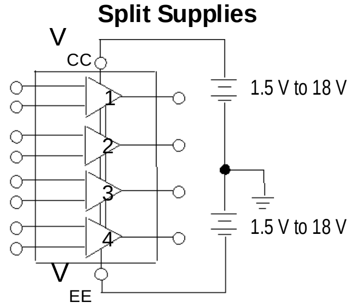
Features

- □ Short Circuit Protected Outputs
- □ Class AB Output Stage for Minimal Crossover Distortion
- □ True Differential Input Stage
- □ Single Supply Operation: 3.0 V to 36 V
- □ Split Supply Operation: ±1.5 V to ±18 V
- □ Low Input Bias Currents: 500 nA Max
- □ Four Amplifiers Per Package
- □ Internally Compensated
- □ Similar Performance to Popular MC1741C
- □ Industry Standard Pin−outs
- □ ESD Diodes Added for Increased Ruggedness
- □ Pb−Free Packages are Available

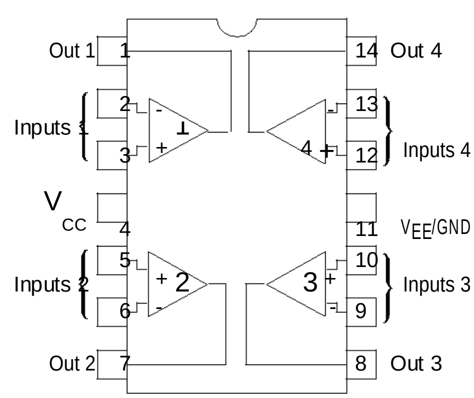
Single Supply



Split Supplies



PIN CONNECTIONS



(Top View)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power Supply Voltages Single Supply Split Supplies	 V_{CC} V_{CC}, V_{EE}	 36 ±18	Vdc
Input Differential Voltage Range (Note 1)	V_{IDR}	±36	Vdc
Input Common Mode Voltage Range (Notes 1 and 2)	V_{ICR}	±18	Vdc
Storage Temperature Range	T_{stg}	−55 to +125	°C
Operating Ambient Temperature Range HT3303 HT3403	T_A	 −40 to +85 0 to +70	°C
Junction Temperature	T_J	150	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Split power supplies.
2. For supply voltages less than ±18 V, the absolute maximum input voltage is equal to the supply voltage.

ELECTRICAL CHARACTERISTICS

(V_{CC} = +15 V, V_{EE} = −15 V for HT3403; V_{CC} = +14 V, V_{EE} = GND for HT3303 T_A = 25°C, unless otherwise noted.)

Characteristic	Symbol	HT3403			HT3303			Unit
		Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage $T_A = T_{high}$ to T_{low} (Note 3)	V_{IO}	– –	2.0 –	10 12	– –	2.0 –	8.0 10	mV
Input Offset Current $T_A = T_{high}$ to T_{low}	I_{IO}	– –	30 –	50 200	– –	30 –	75 250	nA
Large Signal Open Loop Voltage Gain V_O = ±10 V, R_L = 2.0 kW $T_A = T_{high}$ to T_{low}	A_{VOL}	20 15	200 –	– –	20 15	200 –	– –	V/mV
Input Bias Current $T_A = T_{high}$ to T_{low}	I_{IB}	– –	−200 –	−500 −800	– –	−200 –	−500 −1000	nA
Output Impedance f = 20 Hz	z_O	–	75	–	–	75	–	W
Input Impedance f = 20 Hz	z_i	0.3	1.0	–	0.3	1.0	–	MW
Output Voltage Range R_L = 10 kW R_L = 2.0 kW R_L = 2.0 kW, $T_A = T_{high}$ to T_{low}	V_O	±12 ±10 ±10	±13.5 ±13 –	– – –	12 10 10	12.5 12 –	– – –	V
Input Common Mode Voltage Range	V_{ICR}	+13 V $-V_{EE}$	+13 V $-V_{EE}$	–	+12 V $-V_{EE}$	+12.5 V $-V_{EE}$	–	V
Common Mode Rejection R_S ≤ 10 kW	CMR	70	90	–	70	90	–	dB
Power Supply Current (V_O = 0) R_L = ∞	I_{CC}, I_{EE}	–	2.8	7.0	–	2.8	7.0	mA
Individual Output Short−Circuit Current (Note 4)	I_{SC}	±10	±20	±45	±10	±30	±45	mA
Positive Power Supply Rejection Ratio	PSRR+	–	30	150	–	30	150	mV/V
Negative Power Supply Rejection Ratio	PSRR−	–	30	150	–	30	150	mV/V
Average Temperature Coefficient of Input Offset Current $T_A = T_{high}$ to T_{low}	DI_{IO}/DT	–	50	–	–	50	–	pA/°C
Average Temperature Coefficient of Input Offset Voltage $T_A = T_{high}$ to T_{low}	DV_{IO}/DT	–	10	–	–	10	–	mV/°C
Power Bandwidth A_V = 1, R_L = 10 kW, V_O = 20 V(p−p), THD = 5%	BWp	–	9.0	–	–	9.0	–	kHz
Small−Signal Bandwidth A_V = 1, R_L = 10 kW, V_O = 50 mV	BW	–	1.0	–	–	1.0	–	MHz
Slew Rate A_V = 1, V_i = −10 V to +10 V	SR	–	0.6	–	–	0.6	–	V/ms
Rise Time A_V = 1, R_L = 10 kW, V_O = 50 mV	t_{TLH}	–	0.35	–	–	0.35	–	ms
Fall Time A_V = 1, R_L = 10 kW, V_O = 50 mV	t_{TLH}	–	0.35	–	–	0.35	–	ms
Overshoot A_V = 1, R_L = 10 kW, V_O = 50 mV	os	–	20	–	–	20	–	%
Phase Margin A_V = 1, R_L = 2.0 kW, V_O = 200 pF	fm	–	60	–	–	60	–	°
Crossover Distortion (V_{in} = 30 mVpp, V_{out} = 2.0 Vpp, f = 10 kHz)	-	–	1.0	–	–	1.0	–	%

