



钜地半导体
Tudi Semiconductor

Product Specification

TUDI-MCP606/607/608/609

2.5V to 5.5V Micropower CMOS Op Amps

网址 www.sztdbdt.com 🔍

用芯智造 · 卓越品质

**semiconductor device
manufacturer**

- Design
- research and development
- production
- and sales



FEATURES

- Low Power $I_{DD} = 25\mu A, \max$
- Low Offset Voltage: $250\mu V, \max$
- Rail-to-Rail Swing at Output
- 80 pA, Low Input Bias Current over Temperature
- Specifications rated for 2.5V to 5.5V Supplies
- Unity Gain Stable
- Chip Select(CS) Capability with MCP608
- Industrial Temperature range supported
- No Phase Reversal
- Available in Single, Dual, and Quad

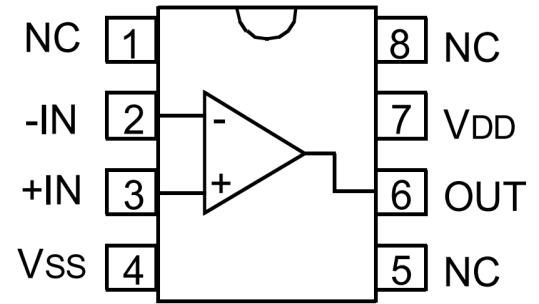
APPLICATIONS

- Battery Power Instruments
- High Impedance Applications
 - Photodiode Pre-amps
 - pH probe Buffer Amplifier
 - Infrared Detectors
 - Precision Integrators
 - Charge Amplifier for Piezoelectric Transducers
- Strain Gauges
- Medical Instruments
- Test Equipment

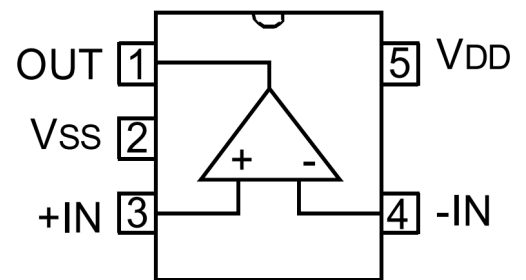
DESCRIPTION

The MCP606, MCP607, MCP608 and MCP609 are unity gain stable, low offset voltage operational amplifiers capable of precision low power single supply operation. Performance characteristics include ultra low offset voltage ($250\mu V, \max$), rail-to-rail output swing capability, and low input bias current ($80\text{ pA}@ 85^\circ\text{C}$). These features make this family of amplifiers well suited for single supply precision, high impedance, battery powered applications.

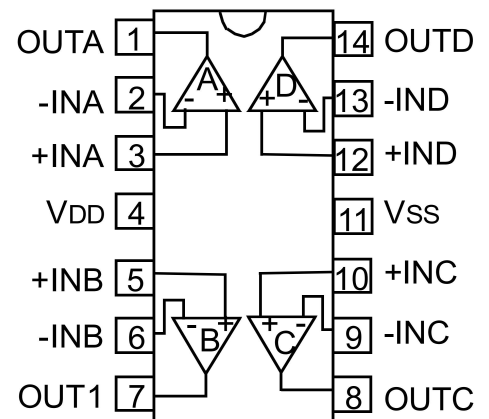
The single MCP606 is available in standard 8-lead PDIP, SOIC, and TSSOP packages. Another version of the single op amp, MCP608 is offered with a ChipSelect option in standard 8-lead PDIP, SOIC, and TSSOP packages. The dual MCP607 is offered in standard 8-lead PDIP, SOIC, as well as the TSSOP package. Finally, the quad MCP609 is offered in 14-lead PDIP, SOIC and TSSOP packages. All devices are fully specified from -40°C to $+85^\circ\text{C}$ with power supplies from 2.5V to 5.5V.



SOP8/DIP8/TSSOP8



SOT23-5



SOP8/DIP8/TSSOP8



ELECTRICAL CHARACTERISTICS

Maximum Ratings*

V_{DD}7.0V
All inputs and outputs w.r.t. V_{SS} -0.3Vto V_{DD} +0.3V
Difference Input voltage..... $|V_{DD}-V_{SS}|$
Output Short Circuit Current.....continuous
Current at Input Pin..... $\pm 2mA$
Current at Output and Supply Pin..... $\pm 30mA$
Storage temperature..... $65^{\circ}C$ to $+150^{\circ}C$
Ambient temp.with power applied..... $5^{\circ}C$ to $+125^{\circ}C$
Soldering temperature of leads(10 seconds).. $+300^{\circ}C$
ESD protection on all pins>2kV

Notice: Stresses above those listed under "Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

PIN FUNCTION TABLE

Name	Function
+IN/+INA/+INB/+INC/ +IND	Non-inverting Input Terminals
-IN/-INA/-INB/-INC/-IND	Inverting Input Terminals
V_{DD}	Positive Power Supply
V_{SS}	Negative Power Supply
OUT/OUTA/OUTB/OUTC/ OUTD	Output Terminals
CS	Chip Select
NC	No internal connection to IC



