钛地半导体
Tudi Semiconductor

Product Specification

TUDI-LM2904, LM2904A LM2904W, LM2904AW

Low-power dual operational amplifier

网址 www.sztdbdt.com

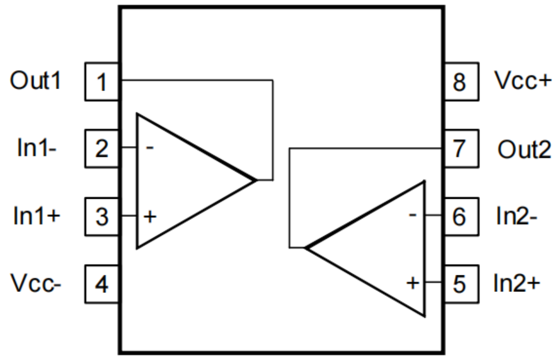
用芯智造 · 卓越品质

semiconductor device manufacturer

- Design
- research and development
- production
- and sales

Features

- Frequency compensation implemented internally
- Large DC voltage gain: 100 dB
- Wide bandwidth (unity gain): 1.1 MHz (temperature compensated)
- Very low supply current/amplifier, essentially independent of supply voltage
- Low input bias current: 20 nA (temperature compensated)
- Low input offset current: 2 nA
- Input common-mode voltage range includes negative rail
- Differential input voltage range equal to the power supply voltage
- Large output voltage swing 0 V to [(VCC +) -1.5 V]



MiniSO8, TSSOP8, and SO8 package pin connections

Description

This circuit consists of two independent, high gainoperational amplifiers (op amps) that have frequency compensation implemented internally. They are designed specifically for automotive and industrial control systems. The circuit operates from a single power supply over a wide range of voltages. The low power supply drain is independent of the magnitude of the power supply voltage.

Application areas include transducer amplifiers, DC gain blocks and all the conventional op amp circuits which can now be more easily implemented in single power supply systems. For example, these circuits can be directly supplied from the standard 5 V which is used in logic systems and easily provides the required electronic interfaces without requiring any additional power supply.

In linear mode, the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from a single power supply

1 Schematic diagram

Figure 1. Schematic diagram (LM2904, LM2904A)

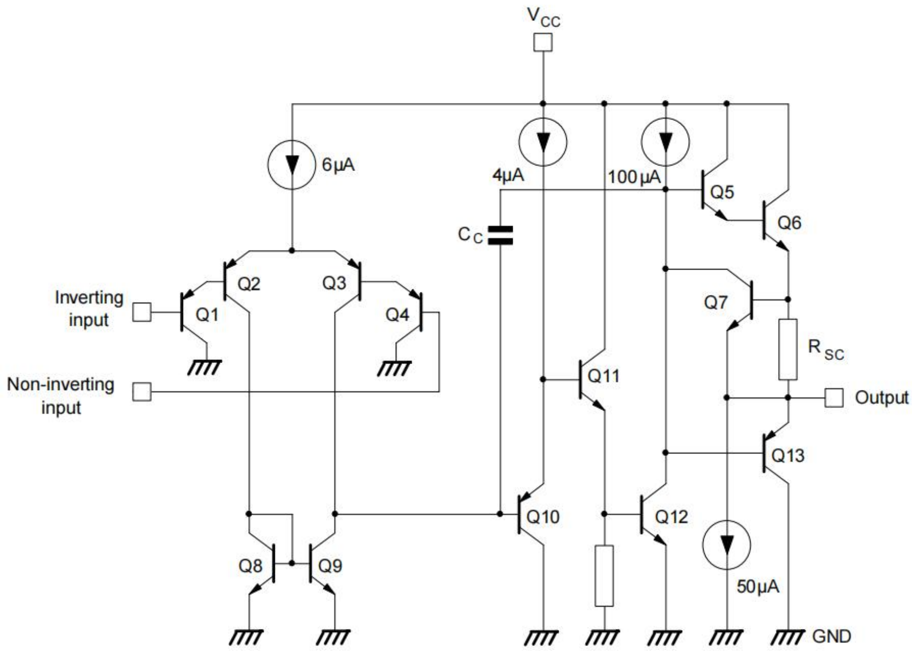
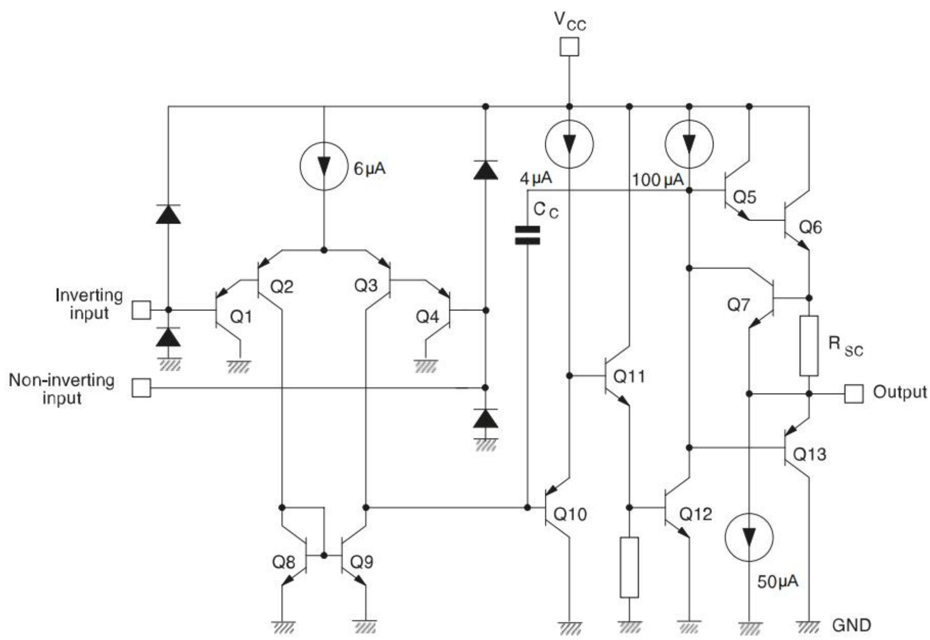


