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4 CHANNELS RAIL-TO-RAIL VCOM/GAMMA BUFFER

FEATURES

- 4.5V to 20V Input Voltage Range
- Rail-to-Rail Output Swing
- Maximum Peak Output Current : 220mA
- Slew Rate : Rising 150V/μS, Falling 100V/μS
- Supply Current Per Channel : 2.0mA
- 30MHz -3dB Bandwidth
- Protections
 - ◆ Over Current Protection (OCP)
 - ◆ Short Circuit Protection (SCP)
 - ◆ Thermal Shutdown (OTP)
- Package Available
 - ◆ TSSOP-14 Package
 - ◆ TSSOP-14 (Power Pad) Package
 - ◆ WQFN16 4x4x0.75 Package

APPLICATIONS

- TFT LCD Panel

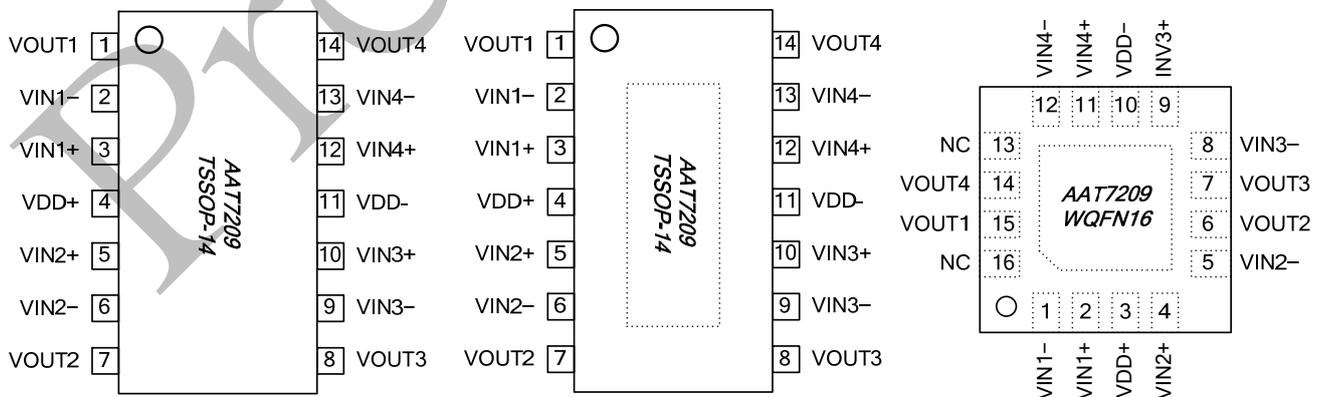
GENERAL DESCRIPTION

The AAT7209 is a device that includes four channel rail-to-rail operational amplifiers, designed for use as a buffer in thin film transistor liquid crystal display (TFT LCD). This device has an input voltage range from 4.5V to 20V, exhibits supply current of 2.0mA per channel, has rail to rail output swing capability, the ultra high slew rate of typically 100V/us, and a maximum output current capability of 220mA. A 30MHz open loop -3dB bandwidth allows for fast transient response and fast settling time.

The AAT7209 includes various protection features such as over current protection (OCP), short circuit protection (SCP) and Thermal Shutdown (OTP).

The AAT7209 is available in a TSSOP-14 pin package and a small 4x4x0.75mm, ultra-thin, 16 pin WQFN package. All packages have with a bottom side exposed thermal pad to provide optimal heat dissipation. The packages offered for the AAT7209 make it an ideal component for use in space-sensitive designs of LCD panel. The device is rated to operate from -40°C to +85°C ambient temperature range.

