DESCRIPTION

The AO321 brings performance and economy to low power systems. With a high unity gain frequency and a specified 0.4V/μs slew rate, the quiescent current is only 430μA/amplifier (5V). The input common mode range includes ground and therefore the device can operate in single supply applications as well as in dual supply applications. It is also capable of comfortably driving large capacitive loads.

Overall, the AO321 is a low power, wide supply range performance op amp that can be designed into a wide range of applications at an economical price without sacrificing valuable board space.

The AO321 is available in SOT-25 Package.

ORDERING INFORMATION

Package Type	Part Number	
SOT-25 SPQ:3,000pcs/Reel	E5	AO321E5R
Note	R: Tape & Reel	
AiT provides all RoHS products		

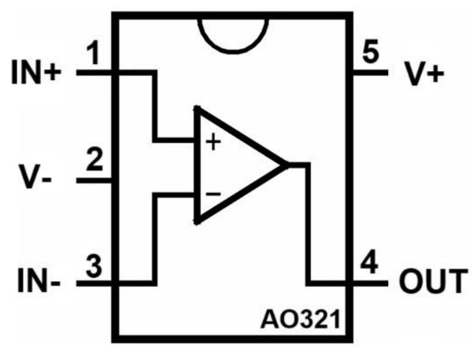
FEATURES

- V_{CC} = 5V, T_A = 25°C.
  Typical values unless specified.
- Gain-Bandwidth Product 1MHz
- Low Supply Current 430μA
- Low Input Bias Current 45nA
- Wide Supply Voltage Range +3V to +32V
- Stable with High Capacitive Loads

APPLICATION

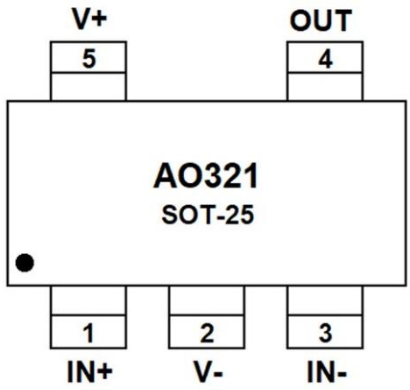
- Chargers
- Desktops
- Power Supplies
- Communications Infrastructure
- Industrial: Controls, Instruments

TYPICAL APPLICATION



SOT-25

PIN DESCRIPTION



SOT-25, E5
Top View

Pin #	Symbol	Functions
1	IN+	Noninverting Input
2	V-	Negative (Lowest) Power Supply
3	IN-	Inverting Input
4	OUT	Output
5	V+	Positive (Highest) Power Supply

ABSOLUTE MAXIMUM RATINGS

Differential Input Voltage		±Supply Voltage
Input Current (V_{IN} < −0 3V) (1)		50mA
Supply Voltage (V+ - V−)		32V
Input Voltage		−0.3V to +32V
Output Short Circuit to GND, V+ ≤ 15V and T_A = 25°C (2)		Continuous
Storage Temperature Range		−65°C~ 150°C
Junction Temperature (3)		150°C
Mounting Temperature	Lead Temp (Soldering, 10 sec)	245°C
	Infrared (10 sec)	215°C
θ_{JA}, Thermal Resistance to Ambient		265°C/W
ESD Tolerance (4)		300V

Stresses above 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 in the Electrical Characteristics is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

(1) This input current will only exist when the voltage at any of the input leads is driven negative. It is due to the collector base junction of the input PNP transistors becoming forward biased and thereby acting as input diode clamps. In addition to this diode action, there is also lateral NPN parasitic transistor action on the IC chip. This transistor action can cause the output voltages of the op amps to go to the V+ voltage level (or to ground for a large overdrive) for the time duration that an input is driven negative. This is not destructive and normal output states will re-establish when the input voltage, which was negative, again returns to a value greater than −0.36V (at 25°C).

(2) Short circuits from the output V+ can cause excessive heating and eventual destruction. When considering short circuits to ground the maximum output current is approximately 40mA independent of the magnitude of V+. At values of supply voltage in excess of +15V, continuous short circuits can exceed the power dissipation ratings and cause eventual destruction.