DC CHARACTERISTICS

Unless otherwise specified, all limits are specified for $V_{DD} = +2.5V$ to $+5.5V$, $V_{SS} = GND$, $T_A = 25^\circ C$, $V_{CM} = V_{DD}/2$, and $V_{OUT} \sim V_{DD}/2$

PARAMETERS	SYMBOL	MIN.	TYP.	MAX.	UNITS	CONDITIONS
INPUT OFFSET						
Input Offset Voltage	V_{OS}	-250	—	+250	μV	
Drift with Temperature	dV_{OS}/dT	—	± 1.8	—	$\mu V/^\circ C$	$T_A = -40^\circ C$ to $+85^\circ C$
Power Supply Rejection	PSRR	80	93	—	dB	for $V_{DD} = 2.5V$ to $5.5V$
INPUT BIAS CURRENT AND IMPEDANCE						
Input Bias Current	I_B	—	1	—	pA	
Over Temperature	I_B	—	—	80	pA	$T_A = -40^\circ C$ to $+85^\circ C$
Input Offset Bias Current	I_{OS}	—	1	—	pA	
Common-Mode Input Impedance	Z_{CM}	—	$10^{13} 6$	—	ΩpF	
Differential Input Impedance	Z_{DIFF}	—	$10^{13} 6$	—	ΩpF	
COMMON MODE						
Common-Mode Input Range	V_{CM}	$V_{SS} - 0.3$	—	$V_{DD} - 1.1$	V	$CMRR \geq 75$ dB
Common-Mode Rejection Ratio	$CMRR$	75	91	—	dB	$V_{DD} = 5V$, $V_{CM} = -0.3$ to $3.9V$
OPEN LOOP GAIN						
DC Open Loop Gain	A_{OL}	105	121	—	dB	$R_L = 25$ k Ω to $V_{DD}/2$, 50 mV $< V_{OUT} < (V_{DD} - 50$ mV)
DC Open Loop Gain	A_{OL}	100	118	—	dB	$R_L = 5$ k Ω to $V_{DD}/2$, 100 mV $< V_{OUT} < (V_{DD} - 100$ mV)



DC CHARACTERISTICS(Continue)

Unless otherwise specified, all limits are specified for $V_{DD} = +2.5V$ to $+5.5V$, $V_{SS} = GND$, $T_A = 25^\circ C$, $V_{CM} = V_{DD}/2$, and $V_{OUT} \sim V_{DD}/2$

PARAMETERS	SYMBOL	MIN.	TYP.	MAX.	UNIT S	CONDITIONS
OUTPUT						
Low Level/High Level Output Voltage Swing	V_{OL}, V_{OH}	$V_{SS} + 0.015$	—	$V_{DD} - 0.020$	V	$R_L = 25\text{ k}\Omega$ to $V_{DD}/2$
	V_{OL}, V_{OH}	$V_{SS} + 0.045$	—	$V_{DD} - 0.060$	V	$R_L = 5\text{ k}\Omega$ to $V_{DD}/2$
Linear Region Maximum Output Voltage Swing	V_{OUT}	$V_{SS} + 0.050$	—	$V_{DD} - 0.050$	V	$R_L = 25\text{ k}\Omega$ to $V_{DD}/2$, $A_{OL} \geq 105\text{ dB}$
	V_{OUT}	$V_{SS} + 0.100$	—	$V_{DD} - 0.100$	V	$R_L = 5\text{ k}\Omega$ to $V_{DD}/2$, $A_{OL} \geq 100\text{ dB}$
Output Short Circuit Current	I_{SC}	—	17	—	mA	$V_{OUT} = 2.5V$, $V_{DD} = 5V$
POWER SUPPLY						
Supply Voltage	V_S	2.5	—	5.5	V	
Quiescent Current Per Amplifier	I_Q	—	18.7	25	μA	$I_O = 0$

AC CHARACTERISTICS

Unless otherwise specified, all limits are specified for $V_{DD} = +2.5V$ to $+5.5V$, $V_{SS} = GND$, $T_A = 25^\circ C$, $V_{CM} = V_{DD}/2$, and $V_{OUT} \sim V_{DD}/2$

PARAMETERS	SYMBOL	MIN.	TYP.	MAX.	UNITS	CONDITIONS
Gain Bandwidth Product	GBWP	—	155	—	kHz	$V_{DD} = 5V$, $C_L = 60\text{ pF}$
Phase Margin at Unity Crossing	θ	—	62	—	degrees	$V_{DD} = 5V$, $C_L = 60\text{ pF}$
Slew Rate	SR	—	0.08	—	V/ μs	$G = 1$, $V_{DD} = 5V$, $C_L = 60\text{ pF}$
Input Voltage Noise	e_n	—	2.8	—	μV_{p-p}	$f = 0.1\text{ Hz}$ to 10 Hz
Noise Density	e_n	—	38	—	$nV/\sqrt{\text{Hz}}$	$f = 1\text{ kHz}$
Input Current Noise Density	i_n	—	3	—	$fA/\sqrt{\text{Hz}}$	$f = 1\text{ kHz}$