PIN CONFIGURATION



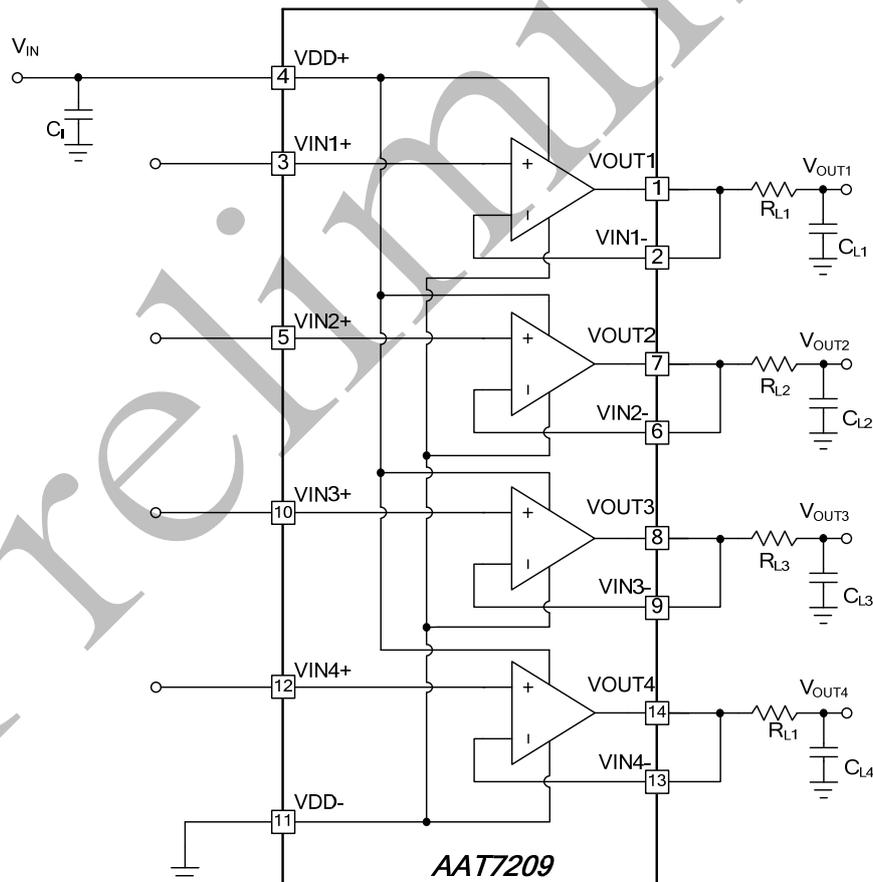


ORDERING INFORMATION

DEVICE TYPE	PART NUMBER	PACKAGE	PACKING	TEMPRANGE	MARKING	MARKING DESCRIPTION
AAT7209	AAT7209-T 5-T	T5:TSSOP14	T: Tape and Reel	-40 °C to +85 °C	AAT7209 XXXXXX	Device Type Lot no. (6~9 Digits)
AAT7209	AAT7209-T 12-T	T12:TSSOP14 (Power Pad)	T: Tape and Reel	-40 °C to +85 °C	AAT7209 XXXXXX	Device Type Lot no. (6~9 Digits)
AAT7209	AAT7209-Q 24-T	Q24 : WQFN16-4X4	T: Tape and Reel	-40 °C to +85 °C	AAT7209 XXXXX XXXX	Device Type Lot no. (6~9 Digits) Date Code (4 Digits)

Note: All AAT products are lead free and halogen free.

TYPICAL APPLICATION





ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	VALUE	UNIT
VDD+ to GND	V_{IN}	-0.3 to +22	V
Input Voltage (VIN1+, VIN1-, VIN2+, VIN2-, VIN3+, VIN3-, VIN4+, VIN4-)	V_{INX}	-0.3 to ($V_{IN} + 0.3$)	V
Output Voltage (VOUT1, VOUT2, VOUT3, VOUT4)	V_{OUT}	-0.3 to ($V_{IN} + 0.3$)	V
Maximum Continuous Output Current	I_{COON}	250	mA
Operating Ambient Temperature Range	T_C	-40 to +85	°C
Operating Junction Temperature Range	T_J	-40 to +150	°C
Storage Temperature Range	$T_{STORAGE}$	-65 to +150	°C
Package Thermal Resistance – TSSOP14 PP	θ_{JA}	40	°C/W
Power Dissipation, @ $T_C = +25^\circ\text{C}$, $T_J = +125^\circ\text{C}$	P_d	1.5	W
Package Thermal Resistance – TSSOP14	θ_{JA}	97	°C/W
Power Dissipation, @ $T_C = +25^\circ\text{C}$, $T_J = +125^\circ\text{C}$	P_d	1.0	W
Package Thermal Resistance – WQFN16	θ_{JA}	36	°C/W
Power Dissipation, @ $T_C = +25^\circ\text{C}$, $T_J = +125^\circ\text{C}$	P_d	2.778	W
ESD Susceptibility Human Body Mode		2K	V
ESD Susceptibility Machine Mode		200	V

