

## General Description

The LTA8281, LTA8282 and LTA8284 (LTA828x) are a family of low power, 48 V wide supply voltage, low noise, rail-to-rail output operational amplifiers capable of operating on supplies ranging from +4.5 V ( $\pm 2.25$  V) to +48 V ( $\pm 24$  V). This new generation of high-voltage CMOS operational amplifiers, in conjunction with the LTA829x, LTA827x and LTA826x, provide a family of bandwidth, noise, and power options to meet the needs of a wide variety of applications. The LTA828x devices offer outstanding dc precision and ac performance, including low offset ( $\pm 0.5$  mV typically), low offset drift ( $\pm 2$   $\mu$ V/ $^{\circ}$ C typically), 10 MHz bandwidth, and 8 nV/ $\sqrt{\text{Hz}}$  input voltage noise density at 10 kHz. Unique features such as differential input-voltage range to the negative supply rail, high output current ( $\pm 45$  mA), high capacitive load drive of up to 1 nF, and high slew rate (9 V/ $\mu$ s) make the LTA828x high-performance operational amplifiers for high-voltage industrial applications.

The robust design of the LTA828x family provides ease-of-use to the circuit designer: integrated RF/EMI rejection filter, no phase reversal in overdrive conditions, and high electro-static discharge (ESD) protection. The LTA828x are optimized for operation at voltages from +4.5 V ( $\pm 2.25$  V) to +48 V ( $\pm 24$  V) over the extended temperature range of  $-40$   $^{\circ}$ C to  $+125$   $^{\circ}$ C.

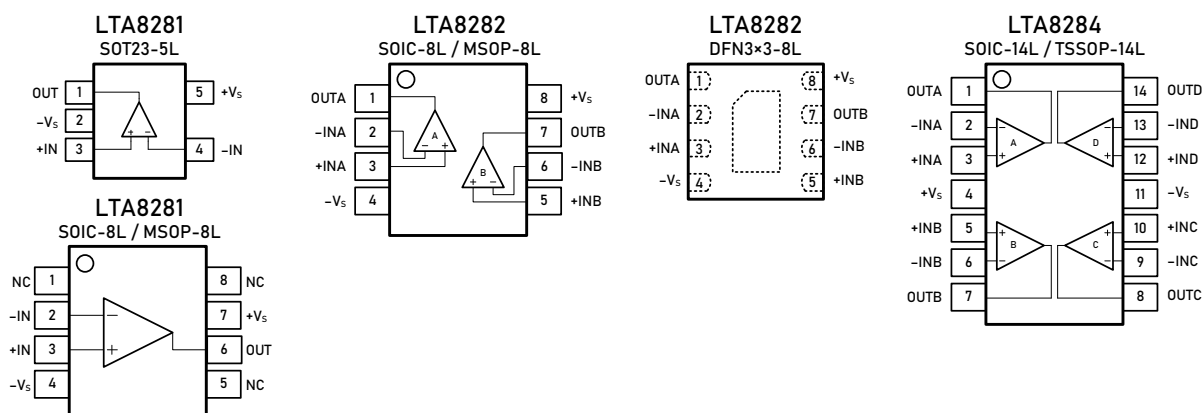
## Features and Benefits

- Wide Supply:  $\pm 2.25$  V to  $\pm 24$  V, 4.5 V to 48 V
- Low Offset Voltage:  $\pm 0.5$  mV Typically
- Low Offset Voltage Drift:  $\pm 2$   $\mu$ V/ $^{\circ}$ C
- High Common-Mode Rejection: 112 dB
- Gain Bandwidth: 10 MHz
- Slew Rate: 9 V/ $\mu$ s
- Low Noise: 8 nV/ $\sqrt{\text{Hz}}$  at 10 kHz
- Low Bias Current:  $\pm 10$  pA
- Rail-to-Rail Output

## Applications

- Tracking Amplifier in Power Modules
- Merchant Power Supplies
- High-Side and Low-Side Current Sensing
- High Precision Comparator
- Battery-Powered Instruments
- Test and Measurement Equipment
- Multiplexed Data-Acquisition Systems
- Programmable Logic Controllers

## Pin Configuration (Top View)



## Pin Description

| Symbol          | Description  |
|-----------------|--|
| -IN             | Inverting input of the amplifier. The voltage range is from $V_{S-}$ to $V_{S+} - 1.5$ V.  |
| +IN             | Non-inverting input of the amplifier. This pin has the same voltage range as -IN.  |
| +V <sub>S</sub> | Positive power supply. The voltage is from 4.5 V to 48 V. Split supplies are possible as long as the voltage between $V_{S+}$ and $V_{S-}$ is from 4.5 V to 48 V.                    |
| -V <sub>S</sub> | Negative power supply. It is normally tied to ground. It can also be tied to a voltage other than ground as long as the voltage between $V_{S+}$ and $V_{S-}$ is from 4.5 V to 48 V. |
| OUT             | Amplifier output.  |
| NC              | No connection  |

## Ordering Information <sup>(1)</sup>

| Type Number    | Package Name | Package Quantity     | Eco Class <sup>(2)</sup> | Marking Code <sup>(3)</sup> |
|----------------|--------------|----------------------|--------------------------|-----------------------------|
| LTA8281XT5/R6  | SOT23-5L     | Tape and Reel, 3 000 | Green (RoHS & no Sb/Br)  | H81                         |
| LTA8281XS8/R8  | SOIC-8L      | Tape and Reel, 4 000 | Green (RoHS & no Sb/Br)  | HV-81                       |
| LTA8281XV8/R6  | MSOP-8L      | Tape and Reel, 3 000 | Green (RoHS & no Sb/Br)  | HV81                        |
| LTA8282XS8/R8  | SOIC-8L      | Tape and Reel, 4 000 | Green (RoHS & no Sb/Br)  | HV-82                       |
| LTA8282XV8/R6  | MSOP-8L      | Tape and Reel, 3 000 | Green (RoHS & no Sb/Br)  | HV82                        |
| LTA8282XF8/R10 | DFN3x3-8L    | Tape and Reel, 3 000 | Green (RoHS & no Sb/Br)  | HV82                        |
| LTA8284XS14/R5 | SOIC-14L     | Tape and Reel, 2 500 | Green (RoHS & no Sb/Br)  | HV-84                       |
| LTA8284XT14/R6 | TSSOP-14L    | Tape and Reel, 3 000 | Green (RoHS & no Sb/Br)  | HV-84                       |

(1) Please contact to your Linearin representative for the latest availability information and product content details.

(2) Eco Class - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & Halogen Free).