Figure 2. Schematic diagram (LM2904W, LM2904AW)



2 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

Symbol	Parameter		Value	Unit
V_{CC}	Supply voltage [1]		±16 or 32	V
V_{id}	Differential input voltage (LM2904, LM2904A) [2]		±32	
	Differential input voltage (LM2904W, LM2904AW) [2]		-0.3 to V_{CC} +0.3	
V_{in}	Input voltage (LM2904, LM2904A)		-0.3 to 32	
	Input voltage (LM2904W, LM2904AW)		-0.3 to V_{CC} +0.3	
	Output short-circuit duration [3]		Infinite	s
I_{in}	Input current : V_{in} driven negative		5 mA in DC or 50 mA in AC, (duty cycle = 10 %, T = 1 s)	mA
	Input current : V_{in} driven positive above AMR value [5]		0.4	
T_{oper}	Operating free-air temperature range		-40 to 125	°C
T_{stg}	Storage temperature range		-65 to 150	
T_j	Maximum junction temperature		150	
R_{thja}	Thermal resistance junction to ambient [6]	DFN8 2x2	57	°C/W
		MiniSO8	190	
		TSSOP8	120	
		SO8	125	
R_{thjc}	Thermal resistance junction to case [6]	MiniSO8	39	
		TSSOP8	37	
		SO8	40	
ESD	HBM: human body model (LM2904, LM2904A) [7]		300	V
	HBM: human body model (LM2904W, LM2904AW) [7]		2000	
	MM: machine model [8]		200	
	CDM: charged device model [9]		1.5	kV

1. *All voltage values, except differential voltage are with respect to network ground terminal.*
2. *Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.*
3. *Short-circuits from the output to V_{CC} can cause excessive heating if ($V_{cc}{}^{+}$) > 15 V. The maximum output current is approximately 40 mA, independent of the magnitude of V_{CC}. Destructive dissipation can result from simultaneous short-circuits on all amplifiers.*
4. *This input current only exists when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistor becoming forward-biased and thereby acting as an input diode clamp. In addition to this diode action, there is NPN parasitic action on the IC chip. This transistor action can cause the output voltages of the op amps to go to the V_{CC} voltage level (or to ground for a large overdrive) for the time during which an input is driven negative. This is not destructive and normal output is restored for input voltages above -0.3 V.*
5. *The junction base/substrate of the input PNP transistor polarized in reverse must be protected by a resistor in series with the inputs to limit the input current to 400 µA max ($R = (V_{in} - 32\ V)/400\ \mu A$).*
6. *Short-circuits can cause excessive heating and destructive dissipation. Values are typical.*
7. *Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 kΩ resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.*
8. *Machine model: a 200 pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω). This is done for all couples of connected pin combinations while the other pins are floating.*

9. *Charged device model: all pins and the package are charged together to the specified voltage and then discharged directly to the ground through only one pin. This is done for all pins.*