3. HT3303: T_{low} = −40°C, T_{high} = +85°C, HT3403: T_{low} = 0°C, T_{high} = +70°C
4. Not to exceed maximum package power dissipation.

ELECTRICAL CHARACTERISTICS (V_{CC} = 5.0 V, V_{EE} = GND, T_A = 25°C, unless otherwise noted.)

Characteristic	Symbol	HT3403 Min	HT3403 Typ	HT3403 Max	HT3303 Min	HT3303 Typ	HT3303 Max	Unit
Input Offset Voltage	V_{IO}	–	2.0	10	–	–	10	mV
Input Offset Current	I_{IO}	–	30	50	–	–	75	nA
Input Bias Current	I_{IB}	–	−200	−500	–	–	−500	nA
Large Signal Open Loop Voltage Gain R_L = 2.0 kW	A_{VOL}	10	200	–	10	200	–	V/mV
Power Supply Rejection Ratio	PSRR	–	–	150	–	–	150	mV/V
Output Voltage Range (Note 5) R_L = 10 kW, V_{CC} = 5.0 V R_L = 10 kW, 5.0 ≤ V_{CC} ≤ 30 V	V_{OR}	 3.3 V_{CC}−2.0	 3.5 V_{CC}−1.7	 – –	 3.3 V_{CC}−2.0	 3.5 V_{CC}−1.7	 – –	V_{pp}
Power Supply Current	I_{CC}	–	2.5	7.0	–	2.5	7.0	mA
Channel Separation f = 1.0 kHz to 20 kHz (Input Referenced)	CS	–	−120	–	–	−120	–	dB

