



### DESCRIPTION

The AO358 is include two high-voltage (30V) OP Amp. The AO358 provide outstanding value for cost-effective applications, with features including low offset (500uA, typical) common-mode input range to ground, and high differential input voltage capability.

The AO358 design with enhanced features such as unity-gain stability, lower offset voltage of 5mV (Max), and lower quiescent current of 500uA per amplifier (typical), which to provide optimal performance in low voltage and low noise systems.

The AO358 Dual is available in SOP8 and MSOP8 packages.

### ORDERING INFORMATION

Package Type	Part Number	
SOP8 SPQ: 2,500pcs/Reel	M8	AO358M8R
		AO358M8VR
MSOP8 SPQ: 3,000pcs/Reel	MS8	AO358MS8R
		AO358MS8VR
Note	V: Halogen free Package R: Tape & Reel	
AiT provides all RoHS products		

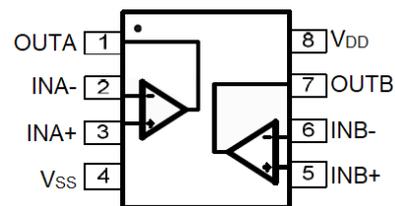
### FEATURES

- Single-Supply Operation from +3V to +30V
- Quiescent Current: 500µA per Amplifier (Typ.)
- Unity-gain bandwidth of 1MHz (Typ.)
- Low Offset Voltage: 5mV (Max.)
- Low Input Bias Current: 45nA (Typ.)
- Dual-Supply Operation from ±1.5V to ±15V
- Operating Temperature: -25°C ~ +85°C
- Available in SOP8 and MSOP8 packages

### APPLICATION

- Merchant network and server power supply units
- Power supplies and mobile chargers
- Motor control: AC induction, brushed DC, brushless DC, high-voltage, low-voltage, permanent magnet, and stepper motor
- Desktop PC, motherboard, and printers
- Indoor and outdoor air conditioners
- Washers, dryers, and refrigerators
- AC inverters, string inverters, central inverters, and voltage frequency drives
- Uninterruptible power supplies
- Programmable logic controllers
- Electronic point-of sales (POS) systems
- Battery Management Solution
- Transducer Amplifiers, Summing Amplifiers