SPECIFICATIONS FOR MCP608 CHIP SELECT FEATURE

Unless otherwise specified, all limits are specified for $V_{DD} = +2.5V$ to $+5.5V$, $V_{SS} = GND$, $T_A = 25^\circ C$, $V_{CM} = V_{DD}/2$, and $V_{OUT} \sim V_{DD}/2$

PARAMETERS	SYMBOL	MIN.	TYP.	MAX.	UNITS	CONDITIONS
CS LOW SPECIFICATIONS						
CS Logic Threshold, Low	V_{IL}	V_{SS}	—	$0.2 V_{DD}$	V	For entire V_{DD} range
CS Input Current, Low	I_{CSL}	-0.1	0.01	—	μA	$CS = 0.2V_{DD}$
CS HIGH SPECIFICATIONS						
CS Logic Threshold, High	V_{IH}	$0.8 V_{DD}$	—	V_{DD}	V	For entire V_{DD} range
CS Input Current, High	I_{CSH}	—	0.01	0.1	μA	$CS = V_{DD}$
CS Input High, GND Current	I_Q	—	0.05	2	μA	$CS = V_{DD}$
Amplifier Output Leakage, CS High	—	—	10	—	nA	$CS = 0.8V_{DD}$
DYNAMIC SPECIFICATIONS						
CS Low to Amplifier Output High Turn-on Time	t_{ON}	—	9	100	μs	$CS \text{ low} = 0.2V_{DD}$, $V_{OUT} = 0.9 \cdot V_{DD}/2$, $G = +1V/V$
CS High to Amplifier Output High Z	t_{OFF}	—	0.1	—	μs	$CS \text{ high} = 0.8V_{DD}$, $V_{OUT} = 0.1 \cdot V_{DD}/2$, $G = +1V/V$
Hysteresis	—	—	0.6	—	V	$V_{DD} = 5V$



TEMPERATURE SPECIFICATIONS

Unless otherwise specified, all limits are specified for $V_{DD} = +2.5V$ to $+5.5V$, $V_{SS} = GND$

PARAMETERS	SYMBOL	MIN.	TYP.	MAX.	UNITS	CONDITIONS
TEMPERATURE RANGES						
Specified Temperature Range	T_A	-40	—	+85	°C	
Operating Temperature Range	T_A	-40	—	+85	°C	
Storage Temperature Range	T_A	-65	—	+150	°C	
THERMAL PACKAGE RESISTANCE						
Thermal Resistance, 5L-SOT23	θ_{JA}		—	256	°C/W	
Thermal Resistance, 8L-PDIP	θ_{JA}		—	85	°C/W	
Thermal Resistance, 8L-SOIC	θ_{JA}		—	163	°C/W	
Thermal Resistance, 8L-TSSOP	θ_{JA}		—	124	°C/W	
Thermal Resistance, 14L-PDIP	θ_{JA}		—	70	°C/W	
Thermal Resistance, 14L-SOIC	θ_{JA}		—	120	°C/W	
Thermal Resistance, 14L-TSSOP	θ_{JA}		—	100	°C/W	



Application Note

Size: P60X series op amps are unity-gain stable and suitable for a wide range of general-purpose applications. The small footprints of the P60X series packages save space on printed circuit boards and enable the design of smaller electronic products.

Power Supply Bypassing and Board Layout: P60X series operates from a single 2.1V to 5.5V supply or dual $\pm 1.05\text{V}$ to $\pm 2.75\text{V}$ supplies. For best performance, a $0.1\mu\text{F}$ 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 $0.1\mu\text{F}$ ceramic capacitors.

Low Supply Current: The low supply current (typical 1.1mA per channel) of P60X series will help to maximize battery life. They are ideal for battery powered systems.

Operating Voltage: P60X series operate under wide input supply voltage (2.1V to 5.5V). In addition, all temperature specifications apply from -40°C to $+125^\circ\text{C}$. Most behavior remains unchanged throughout the full operating voltage range. These guarantees ensure operation throughout the single Li-Ion battery lifetime.

Rail-to-Rail Input: The input common-mode range of P60X series extends 100mV beyond the supply rails ($V_{SS}-0.1\text{V}$ to $V_{DD}+0.1\text{V}$). This is achieved by using complementary input stage. For normal operation, inputs should be limited to this range.

Rail-to-Rail Output: Rail-to-Rail output swing provides maximum possible dynamic range at the output. This is particularly important when operating in low supply voltages. The output voltage of P60X series can typically swing to less than 2mV from supply rail in light resistive loads ($>100\text{k}\Omega$), and 15mV of supply rail in moderate resistive loads ($10\text{k}\Omega$).

Capacitive Load Tolerance: The P60X family 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. shows 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.

