



Features

- Wide single-supply voltage range or dual supplies: +2 V to +36 V or ± 1 V to ± 18 V
- Very low supply current (0.45 mA) independent of supply voltage (1 mW/comparator at +5 V)
- Low input bias current: 20 nA typ.
- Low input offset current: ± 3 nA typ.
- Low input offset voltage: ± 1 mV typ.
- Input common-mode voltage range includes ground
- Low output saturation voltage: 80 mV typ. ($I_{\text{sink}} = 4$ mA)
- Differential input voltage range equal to the supply voltage
- TTL, DTL, ECL, MOS, CMOS compatible outputs
- Available in DIP8, SO-8, TSSOP8, MiniSO-8, and DFN8 2 x 2 mm packages

Description

The LM193, LM293, and LM393 devices consist of two independent low voltage comparators designed specifically to operate from a single supply over a wide range of voltages. Operation from split power supplies is also possible.

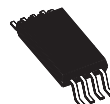
These comparators also have a unique characteristic in that the input common-mode voltage range includes ground even though operated from a single power supply voltage.



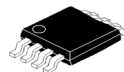
DIP8
(plastic package)



SO-8
(plastic micropackage)



TSSOP8
(thin shrink small outline package)



MiniSO-8
(plastic micropackage)



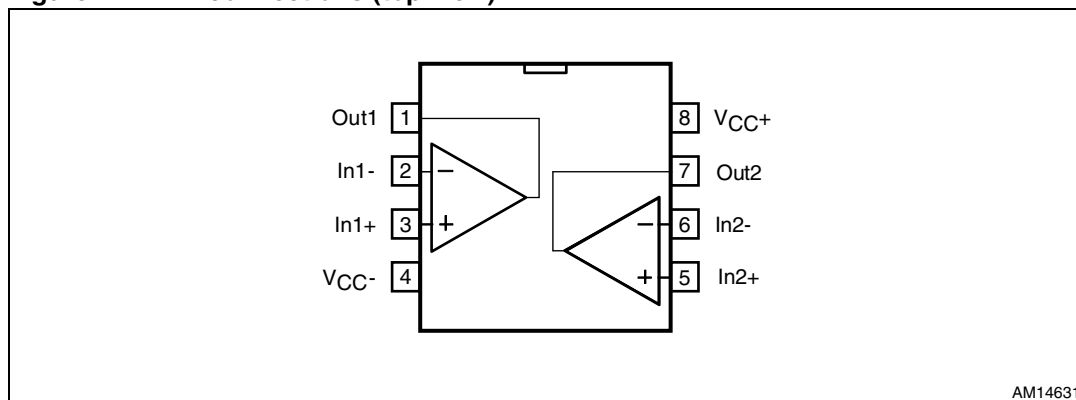
DFN8 2 x 2 mm
(plastic micropackage)

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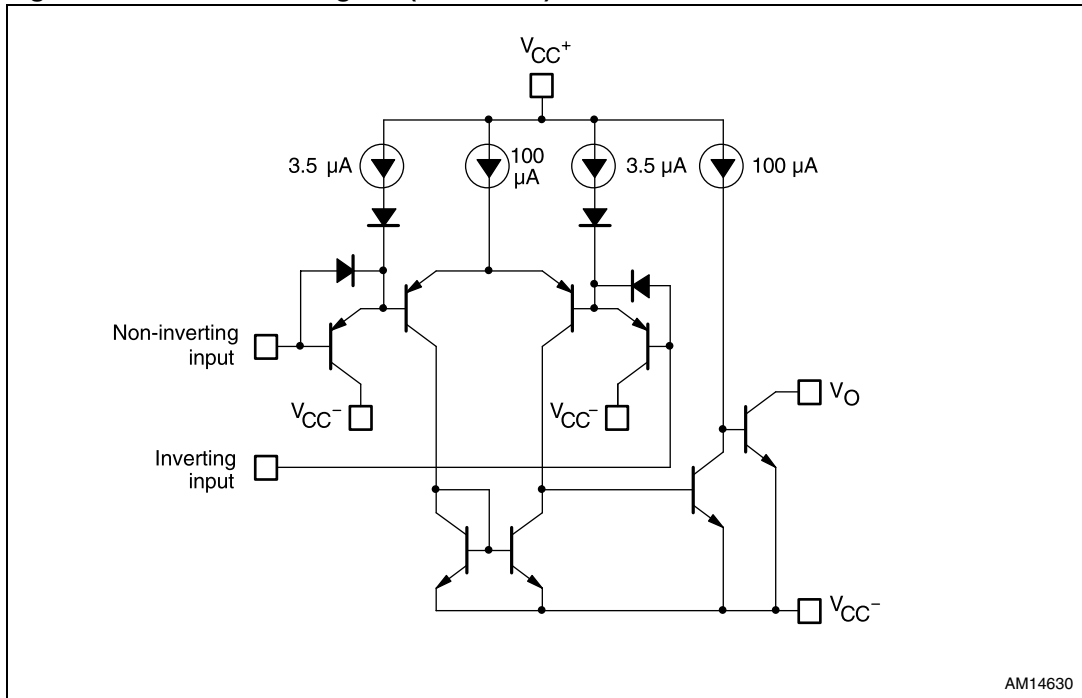
1 Pin connections