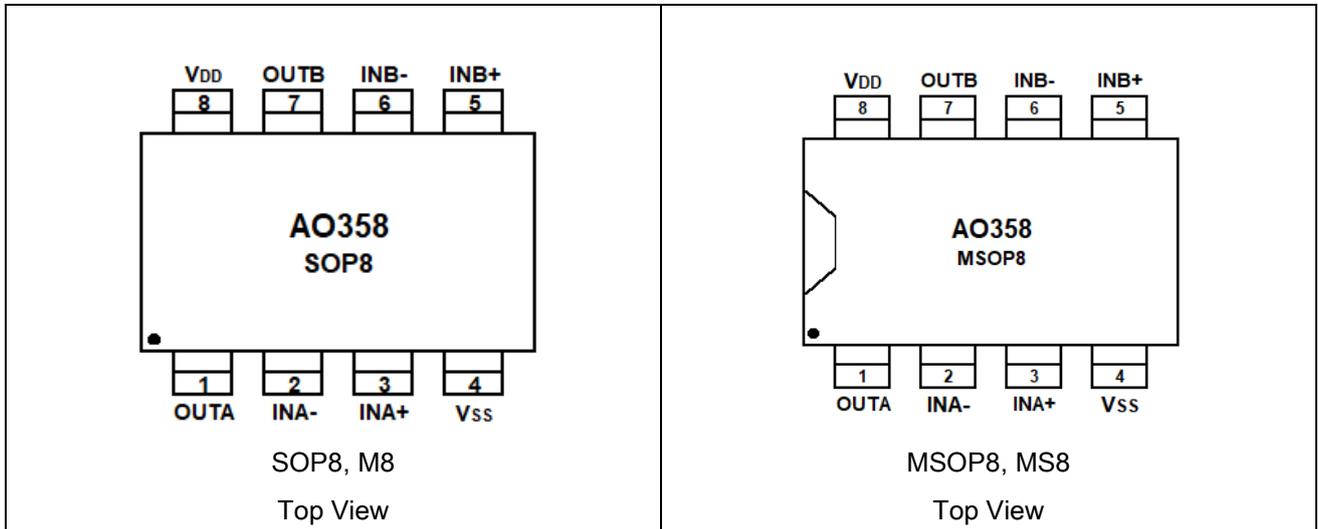
### TYPICAL APPLICATION



SOP8/MSOP8



**PIN DESCRIPTION**



Pin #		Symbol	Function
SOP8	MSOP8		
1	1	OUTA	Output A
2	2	INA-	Analog Inverting Input A
3	3	INA+	Analog Positive Input A
4	4	V <sub>SS</sub>	Ground or Negative Power Supply Input
5	5	INB+	Analog Positive Input B
6	6	INB-	Analog Inverting Input B
7	7	OUTB	Output B
8	8	V <sub>DD</sub>	Positive Power Supply Input



**ABSOLUTE MAXIMUM RATINGS**

V <sub>CC</sub> , Power Supply Voltage	±16V or 32V
V <sub>I(DIFF)</sub> , Differential Input Voltage	32V
V <sub>I</sub> , Input Voltage	-0.3 ~ 32V
T <sub>OPR</sub> , Operating Temperature Range	-25°C ~ 85°C
T <sub>STG</sub> , Storage Temperature Range	-65°C ~ 150°C

Stress beyond above listed “Absolute Maximum Ratings” may lead permanent damage to the device. These are stress ratings only and operations of the device at these or any other conditions beyond those indicated in the operational sections of the specifications are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**ELECTRICAL CHARACTERISTICS**

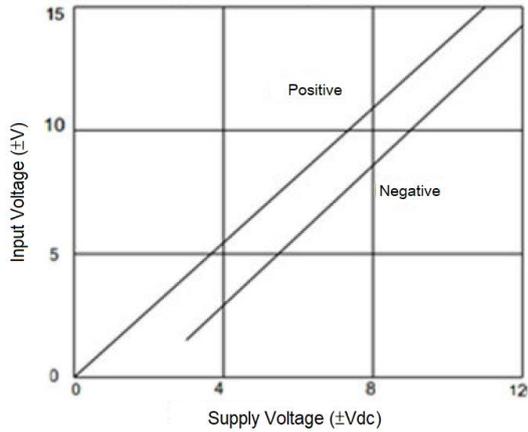
At V<sub>S</sub> = +15V, T<sub>A</sub>=25°C, unless otherwise noted.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
<b>INPUT CHARACTERISTICS</b>						
Input Offset Voltage	V <sub>OS</sub>	V <sub>CM</sub> = V <sub>S</sub> /2	-	0.4	5	mV
Input Bias Current	I <sub>B</sub>		-	45	-	nA
Input Offset Current	I <sub>OS</sub>		-	5	-	nA
Common-Mode Voltage Range	V <sub>CM</sub>	V <sub>S</sub> = 5.5V	-	-0.1 to 4	-	V
Common-Mode Rejection Ratio	CMRR	V <sub>CM</sub> = 0V to V <sub>S</sub> -1.5V	70	90	-	dB
Open-Loop Voltage Gain	A <sub>OL</sub>	R <sub>L</sub> = 5kΩ, V <sub>O</sub> = 1V to 11V	85	100	-	dB
Input Offset Voltage Drift	ΔV <sub>OS</sub> /ΔT			7	-	μV/°C
<b>OUTPUT CHARACTERISTICS</b>						
Output Voltage Swing from Rail	V <sub>OH</sub>	R <sub>L</sub> = 2kΩ	-	11	-	V
	V <sub>OL</sub>	R <sub>L</sub> = 2kΩ	-	5	20	mV
	V <sub>OH</sub>	R <sub>L</sub> = 10kΩ	-	12	13	V
	V <sub>OL</sub>	R <sub>L</sub> = 10kΩ	-	5	20	mV
Output Current	I <sub>SOURCE</sub>	R <sub>L</sub> = 10Ω to V <sub>S</sub> /2	-	40	60	mA
	I <sub>SINK</sub>		-	40	60	
<b>POWER SUPPLY</b>						
Operating Voltage Range			3	-	-	V
			-	-	30	V
Power Supply Rejection Ratio	PSRR	V <sub>S</sub> = +5V to +30V, V <sub>CM</sub> = +0.5V	70	100	-	dB
Quiescent Current/Amplifier	I <sub>Q</sub>	V <sub>S</sub> =30V, R <sub>L</sub> =∞	-	0.5	2.5	mA
<b>DYNAMIC PERFORMANCE</b>						
Gain-Bandwidth Product	GBP		-	1	-	MHz
Slew Rate	SR	G = +1, 2V Output Step	-	0.4	-	V/μs