(3) The maximum power dissipation is a function of $T_{J(MAX)}$, θ_{JA}, and T_A The maximum allowable power dissipation at any ambient temperature is PD = ($T_{J(MAX)}$ - T_A)/ θ_{JA}. All numbers apply for packages soldered directly onto a PC board.

(4) Human Body Model, 1.5kΩ in series with 100pF.

RECOMMENDED OPERATING CONDITIONS

Parameter	Min.	Non.	Max.	Units
Temperature Range	-40	-	85	°C
Supply Voltage	3	-	30	V

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, all limits specified for at T_A = 25°C; V+ = 5V, V − = 0V, V_O = 1.4V. Boldface limits apply at temperature extremes.

Parameter	Symbol	Conditions	Min. (1)	Typ. (2)	Max. (1)	Units
Input Offset Voltage	V_{OS}	(3)	-	2	7	mV
					9	
Input Offset Current	I_{OS}		-	5	50	nA
					150	
Input Bias Current (4)	I_B		-	45	250	nA
					500	
Input Common-Mode Voltage Range	VCM	V^+= 30V (5) For CMRR > = 50dB	0	-	V^+ -1.5	V
					V^+ -2	
Large Signal Voltage Gain	A_V	(V^+ = 15V, R_L = 2kΩ V_O = 1.4V to 11.4V)	25	100	-	V/mV
			15			
Power Supply Rejection Ratio	PSRR	R_S ≤10kΩ, V+≤ 5V ~30V	65	100	-	dB
Common Mode Rejection Ratio	CMRR	R_S ≤ 10kΩ	65	85	-	dB
Output Swing VOH	V_O	V^+ = 30V, R_L = 2kΩ	26	-	-	V
		V^+ = 30V, R_L = 10kΩ	27	28	-	
Output Swing VOL		V^+ = 5V, R_L = 10kΩ	-	5	20	mV
Supply Current, No Load	I_S	V^+=5V	-	0.43	1.15	mA
				0.70	1.20	
		V^+=30V	-	0.66	2.85	mA
				1.50	3.00	
Output Current Sourcing	ISOURCE	V_{ID} = +1V, V^+ = 15V, V_O = 2V	20	40	-	mA
			10	20		
Output Current Sinking	ISINK	V_{ID} = −1V V^+ = 15V, V_O = 2V	10	20	-	mA
			5	8		
		V_{ID} = − 1V, V^+ = 15V, V_O = 0.2V	12	100	-	μA
Output Short Circuit to Ground (6)	I_O	V^+ = 15V	-	40	85	mA
Slew Rate	SR	V^+ = 15V, R_L = 2kΩ, V_{IN}= 0.5 ~ 3V C_L= 100pF, Unity Gain	-	0.4	-	V/μs
Gain Bandwidth Product	GBW	V^+ = 30V, f = 100kHz, V_{IN} = 10mV, R_L =2kΩ, C_L = 100pF	-	1	-	MHz
Phase Margin	φm	-	-	60	-	deg
Total Harmonic Distortion	THD	f = 1kHz, A_V = 20dB R_L = 2kΩ, V_O = $2V_{PP}$, C_L = 100pF, V^+ = 30V	-	0.015	-	%
Equivalent Input Noise Voltage	e_n	f = 1kHz, R_S = 100Ω V^+ = 30V	-	40	-	nV Hz

(1) All limits are specified by testing or statistical analysis.

(2) Typical values represent the most likely parametric norm.

(3) V_O ≅1.4V, R_S = 0Ω with V + from 5V to 30V; and over the full input common-mode range (0V to V^+ - 1.5V) at 25°C.

(4) The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output, so no loading change exists on the input lines.

(5) The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3V (at 25°C). The upper end of the common-mode voltage range is V^+ - 1.5V at 25°C, but either or both inputs can go to +32V without damage, independent of the magnitude of V^+.

(6) Short circuits from the output V^+ can cause excessive heating and eventual destruction. When considering short circuits to ground the maximum output current is approximately 40mA independent of the magnitude of V^+. At values of supply voltage in excess of +15V, continuous short circuits can exceed the power dissipation ratings and cause eventual destruction.