(3) There may be multiple device markings, a varied marking character of "x", or additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

## Limiting Value – In accordance with the Absolute Maximum Rating System (IEC 60134).

| Parameter                                 | Absolute Maximum Rating                       |
|---|---|
| Supply Voltage, $V_{S+}$ to $V_{S-}$      | 60 V  |
| Signal Input Terminals: Voltage, Current  | $-V_S - 0.3$ V to $+V_S + 0.3$ V, $\pm 10$ mA |
| Output Short-Circuit                      | Continuous                                    |
| Storage Temperature Range, $T_{stg}$      | $-65$ to $+150$ °C                            |
| Junction Temperature, $T_J$               | 150 °C  |
| Lead Temperature Range (Soldering 10 sec) | 260 °C  |

## ESD Rating

| Parameter                       | Item  | Value | Unit |
|---------------------------------|---|-------|------|
| Electrostatic Discharge Voltage | Human body model (HBM), per MIL-STD-883J / Method 3015.9 <sup>(1)</sup> | 2 000 | V    |
|                                 | Charged device model (CDM), per ESDA/JEDEC JS-002-2014 <sup>(2)</sup>   | 2 000 |      |

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 500-V HBM is possible if necessary precautions are taken.

(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process. Manufacturing with less than 250-V CDM is possible if necessary precautions are taken.

## Electrical Characteristics

$V_S = 4.5 \text{ V to } 48 \text{ V}$ ,  $T_A = +25 \text{ }^\circ\text{C}$ ,  $V_{CM} = V_{OUT} = V_S/2$ , and  $R_L = 10 \text{ k}\Omega$  connected to  $V_S/2$ , unless otherwise noted. Boldface limits apply over the specified temperature range,  $T_A = -40 \text{ }^\circ\text{C to } +125 \text{ }^\circ\text{C}$ .

| Parameter                         | Symbol             | Conditions   | Min.            | Typ.   | Max.                 | Unit              |
|-----------------------------------|--------------------|--|-----------------|--------|----------------------|-------------------|
| OFFSET VOLTAGE                    |                    |  |                 |        |                      |                   |
| Input offset voltage              | V <sub>OS</sub>    |  |                 | ±0.5   | ±1.8                 | mV                |
| Offset voltage drift              | V <sub>OS</sub> TC | T <sub>A</sub> = -40 to +125 °C                                |                 | ±2     |                      | μV/°C             |
| Power supply rejection ratio      | PSRR               | V <sub>S</sub> = 4.5 to 48 V, V <sub>CM</sub> = 0.1 V          |                 | 5      |                      | μV/V              |
|                                   |                    | T <sub>A</sub> = -40 to +125 °C                                |                 | 10     |                      |                   |
| INPUT BIAS CURRENT                |                    |  |                 |        |                      |                   |
| Input bias current                | I <sub>B</sub>     |  |                 | 10     |                      | pA                |
|                                   |                    | T <sub>A</sub> = -40 to +85 °C                                 |                 | 150    |                      |                   |
|                                   |                    | T <sub>A</sub> = -40 to +125 °C                                |                 | 600    |                      |                   |
| Input offset current              | I <sub>OS</sub>    |  |                 | 5      |                      | pA                |
| NOISE                             |                    |  |                 |        |                      |                   |
| Input voltage noise               | V <sub>n</sub>     | f = 0.1 to 10 Hz   |                 | 4      |                      | μV <sub>P-P</sub> |
| Input voltage noise density       | e <sub>n</sub>     | f = 1 kHz  |                 | 10     |                      | nV/√Hz            |
|                                   |                    | f = 10 kHz   |                 | 8      |                      |                   |
| Input current noise density       | I <sub>n</sub>     | f = 1 kHz  |                 | 5      |                      | fA/√Hz            |
| INPUT VOLTAGE                     |                    |  |                 |        |                      |                   |
| Common-mode voltage range         | V <sub>CM</sub>    |  | -V <sub>S</sub> |        | +V <sub>S</sub> -1.5 | V                 |
| Common-mode rejection ratio       | CMRR               | V <sub>S</sub> = 40 V, V <sub>CM</sub> = 0 to 38 V             |                 | 112    |                      | dB                |
|                                   |                    | V <sub>CM</sub> = 0.1 to 38 V, T <sub>A</sub> = -40 to +125 °C |                 | 100    |                      |                   |
|                                   |                    | V <sub>S</sub> = 5 V, V <sub>CM</sub> = 0 to 3.5 V             |                 | 93     |                      |                   |
|                                   |                    | V <sub>CM</sub> = 0.1 to 3 V, T <sub>A</sub> = -40 to +125 °C  |                 | 82     |                      |                   |
| INPUT IMPEDANCE                   |                    |  |                 |        |                      |                   |
| Input capacitance                 | C <sub>IN</sub>    | Differential   |                 | 2.0    |                      | pF                |
|                                   |                    | Common mode  |                 | 3.5    |                      |                   |
| OPEN-LOOP GAIN                    |                    |  |                 |        |                      |                   |
| Open-loop voltage gain            | A <sub>VOL</sub>   | V <sub>S</sub> = 40 V, V <sub>O</sub> = 0.1 to 39.9 V          |                 | 126    |                      | dB                |
|                                   |                    | T <sub>A</sub> = -40 to +125 °C                                |                 | 118    |                      |                   |
|                                   |                    | V <sub>S</sub> = 5 V, V <sub>O</sub> = 0.1 to 4.9 V            |                 | 116    |                      |                   |
|                                   |                    | T <sub>A</sub> = -40 to +125 °C                                |                 | 108    |                      |                   |
| FREQUENCY RESPONSE                |                    |  |                 |        |                      |                   |
| Gain bandwidth product            | GBW                |  |                 | 10     |                      | MHz               |
| Slew rate                         | SR                 | V <sub>S</sub> = 40 V, G = +1, 10 V step                       |                 | 9      |                      | V/μs              |
| Total harmonic distortion + noise | THD+N              | G = +1, f = 1 kHz, V <sub>O</sub> = 3 V <sub>RMS</sub>         |                 | 0.0002 |                      | %                 |
| Settling time                     | t <sub>S</sub>     | To 0.1%, V <sub>S</sub> = 40 V, G = +1, 5 V step               |                 | 1.6    |                      | μs                |
|                                   |                    | To 0.01%, V <sub>S</sub> = 40 V, G = +1, 5 V step              |                 | 3.5    |                      |                   |
| Overload recovery time            | t <sub>OR</sub>    | V <sub>IN</sub> × Gain > V <sub>S</sub>                        |                 | 0.6    |                      | μs                |

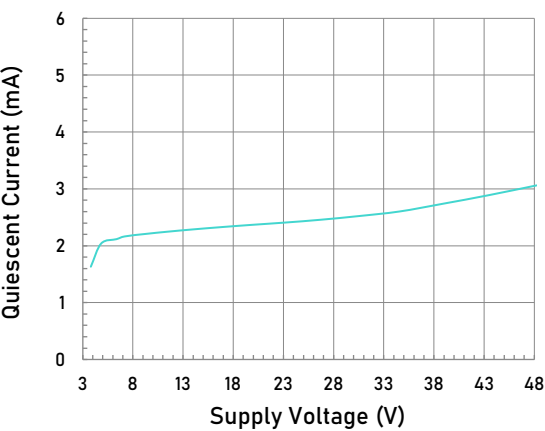
Electrical Characteristics (continued)

$V_S = 4\text{ V to }48\text{ V}$ ,  $T_A = +25\text{ }^\circ\text{C}$ ,  $V_{CM} = V_{OUT} = V_S/2$ , and  $R_L = 10\text{ k}\Omega$  connected to  $V_S/2$ , unless otherwise noted.  
Boldface limits apply over the specified temperature range,  $T_A = -40\text{ }^\circ\text{C to }+125\text{ }^\circ\text{C}$ .

