

**QUAD OP AMP AND VOLTAGE REFERENCE****AP4303****General Description**

The AP4303 is a monolithic IC that contains quad operational amplifiers and a precision shunt regulator, 1.25V for AP4303-C or 1.24V for AP4303-D respectively. It is specifically designed to regulate the output current and voltage levels of switching battery chargers and power supplies.

The four Op Amps feature accurate voltage and current control. Combining a stable voltage reference with the four Op Amps makes AP4303 ideal for use in multi-function charger, power supply voltage monitor, signal processing and control system.

The IC offers the power converter designer a control solution that features increased precision with a corresponding reduction in system complexity and cost.

The AP4303 is available in standard packages of DIP-16 and SOIC-16.

**Features****Op Amp**

- Input Offset Voltage: 0.5mV
- Supply Current: 250 $\mu$ A per Op Amp at 5.0V Supply Voltage
- Unity Gain Bandwidth: 1MHz
- Output Voltage Swing: 0 to ( $V_{CC}-1.5$ )V
- Power Supply Range: 3 to 18V

**Voltage Reference**

- Reference Voltage Tolerance: 0.5%, 1%
- Sink Current Capability from 0.1 to 80mA
- Output Dynamic Impedance: 0.2 $\Omega$
- Externally Adjusted Output Voltage Reference: 1.25V for AP4303-C and 1.24V for AP4303-D