5. Output will swing to ground with a 10 kW pull down resistor.

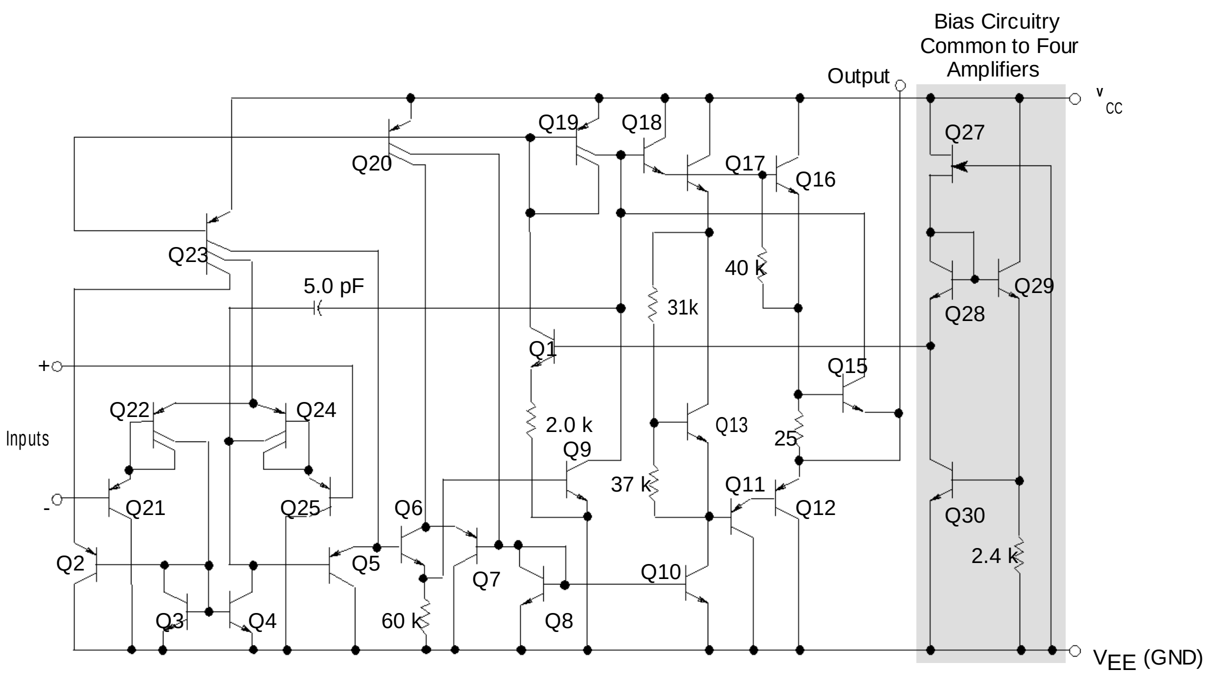


Figure 1. Representative Schematic Diagram
(1/4 of Circuit Shown)

CIRCUIT DESCRIPTION

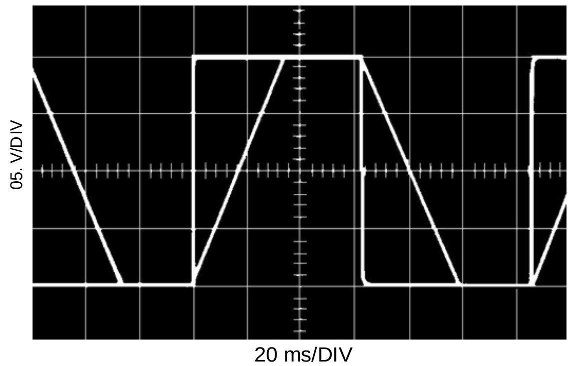


Figure 2. Inverter Pulse Response

The HT3403/3303 is made using four internally compensated, two−stage operational amplifiers. The first stage of each consists of differential input device Q24 and Q22 with input buffer transistors Q25 and Q21 and the differential to single ended converter Q3 and Q4. The first stage performs not only the first stage gain function but also performs the level shifting and Transconductance reduction functions. By reducing the Transconductance, a smaller compensation capacitor (only 5.0 pF) can be employed, thus saving chip area. The Transconductance reduction is accomplished by splitting the collectors of Q24 and Q22. Another feature of this input stage is that the input common mode range can include the negative supply or ground, in single supply operation, without saturating either the input devices or the differential to single−ended converter. The second stage consists of a standard current source load amplifier stage.

The output stage is unique because it allows the output to swing to ground in single supply operation and yet does not exhibit any crossover distortion in split supply operation. This is possible because Class AB operation is utilized.

Each amplifier is biased from an internal voltage regulator which has a low temperature coefficient, thus giving each amplifier good temperature characteristics as well as excellent power supply rejection.