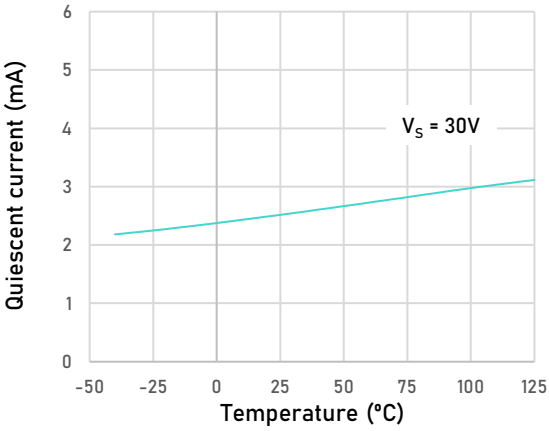
| Parameter                         | Symbol          | Conditions                                     | Min. | Typ.                 | Max. | Unit |
|-----------------------------------|-----------------|--|------|----------------------|------|------|
| <i>OUTPUT</i>                     |                 |  |      |                      |      |      |
| High output voltage swing         | V <sub>OH</sub> | V <sub>S</sub> = ±20 V, R <sub>L</sub> = 10 kΩ |      | +V <sub>S</sub> -95  |      | mV   |
|                                   |                 | V <sub>S</sub> = ±20 V, R <sub>L</sub> = 2 kΩ  |      | +V <sub>S</sub> -255 |      |      |
| Low output voltage swing          | V <sub>OL</sub> | V <sub>S</sub> = ±20 V, R <sub>L</sub> = 10 kΩ |      | -V <sub>S</sub> +60  |      | mV   |
|                                   |                 | V <sub>S</sub> = ±20 V, R <sub>L</sub> = 2 kΩ  |      | -V <sub>S</sub> +240 |      |      |
| Short-circuit current             | I <sub>SC</sub> |  |      | ±45                  |      | mA   |
| <i>POWER SUPPLY</i>               |                 |  |      |                      |      |      |
| Operating supply voltage          | V <sub>S</sub>  | T <sub>A</sub> = -40 to +125 °C                | 4.5  |                      | 48   | V    |
| Quiescent current (per amplifier) | I <sub>Q</sub>  | V <sub>S</sub> = 5 V                           |      | 2.05                 |      | mA   |
|                                   |                 | V <sub>S</sub> = 40 V                          |      | 2.75                 |      |      |
| <i>THERMAL CHARACTERISTICS</i>    |                 |  |      |                      |      |      |
| Operating temperature range       | T <sub>A</sub>  |  | -40  |                      | +125 | °C   |
| Package Thermal Resistance        | θ <sub>JA</sub> | SOT23-5L                                       |      | 190                  |      | °C/W |
|                                   |                 | MSOP-8L  |      | 201                  |      |      |
|                                   |                 | SOIC-8L  |      | 125                  |      |      |
|                                   |                 | TSSOP-14L                                      |      | 112                  |      |      |
|                                   |                 | SOIC-14L                                       |      | 115                  |      |      |

Typical Performance Characteristics

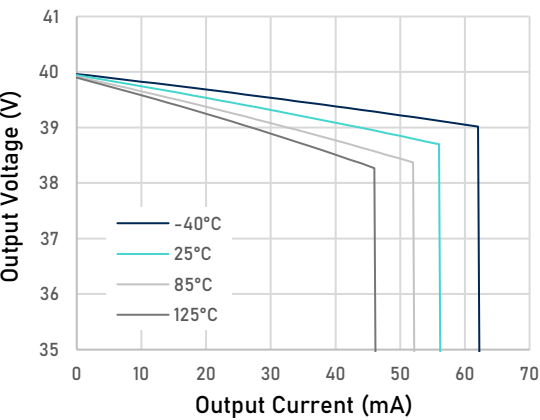
At  $T_A = +25^\circ\text{C}$ ,  $V_{CM} = V_S/2$ , and  $R_L = 10\text{ k}\Omega$  connected to  $V_S/2$ , unless otherwise noted.



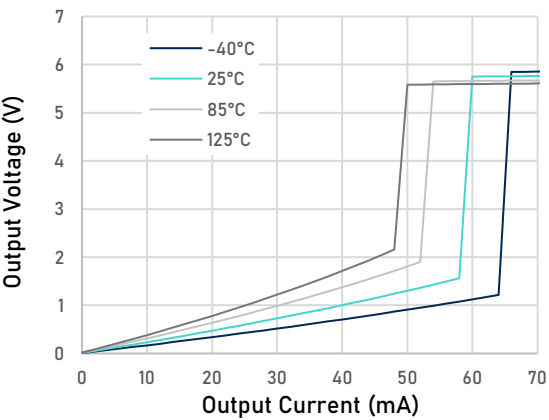
Quiescent Current as a function of Supply Voltage



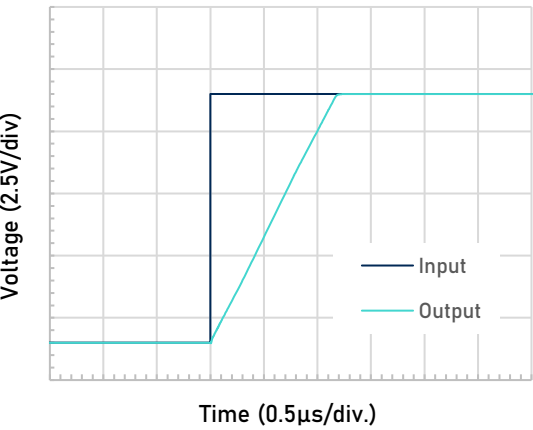
Quiescent Current as a function of Temperature



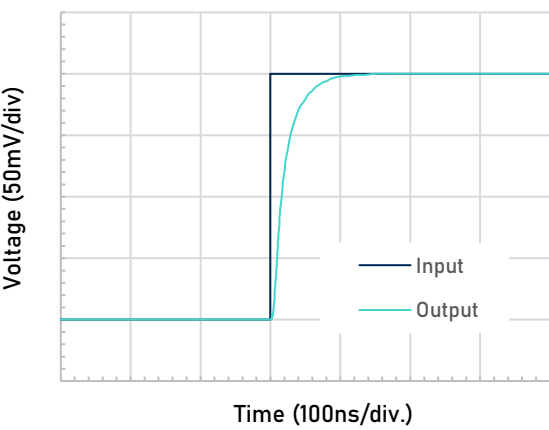
Output Voltage Swing as a function of Output Current (Sourcing,  $V_S = 40\text{ V}$ )