TYPICAL PERFORMANCE CHARACTERISTICS

Unless otherwise specified, V_S = +5V, single supply, T_A = 25°C.

Fig 1. Small Signal Pulse Response

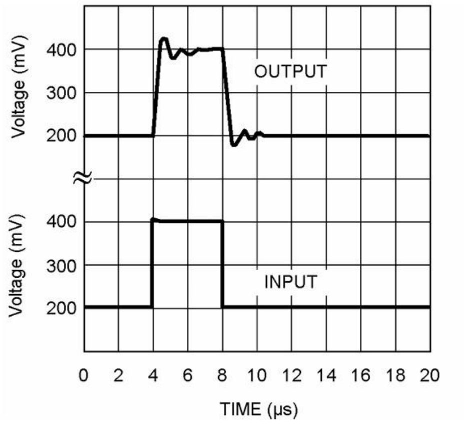


Fig 2. Large Signal Pulse Response

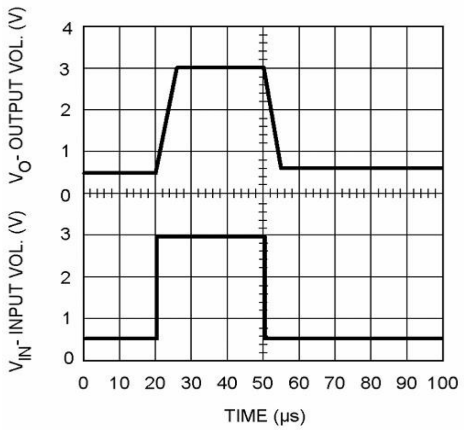


Fig 3. Supply Current vs. Supply Voltage

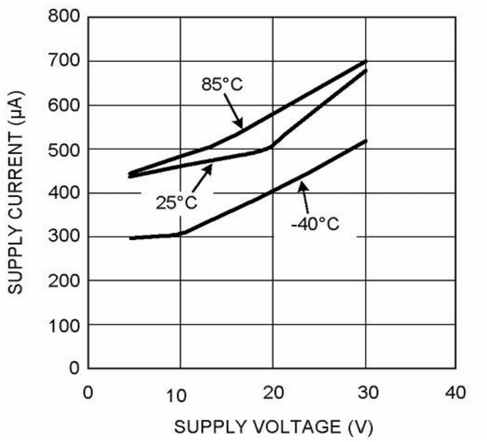


Fig 4. Sinking Current vs. Output Voltage

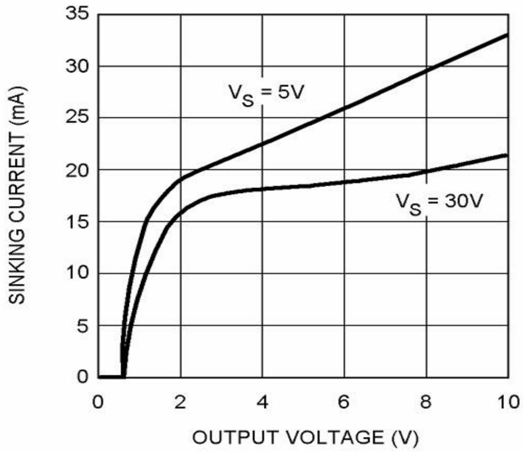


Fig 5. Source Current vs. Output Voltage

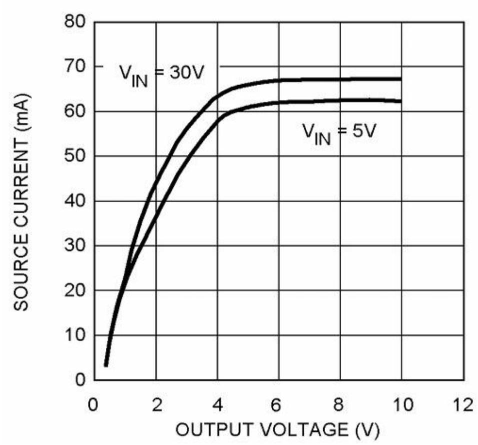
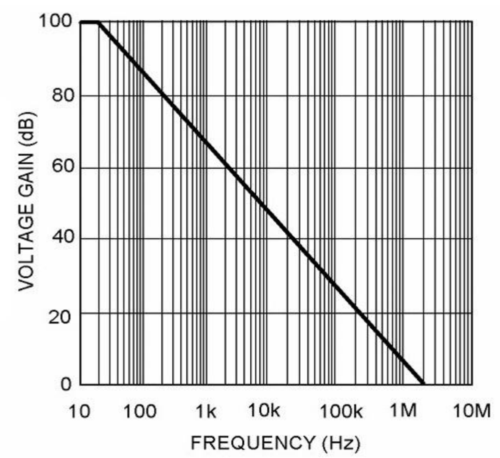
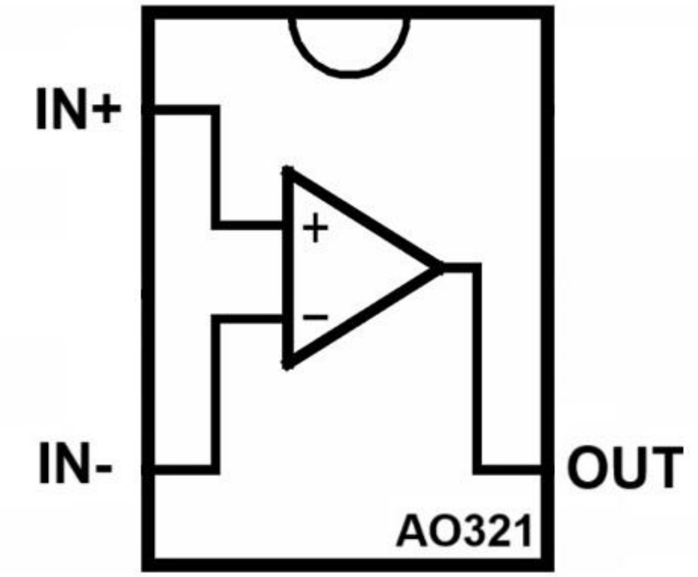


Fig 6. Open Loop Frequency Response



BLOCK DIAGRAM



DETAILED INFORMATION

The AO321 op amp can operate with a single or dual power supply voltage, has true-differential inputs, and remain in the linear mode with an input common-mode voltage of 0 V_{DC}. This amplifier operates over a wide range of power supply voltages, with little change in performance characteristics. At 25°C amplifier operation is possible down to a minimum supply voltage of 3V.

Large differential input voltages can be easily accommodated and, as input differential voltage protection diodes are not needed, no large input currents result from large differential input voltages. The differential input voltage may be larger than V^+ without