**Applications**

- Battery Charger
- Switching Power Supply

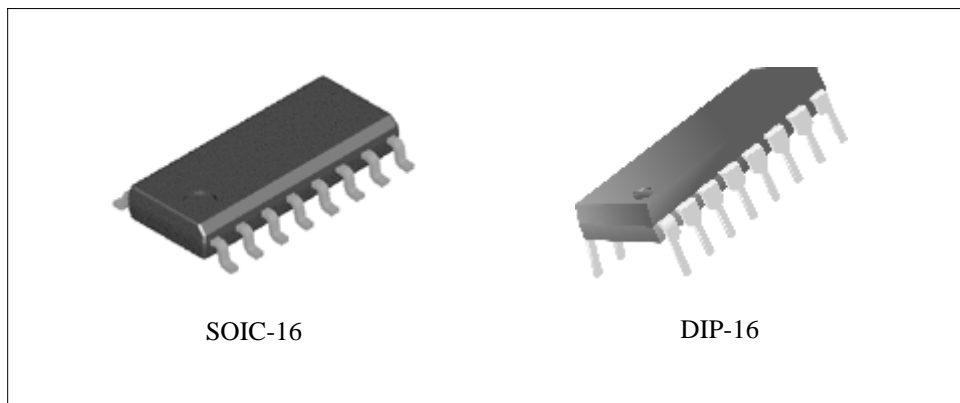


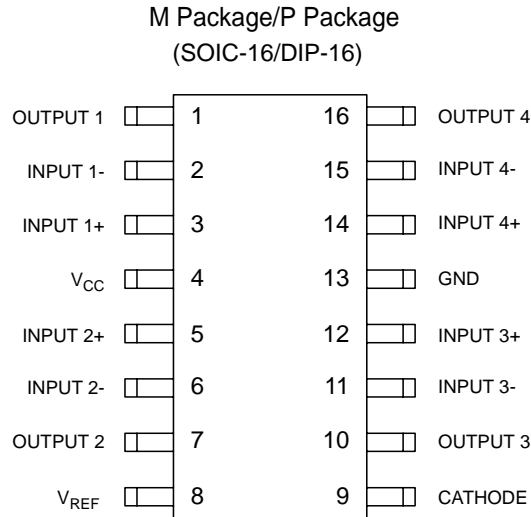
Figure 1. Package Types of AP4303



**QUAD OP AMP AND VOLTAGE REFERENCE**

**AP4303**

**Pin Configuration**



Top View

Figure 2. Pin configuration of AP4303

**Functional Block Diagram**

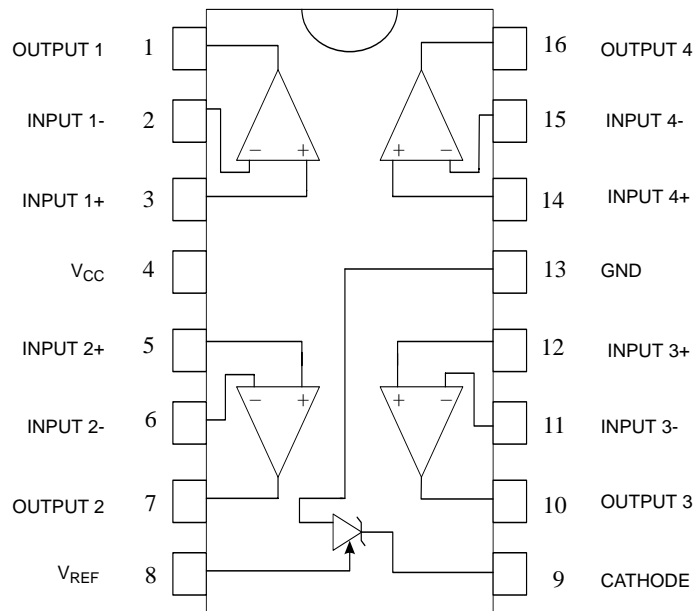


Figure 3. Functional Block Diagram of AP4303



**QUAD OP AMP AND VOLTAGE REFERENCE**

**AP4303**

**Functional Block Diagram (Continued)**

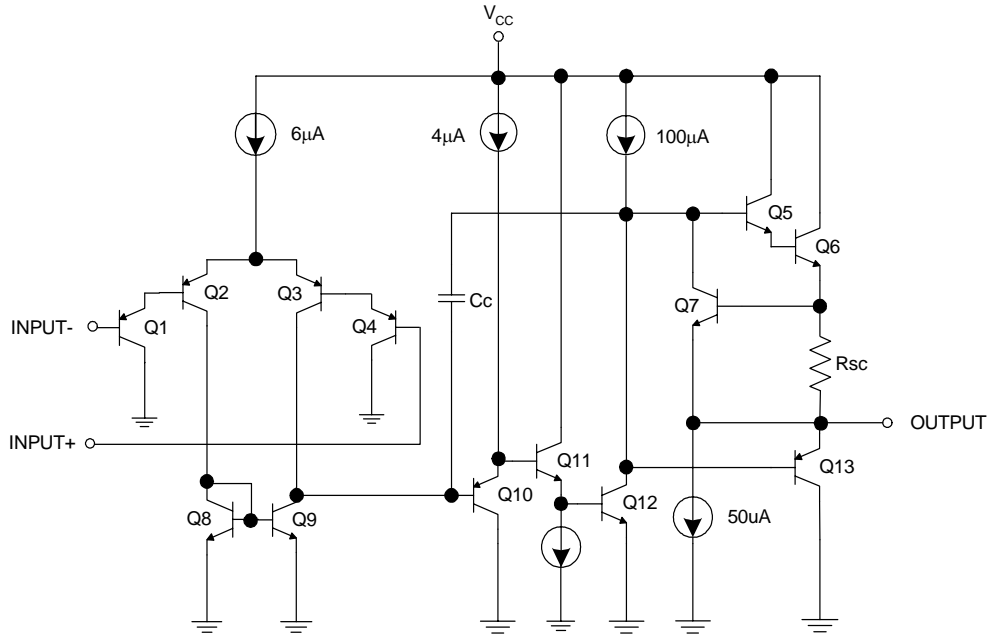


Figure 4. Op Amp Functional Block Diagram  
(Each Amplifier)