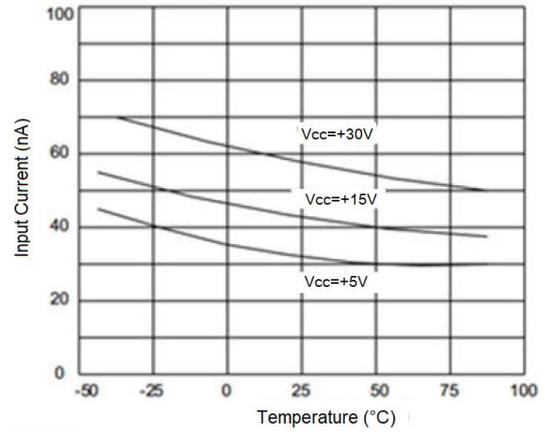


## TYPICAL PERFORMANCE CHARACTERISTICS

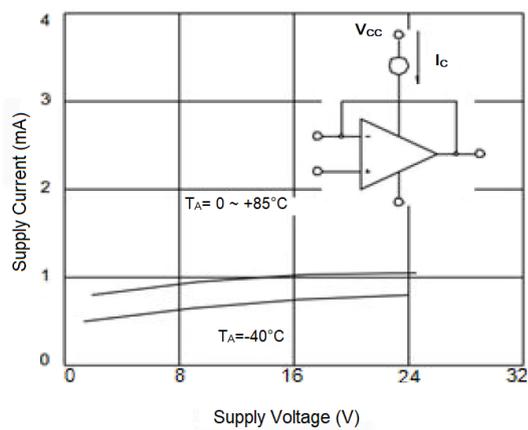
### 1. Input Voltage Range



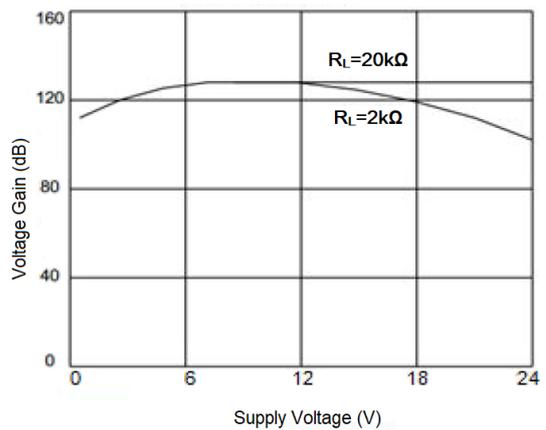
### 2. Input Current



### 3. Supply Current



### 4. Voltage Gain





## DETAILED INFORMATION

AO358 series op amps are unity-gain stable and suitable for a wide range of general-purpose applications.

### Power Supply Bypassing and Board Layout

AO358 series operates from a single 3V to 30V supply or dual  $\pm 1.5V$  to  $\pm 15V$  supplies. For best performance, a  $0.1\mu F$  ceramic capacitor should be placed close to the  $V_{DD}$  pin in single supply operation. For dual supply operation, both  $V_{DD}$  and  $V_{SS}$  supplies should be bypassed to ground with separate  $0.1\mu F$  ceramic capacitors.