Note: Stresses above those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the devices. Exposure to ABSOLUTE MAXIMUM RATINGS conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	MIN	MAX	UNIT
Operating Ambient Temperature	T_C	-40	+85	°C
Power Supply Voltage (VIN)	V_{IN}	4.5	20.0	V



ELECTRICAL CHARACTERISTICS

(VDD+ = 18V, VDD- = 0V, $V_{INX} = V_{OUTX} = (VDD+)/2$, $R_L = 0\Omega$ and $C_L = 10\text{pF}$, Typical values are tested at +25 °C ambient temperature)

Input Characteristics

PARAMETER	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Supply Voltage Range	V_{IN}		4.5	-	20.0	V
Supply Current (Per Amplifier)	I_{QS}	No Load	-	2.0	-	mA
Input Offset Voltage	V_{OS}	$V_{INX} = 10V$	-	± 2	15	mV
Input Bias Current	I_B	$V_{INX} = 10V$	-40	-	+40	nA
Output Swing Low	V_{OL}	$V_{INX+} = 0V$, $I_L = -5\text{mA}$	-	100	150	mV
Output Swing High	V_{OH}	$V_{INX+} = 18V$, $I_L = +5\text{mA}$	17.85	17.90	-	V
Continue Output Current	I_O		± 40	± 50	-	mA
Transient Peak Output Current	I_{O_PEAK}		± 180	± 220	-	mA
Rising Slew Rate	SR	$+0.5V < V_{OUT} < 17.5V$; 20% to 80%	100	150	-	V/ μ S
Falling Slew Rate	SR	$+0.5V < V_{OUT} < 17.5V$; 20% to 80%	80	100	-	V/ μ S
Setting Time	t_s		-	150	200	nS
Bandwidth	BW	-3dB	20	30	-	MHz
Gain-Bandwidth Product	B_{GWP}	No Load	16	24	-	MHz
Voltage Gain	A_V	$R_L = 10\text{k}\Omega$, $C_L = 50\text{pF}$	0.99	-	1.01	V/V
Open-Loop Gain	A_{VOL}		60	70	-	dB
Input Impedance	R_{IN}		-	1	-	G Ω
Input Capacitance	C_{IN}		-	1.5	-	pF
Power Supply Rejection Ratio	PSRR	$+6V < V_{S+} < +18V$	54	80	-	dB
Common-Mode Input Range	CMIR		-0.5	-	+17.5	V
Common-Mode Rejection Ratio	CMRR		50	70	-	dB
Thermal Shutdown	T_{SD}		-	150	-	$^{\circ}\text{C}$