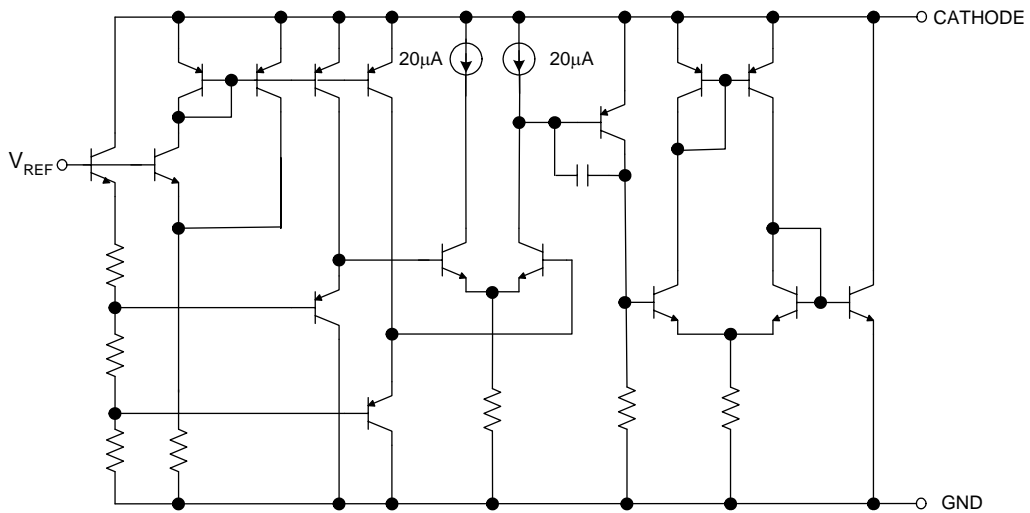
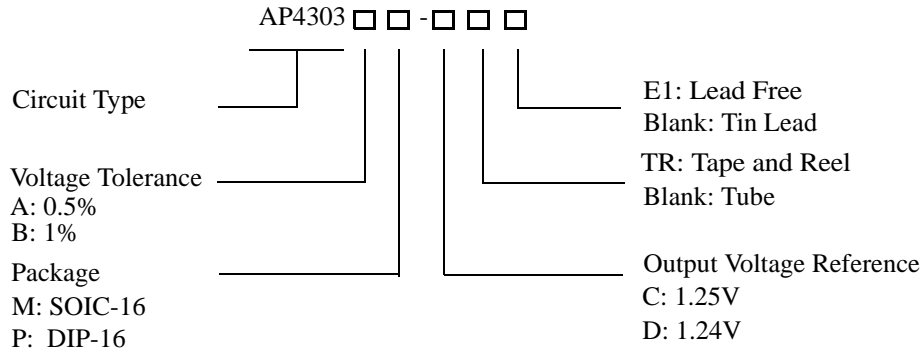


Figure 5. Voltage Reference Functional Block Diagram



**QUAD OP AMP AND VOLTAGE REFERENCE AP4303**

**Ordering Information**



Package	Reference Voltage	Voltage Tolerance	Temperature Range	Part Number		Marking ID		Packing Type
				Tin Lead	Lead Free	Tin Lead	Lead Free	
DIP-16	1.25V	0.5%	-40 to 85°C	AP4303AP-C	AP4303AP-CE1	AP4303AP-C	AP4303AP-CE1	Tube
		1%		AP4303BP-C	AP4303BP-CE1	AP4303BP-C	AP4303BP-CE1	
	1.24V	0.5%		AP4303AP-D	AP4303AP-DE1	AP4303AP-D	AP4303AP-DE1	
		1%		AP4303BP-D	AP4303BP-DE1	AP4303BP-D	AP4303BP-DE1	
SOIC-16	1.25V	0.5%	-40 to 85°C	AP4303AM-C	AP4303AM-CE1	AP4303AM-C	AP4303AM-CE1	Tube
		1%		AP4303AM-CTR	AP4303AM-CTRE1	AP4303AM-C	AP4303AM-CE1	Tape & Reel
				AP4303BM-C	AP4303BM-CE1	AP4303BM-C	AP4303BM-CE1	Tube
		AP4303BM-CTR		AP4303BM-CTRE1	AP4303BM-C	AP4303BM-CE1	Tape & Reel	
	1.24V	0.5%		AP4303AM-D	AP4303AM-DE1	AP4303AM-D	AP4303AM-DE1	Tube
				AP4303AM-DTR	AP4303AM-DTRE1	AP4303AM-D	AP4303AM-DE1	Tape & Reel
		1%		AP4303BM-D	AP4303BM-DE1	AP4303BM-D	AP4303BM-DE1	Tube
				AP4303BM-DTR	AP4303BM-DTRE1	AP4303BM-D	AP4303BM-DE1	Tape & Reel

BCD Semiconductor's Pb-free products, as designated with "E1" suffix in the part number, are RoHS compliant.