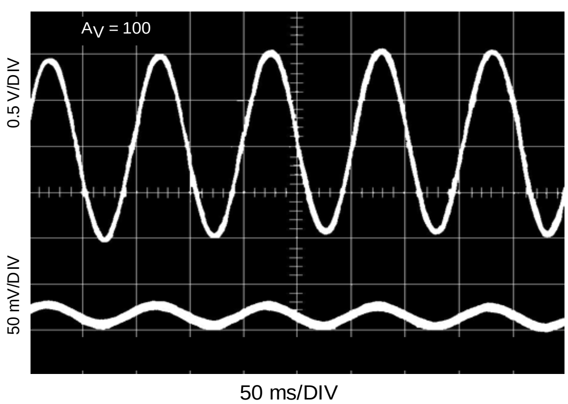


Figure 3. Sine Wave Response

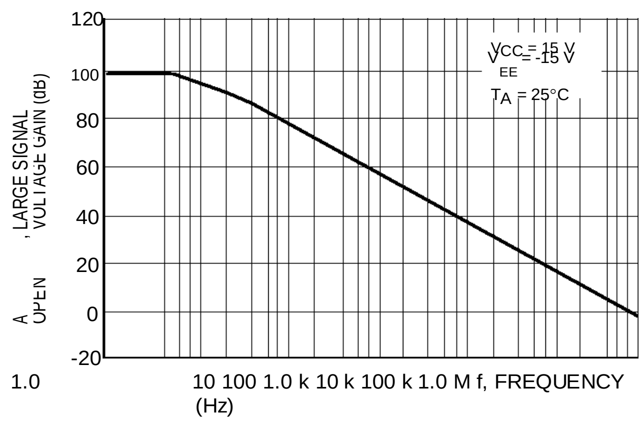


Figure 4. Open Loop Frequency Response

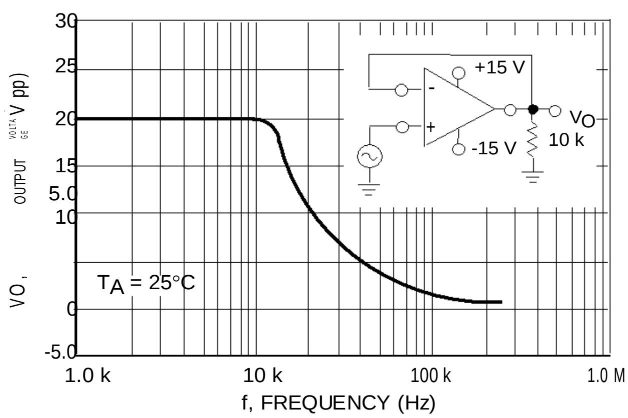


Figure 5. Power Bandwidth

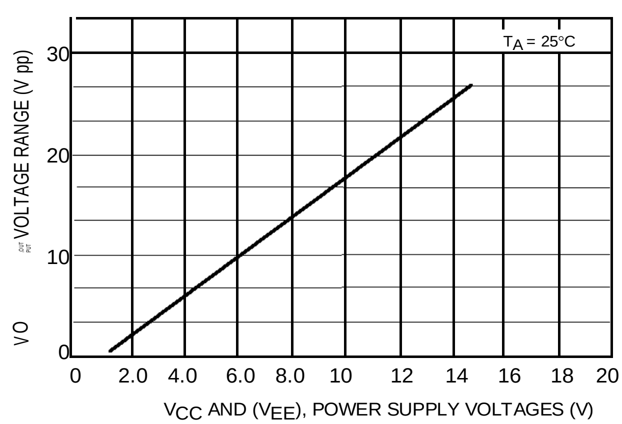


Figure 6. Output Swing versus Supply Voltage

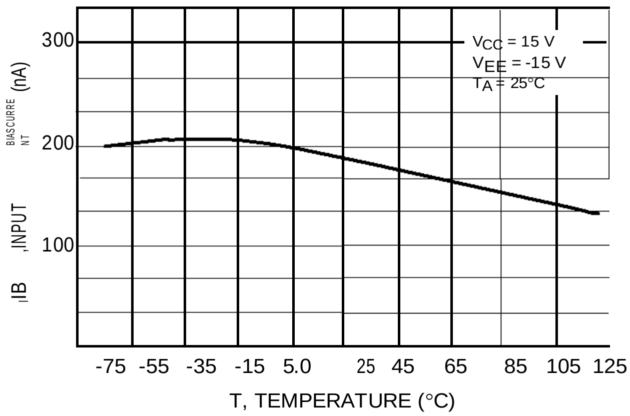