damaging the device. Protection should be provided to prevent the input voltages from going negative more than −0.3 V_{DC} (at 25°C).An input clamp diode with a resistor to the IC input terminal can be used.

To reduce the power supply drain, the amplifier has a class A output stage for small signal levels which converts to class B in a large signal mode. This allows the amplifiers to both source and sink large output currents.

Therefore both NPN and PNP external current boost transistors can be used to extend the power capability of the basic amplifiers. The output voltage needs to raise approximately 1 diode drop above ground to bias the on chip vertical PNP transistor for output current sinking applications.

For AC applications, where the load is capacitively coupled to the output of the amplifier, a resistor should be used, from the output of the amplifier to ground to increase the class A bias current and to reduce distortion.

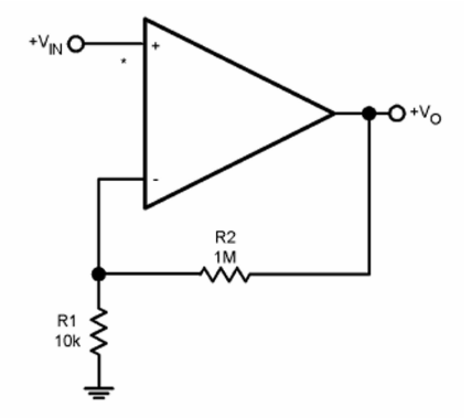
Capacitive loads which are applied directly to the output of the amplifier reduce the loop stability margin. Values of 50pF can be accommodated using the worst- case non- inverting unity gain connection. Large closed loop gains or resistive isolation should be used if large load capacitance must be driven by the amplifier.