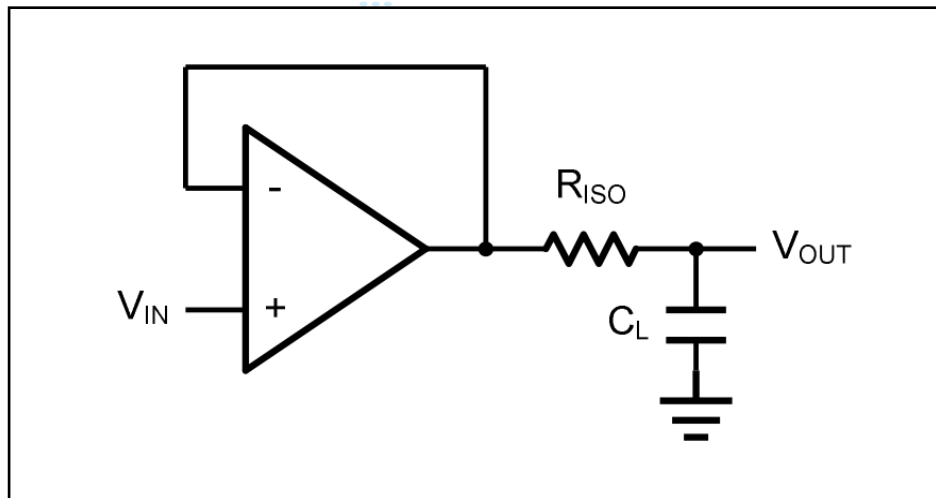


Figure 1. Indirectly Driving a Capacitive Load Using Isolation Resistor

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 3 is an improvement to the one in Figure 2. 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

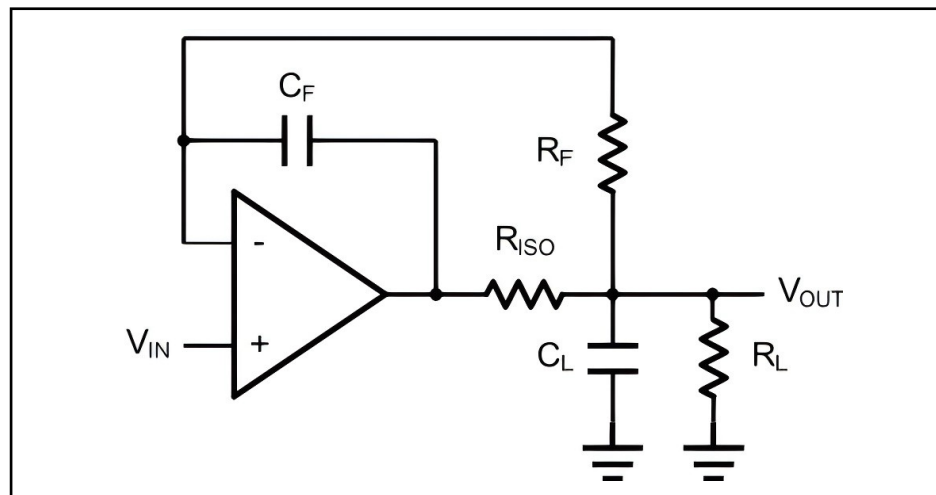


Figure 3. Indirectly Driving a Capacitive Load with DC Accuracy



Order information

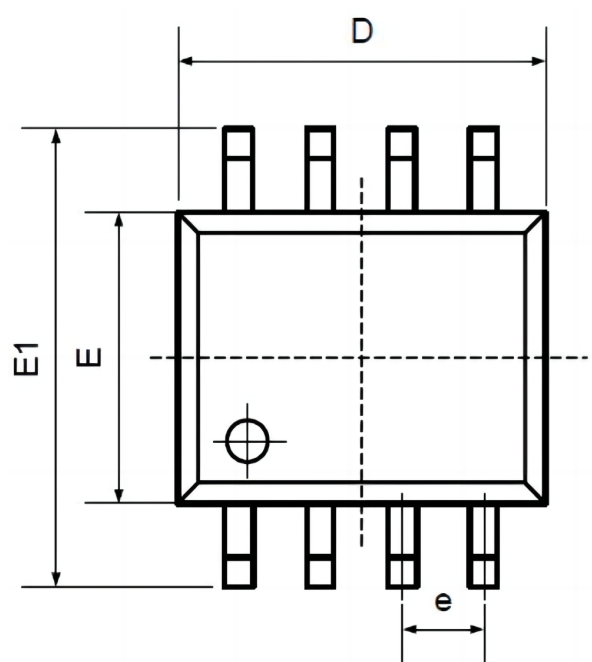
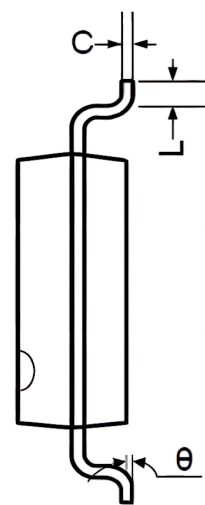
Order Number	Package	Package Quantity	Marking On The park	Temperature
MCP606T-I/OT-TUDI	SOT23-5	Tape,Reel,3000	SBxx	-40°C to +85°C
MCP606T-I/SN-TUDI	SOP8	Tape,Reel,4000	MCP606I/SN	
MCP606T-I/ST-TUDI	TSSOP8	Tape,Reel,4000	606I	
MCP606-I/P-TUDI	DIP8	Tube,50,A box of 2000	MCP606-I/P	
MCP607T-I/SN-TUDI	SOP8	Tape,Reel,4000	MCP607I/SN	
MCP607T-I/ST-TUDI	TSSOP8	Tape,Reel,4000	607I	
MCP607-I/P-TUDI	DIP8	Tube,50,A box of 2000	MCP607-I/P	
MCP608T-I/SN-TUDI	SOP8	Tape,Reel,4000	MCP608I/SN	
MCP608T-I/ST-TUDI	TSSOP8	Tape,Reel,4000	608I	
MCP608-I/P-TUDI	DIP8	Tube,50,A box of 2000	MCP608-I/P	
MCP609T-I/SL-TUDI	SOP14	Tape,Reel,4000	MCP609-I/SL	
MCP609T-I/ST-TUDI	TSSOP14	Tape,Reel,4000	609IST	
MCP609-I/P-TUDI	DIP14	Tube,25,A box of 1000	MCP609-I/P	