Output Voltage Swing as a function of Output Current (Sinking,  $V_S = 40\text{ V}$ )



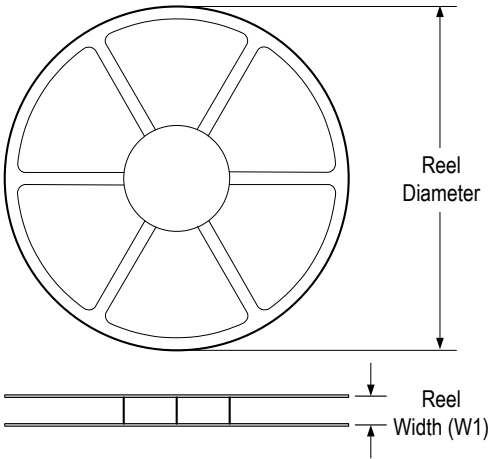
Large-Signal Step Response(Failing)



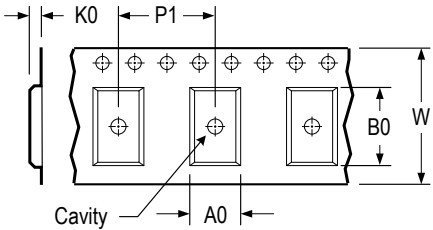
Small-Signal Step Response

Tape and Reel Information

REEL DIMENSIONS

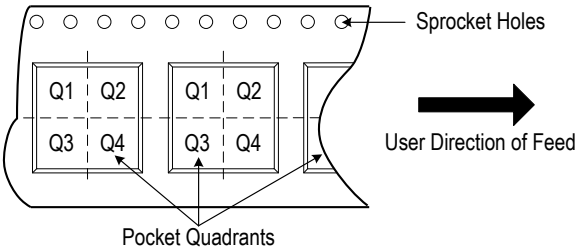


TAPE DIMENSIONS



|    |   |
|----|---|
| A0 | Dimension designed to accommodate the component width     |
| B0 | Dimension designed to accommodate the component length    |
| K0 | Dimension designed to accommodate the component thickness |
| W  | Overall width of the carrier tape                         |
| P1 | Pitch between successive cavity centers                   |

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE

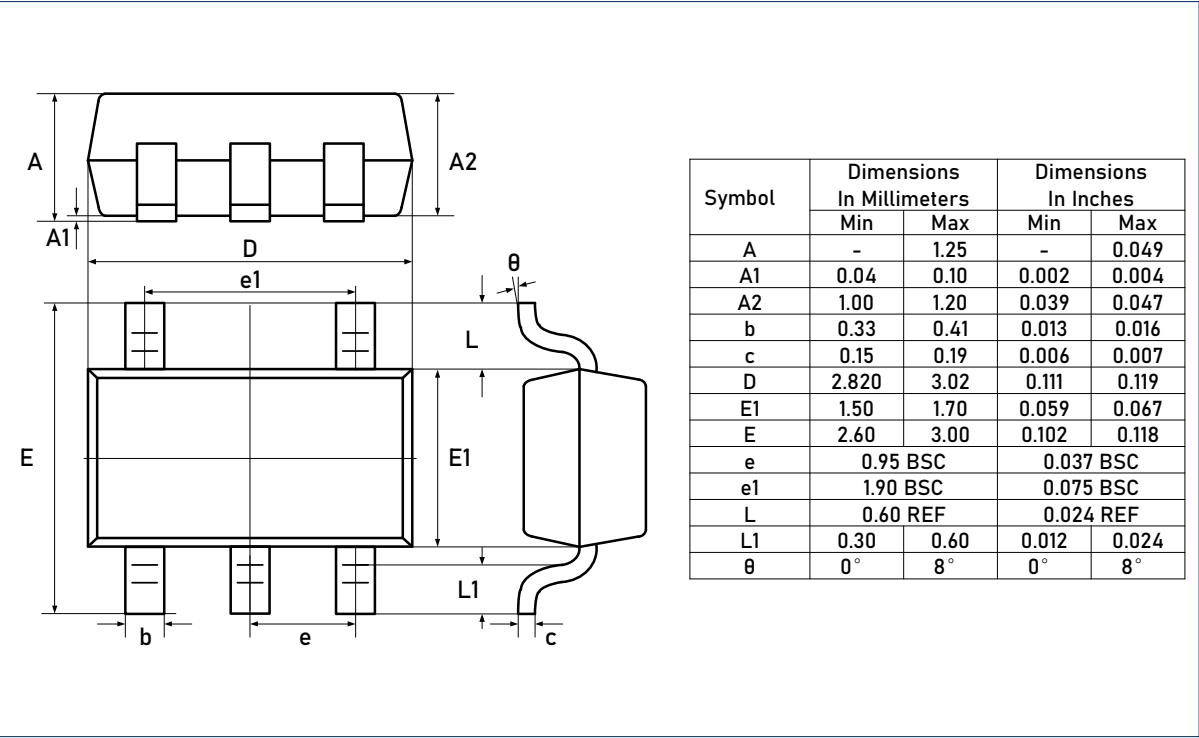


\* All dimensions are nominal

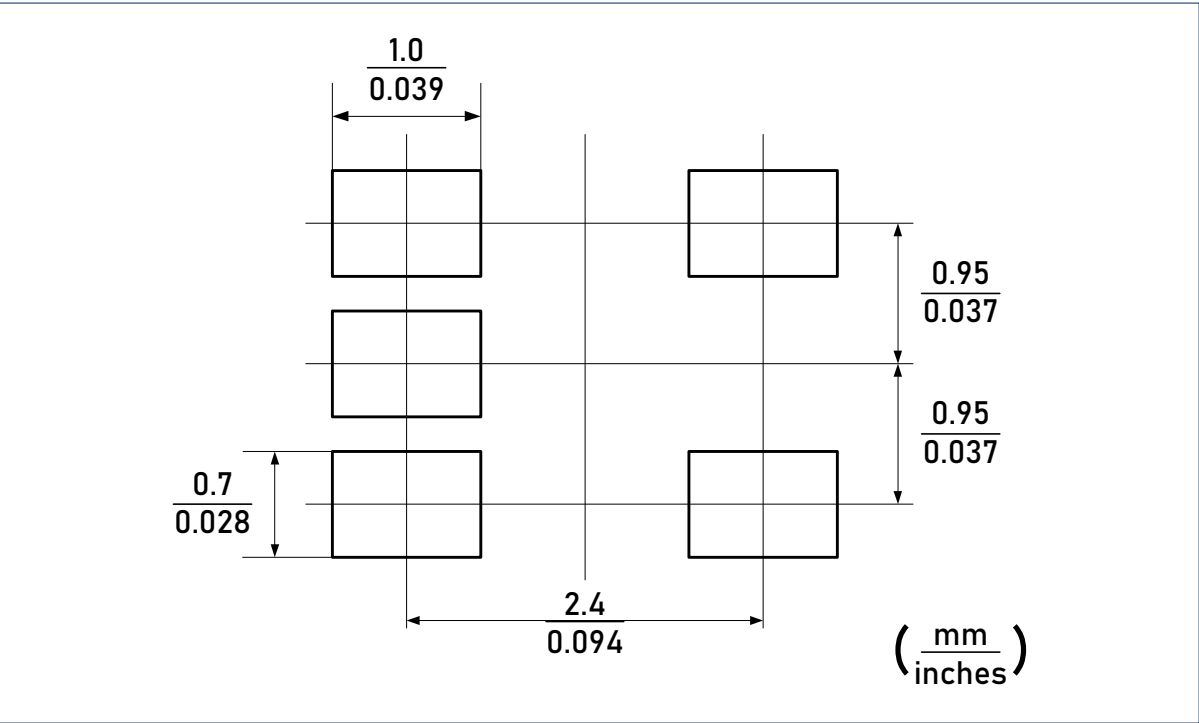
| Device        | Package Type | Pins | SPQ   | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin 1 Quadrant |
|---------------|--------------|------|-------|--------------------|--------------------|---------|---------|---------|---------|--------|----------------|
| LTA8281XT5/R6 | SOT23        | 5    | 3 000 | 178                | 9.0                | 3.3     | 3.2     | 1.5     | 4.0     | 8.0    | Q3             |