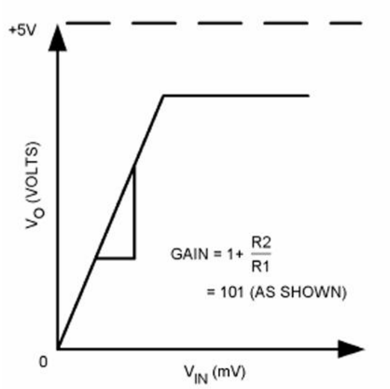
The bias network of the AO321 establishes a supply current which is independent of the magnitude of the power supply voltage over the range of from 3 V_{DC} to 30 V_{DC} .

Output short circuits either to ground or to the positive power supply should be of short time duration. Units can be destroyed, not as a result of the short circuit current causing metal fusing, but rather due to the large increase in IC chip dissipation which will cause eventual failure due to excessive junction temperatures. The larger value of output source current which is available at 25°C provides a larger output current capability at elevated temperatures than a standard IC op amp.

The circuits presented in the section on typical applications emphasize operation on only a single power supply voltage. If complementary power supplies are available, all of the standard op amp circuits can be used. In general, introducing a pseudo-ground (a bias voltage reference of $V^+/2$) will allow operation above and below this value in single power supply systems. Many application circuits are shown which take advantage of the wide input common-mode voltage range which includes ground. In most cases, input biasing is not required and input voltages which range to ground can easily be accommodated.

Noninverting DC Gain (0-V Input = 0-V Output)





* R not needed due to temperature independent

Fig 7. Non-Inverting DC Gain (0V Input = 0V Output)

Amplitude Modulator Circuit

The modulator circuit is shown in Fig 8. PWM signal is used to switch the MOSFET. When the MOSFET is on, the circuit acts as an inverting amplifier with gain 1. When The MOSFET is off, the inverting and non-inverting signals cancel each other out. Therefore, the output switches from–VIN to GND at the carrier frequency

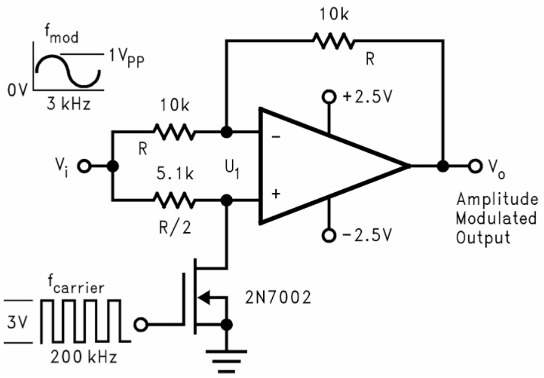
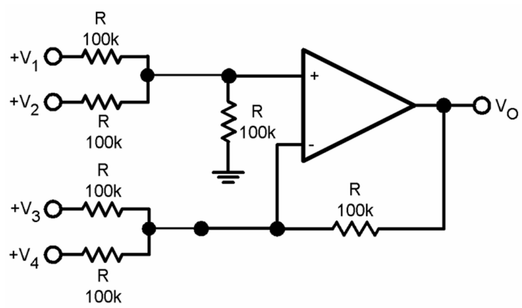


Fig 8. Amplitude Modulator Circuit

DC Summing Amplifier ($V_{IN's}$ ≥ 0 V_{DC} and V_O ≥ V_{DC})

The summing amplifier, a special case of the inverting amplifier, is shown in Fig9. The circuit gives an inverted output which is equal to the weighted algebraic sum of all four inputs. The gain of any input of this circuit is equal to the ratio of the appropriate input resistor to the feedback resistor. The advantage of this circuit is that there is no interaction between inputs and operations such as summing and weighted averaging are implemented very easily.