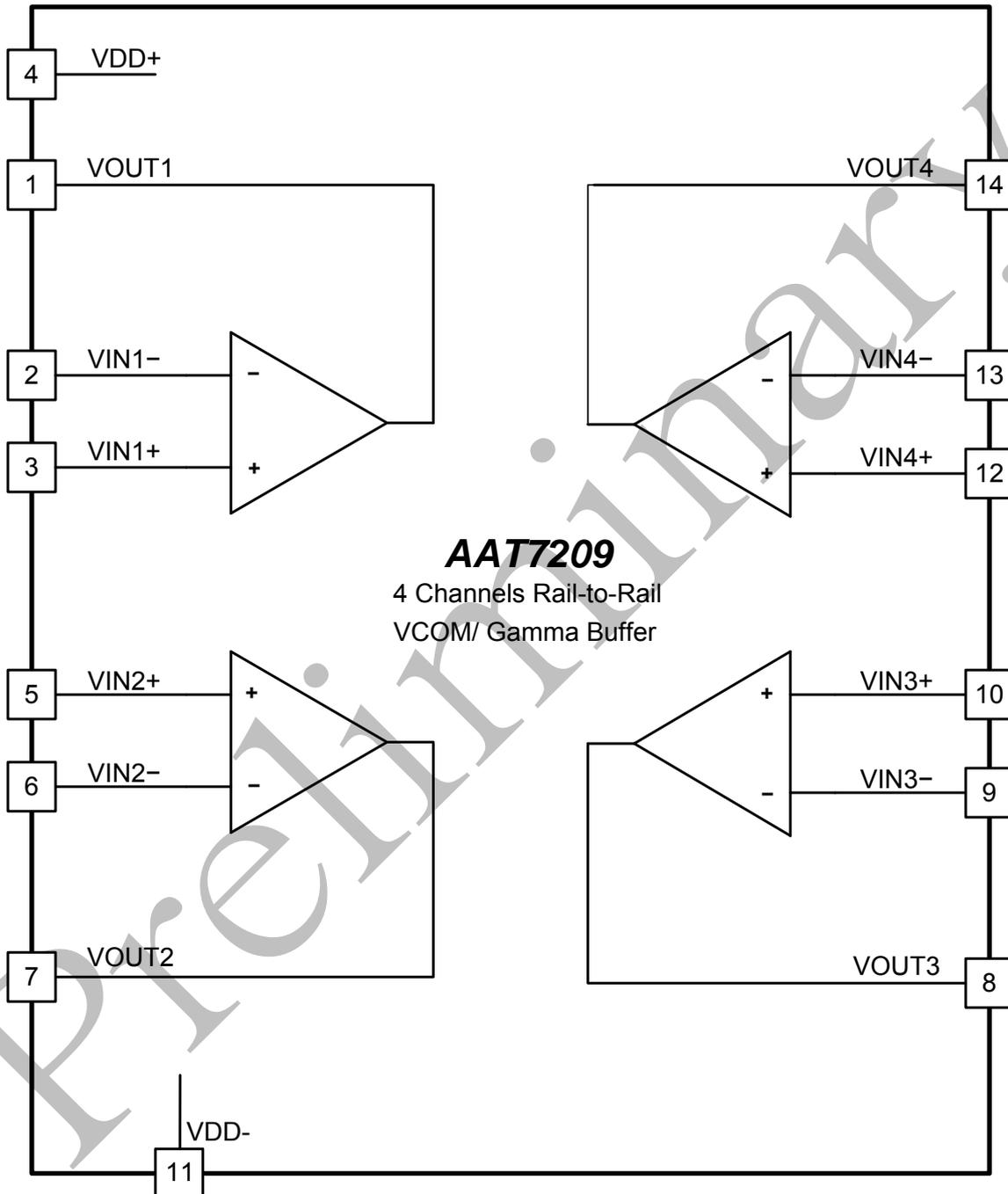


PIN DESCRIPTION

PIN	NAME	I/O	FUNCTION
1	VOUT1	I	Output of the Amplifier-1
2	VIN1-	I	Inverted input pin of the Amplifier-1
3	VIN1+	I	Non-inverted input pin of the Amplifier-1
4	VDD+	I	Positive Power Supply
5	VIN2+	O	Non-inverted input pin of the Amplifier-2
6	VIN2-	I	Inverted input pin of the Amplifier-2
7	VOUT2	I	Output of the Amplifier-2
8	VOUT3	O	Output of the Amplifier-3
9	VIN3-	I	Inverted input pin of the Amplifier-3
10	VIN3+	O	Non-inverted input pin of the Amplifier-3
11	VDD-	O	Negative Power Supply
12	VIN4+	I	Non-inverted input pin of the Amplifier-4
13	VIN4-	I	Inverted input pin of the Amplifier-4
14	VOUT4	I	Output of the Amplifier-4