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	3 to 30	V
V_{icm}	Common mode input voltage range T_{amb} = 25 °C	V_{CC-} to V_{CC+} - 1.5	V
	Common mode input voltage range $T_{min} \leq T_{amb} \leq T_{max}$	V_{CC-} to V_{CC+} - 2	V
T_{oper}	Operating free-air temperature range	-40 to 125	°C

3 Electrical characteristics

Table 3. V_{CC}^{+} = 5 V, V_{CC-} = ground, V_O = 1.4 V, R_L connected to GND, T_{amb} = 25 °C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input offset voltage, T_{amb} = 25 °C, LM2904, LM2904W (1)		2	7	mV
	Input offset voltage, T_{amb} = 25 °C, LM2904A, LM2904AW (1)		1	2	
	Input offset voltage, $T_{min} \le T_{amb} \le T_{max}$, LM2904, LM2904W (1)			9	
	Input offset voltage, $T_{min} \le T_{amb} \le T_{max}$, LM2904A, LM2904AW (1)			4	
$\Delta V_{io}/\Delta T$	Input offset voltage drift		7	30	µV/°C
I_{io}	Input offset current, T_{amb} = 25 °C		2	30	nA
	Input offset current, $T_{min} \le T_{amb} \le T_{max}$			40	
$\Delta I_{io}/\Delta T$	Input offset current drift		10	300	pA/°C
I_{ib}	Input bias current, T_{amb} = 25 °C (2)		20	150	nA
	Input bias current, $T_{min} \le T_{amb} \le T_{max}$ (2)			200	
A_{vd}	Large signal voltage gain, V_{CC}^{+} = 15 V, R_L = 2 kΩ, V_o = 1.4 V to 11.4 V, T_{amb} = 25 °C	50	100		V/mV
	Large signal voltage gain, V_{CC}^{+} = 15 V, R_L = 2 kΩ, V_o = 1.4 V to 11.4 V, $T_{min} \le T_{amb} \le T_{max}$	25			
SVR	Supply voltage rejection ratio, V_{CC}^{+} = 5 V to 30 V, V_{icm} = 0 V, T_{amb} = 25 °C	65	100		dB
	Supply voltage rejection ratio, V_{CC}^{+} = 5 V to 30 V, V_{icm} = 0 V, $T_{min} \le T_{amb} \le T_{max}$	65			
I_{CC}	Supply current, all amp, no load, T_{amb} = 25 °C, V_{CC}^{+} = 5 V		0.7	1.2	mA
	Supply current, all amp, no load, $T_{min} \le T_{amb} \le T_{max}$, V_{CC}^{+} = 30 V			2	
CMR	Common-mode rejection ratio, V_{CC}^{+} = 30 V, V_{icm} = 0 V to 28.5 V, T_{amb} = 25 °C	70	85		dB
	Common-mode rejection ratio, V_{CC}^{+} = 30 V, V_{icm} = 0 V to 28 V, $T_{min} \le T_{amb} \le T_{max}$	60			
I_{source}	Output short-circuit current, V_{CC}^{+} = 15 V, V_o = 2 V, V_{id} = 1 V	20	40	60	mA
I_{sink}	Output sink current, V_O = 2 V, V_{CC+} = 15 V	10	20		
	Output sink current, V_O = 0.2 V, V_{CC+} = 15 V	12	50		µA
V_{OH}	High-level output voltage (V_{CC}^{+} = 30 V), T_{amb} = 25 °C, R_L = 2 kΩ	26			V
	High-level output voltage (V_{CC}^{+} = 30 V), $T_{min} \le T_{amb} \le T_{max}$	26	27		
	High-level output voltage (V_{CC}^{+} = 30 V), T_{amb} = 25 °C, R_L = 10 kΩ	27			
	High-level output voltage (V_{CC}^{+} = 30 V), $T_{min} \le T_{amb} \le T_{max}$	27	28		
V_{OL}	Low-level output voltage (R_L = 10 kΩ), T_{amb} = 25 °C		5	20	mV
	Low-level output voltage (R_L = 10 kΩ), $T_{min} \le T_{amb} \le T_{max}$			20	