Package Outlines

DIMENSIONS, SOT23-5L

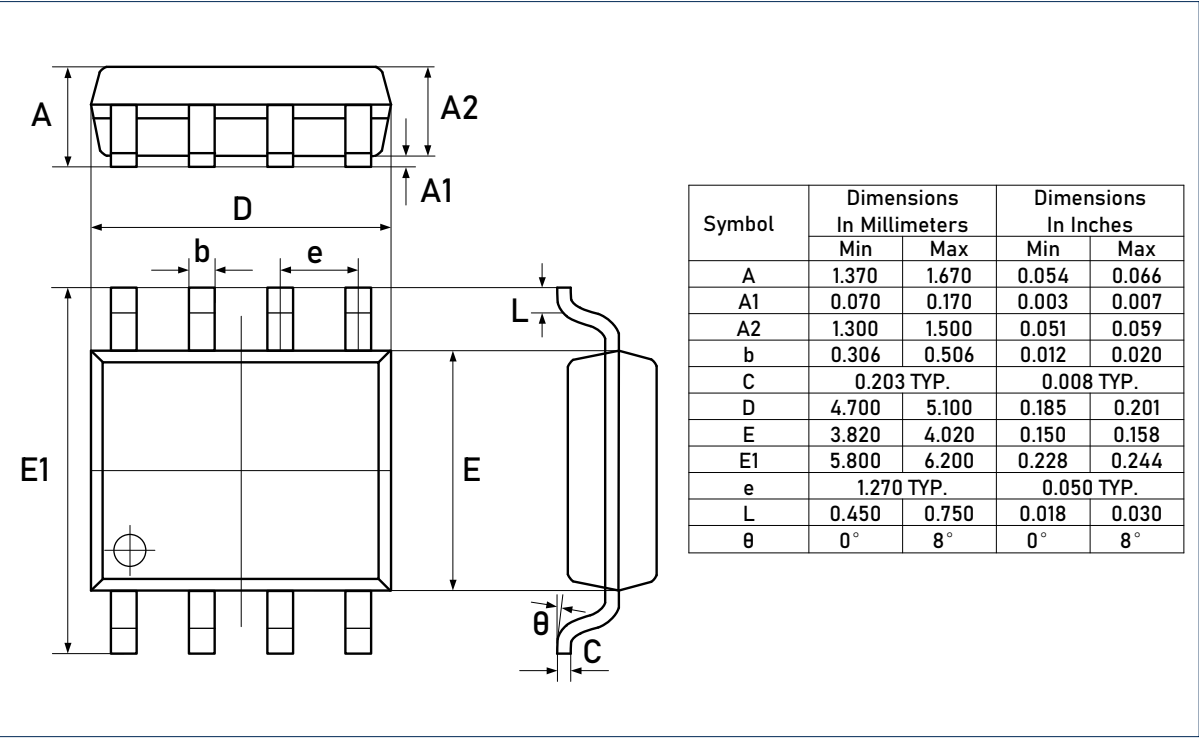


RECOMMENDED SOLDERING FOOTPRINT, SOT23-5L

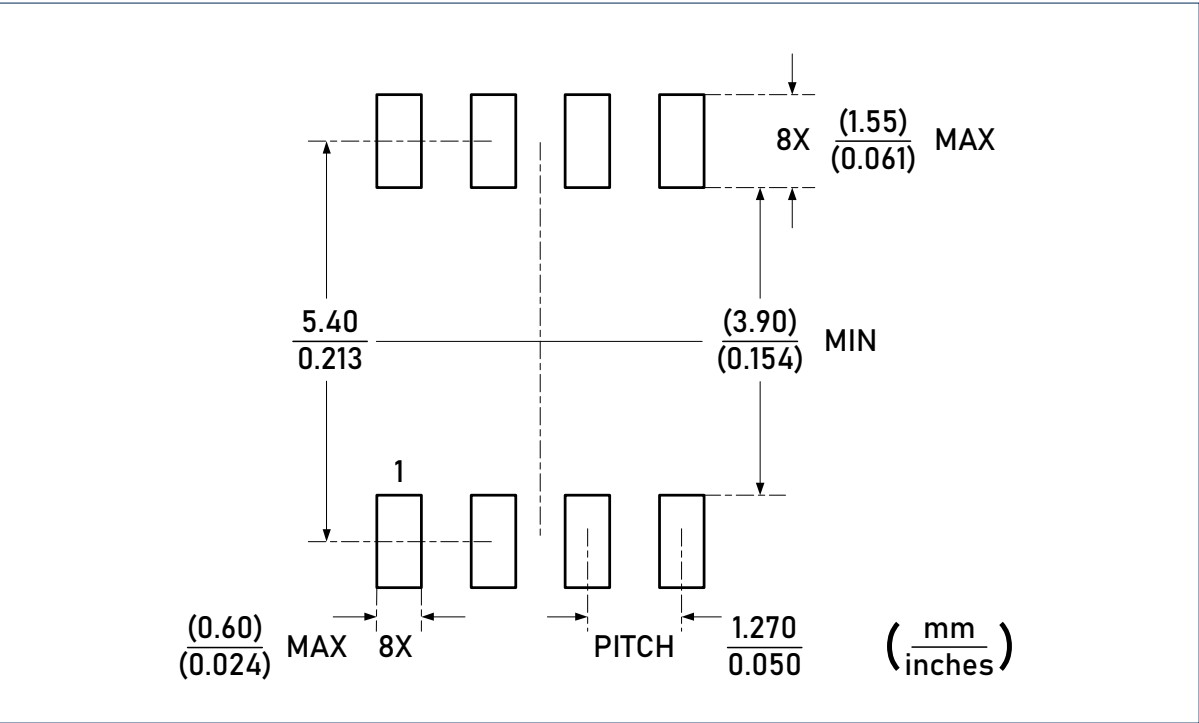


Package Outlines (continued)