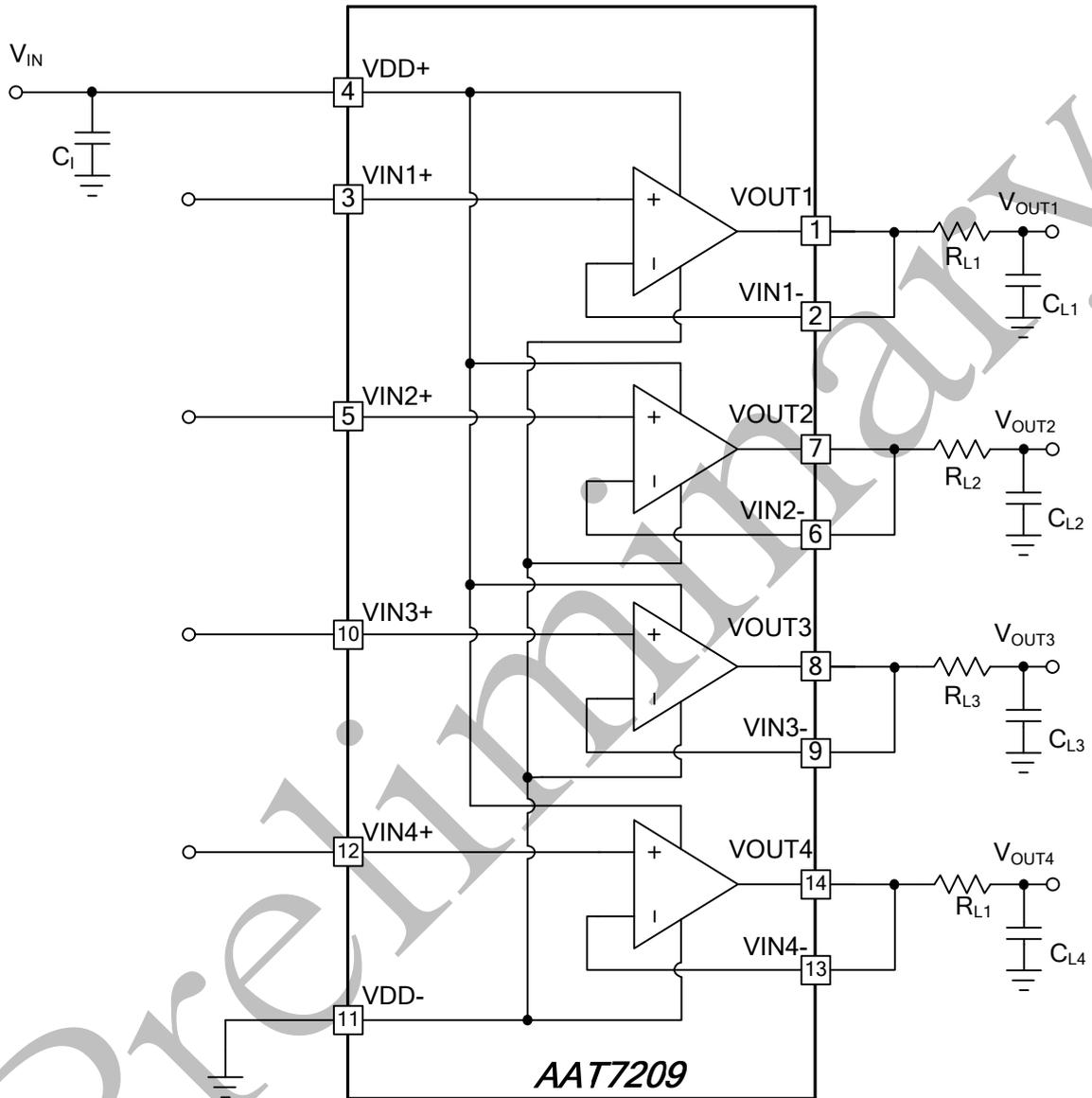


FUNCTION BLOCK DIAGRAM





TYPICAL APPLICATION CIRCUIT





APPLICATION NOTE

The operational amplifier drives the LCD backplane (VCOM) or the gamma-correction divider string. The Op Amp is capable of rail-to-rail input and output, $\pm 220\text{mA}$ maximum peak output current, and a $100\text{V}/\mu\text{s}$ high slew rate. In typical application, the inverting input is shorted to the output for a unity-gain (voltage follower) configuration.

In the unity-gain configuration, the capacitive load adds a pole to the loop gain that impacts the stability of the system and leads to output peaking, ringing and oscillation. A higher pole frequency results in greater stability. In fact, if the pole frequency is lower than or close to the unity gain frequency, the pole can have a significant negative impact on phase and gain margins. Therefore, the stability decreases when the capacitive load increases. One method of improving capacitive load drive is to insert a 2Ω to 20Ω resistor (R_{LX}) in series with the output, as shown in Figure 1.