Symbol	Parameter	Min.	Typ.	Max.	Unit
SR	Slew rate, $V_{CC}{}^{+}$ = 15 V, V_{in} = 0.5 to 3 V, R_L = 2 kΩ, C_L =100 pF, unity gain, T_{amb} = 25 °C	0.3	0.6		V/μs
	Slew rate, $V_{CC}{}^{+}$ = 15 V, V_{in} = 0.5 to 3 V, R_L = 2 kΩ, C_L =100 pF, unity gain, $T_{min} \le T_{amb} \le T_{max}$	0.2			
GBP	Gain bandwidth product, f = 100 kHz, $V_{CC}{}^{+}$ = 30 V, V_{in} = 10 mV, R_L = 2 kΩ, C_L = 100 pF	0.7	1.1		MHz
THD	Total harmonic distortion, f = 1 kHz, A_V = 20 dB, R_L = 2 kΩ, V_o = 2 V_{pp}, C_L = 100 pF, $V_{CC}{}^{+}$ = 30 V		0.02		%
e_n	Equivalent input noise voltage, f = 1 kHz, R_S = 100 Ω, $V_{CC}{}^{+}$ = 30 V		55		nV/√Hz
V_{O1}/V_{O2}	Channel separation, 1 kHz ≤ f ≤ 20 kHz [3]		120		dB

1. *V_O = 1.4 V, 5 V < $V_{CC}{}^{+}$ < 30 V, 0 V < V_{ic} < ($V_{CC}{}^{+}$) - 1.5 V*
2. *The direction of the input current is out of the IC. This current is essentially constant as long as the output is not saturated, so there is no change in the loading charge on the input lines.*
3. *Due to the proximity of external components, ensure that the stray capacitance does not cause coupling between these external parts. This can typically be detected at higher frequencies because this type of capacitance increases.*