Figure 1. Pin connections (top view)



2 Schematic diagram

Figure 2. Schematic diagram (1/2 LM193)



3 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|--------------------------|---|----------------|------|
| V_{CC} | Supply voltage | ± 18 or 36 | V |
| V_{id} | Differential input voltage | ± 36 | V |
| V_{in} | Input voltage | -0.3 to +36 | V |
| | Output short-circuit to ground ⁽¹⁾ | Infinite | |
| R_{thja} | Thermal resistance junction to ambient ⁽²⁾ | | °C/W |
| | SO-8 | 125 | |
| | TSSOP8 | 120 | |
| | DIP8 | 85 | |
| | MiniSO-8 DFN8 2 x 2 mm | 190 57 | |
| R_{thjc} | Thermal resistance junction to case ⁽²⁾ | | °C/W |
| | SO-8 | 40 | |
| | TSSOP8 | 37 | |
| | DIP8 | 41 | |
| | MiniSO-8 DFN8 2 x 2 mm | 39 | |
| T_j | Maximum junction temperature | 150 | °C |
| T_{stg} | Storage temperature range | -65 to +150 | °C |
| ESD Class ⁽³⁾ | HBM: human body model | H1B | |
| | MM: machine model | M2 | |
| | CDM: charged device model | C5 | |

- Short-circuits from the output to V_{CC+} can cause excessive heating and potential destruction. The maximum output current is approximately 20 mA independent of the magnitude of V_{CC+} .
- Short-circuits can cause excessive heating and destructive dissipation. Values are typical.
- ESD class definition from AEC-Q100:
HBM class H1B: ESD voltage level from 500 V to 1000 V
MM class M2: ESD voltage level from 100 V to 200 V
CDM class C5: ESD voltage level greater than 1500 V.

Table 2. Operating conditions

| Symbol | Parameter | Value | Unit |
|------------|---|--|------|
| V_{CC} | Supply voltage ($V_{CC+} - V_{CC-}$) | 2 to 36 | V |
| V_{icm} | Common mode input voltage range ($V_{CC+} = 30$ V) ⁽¹⁾ $T_{amb} = +25$ °C $T_{min} \leq T_{amb} \leq T_{max}$ | 0 to $V_{CC+} - 1.5$ 0 to $V_{CC+} - 2$ | V |
| T_{oper} | Operating free-air temperature range LM193, LM193A LM293, LM293A LM393, LM393A | -55 to +125 -40 to +105 0 to +70 | °C |

- The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3 V. The high end of the common-mode voltage range is $V_{CC+} - 1.5$ V, but either or both inputs can go to +30 V without damage.

4 Electrical characteristics

Table 3. $V_{CC}^+ = +5V$, $V_{CC}^- = 0V$, $T_{amb} = +25\text{ }^\circ\text{C}$ (unless otherwise specified)