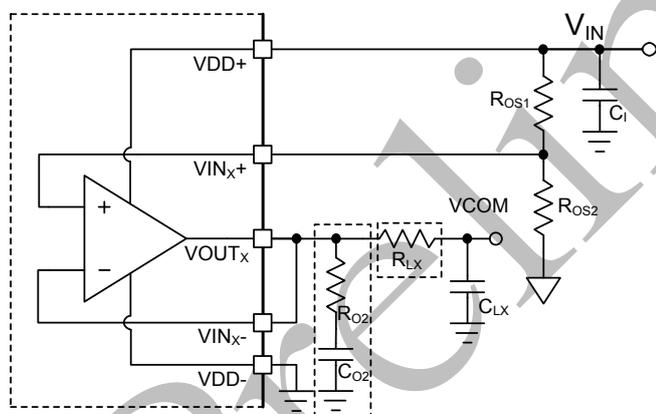


Figure 1. Operational Amplifier Functional Block Diagram

This reduces ringing with large capacitive loads while maintaining DC accuracy. However, for typical applications, the AAT7209 should be able to handle the capacitive load with sufficient phase margin. Thus, adding the resistor R_{LX} is usually not critical.

Another method for improving transient response is to add a snubber circuit at the output. A snubber circuit consists of a resistor (R_{O2}) in series with a capacitor (C_{O2}), which improves output settling time and reduces peaking. The advantage of this topology is that it draws no DC current nor does it reduce the gain.

Unused Buffer

For channels that are not used, it is recommended to connect the unused channels in unity gain, with the non-inverting input connected directly to ground.

Bypass Capacitors

For stability while driving load transients, and to minimize the noise to the system, use a $\text{TBD}\mu\text{F}$ capacitor for the VDD+ supply. Connect this bypass capacitor as close as possible to the input VDD+.

Protection

When one of the three protection mechanism (OCP, SCP, OTP) is triggered, shutdown mode for all 4 channels will be latched. For the device to resume operation when nominal conditions have returned, the power VDD+ must be recycled to restart.