4 Typical single-supply applications

Figure 3. AC coupled inverting amplifier

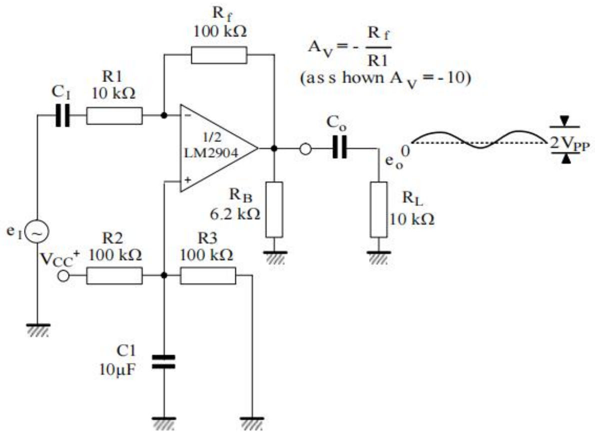


Figure 4. AC coupled non-inverting amplifier

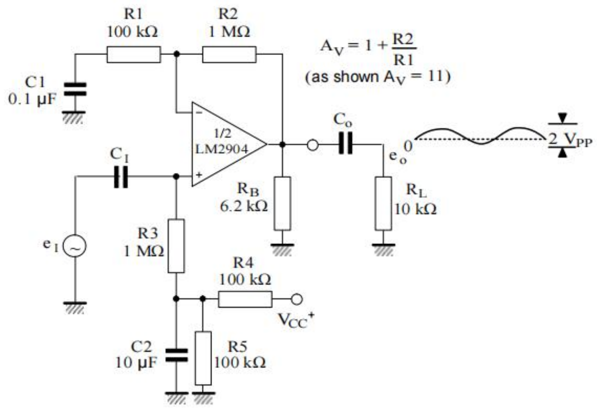


Figure 5. Non-inverting DC gain

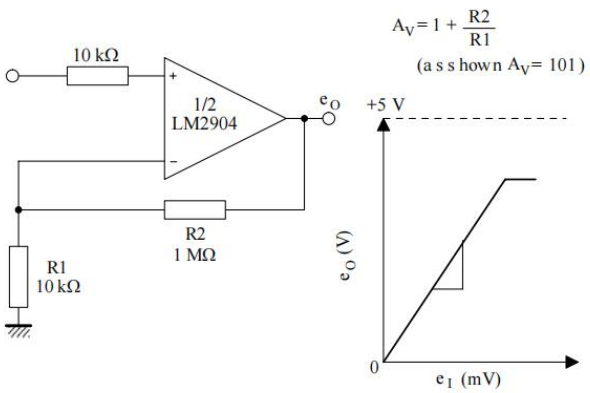


Figure 6. DC summing amplifier

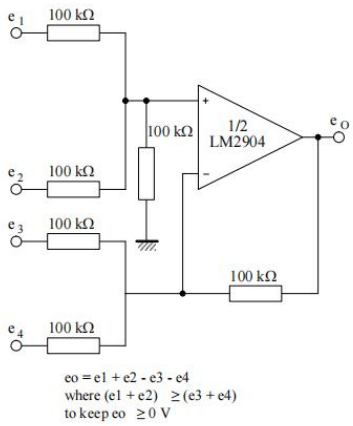
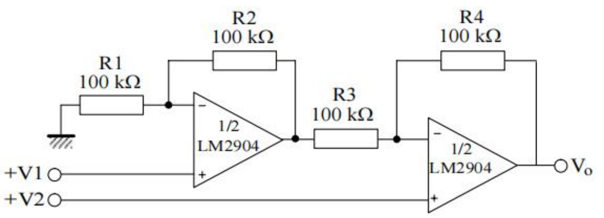


Figure 7. High input Z, DC differential amplifier



If R1 = R5 and R3 = R4 = R6 = R7

$$eo = \left[1 + \frac{2R1}{R2}\right](e2 - e1)$$

As shown eo = 101 (e2 - e1)

Figure 8. Using symmetrical amplifiers to reduce input current

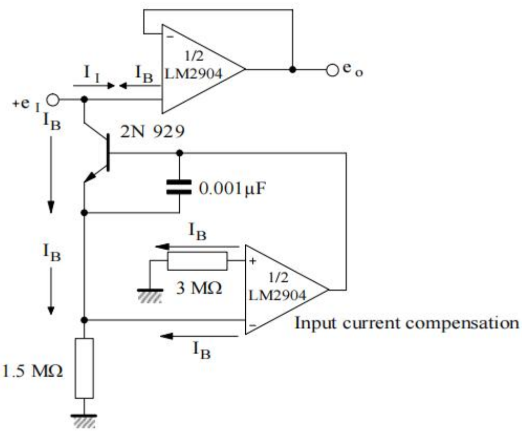


Figure 9. Low drift peak detector

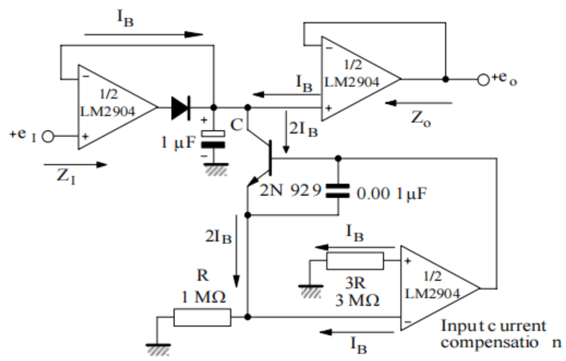
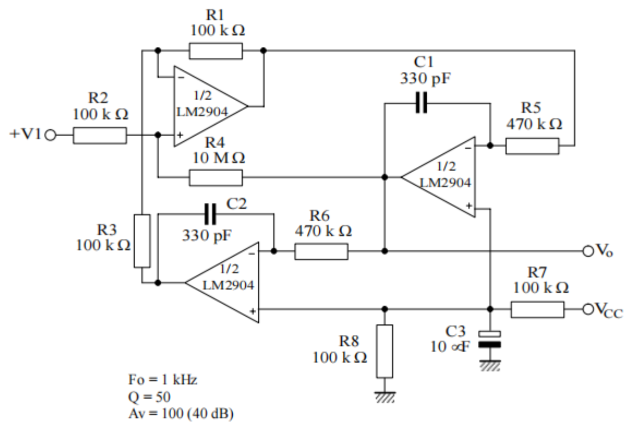