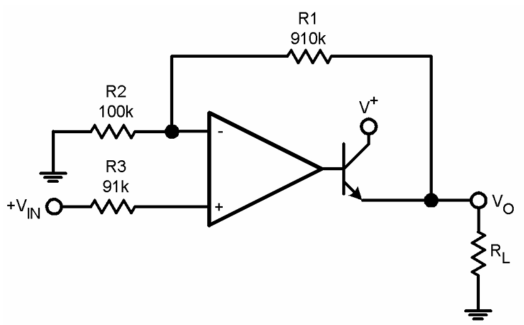


Where: $V_0 = V_1 + V_2 - V_3 - V_4$, $(V_1 + V_2) \geq (V_3 + V_4)$ to keep $V_O > 0$ V_{DC}

Fig 9. DC Summing Amplifier (V) ($V_{IN's}$ ≥ 0 V_{DC} and V_O ≥ V_{DC})

Power Amplifier

Power amplifier application circuit is shown in Fig10. Voltage gain is set by R1 and R2. The output of the amplifier is connected to the base of BJT which amplifies the current. Current gain is set by β, current gain of a BJT. The resulting output provides high power to the load. Differential voltage supplies are necessary.



V_0 = 0 V_{DC} for V_{IN} = 0 V_{DC}, A_V = 10

Fig 10. Power Amplifier

LED Driver

AO321 operating as an LED driver is shown in Fig11. The output of the amplifier sets the current through the diode. The voltage across the LED is assumed constant.

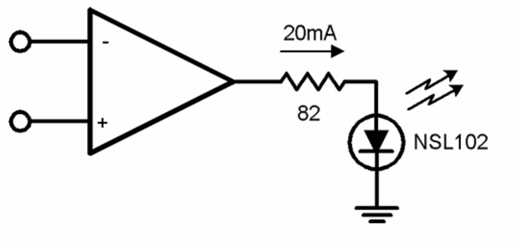


Fig 11. LED Driver

Fixed Current Sources

Operational amplifier can be used to provide fixed current source to multiple loads. The output voltage of the amplifier is connected to bases of bipolar transistors. The feedback is provided from the drain of a BJT to the inverting terminal of the amplifier. Currents in the second and later BJTs are set by the ratio of R1 and R2.

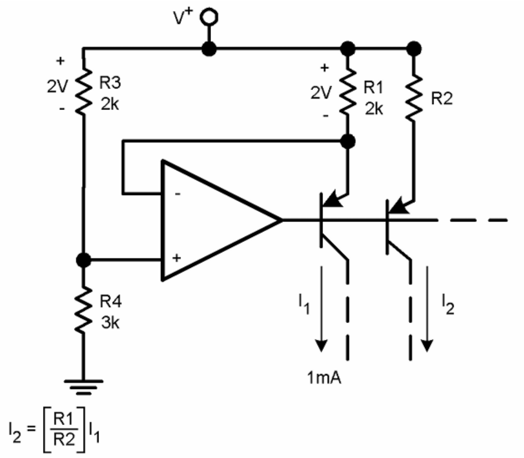


Fig 12. Fixed Current Sources

Lamp Driver

Similar to the LED driver, AO321 can be used as a lamp driver. The output of the amplifier is to be connected to the base of a bipolar transistor which will drive β*output current of the amplifier through the lamp