| Symbol | Parameter | LM193A - LM293A LM393A | | | LM193- LM293 LM393 | | | Unit |
|------------|--|---------------------------|-------------|------------|-----------------------|-------------|------------|---------------------|
| | | Min. | Typ. | Max. | Min. | Typ. | Max. | |
| V_{io} | Input offset voltage ⁽¹⁾ $T_{min} \leq T_{amb} \leq T_{max}$ | | 1 | 2 4 | | 1 | 5 9 | mV |
| I_{io} | Input offset current $T_{min} \leq T_{amb} \leq T_{max}$ | | 3 | 25 100 | | 3 | 50 150 | nA |
| I_{ib} | Input bias current (I^+ or I^-) ⁽²⁾ $T_{min} \leq T_{amb} \leq T_{max}$ | | 20 | 100 300 | | 20 | 250 400 | nA |
| A_{vd} | Large signal voltage gain $V_{CC} = 15\text{ V}$, $R_L = 15\text{ k}\Omega$, $V_o = 1\text{ V to }11\text{ V}$ | 50 | 200 | | 50 | 200 | | V/mV |
| I_{CC} | Supply current (all comparators) $V_{CC} = +5\text{ V}$, no load $V_{CC} = +30\text{ V}$, no load | | 0.45 0.6 | 1 2.5 | | 0.45 0.6 | 1 2.5 | mA |
| V_{id} | Differential input voltage ⁽³⁾ | | | V_{CC}^+ | | | V_{CC}^+ | |
| V_{OL} | Low level output voltage $V_{id} = -1\text{ V}$, $I_{sink} = 4\text{ mA}$ $T_{min} \leq T_{amb} \leq T_{max}$ | | 80 | 400 700 | | 80 | 400 700 | mV |
| I_{OH} | High level output current $V_{CC} = V_o = 30\text{ V}$, $V_{id} = 1\text{ V}$ $T_{min} \leq T_{amb} \leq T_{max}$ | | 0.1 | 1 | | 0.1 | 1 | nA μA |
| I_{sink} | Output sink current $V_{id} = 1\text{ V}$, $V_o = 1.5\text{ V}$ | 6 | 18 | | 6 | 18 | | mA |
| t_{re} | Response time ⁽⁴⁾ $R_L = 5.1\text{ k}\Omega$ connected to V_{CC}^+ | | 1.3 | | | 1.3 | | μs |
| t_{rel} | Large signal response time $R_L = 5.1\text{ k}\Omega$ connected to V_{CC}^+ $e_1 = \text{TTL}$, $V_{(ref)} = +1.4\text{ V}$ | | 300 | | | 300 | | ns |

1. At output switch point, $V_o \approx 1.4\text{ V}$, $R_s = 0$ with V_{CC}^+ from 5 V to 30 V, and over the full common-mode range (0 V to $V_{CC}^+ - 1.5\text{ V}$).
2. 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 charge exists on the reference of input lines.
3. Positive excursions of input voltage may exceed the power supply level. As long as the other voltage remains within the common-mode range, the comparator will provide a proper output state. The low input voltage state must not be less than -0.3 V (or 0.3 V below the negative power supply, if used).
4. The response time specified is for a 100 mV input step with 5 mV overdrive. For larger overdrive signals 300 ns can be obtained.

Figure 3. Supply current vs. supply voltage



Figure 4. Input current vs. supply voltage



Figure 5. Output saturation voltage vs. output current



Figure 6. Response time for various input overdrives - negative transition



Figure 7. Response time for various input overdrives - positive transition



5 Typical applications

Figure 8. Basic comparator



Figure 9. Driving TTL



Figure 10. Low frequency op amp



Figure 11. Driving CMOS



Figure 12. Low frequency op amp



Figure 13. Transducer amplifier



Figure 14. Low frequency op amp with offset adjust



AM14643

Figure 15. Zero crossing detector (single power supply)