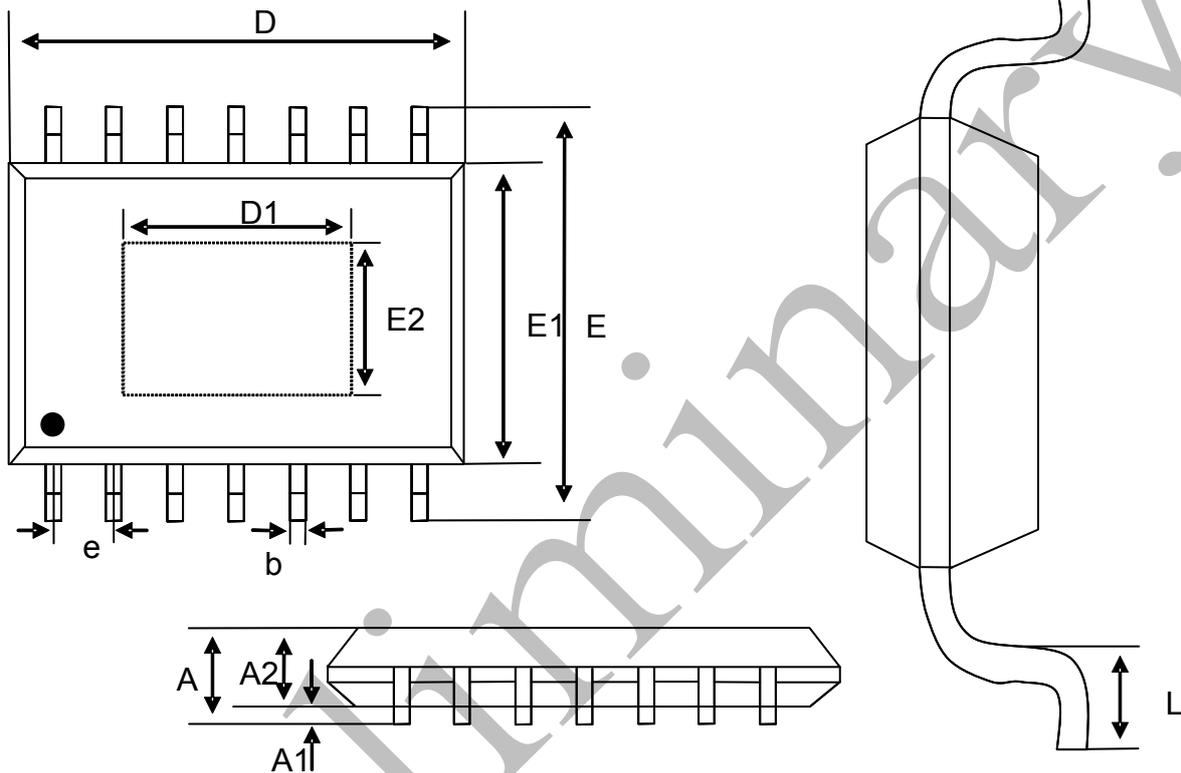
Layout

Connect the exposed pad of the device to the VDD-plane for best thermal dissipation performance, or low thermal resistance. In typical application, VDD- is connected to ground.



PACKAGE DIMENSION

TSSOP14 (Power Pad)

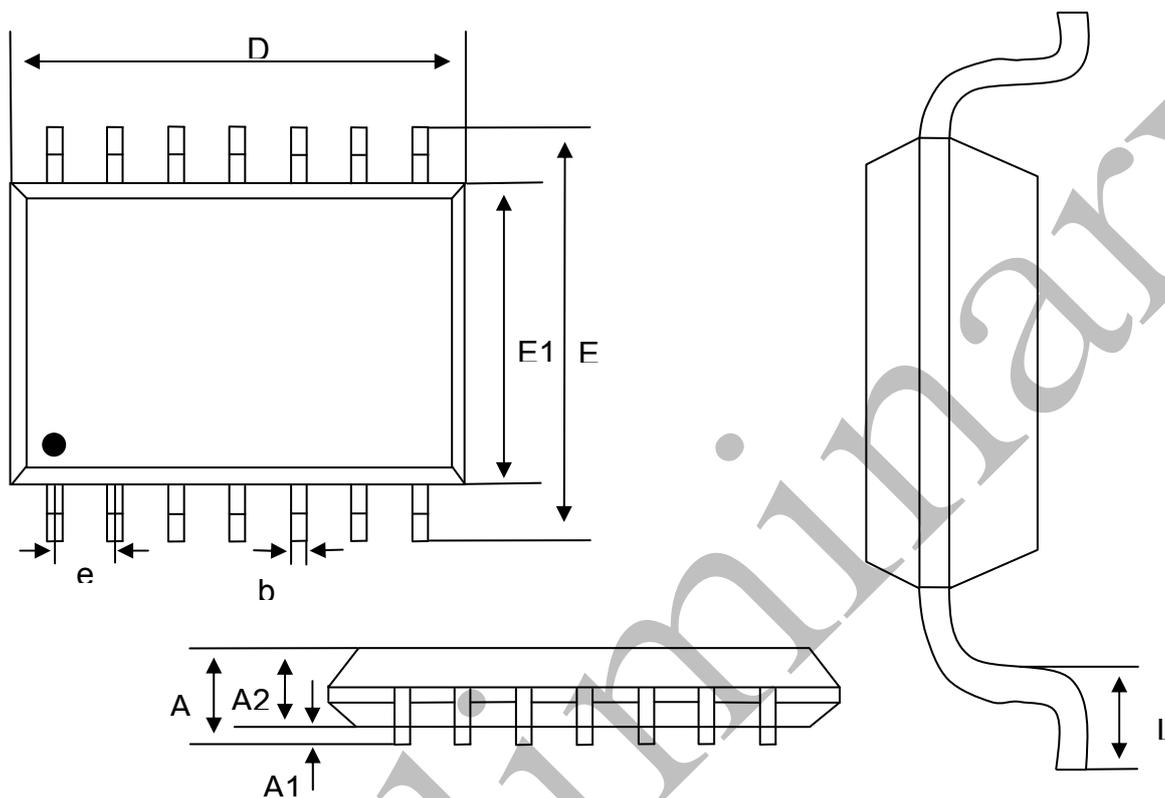


Symbol	Dimensions In Millimeters		
	MIN	TYP	MAX
A	1.00	----	1.20
A1	0.05	----	0.15
A2	0.80	1.00	1.05
b	0.19	----	0.30
D	4.90	5.00	5.10
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	----	0.65	----
L	0.50	0.60	0.75
D1	2.64	----	3.10
E2	2.55	----	3.00