Revision history

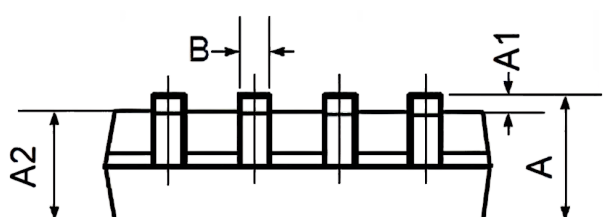
	Date	Revision	Page
V1.0	2021/12	New	1-17
V1.1	2025/3	Update model and PDF template	1-18



Package SOP8

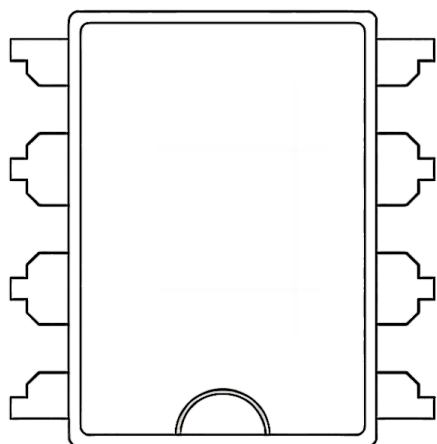
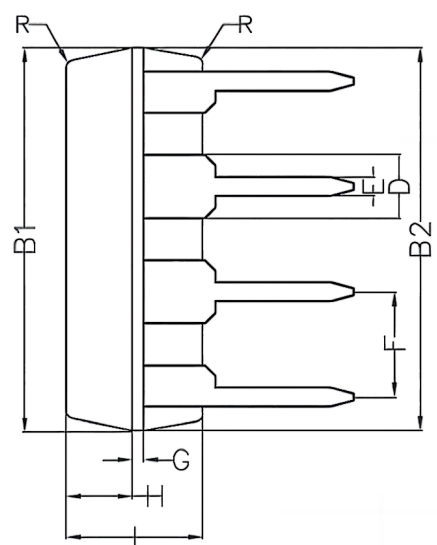
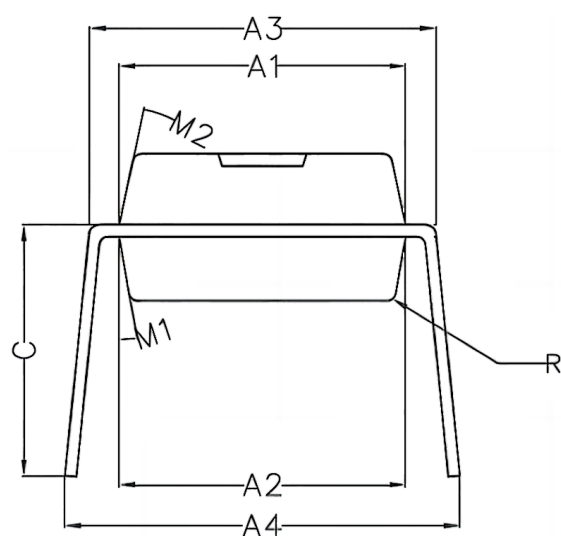


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
B	0.330	0.510	0.013	0.020
C	0.190	0.250	0.007	0.010
D	4.780	5.000	0.188	0.197
E	3.800	4.000	0.150	0.157
E1	5.800	6.300	0.228	0.248
e	1.270TYP		0.050TYP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