DIMENSIONS, SOIC-8L



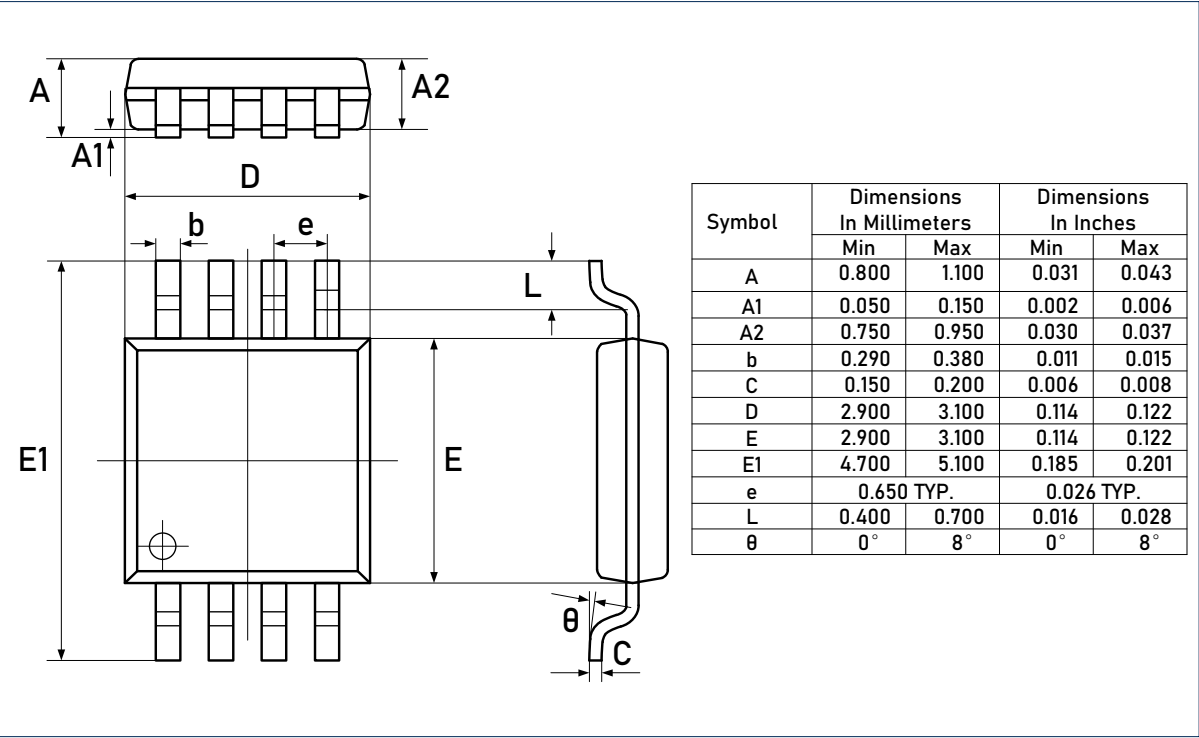
RECOMMENDED SOLDERING FOOTPRINT, SOIC-8L



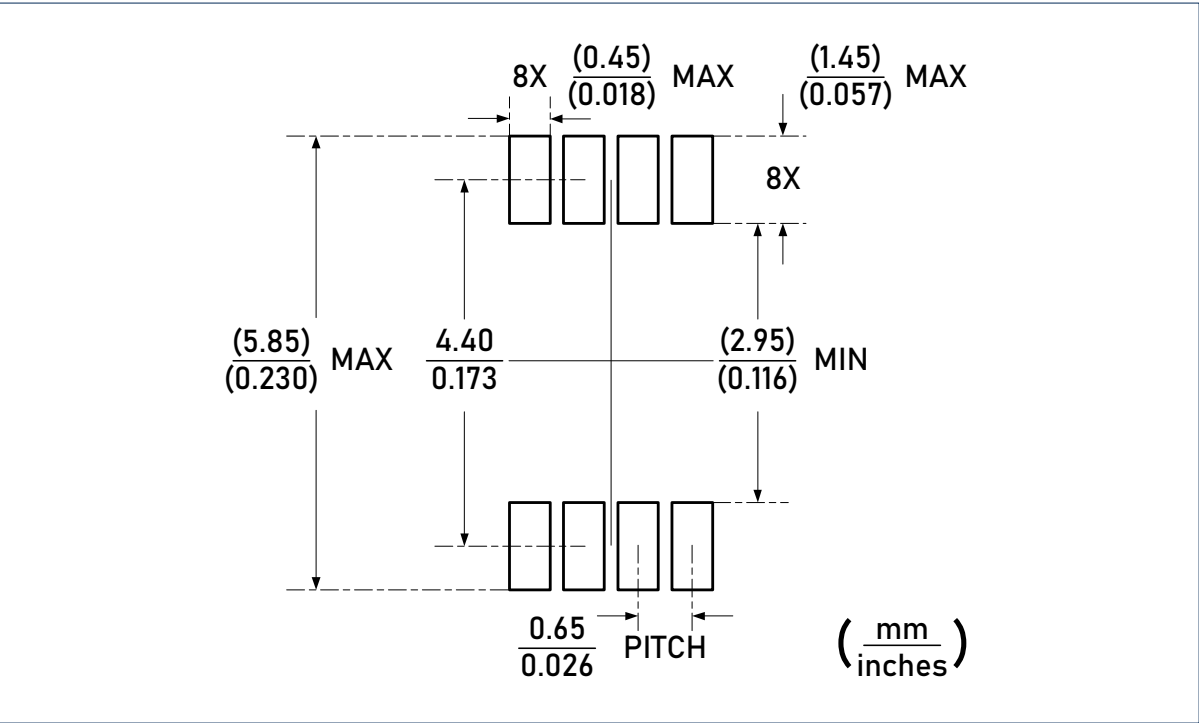


Package Outlines (continued)