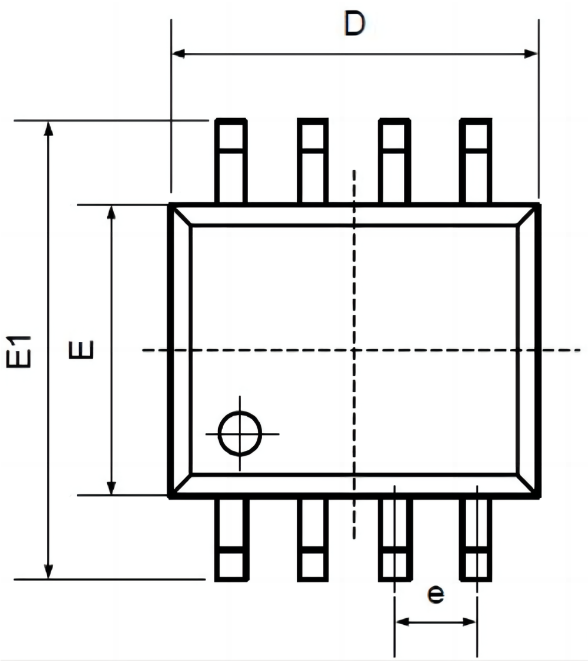
Figure 10. Active bandpass filter

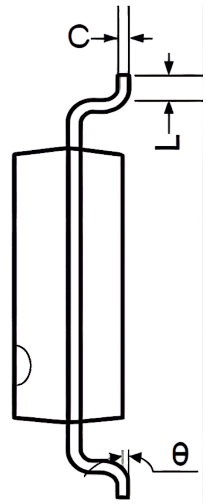


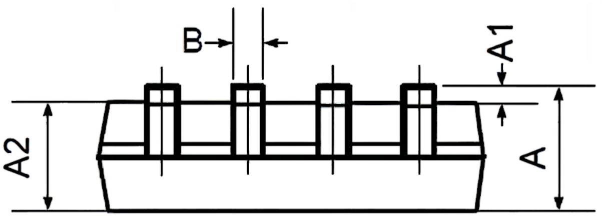
ORDERING INFORMATION

Order Number	Package	Package Quantity	Marking On The park
LM2904DT-TUDI	SOP8	Tape,Reel,2500	2904
LM2904PT-TUDI	TSSOP8	Tape,Reel,2500	2904
LM2904ST-TUDI	MSOP8	Tape,Reel,2500	K403
LM2904Q2T-TUDI	DFN8	Tape,Reel,3000	K1Y
LM2904YDT-TUDI	SOP8	Tape,Reel,2500	2904Y
LM2904AYDT-TUDI	SOP8	Tape,Reel,2500	2904AY
LM2904YPT-TUDI	TSSOP8	Tape,Reel,2500	2904Y
LM2904AYPT-TUDI	TSSOP8	Tape,Reel,2500	904AY
LM2904YST-TUDI	MSOP8	Tape,Reel,2500	K409
LM2904WDT-TUDI	SOP8	Tape,Reel,2500	2904W
LM2904WYDT-TUDI	SOP8	Tape,Reel,2500	2904WY
LM2904WYPT-TUDI	TSSOP8	Tape,Reel,2500	K04WY
LM2904AWYPT-TUDI	TSSOP8	Tape,Reel,2500	K05WY