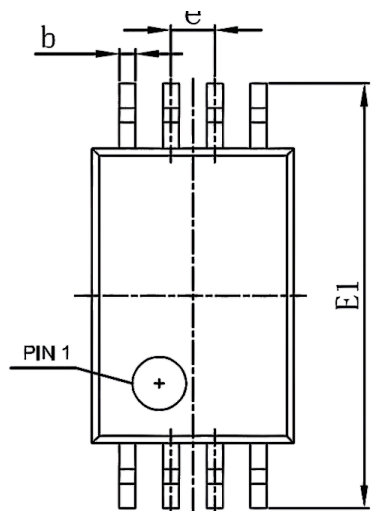
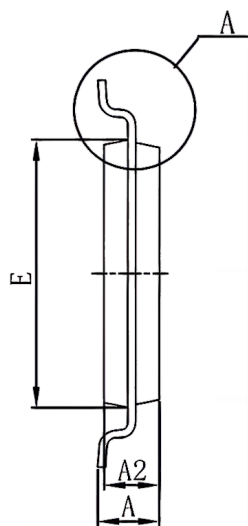
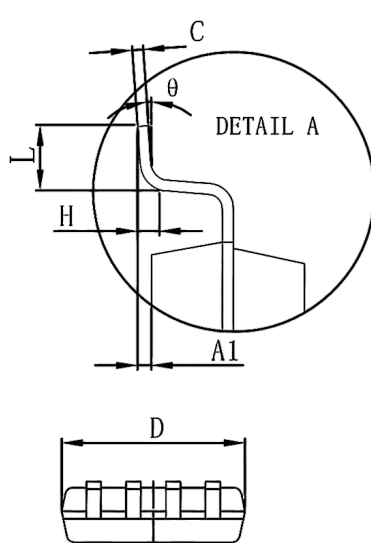


Package DIP8



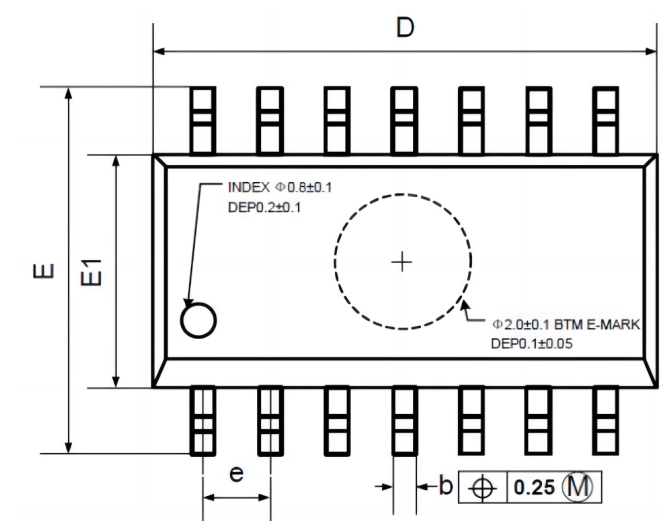
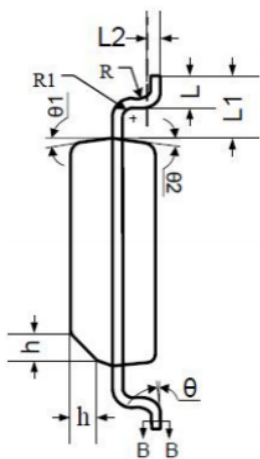
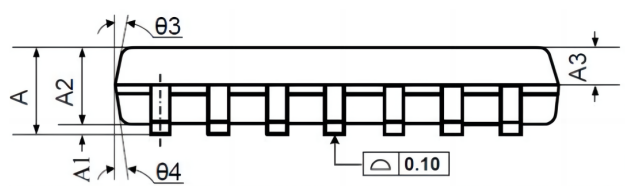
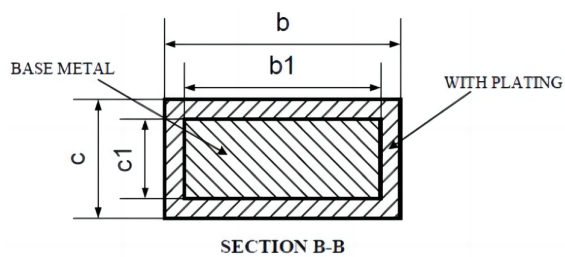
Symbol	Min	Non	Max
A1	6.28	6.33	6.38
A2	6.33	6.38	6.43
A3	7.52	7.62	7.72
A4	7.80	8.40	9.00
B1	9.15	9.20	9.25
B2	9.20	9.25	9.30
C		5.57	
D		1.52	
E	0.43	0.45	0.47
F		2.54	
G		0.25	
H	1.54	1.59	1.64
I	3.22	3.27	3.32
R		0.20	
M1	9°	10°	11°
M2	11°	12°	13°