### Low Supply Current

The low supply current (typical  $500\mu A$  per channel) of AO358 will help to maximize battery life.

### Operating Voltage

AO358 operates under wide input supply voltage (3V to 30V). In addition, all temperature specifications apply from  $-25^{\circ}C$  to  $+85^{\circ}C$ . Most behavior remains unchanged throughout the full operating voltage range. These guarantees ensure operation throughout the single Li-Ion battery lifetime.

### Capacitive Load Tolerance

The AO358 is optimized for bandwidth and speed, not for driving capacitive loads. Output capacitance will create a pole in the amplifier's feedback path, leading to excessive peaking and potential oscillation. If dealing with load capacitance is a requirement of the application, the two strategies to consider are (1) using a small resistor in series with the amplifier's output and the load capacitance and (2) reducing the bandwidth of the amplifier's feedback loop by increasing the overall noise gain.

Figure 1 shown a unity gain follower using the series resistor strategy. The resistor isolates the output from the capacitance and, more importantly, creates a zero in the feedback path that compensates for the pole created by the output capacitance.

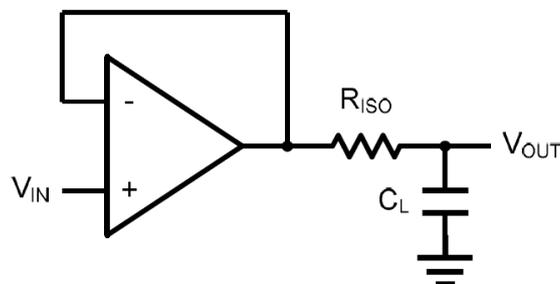


Figure 1. Indirectly Driving a Capacitive Load Using Isolation Resistor



The bigger the  $R_{ISO}$  resistor value, the more stable  $V_{OUT}$  will be. However, if there is a resistive load  $R_L$  in parallel with the capacitive load, a voltage divider (proportional to  $R_{ISO}/R_L$ ) is formed, this will result in a gain error.

The circuit in Figure 2 is an improvement to the one in Figure 1.  $R_F$  provides the DC accuracy by feed-forward the  $V_{IN}$  to  $R_L$ .  $C_F$  and  $R_{ISO}$  serve to counteract the loss of phase margin by feeding the high frequency component of the output signal back to the amplifier's inverting input, thereby preserving the phase margin in the overall feedback loop. Capacitive drive can be increased by increasing the value of  $C_F$ . This in turn will slow down the pulse response.

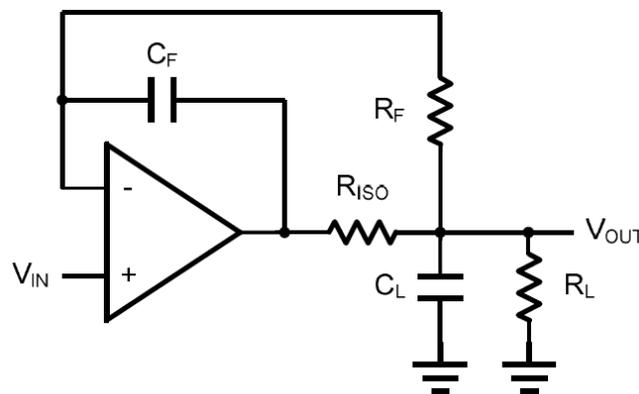


Figure 2. Indirectly Driving a Capacitive Load with DC Accuracy

## Typical Application Circuits

### Differential amplifier

The differential amplifier allows the subtraction of two input voltages or cancellation of a signal common the two inputs. It is useful as a computational amplifier in making a differential to single-end conversion or in rejecting a common mode signal. Figure 3 shown the differential amplifier using AO358.