**QUAD OP AMP AND VOLTAGE REFERENCE****AP4303****Absolute Maximum Ratings (Note 1)**

Parameter	Symbol	Value	Unit
Power Supply Voltage ( $V_{CC}$ to GND)	$V_{CC}$	20	V
Input Voltage Range	$V_{IN}$	-0.3 to $V_{CC}+0.3$	V
Op Amp Input Differential Voltage	$V_{ID}$	20	V
Voltage Reference Cathode Current	$I_K$	100	mA
Power Dissipation	$P_D$	DIP-16	1000
		SOIC-16	850
Operating Junction Temperature	$T_J$	150	°C
Storage Temperature Range	$T_{STG}$	-65 to 150	°C
Lead Temperature (Soldering 10s)	$T_L$	260	°C

Note 1: Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "Recommended Operating Conditions" is not implied. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.

**Recommended Operating Conditions**

Parameter	Min	Max	Unit
Supply Voltage	3	18	V
Ambient Temperature	-40	105	°C



**QUAD OP AMP AND VOLTAGE REFERENCE**

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**Electrical Characteristics**

Operating Conditions:  $V_{CC}=+5V$ ,  $T_A=25^{\circ}C$  unless otherwise specified.

Parameter	Conditions		Min	Typ	Max	Unit
Total Supply Current, Excluding Current in Voltage Reference	$V_{CC}=5V$ , no load, $-40^{\circ}C \leq T_A \leq 85^{\circ}C$			1.0	1.6	mA
	$V_{CC}=18V$ , no load, $-40^{\circ}C \leq T_A \leq 85^{\circ}C$			1.2	2.4	
<b>Voltage Reference Section</b>						
Reference Voltage for AZ4303C	$I_{KA}=10mA$ $T_A=25^{\circ}C$	0.5% tolerance	1.244	1.250	1.256	V
		1% tolerance	1.237		1.263	
Reference Voltage for AZ4303D	$I_{KA}=10mA$ $T_A=25^{\circ}C$	0.5% tolerance	1.234	1.240	1.246	V
		1% tolerance	1.227		1.252	
Reference Voltage Deviation over Full Temperature Range	$I_{KA}=10mA$ , $T_A=-40$ to $85^{\circ}C$			5	17	mV
Minimum Cathode Current for Regulation				0.1	0.2	mA
Ratio of Change in $V_{REF}$ to that of Cathode Voltage	$I_{KA}=10mA$	$V_{REF}$ to 10V		1.0	2.7	mV/V
		10V to 18V		0.5	2.0	
Reference Current	$I_{KA}=10mA$ , $R1=10k\Omega$ , $R2=\infty$			0.7	4	$\mu A$
The Deviation of Reference Current over Temperature	$V_{KA}=V_{REF}$ , $I_{KA}=10mA$ , $T_A=-40^{\circ}C$ to $85^{\circ}C$			0.4	1.2	$\mu A$
Off-State Cathode Current	$V_{REF}=0V$ , $V_{KA}=18V$			0.05	1.0	$\mu A$
Dynamic Impedance	$I_{KA}=1.0$ to $80mA$ , $f<1kHz$			0.2	0.5	$\Omega$



**QUAD OP AMP AND VOLTAGE REFERENCE**

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**Electrical Characteristics (Continued)**

Operating Conditions:  $V_{CC}=+5V$ ,  $T_A=25^{\circ}C$  unless otherwise specified.

