



TS358

Dual Differential Input Operational Amplifiers



DIP-8



SOP-8

**Low power drain
operational amplifier**

General Description

Utilizing the circuit designs perfected for recently introduced Quad Operational Amplifiers, these dual operational amplifiers feature 1) low power drain, 2) a common mode input voltage range extending to ground/ V_{EE} , 3) Single Supply or Split Supply operation, and 4) pin outs compatible with the popular MC1558 dual operational amplifier.

These amplifiers have several distinct advantages over standard operational amplifier types in single supply applications. They can operate at supply voltages as low as 3.0 Volts or as high as 32 Volts with quiescent currents about one fifth of those associated with the LM741 (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.

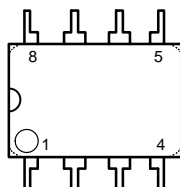
The output voltage range also includes the negative power supply voltage.

Features

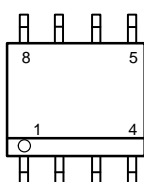
- ✦ Short circuit protected outputs
- ✦ True differential input stage
- ✦ Single supply operation : 3.0 V to 32 Volts
- ✦ Low input bias currents
- ✦ Internally compensated
- ✦ Common mode range extends to negative supply
- ✦ Single and split supply operation
- ✦ Similar performance to the popular MC1558

Pin Configuration

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- PIN : 1. Output A 5. Input B
 2. Input A 6. Input B
 3. Input A 7. Output B
 4. V_{EE} /Gnd 8. V_{CC}

Ordering Information

DEVICE	OPERATING TEMPERATURE (Ambient)	PACKAGE
TS358CD	-20 to +85°C	DIP-8
TS358CS		SOP-8

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Absolute Maximum Ratings

$T_A=25^{\circ}\text{C}$, $V_{CC} = 5\text{V}$, unless otherwise noted.

RATING	SYMBOL	VALUE	UNIT
Power Supply Voltage Single Supply	V_{CC}	32	Vdc
Power Supply Voltage Split Supplies	V_{CC}, V_{EE}	± 16	Vdc
Input Differential Voltage Range (1)	V_{IDR}	± 32	Vdc
Input Common Mode Voltage Range (2)	V_{ICR}	-0.3 to 32	Vdc
Input forward current (3) ($V_I \text{ --} -0.3\text{V}$)	I_{IF}	50	mA
Output Short Circuit Duration	t_S	Continuous	
Junction Temperature Plastic Packages	T_J	150	$^{\circ}\text{C}$
Junction Temperature (Ambient)	T_A	-20 to +85	$^{\circ}\text{C}$
Storage Temperature Range Plastic Packages	T_{stg}	-55 to +125	$^{\circ}\text{C}$

Note:

1. Split Power Supplies.
2. For supply voltages less than 32V for the TS358 the absolute maximum input voltage is equal to the supply voltage.
3. This input current will only exist when the voltage is negative at any of the input leads. Normal output states will reestablish when the input voltage returns to a voltage greater than -0.3V.



Electrical Characteristics

$T_A=25^{\circ}\text{C}$, $V_{CC} = 5\text{V}$, unless otherwise noted.

CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Input Offset Voltage $V_{CC} = 5.0\text{V}$ to 30V $V_{IC} = 0\text{V}$ to $V_{CC} - 1.7\text{V}$, $V_O = 1.4\text{V}$, $R_S = 0\Omega$ $T_A = 25^{\circ}\text{C}$ $T_A = 85^{\circ}\text{C}$ to -20°C	V_{IO}	--	2	5	mV
Average Temperature Coefficient of Input Offset Voltage $T_A = 85^{\circ}\text{C}$ to -20°C	$\Delta I_{IO}/\Delta T$	--	7	--	$\mu\text{V}/^{\circ}\text{C}$
Input Offset Current $T_A = 85^{\circ}\text{C}$ to -20°C	I_{IO}	--	5	50	nA
Average Temperature Coefficient of input Offset Current $T_A = 85^{\circ}\text{C}$ to -20°C	$\Delta I_{IO}/\Delta T$	--	10	--	$\text{pA}/^{\circ}\text{C}$
Input Bias Current $T_A = 85^{\circ}\text{C}$ to -20°C	I_{IB}	--	45	-250	μA
Input Common-Mode Voltage Range (Note1) $V_{CC} = 30\text{V}$ $V_{CC} = 30\text{V}$, ($T_A = 85^{\circ}\text{C}$ to -10°C)	V_{ICR}	0	--	28.3	V
Differential Input Voltage Range	V_{IDR}	--	--	V_{CC}	V
Large Signal Open-Loop Voltage Gain $R_L = 2.0\text{K}$, $V_{CC} = 15\text{V}$, For Large V_O Swing, $T_A = 85^{\circ}\text{C}$ to -20°C	A_{VOL}	25	100	--	V/mV
Channel Separation 1.0 KHz to 20kHz, Input Referenced	--	--	-120	--	dB

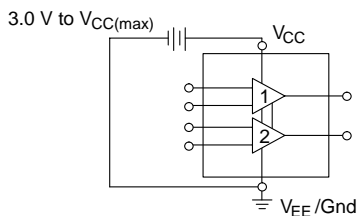
Electrical Characteristics(contd.)