Package SOP8

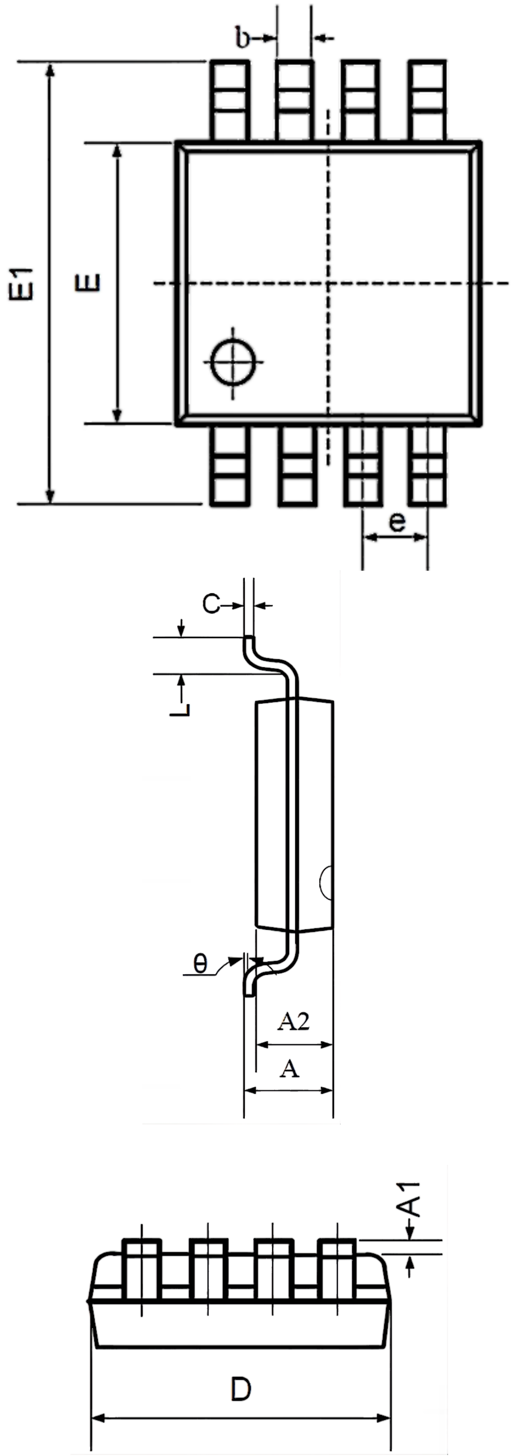






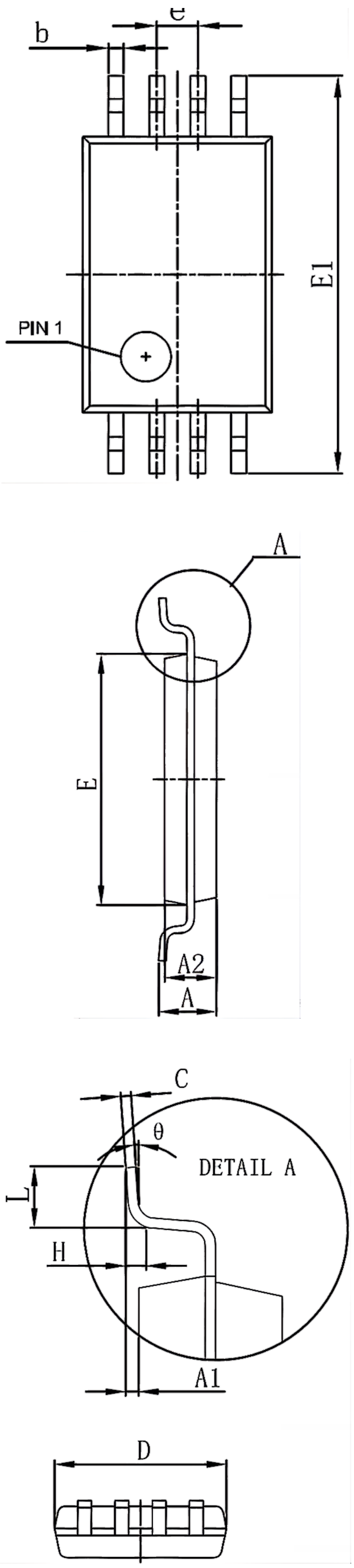
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
B	0.330	0.510	0.013	0.020
C	0.190	0.250	0.007	0.010
D	4.780	5.000	0.188	0.197
E	3.800	4.000	0.150	0.157
E1	5.800	6.300	0.228	0.248
e	1.270TYP		0.050TYP	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