Figure 7. Input Bias Current versus Temperature

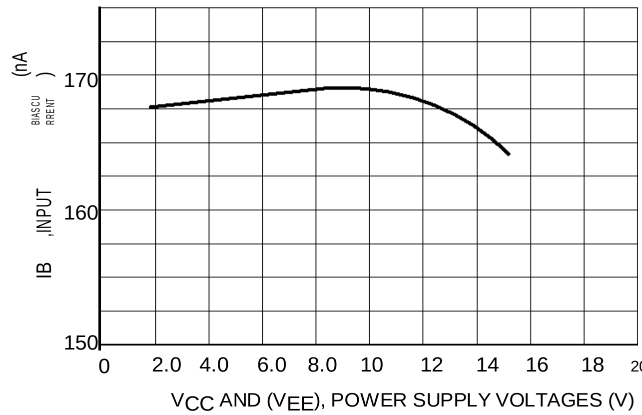


Figure 8. Input Bias Current versus Supply Voltage

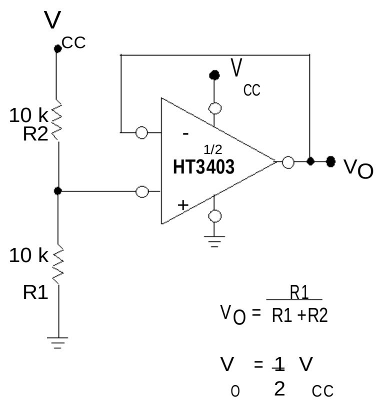


Figure 9. Voltage Reference

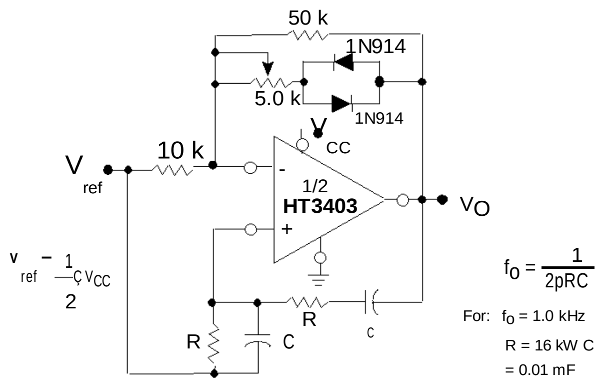


Figure 10. Wien Bridge Oscillator

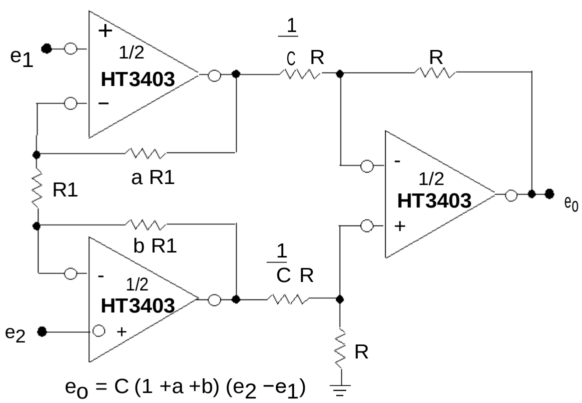