PACKAGE DIMENSION

TSSOP14

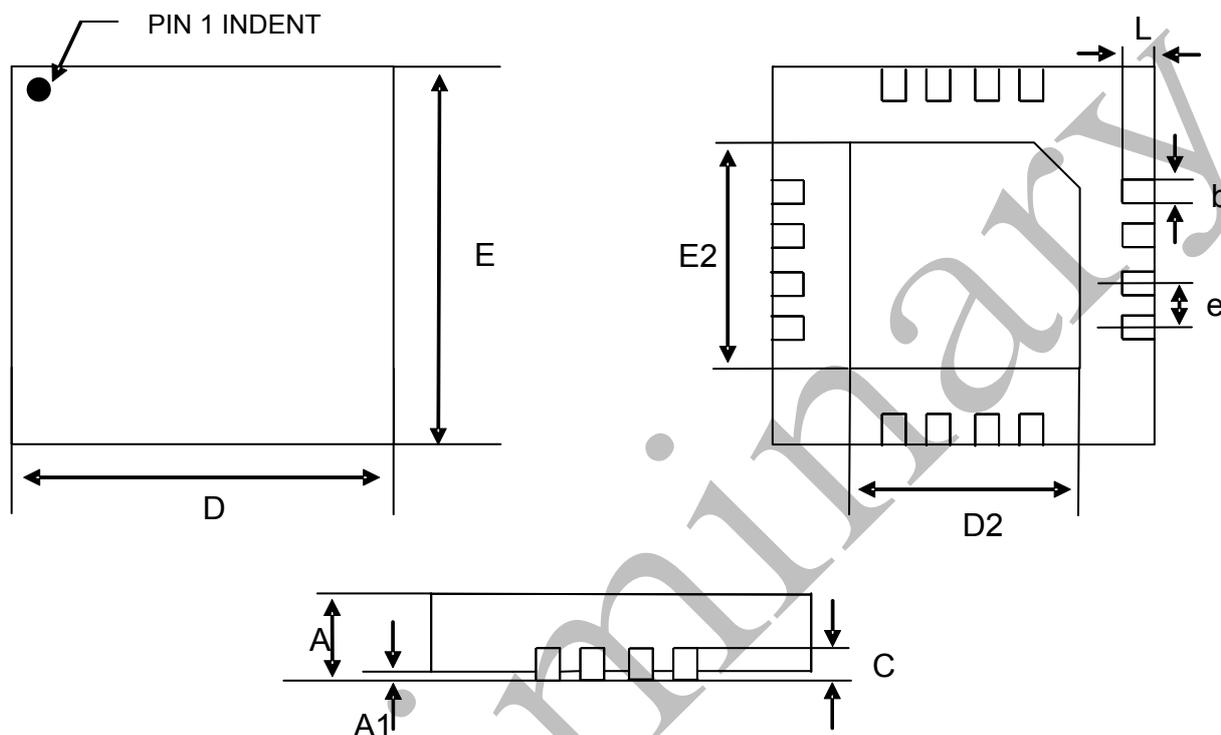


Symbol	Dimensions In Millimeters		
	MIN	TYP	MAX
A	1.00	-----	1.20
A1	0.05	-----	0.15
A2	0.80	1.00	1.05
b	0.19	-----	0.30
D	4.90	5.00	5.10
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	-----	0.65	-----
L	0.45	0.60	0.75



PACKAGE DIMENSION

WQFN16-4X4



Symbol	Dimensions In Millimeters		
	MIN	TYP	MAX
A	0.70	0.75	0.80
A1	0	0.02	0.05
b	0.25	0.30	0.35
C	-----	0.20	-----
D	3.90	4.00	4.10
D2	2.60	2.65	2.70
E	3.90	4.00	4.10
E2	2.60	2.65	2.70
e	-----	0.65	-----
L	0.35	0.40	0.45