Package MSOP8



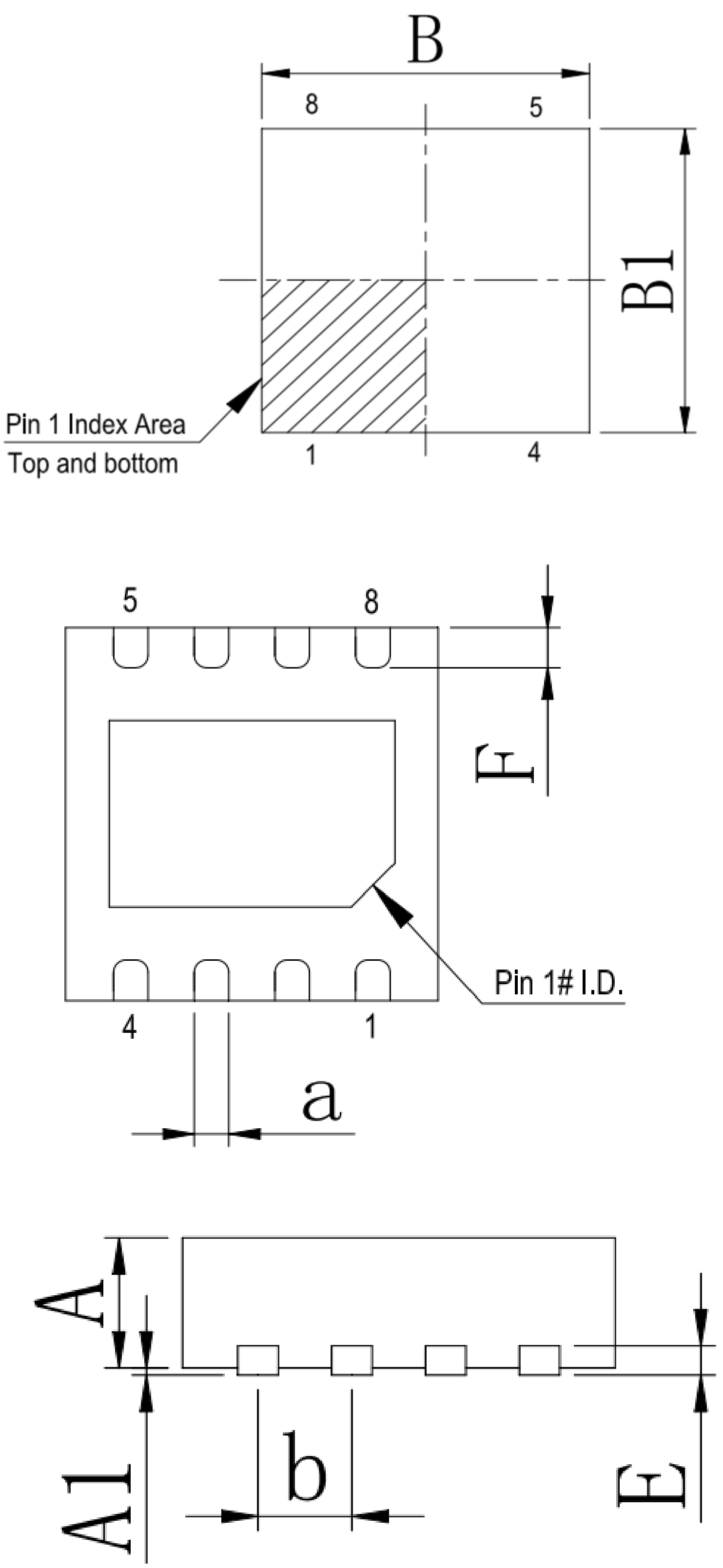
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.800	1.200	0.031	0.047
A1	0.000	0.200	0.000	0.008
A2	0.760	0.970	0.030	0.038
b	0.30 TYP		0.012 TYP	
C	0.15 TYP		0.006 TYP	
D	2.900	3.100	0.114	0.122
e	0.65 TYP		0.026 TYP	
E	2.900	3.100	0.114	0.122
E1	4.700	5.100	0.185	0.201
L	0.410	0.650	0.016	0.026
θ	0°	6°	0°	6°

Package TSSOP8



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
D	2.900	3.100	0.114	0.122
E	4.300	4.500	0.169	0.177
b	0.190	0.300	0.007	0.012
C	0.090	0.200	0.004	0.008
E1	6.250	6.550	0.246	0.258
A		1.200		0.047
A2	0.800	1.000	0.031	0.039
A1	0.050	0.150	0.002	0.006
e	0.65(BSC)		0.026(BSC)	
L	0.500	0.700	0.020	0.028
H	0.25(TYP)		0.01(TYP)	
θ	1°		1°	

Package DFN-8 2*2



Symbol	Dimensions In Millimeters	
	Min	Max
A	0.850	0.950
A1	0.000	0.050
B	2.900	3.100
B1	2.90	3.10
E	0.2	0.3
F	0.300	0.500
a	0.200	0.340
b	0.65 BSC	

Important statement:

●TUDI Semiconductor reserves the right to modify the product manual without prior notice! Before placing an order, customers need to confirm whether the obtained information is the latest version and verify the completeness of the relevant information.

●Any semi-guide product is subject to failure or malfunction under specified conditions. It is the buyer's responsibility to comply with safety standards when using TUDI Semiconductor products for system design and whole machine manufacturing.And take the appropriate safety measures to avoid the potential in the risk of loss of personal injury or loss of property situation!

●TUDI Semiconductor products have not been licensed for life support, military, and aerospace applications,and therefore TUDI Semiconductor is not responsible for any consequences arising from the use of this product in these areas.

●If any or all TUDI Semiconductor products (including technical data, services) described or contained in this document are subject to any applicable local export control laws and regulations, they may not be exported without an export license from the relevant authorities in accordance with such laws.

●The specifications of any and all TUDI Semiconductor products described or contained in this document specify the performance, characteristics, and functionality of said products in their standalone state, but do not guarantee the performance, characteristics, and functionality of said products installed in Customer's products or equipment. In order to verify symptoms and conditions that cannot be evaluated in a standalone device, the Customer should ultimately evaluate and test the device installed in the Customer's product device.

●TUDI Semiconductor documentation is only allowed to be copied without any alteration of the content and with the relevant authorization.TUDI Semiconductor assumes no responsibility or liability for altered documents.

●TUDI Semiconductor is committed to becoming the preferred semiconductor brand for customers, and TUDI Semiconductor will strive to provide customers with better performance and better quallity products.