$T_A=25^{\circ}\text{C}$, $V_{CC} = 5\text{V}$, unless otherwise noted.

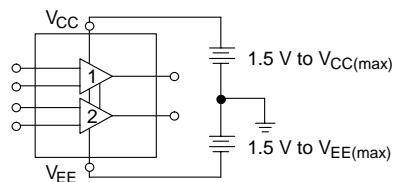
CHARACTERISTIC	SYMBOL	MIN	TYP	MAX	UNIT
Common Mode Rejection Ratio $R_S \leq 10\text{ k}\Omega$	CMRR	65	70	--	dB
Power Supply Rejection Ratio	PSRR	65	100	--	dB
Output Voltage Range $R_L = 2\text{K}\Omega$	V_{OR}	0	--	3.3	V
Output Voltage -- High Limit , ($T_A = 70^{\circ}\text{C}$ to 0°C) $V_{CC} = 30\text{ V}$, $R_L = 2\text{ k}\Omega$ $V_{CC} = 30\text{ V}$, $R_L = 10\text{ k}\Omega$	V_{OH}	26 27	-- 28	-- --	V
Output Voltage -- Low Limit , ($T_A = 70^{\circ}\text{C}$ to 0°C) $V_{CC} = 5.0\text{ V}$, $R_L = 10\text{ k}\Omega$	V_{OL}	--	5	20	mV
Output Source Current $V_{ID}=+1.0\text{V}$, $V_{CC}=15\text{V}$	I_{O+}	20	40	--	mA
Output Sink Current $V_{ID} = -1.0\text{ V}$, $V_{CC} = 15\text{ V}$ $V_{ID} = -1.0\text{ V}$, $V_O = 200\text{ mV}$	I_{O-}	10 12	20 50	-- --	mA μA
Output Short Circuit to Ground (Note 2)	I_{os}	--	40	60	mA
Power Supply Current , ($T_A = -20^{\circ}\text{C}$ to 85°C) $V_{CC} = 30\text{ V}$, $V_O = 0\text{ V}$, $R_L = \infty$ $V_{CC} = 5.0\text{ V}$, $V_O = 0\text{ V}$, $R_L = \infty$	I_{CC}	-- --	1.5 0.7	3.0 1.2	mA

Note:

1. The input common mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common mode voltage range is V_{CC} 17V, but either or both inputs can go to +32V .
2. Short circuits from the output to V_{CC} can cause excessive heating and eventual destruction. Destructive dissipation can result from simultaneous shorts on all amplifiers.



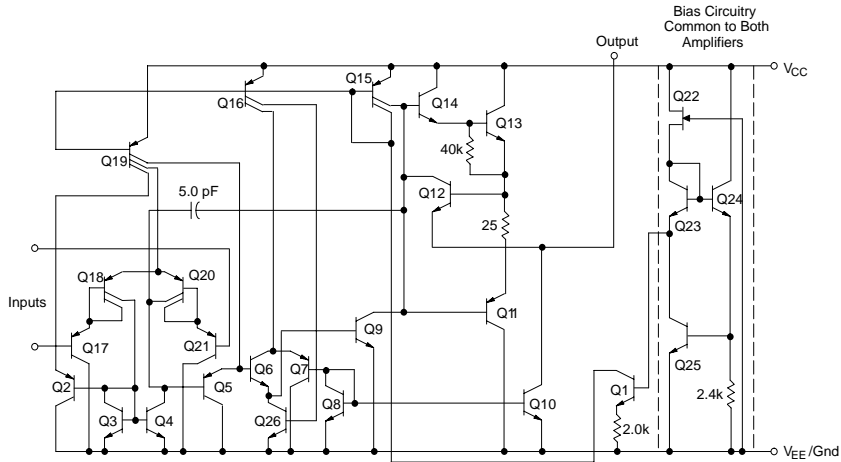
Single Supply



Split Supplies



REPRESENTATIVE CIRCUIT SCHEMATIC



CIRCUIT DESCRIPTION

The TS358 series made using two internally compensated, two-stage operational amplifiers. The first stage of each consists of differential input devices Q20 and Q18 with input buffer transistors Q21 and Q17 and 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 5.0pF) can be employed, thus saving chip area. The transconductance reduction is accomplished by splitting the collectors of Q20 and Q18. 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.

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.