Parameter	Conditions	Min	Typ	Max	Unit
<b>Op Amp Section (Each Op Amp)</b> ( $V_{CC}=5V$ , $V_O=1.4V$ , $T_A=25^{\circ}C$ , unless otherwise noted)					
Input Offset Voltage	$T_A=25^{\circ}C$		0.5	3	mV
	$T_A=-40$ to $85^{\circ}C$			5	
Input Offset Voltage Temperature Drift	$T_A=-40$ to $85^{\circ}C$		7		$\mu V/^{\circ}C$
Input Offset Current	$T_A=25^{\circ}C$		2	30	nA
Input Bias Current	$T_A=25^{\circ}C$		20	150	nA
Input Voltage Range	$V_{CC}=0$ to $18V$	0		$V_{CC}-1.5$	V
Common Mode Rejection Ratio	$T_A=25^{\circ}C$ , $V_{CM}=0$ to $3.5V$	70	85		dB
Large Signal Voltage Gain	$V_{CC}=15V$ , $R_L=2k\Omega$ , $V_O=1.4$ to $11.4V$	85	100		dB
Power Supply Rejection Ratio	$V_{CC}=5$ to $18V$	70	90		dB
Output Current	Source	$V_{CC}=15V$ , $V_{ID}=1V$ , $V_O=2V$	20	40	mA
	Sink	$V_{CC}=15V$ , $V_{ID}=-1V$ , $V_O=2V$	10	20	mA
Output Voltage Swing (High)	$V_{CC}=18V$ , $R_L=10k\Omega$ , $V_{ID}=1V$	16	16.5		V
Output Voltage Swing (Low)	$V_{CC}=18V$ , $R_L=10k\Omega$ , $V_{ID}=-1V$		17	100	mV
Slew Rate	$V_{CC}=18V$ , $R_L=2k\Omega$ , $A_V=1$ , $V_{IN}=0.5$ to $2V$ , $C_L=100pF$	0.3	0.5		$V/\mu s$
Gain Bandwidth Product	$V_{CC}=18V$ , $R_L=2k\Omega$ , $C_L=100pF$ , $V_{IN}=10mV$ , $f=100kHz$	0.7	1		MHz



**QUAD OP AMP AND VOLTAGE REFERENCE**

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**Typical Performance Characteristics**