DIMENSIONS, MSOP-8L



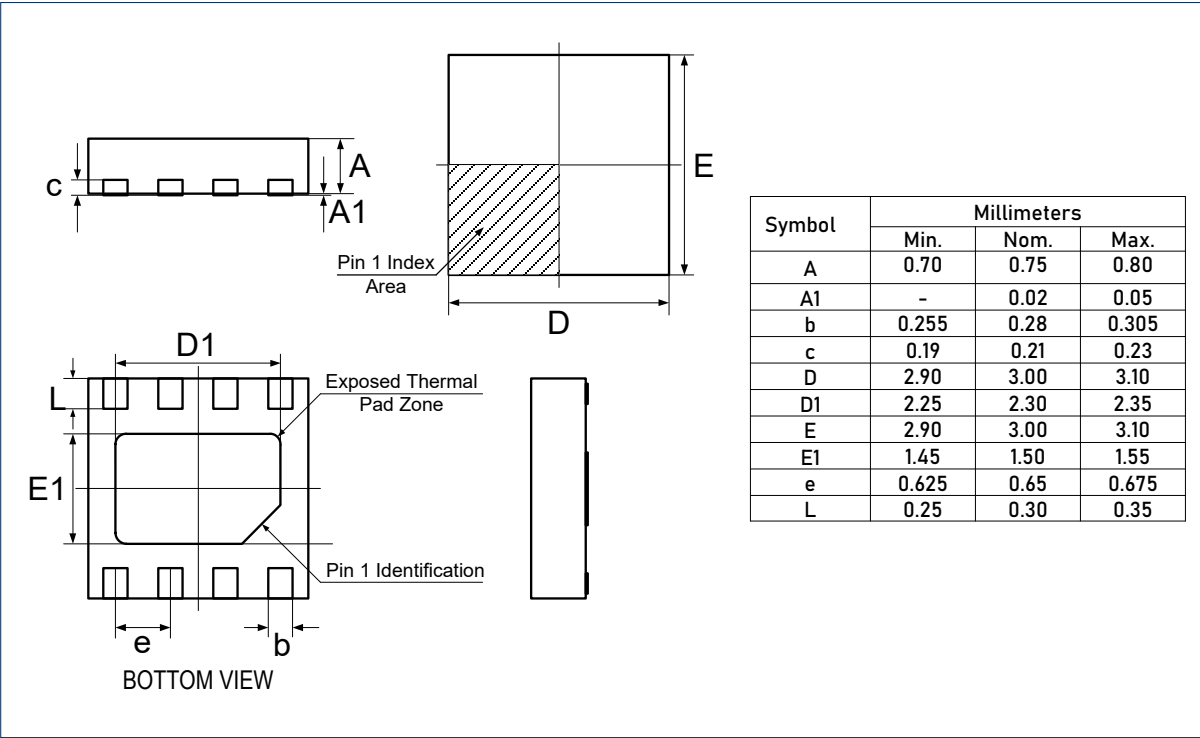
RECOMMENDED SOLDERING FOOTPRINT, MSOP-8L



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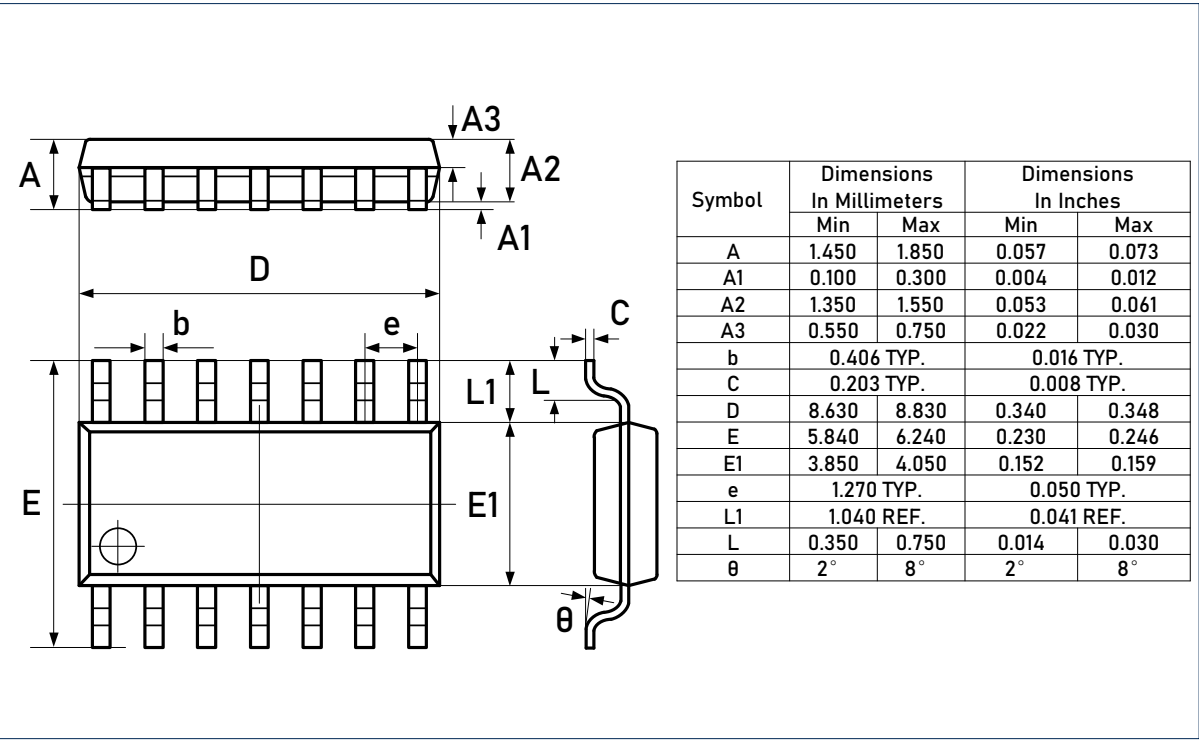
Package Outlines (continued)

DIMENSIONS, DFN3x3-8L

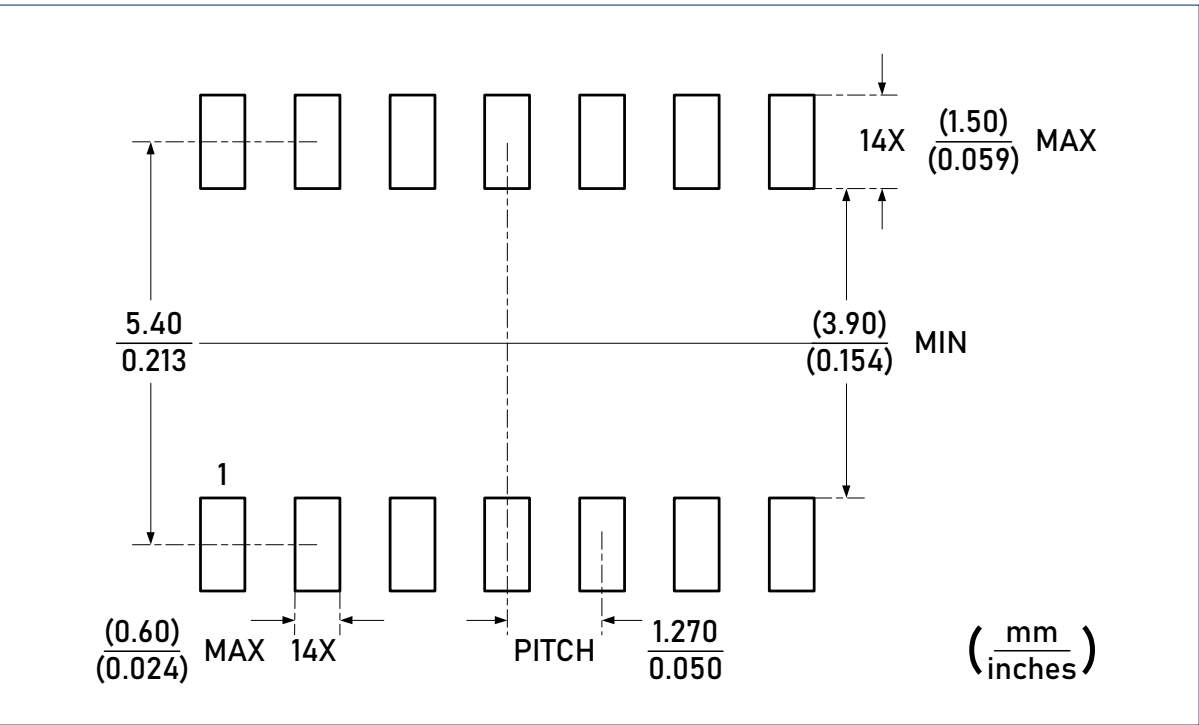


Package Outlines (continued)