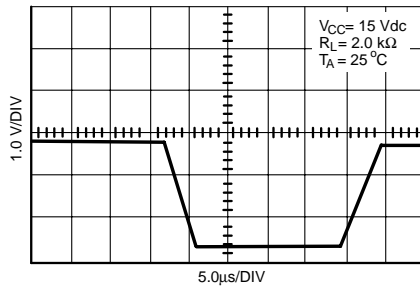


Figure 1. Large Signal Voltage Follower Response

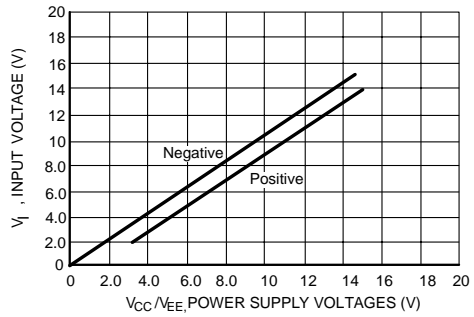


Figure 2. Input Voltage Range

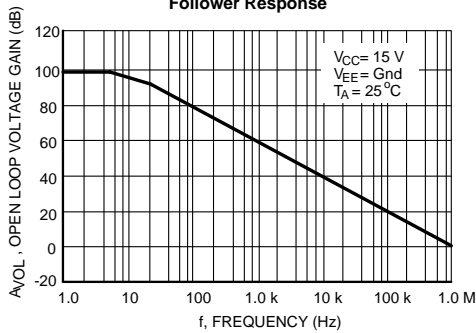


Figure 3. Large-Signal Open Loop Voltage Gain

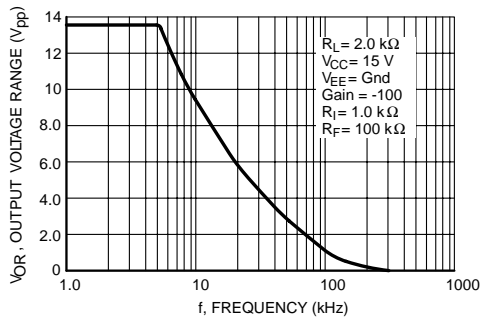


Figure 4. Large-Signal Frequency Response

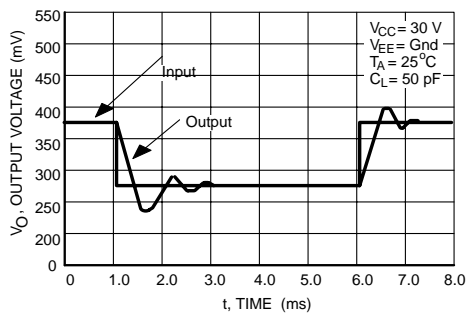


Figure 5. Small Signal Voltage Follower Pulse Response (Noninverting)