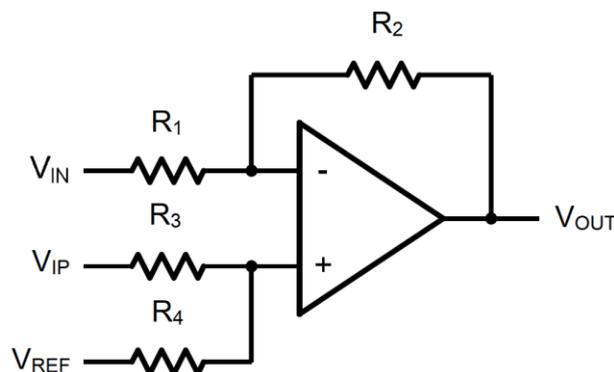


Figure 3. Differential Amplifier



$$V_{OUT} = \left( \frac{R_1 + R_2}{R_3 + R_4} \right) \frac{R_4}{R_1} V_{IN} - \frac{R_2}{R_1} V_{IP} + \left( \frac{R_1 + R_2}{R_3 + R_4} \right) \frac{R_3}{R_1} V_{REF}$$

If the resistor ratios are equal (i.e.  $R_1=R_3$  and  $R_2=R_4$ ), then

$$V_{OUT} = \frac{R_2}{R_1} (V_{IP} - V_{IN}) + V_{REF}$$

### Low Pass Active Filter

The low pass active filter is shown in Figure 4. The DC gain is defined by  $-R_2/R_1$ . The filter has a  $-20\text{dB/decade}$  roll-off after its corner frequency  $f_c=1/(2\pi R_3 C_1)$ .

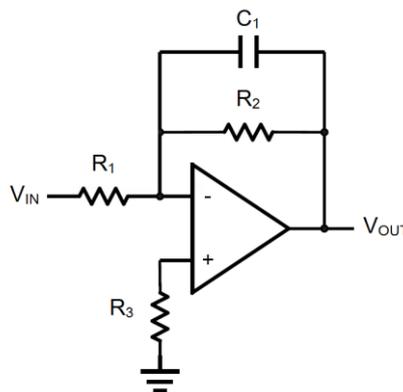


Figure 4. Low Pass Active Filter

### Instrumentation Amplifier

The triple AO358 can be used to build a three-op-amp instrumentation amplifier as shown in Figure 5. The amplifier in Figure 5 is a high input impedance differential amplifier with gain of  $R_2/R_1$ . The two differential voltage followers assure the high input impedance of the amplifier.

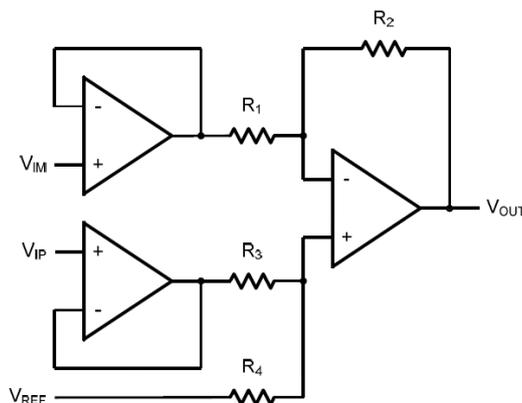
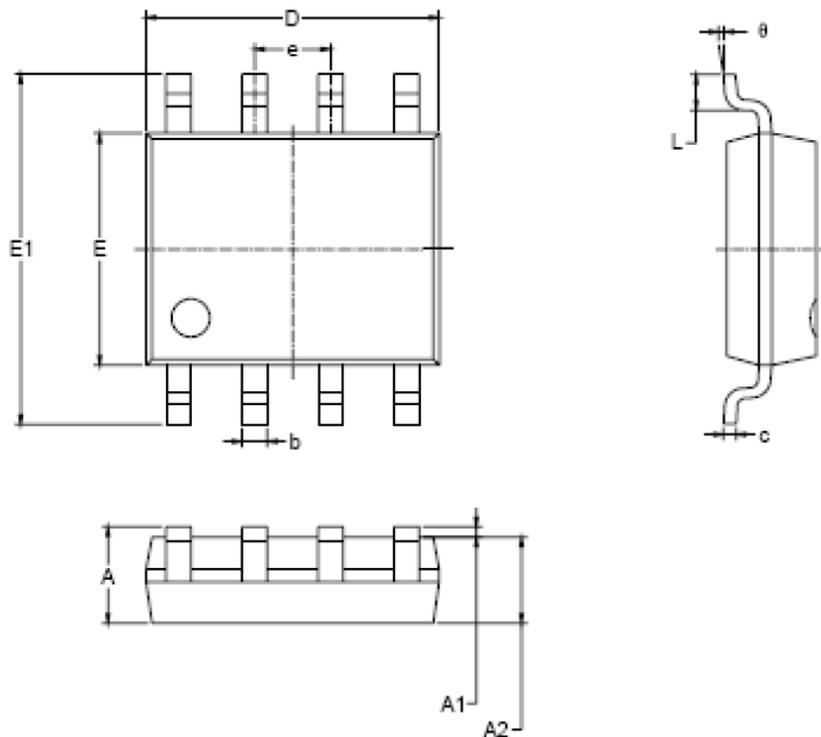