Figure 11. High Impedance Differential Amplifier

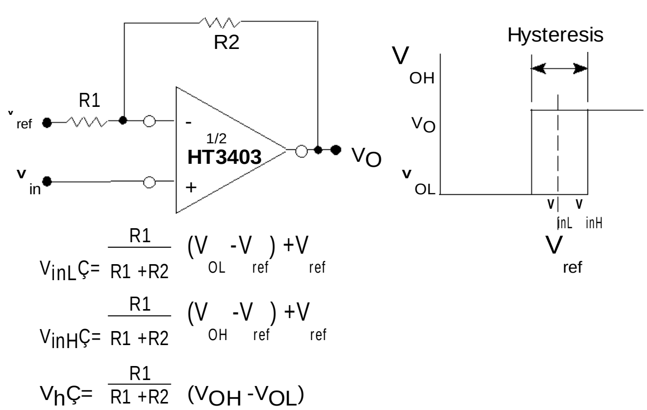


Figure 12. Comparator with Hysteresis

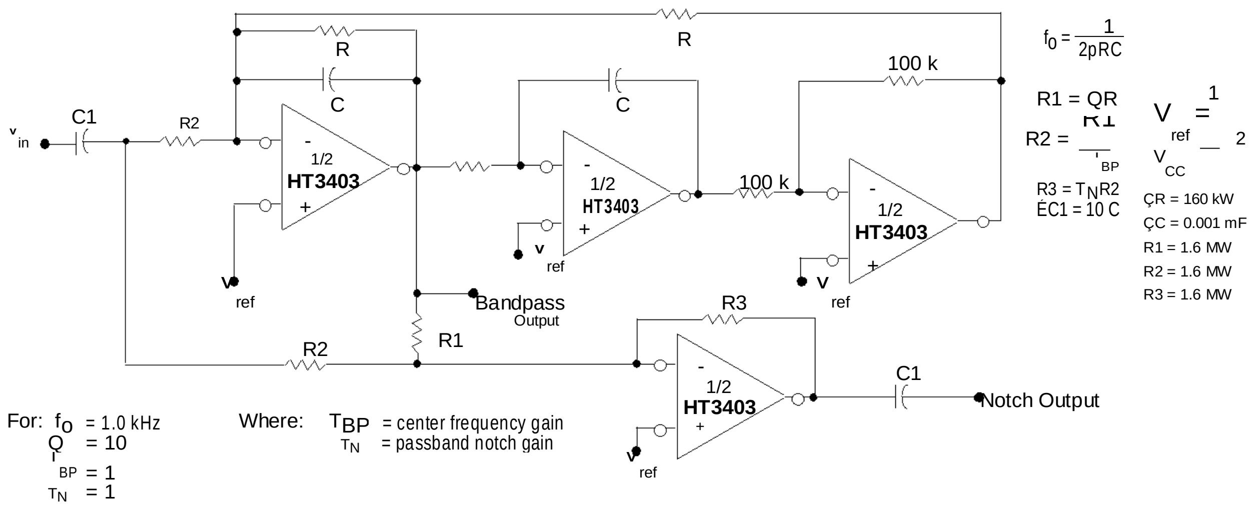


Figure 13. Bi−Quad Filter

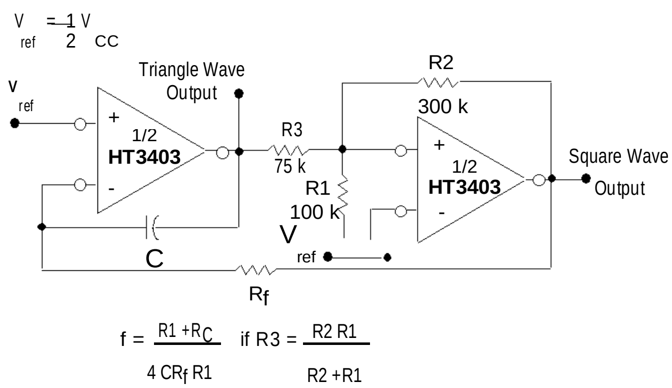


Figure 14. Function Generator

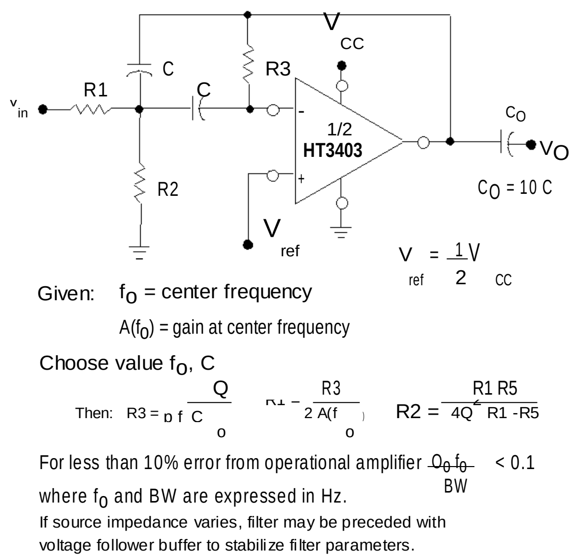
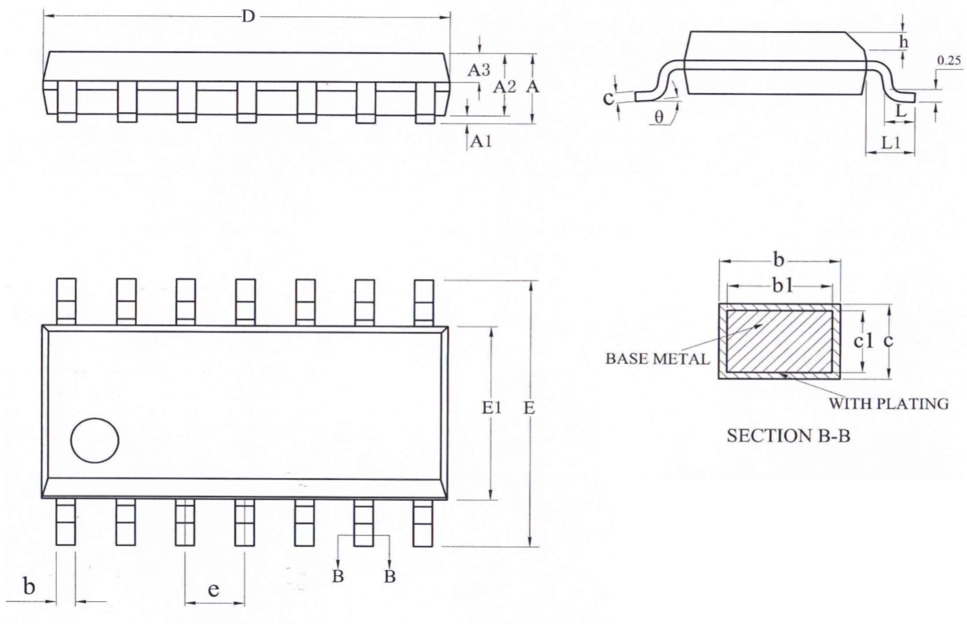