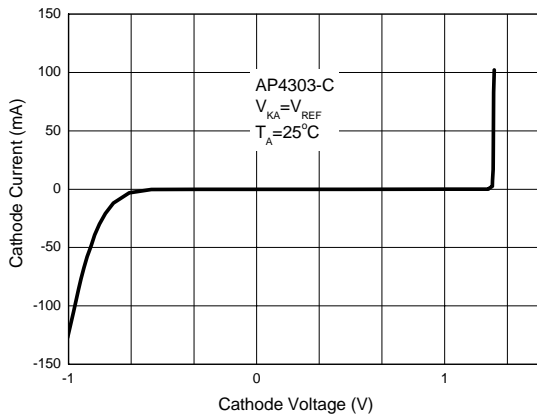


Figure 6. Cathode Current vs. Cathode Voltage

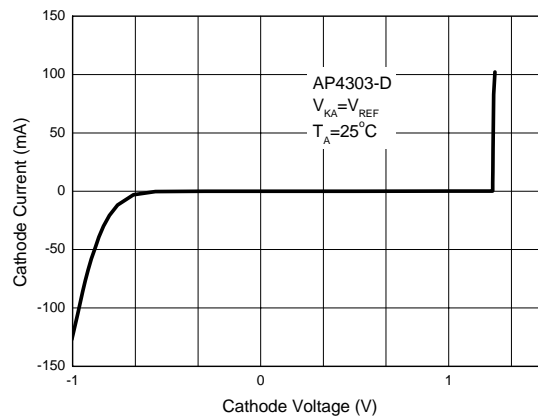


Figure 7. Cathode Current vs. Cathode Voltage

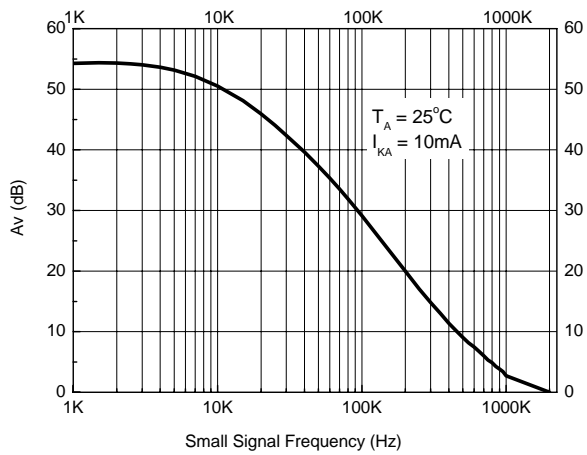


Figure 8. Voltage Reference Small Signal Voltage Gain vs. Frequency

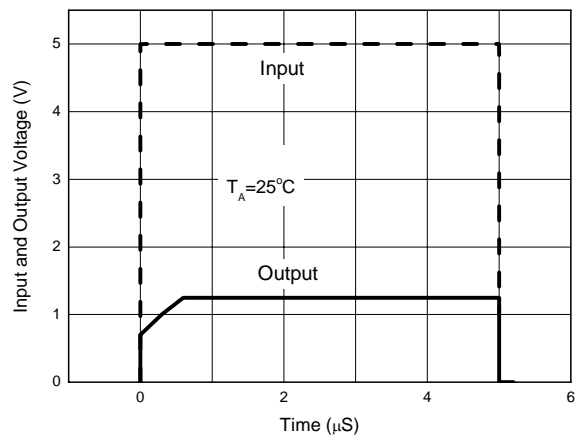


Figure 9. Pulse Response of  $V_{REF}$  with respect to  $V_{KA}$





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**Typical Performance Characteristics (Continued)**