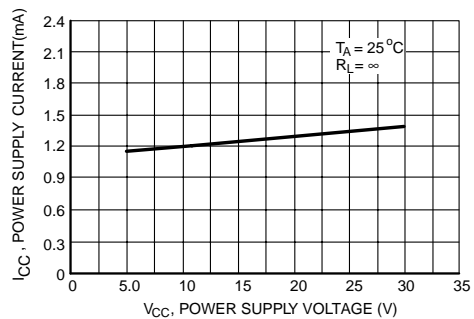


Figure 6. Power Supply Current versus Power Supply Voltage

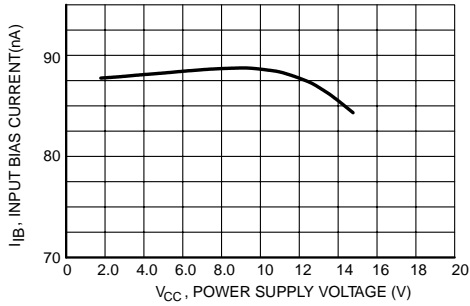


Figure 7. Input Bias Current versus Supply Voltage

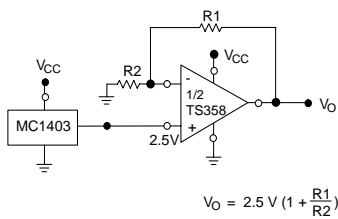


Figure 8. Voltage Reference

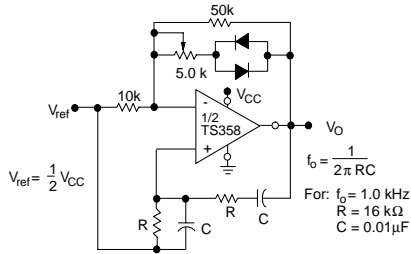


Figure 9. Wien Bridge Oscillator

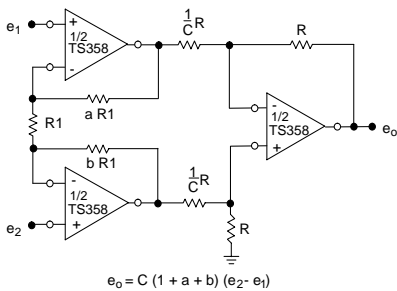


Figure 10. High Impedance Differential Amplifier

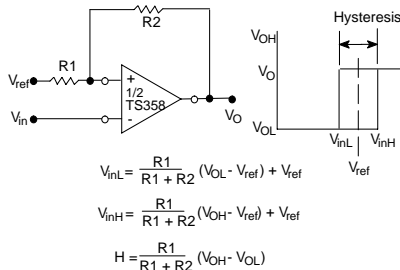


Figure 11. Comparator with Hysteresis

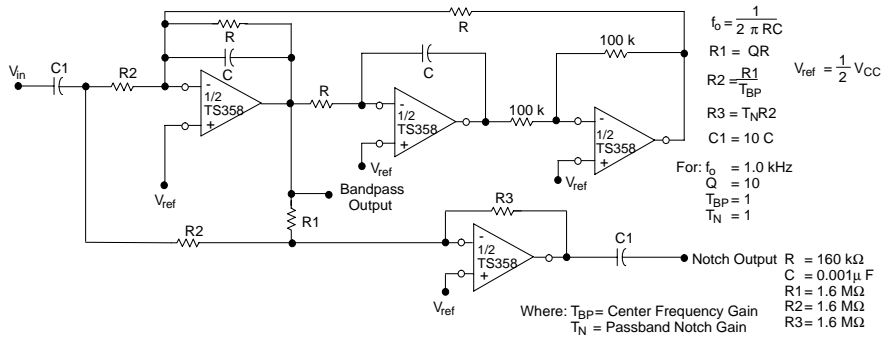


Figure 12. Bi-Quad Filter

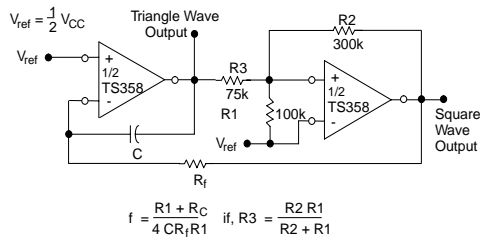
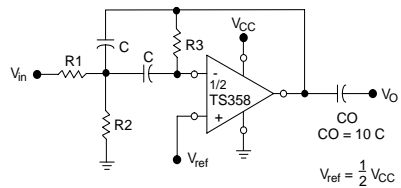


Figure 13. Function Generator



Given: f_o = center frequency
 $A(f_o)$ = gain at center frequency

Choose value f_o, C

Then: $R3 = \frac{Q}{\pi f_o C}$

$R1 = \frac{R3}{2A(f_o)}$

$R2 = \frac{R1 R3}{4Q^2 R1 - R3}$

For less than 10% error from operational amplifier $\frac{Q_o f_o}{BW} < 0.1$

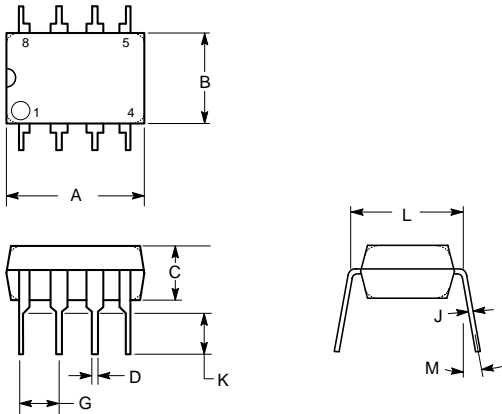
Where f_o and BW are expressed in Hz.

If source impedance varies, filter may be preceded with voltage follower buffer to stabilize filter parameters.

Figure 14. Multiple Feedback Bandpass Filter

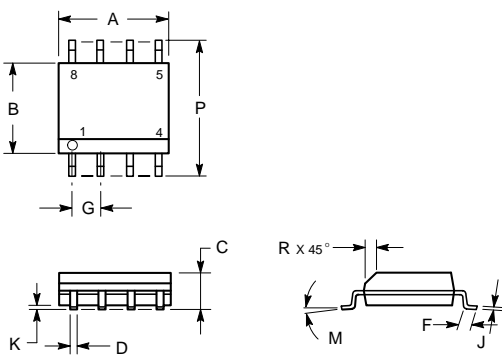


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SYMBOL	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.07	9.32	0.357	0.367
B	6.22	6.48	0.245	0.255
C	3.18	3.43	0.125	0.135
D	0.48	0.51	0.019	0.020
G	2.54BSC		0.10BSC	
J	0.29	0.31	0.011	0.012
K	3.25	3.35	0.128	0.132
L	7.75	8.00	0.305	0.315
M	-	10°	-	10°

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SYMBOL	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.196
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27BSC		0.05BSC	
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019