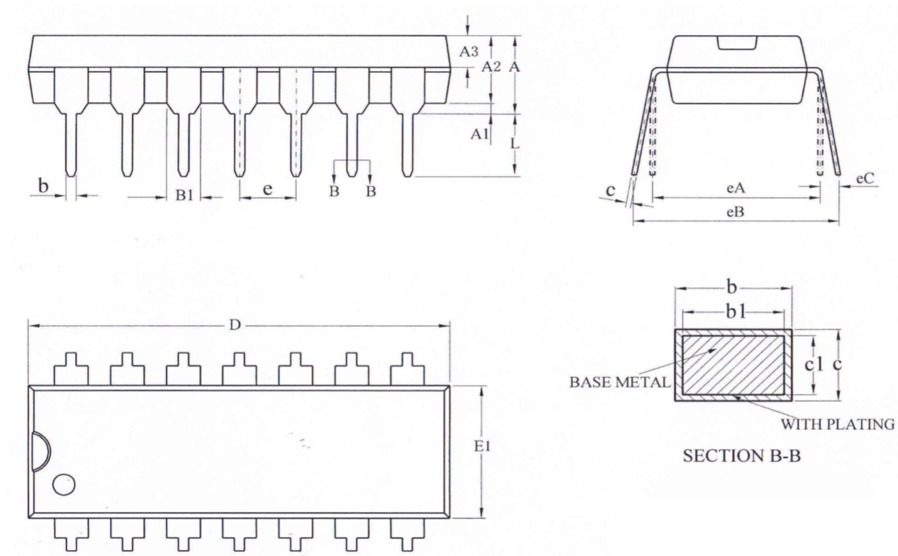
Figure 15. Multiple Feedback Bandpass Filter

SOP14



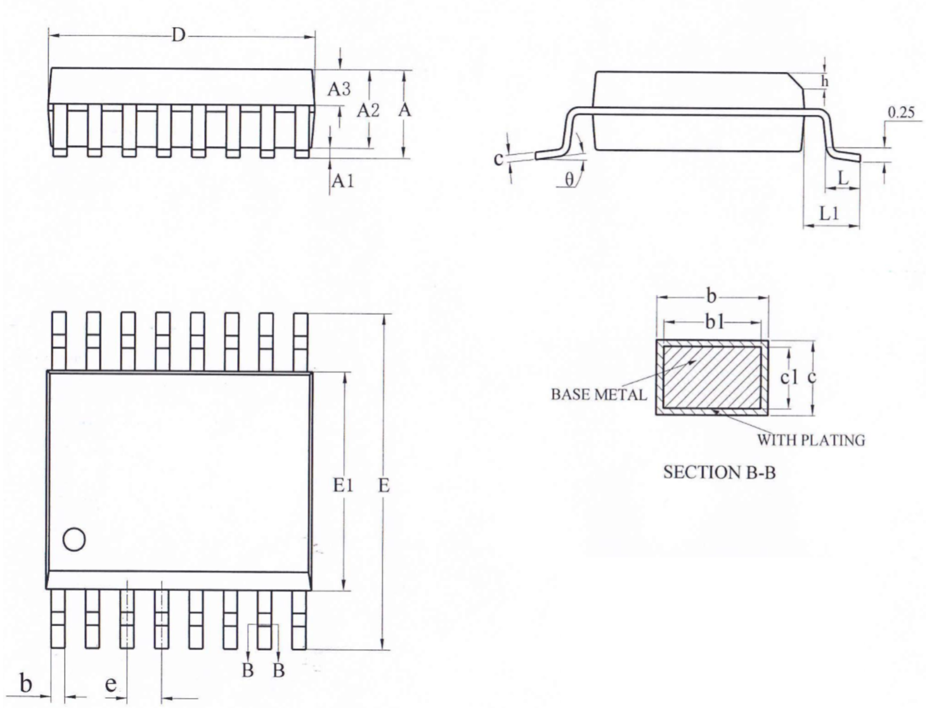
SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.75
A1	0.05	—	0.225
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	—	0.47
b1	0.38	0.41	0.44
c	0.20	—	0.24
c1	0.19	0.20	0.21
D	8.55	8.65	8.75
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27BSC		
h	0.25	—	0.50
L	0.50	—	0.80
L1	1.05REF		
θ	0	—	8°