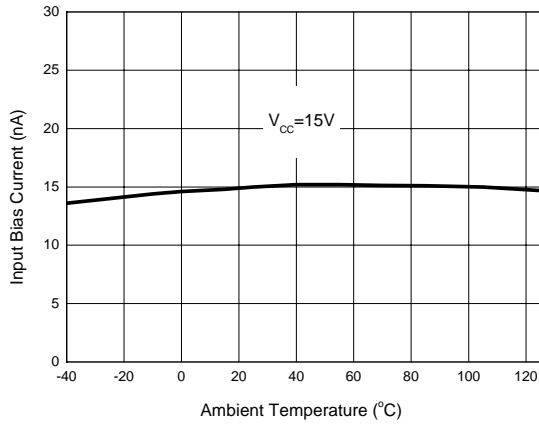


Figure 10. Op Amp Input Current

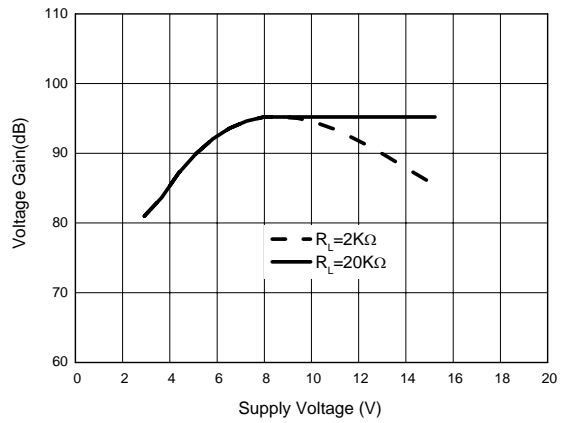


Figure 11. Op Amp Voltage Gain

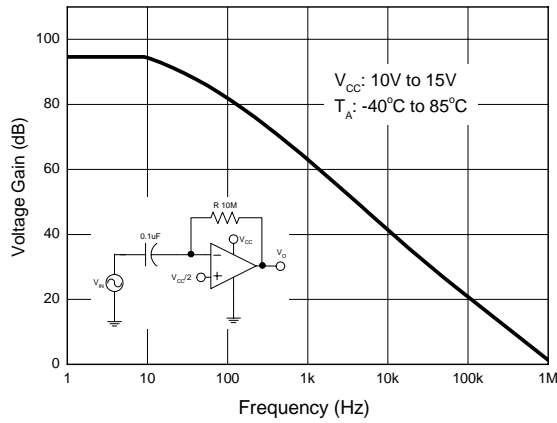


Figure 12. Open Loop Frequency Response



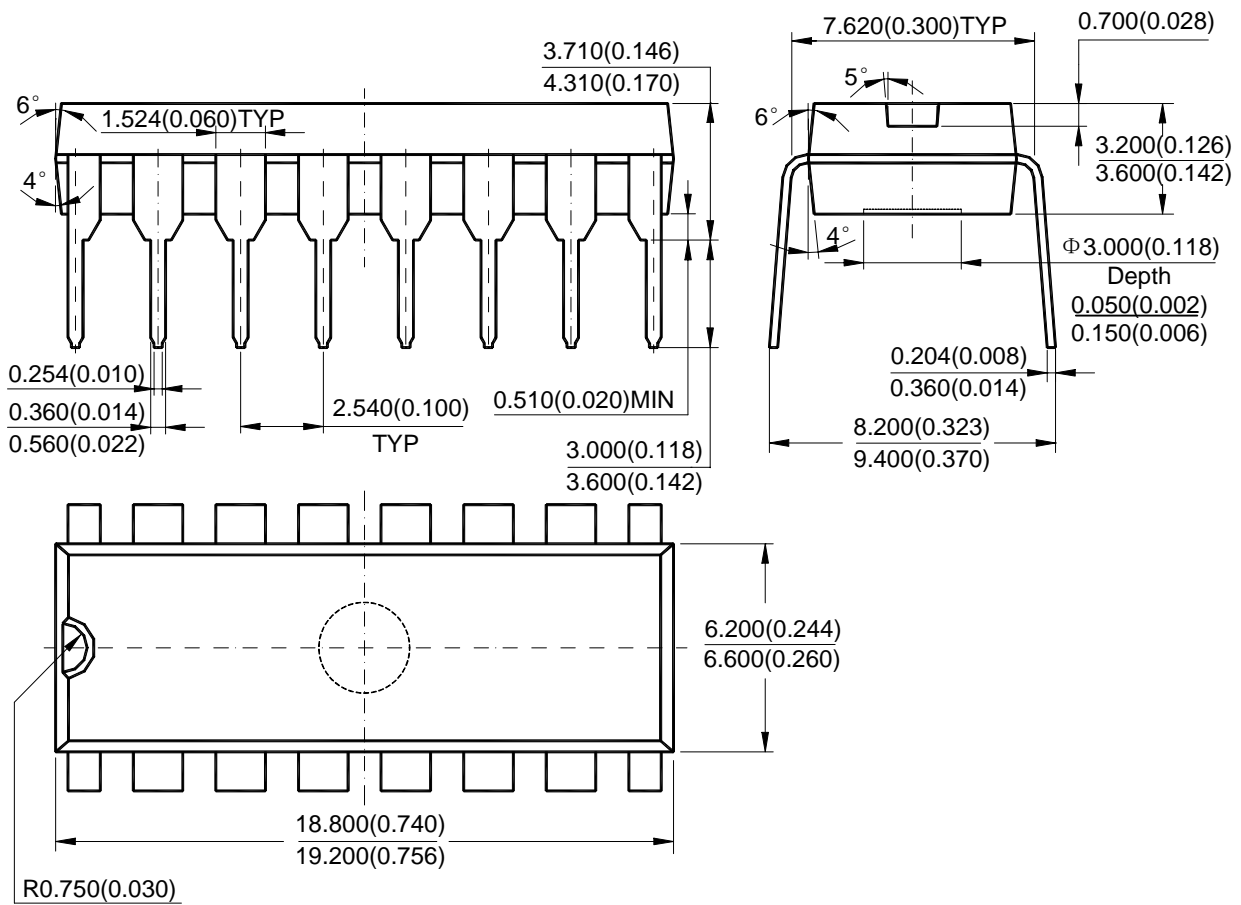