DIMENSIONS, SOIC-14L



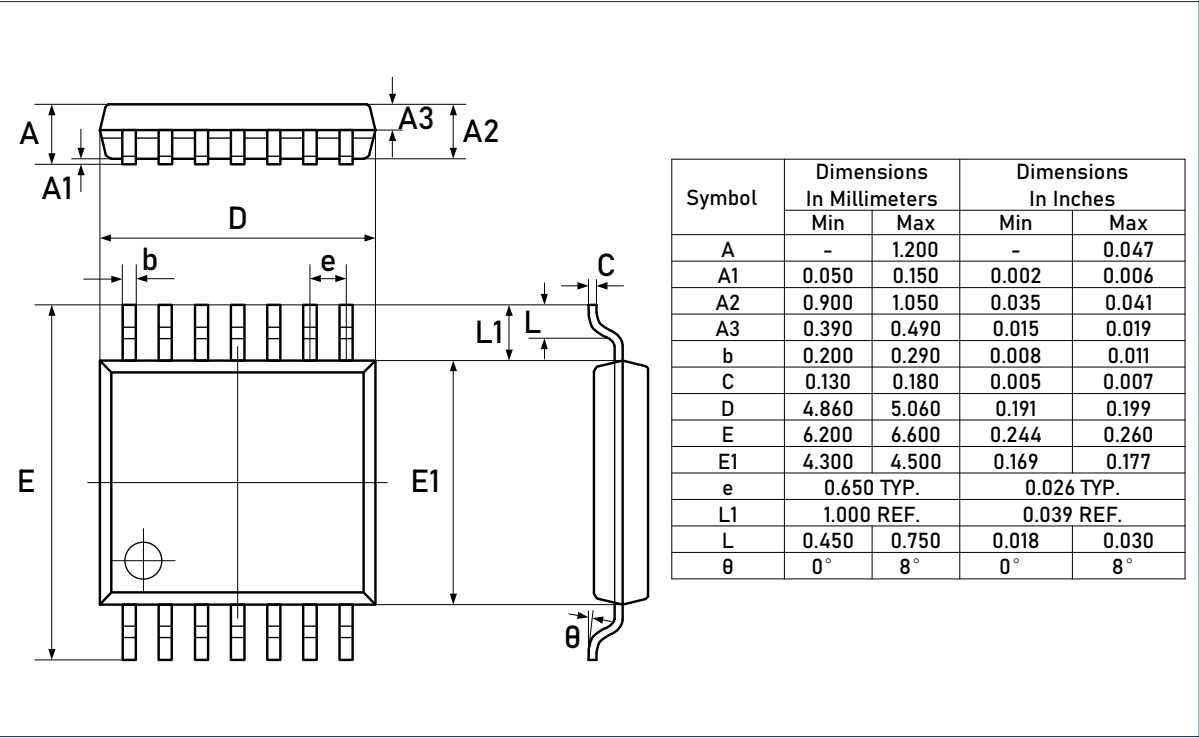
RECOMMENDED SOLDERING FOOTPRINT, SOIC-14L



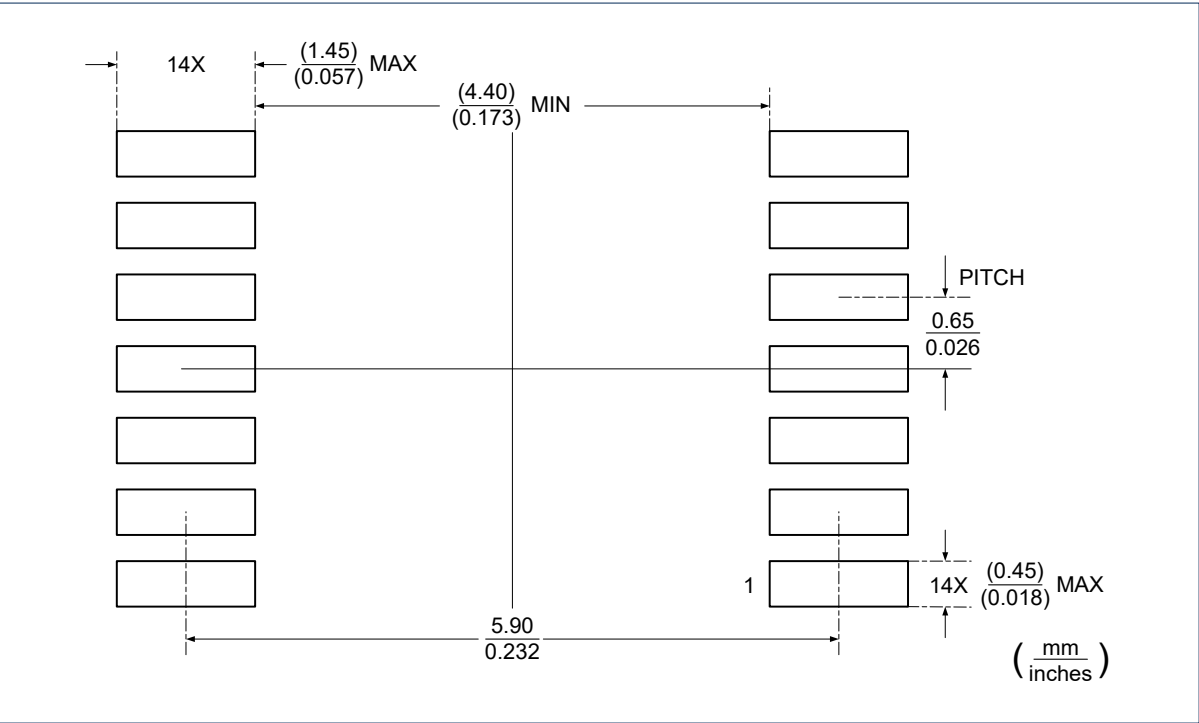
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Package Outlines (continued)

DIMENSIONS, TSSOP-14L



RECOMMENDED SOLDERING FOOTPRINT, SOIC-14L



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For additional product information, or full datasheet, please contact with the Linearin's Sales Department or Representatives.