Package TSSOP8



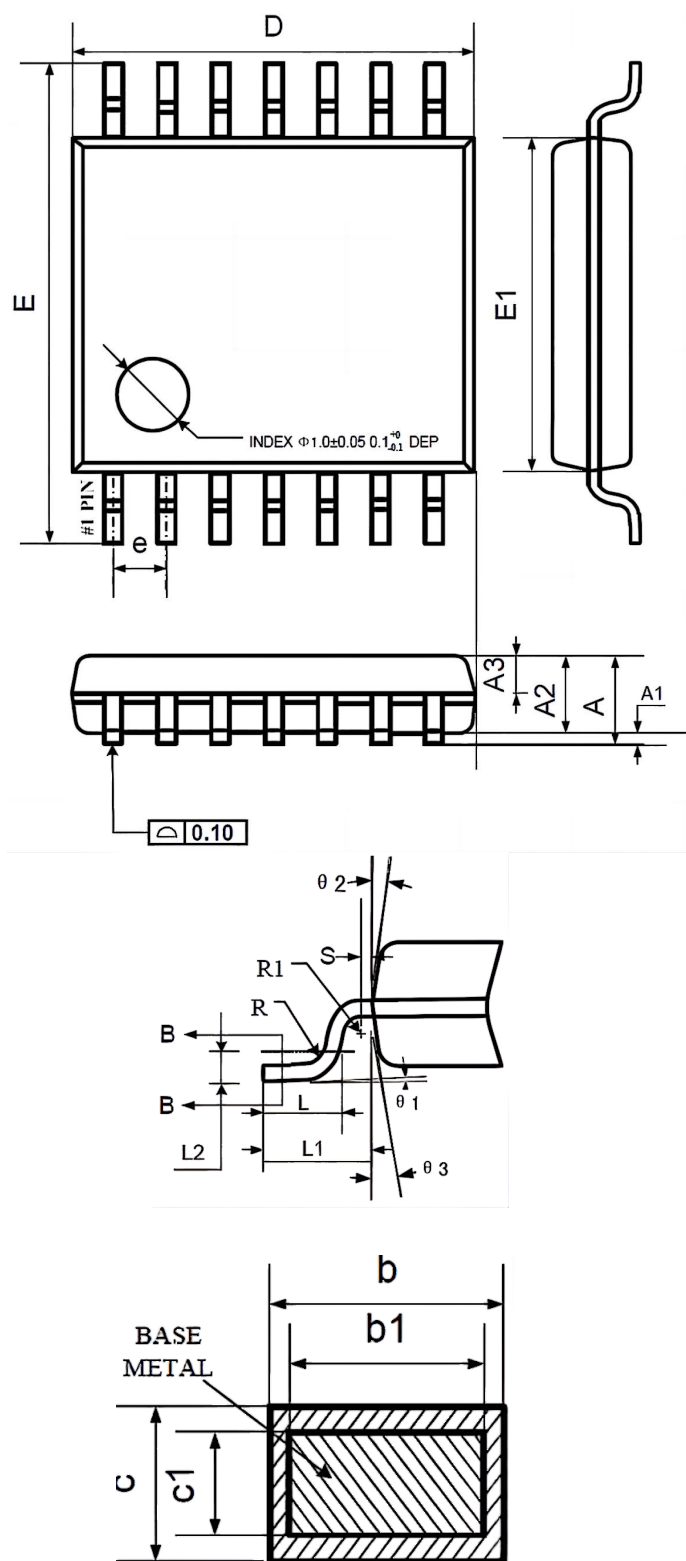
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
D	2.900	3.100	0.114	0.122
E	4.300	4.500	0.169	0.177
b	0.190	0.300	0.007	0.012
C	0.090	0.200	0.004	0.008
E1	6.250	6.550	0.246	0.258
A		1.200		0.047
A2	0.800	1.000	0.031	0.039
A1	0.050	0.150	0.002	0.006
e	0.65(BSC)		0.026(BSC)	
L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

Package SOP14



Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	1.35	1.60	1.75
A1	0.10	0.15	0.25
A2	1.25	1.45	1.65
A3	0.55	0.65	0.75
b	0.36		0.49
b1	0.35	0.40	0.45
C	0.16		0.25
c1	0.15	0.20	0.25
D	8.53	8.63	8.73
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27 BSC		
L	0.45	0.60	0.80
L1	1.04 REF		
L2	0.25 BSC		
R	0.07		
R1	0.07		
h	0.30	0.40	0.50
θ	0°		8°
θ1	6°	8°	10°
θ2	6°	8°	10°
θ3	5°	7°	9°
θ4	5°	7°	9°

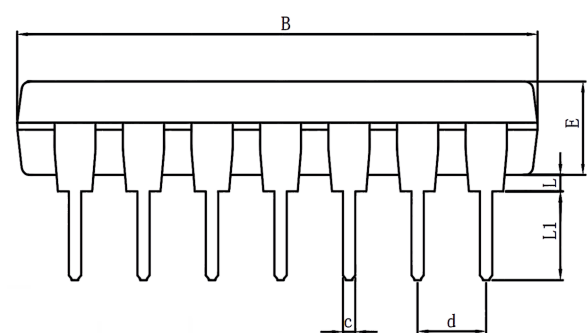
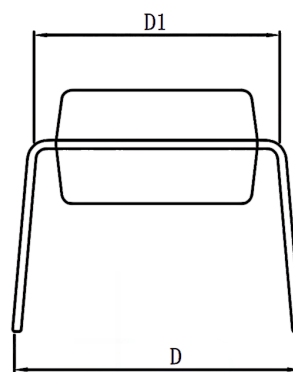
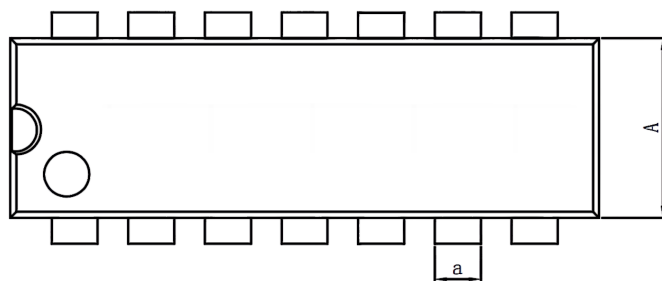
Package TSSOP14