DIP14



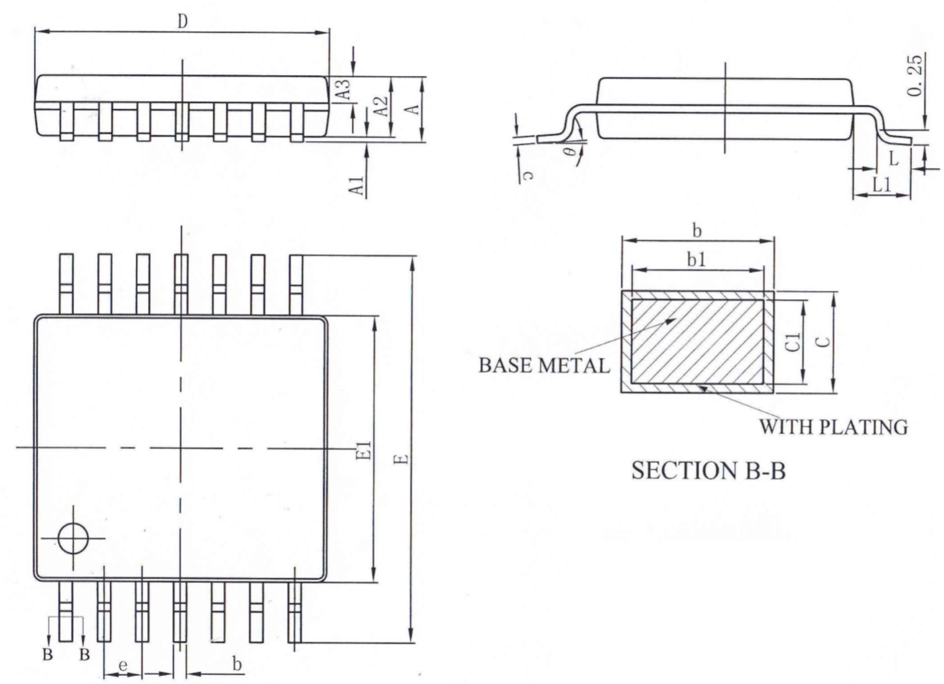
SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	3.60	3.80	4.00
A1	0.51	—	—
A2	3.20	3.30	3.40
A3	1.47	1.52	1.57
b	0.44	—	0.52
b1	0.43	0.46	0.49
B1	1.52REF		
c	0.25	—	0.29
c1	0.24	0.25	0.26
D	19.00	19.10	19.20
E1	6.25	6.35	6.45
e	2.54BSC		
eA	7.62REF		
eB	7.62	—	9.30
eC	0	—	0.84
L	3.00	—	—

SSOP14



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.75
A1	0.10	—	0.225
A2	1.30	1.40	1.50
A3	0.55	0.60	0.65
b	0.23	—	0.31
b1	0.22	0.25	0.28
c	0.20	—	0.24
c1	0.19	0.20	0.21
D	4.80	4.90	5.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	0.635BSC		
h	0.25	—	0.50
L	0.50	0.65	0.80
L1	1.05REF		
θ	0	—	8°

TSSOP14



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.20
A1	0.05	—	0.15
A2	0.90	1.00	1.05
A3	0.39	0.44	0.49
b	0.20	—	0.28
b1	0.19	0.22	0.25
c	0.13	—	0.17
c1	0.12	0.13	0.14
D	4.90	5.00	5.10
E1	4.30	4.40	4.50
E	6.20	6.40	6.60
e	0.65BSC		
L	0.45	0.60	0.75
L1	1.00BSC		
θ	0	—	8°

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