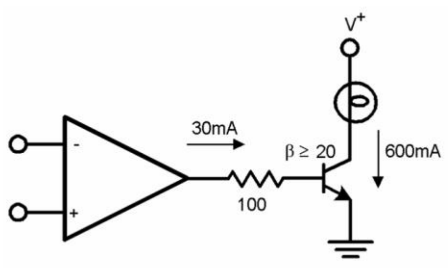


Fig 13. Lamp Driver

Simplified Schematic

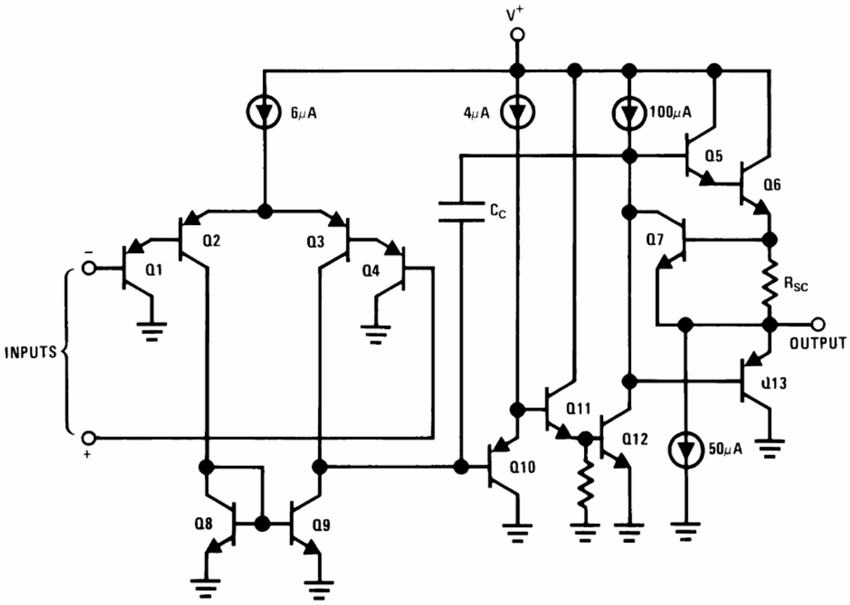
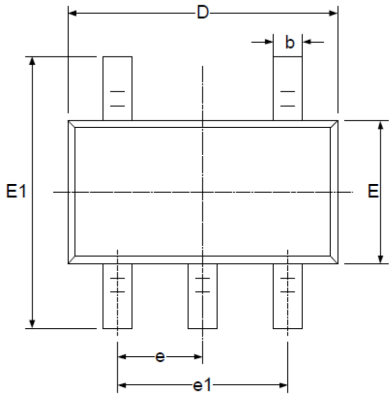
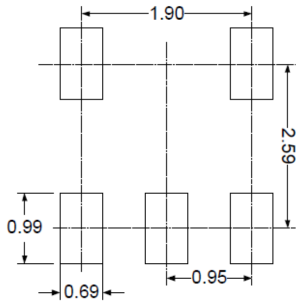


Fig 14. Simplified Schematic

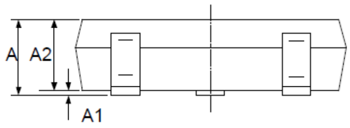
PACKAGE INFORMATION

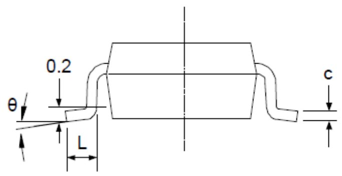
Dimension in SOT-25 (Unit: mm/ inch)





RECOMMENDED LAND PATTERN (Unit: mm)





Symbol	Millimeters	
	Min	Max
A	1.050	1.250
A1	0.000	0.100
A2	1.050	1.150
b	0.300	0.500
c	0.100	0.200
D	2.820	3.020
E	1.500	1.700
E1	2.650	2.950
e	0.950 BSC	
e1	1.800	2.000
L	0.300	0.600
θ	0°	8°

IMPORTANT NOTICE

AiT Semiconductor Inc. (AiT) reserves the right to make changes to any its product, specifications, to discontinue any integrated circuit product or service without notice, and advises its customers to obtain the latest version of relevant information to verify, before placing orders, that the information being relied on is current.

AiT Semiconductor Inc.'s integrated circuit products are not designed, intended, authorized, or warranted to be suitable for use in life support applications, devices or systems or other critical applications. Use of AiT products in such applications is understood to be fully at the risk of the customer. As used herein may involve potential risks of death, personal injury, or servere property, or environmental damage. In order to minimize risks associated with the customer's applications, the customer should provide adequate design and operating safeguards.

AiT Semiconductor Inc. assumes to no liability to customer product design or application support. AiT warrants the performance of its products of the specifications applicable at the time of sale.