Symbol	Dimensions In Millimeters		
	MIN	NOM	MAX
A	—	—	1.20
A1	0.05	—	0.15
A2	0.90	1.00	1.05
A3	0.34	0.44	0.54
b	0.20	—	0.28
b1	0.20	0.22	0.24
C	0.10	—	0.19
c1	0.10	0.13	0.15
D	4.86	4.96	5.06
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	0.65 BSC		
L	0.45	0.60	0.75
L1	1.00 REF		
L2	0.25 BSC		
R	0.09	—	—
R1	0.09	—	—
S	0.20	—	—
$\theta 1$	0°	—	8°
$\theta 2$	10°	12°	14°
$\theta 3$	10°	12°	14°

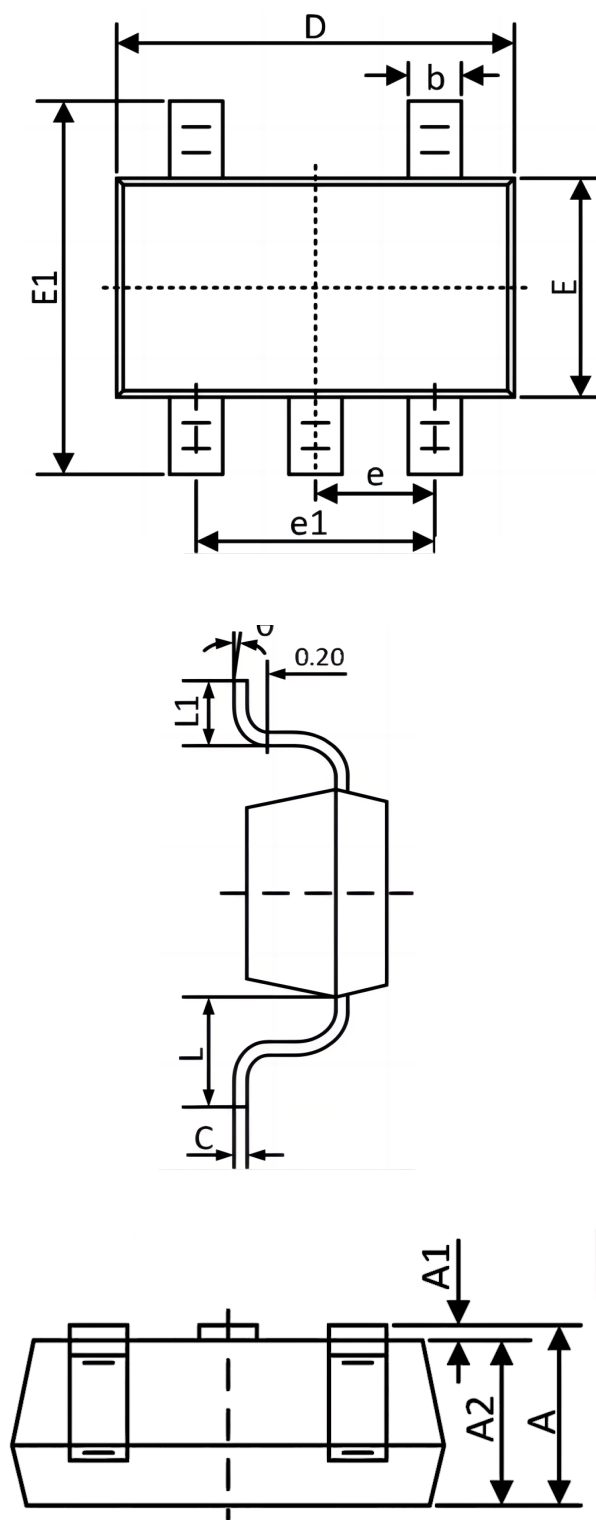


Package DIP14



DIM.	MIN	TYP	MAX	DIM.	MIN	TYP	MAX
A	6.100	6.300	6.680	a	1.504	1.524	1.544
B	18.940	19.200	19.560	C	0.437	0.457	0.477
D	8.200	8.700	9.200	d	2.530	2.540	2.550
D1	7.42	7.62	7.82	L	0.500	—	0.800
E	3.100	3.300	3.550	L1	3.000	3.200	3.600

Package SOT23-5



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.400	0.012	0.016
C	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950TYP		0.037TYP	
e1	1.800	2.000	0.071	0.079
L	0.700REF		0.028REF	
L1	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°



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 quality products.