Figure 5. Instrument Amplifier



**PACKAGE INFORMATION**

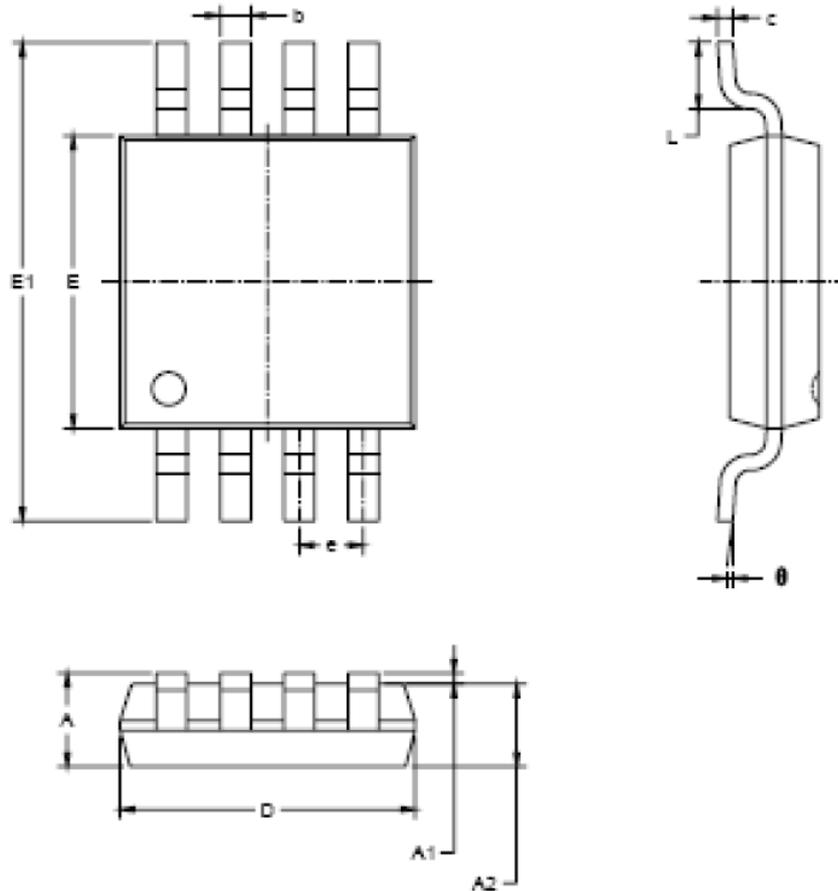
Dimension in SOP8 (Unit: mm)



Symbol	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°



Dimension in MSOP8 (Unit: mm)



Symbol	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	0.820	1.100	0.032	0.043
A1	0.020	0.150	0.001	0.006
A2	0.750	0.950	0.030	0.037
b	0.250	0.380	0.010	0.015
c	0.090	0.230	0.004	0.009
D	2.900	3.100	0.114	0.122
E	2.900	3.100	0.114	0.122
E1	4.750	5.050	0.187	0.199
e	0.650 BSC		0.026 BSC	
L	0.400	0.800	0.016	0.031
$\theta$	0°	6°	0°	6°



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