**QUAD OP AMP AND VOLTAGE REFERENCE**

**AP4303**

**Mechanical Dimensions**

**DIP-16**

**Unit: mm(inch)**





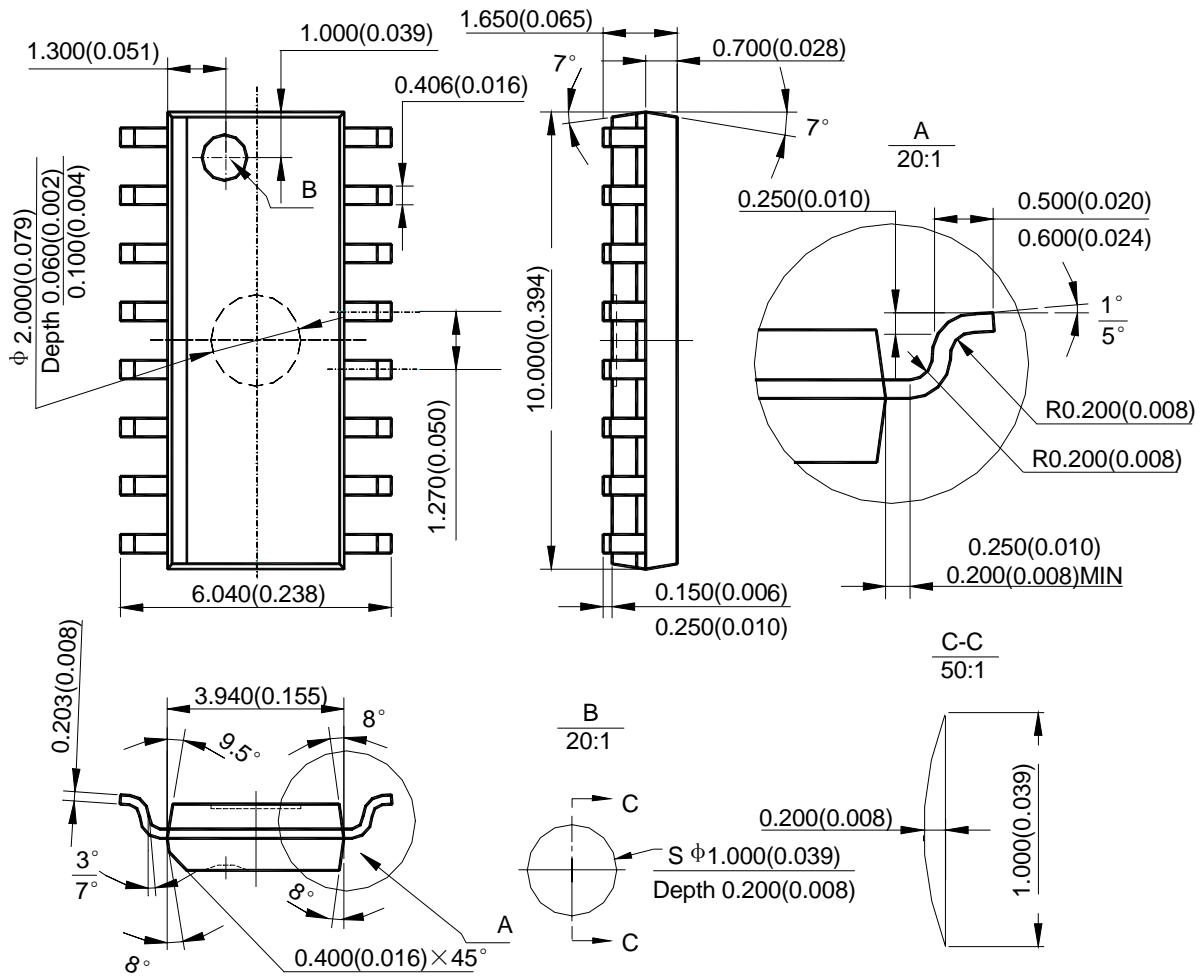
**QUAD OP AMP AND VOLTAGE REFERENCE**

**AP4303**

**Mechanical Dimensions (Continued)**

**SOIC-16**

**Unit: mm(inch)**





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