AM14644

Figure 16. Limit comparator



AM14645

Figure 17. Crystal controlled oscillator



AM14646

Figure 18. Split-supply applications - zero crossing detector



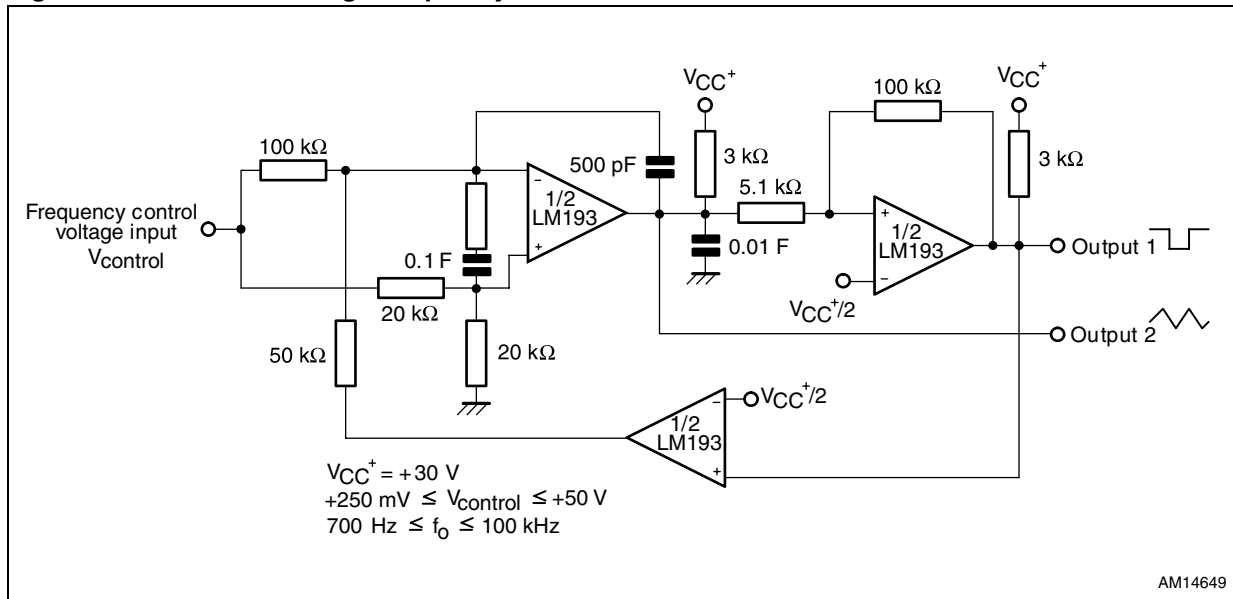
AM14647

Figure 19. Comparator with a negative reference



AM14648

Figure 20. Two-decade high frequency VCO



6 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: www.st.com. ECOPACK is an ST trademark.

6.1 DIP8 package information

Figure 21. DIP8 package outline

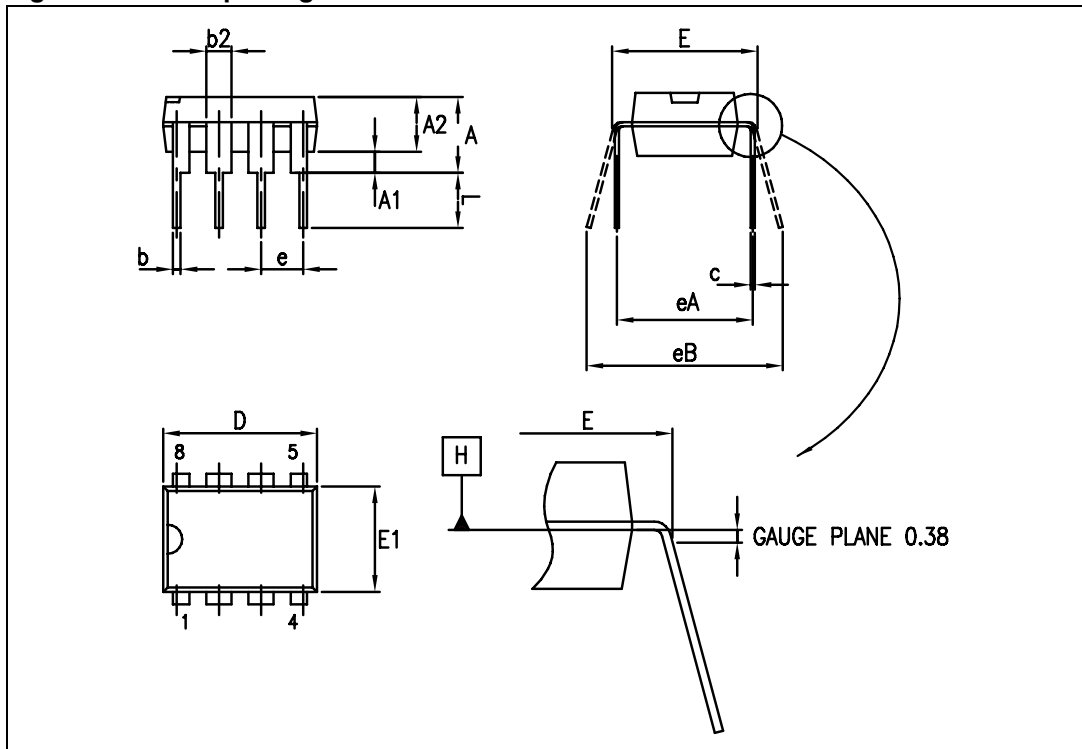


Table 4. DIP8 package mechanical data

| Symbol | Dimensions | | | | | |
|--------|-------------|------|-------|--------|-------|-------|
| | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 5.33 | | | 0.210 |
| A1 | 0.38 | | | 0.015 | | |
| A2 | 2.92 | 3.30 | 4.95 | 0.115 | 0.130 | 0.195 |
| b | 0.36 | 0.46 | 0.56 | 0.014 | 0.018 | 0.022 |
| b2 | 1.14 | 1.52 | 1.78 | 0.045 | 0.060 | 0.070 |
| c | 0.20 | 0.25 | 0.36 | 0.008 | 0.010 | 0.014 |
| D | 9.02 | 9.27 | 10.16 | 0.355 | 0.365 | 0.400 |
| E | 7.62 | 7.87 | 8.26 | 0.300 | 0.310 | 0.325 |
| E1 | 6.10 | 6.35 | 7.11 | 0.240 | 0.250 | 0.280 |
| e | | 2.54 | | | 0.100 | |
| eA | | 7.62 | | | 0.300 | |
| eB | | | 10.92 | | | 0.430 |
| L | 2.92 | 3.30 | 3.81 | 0.115 | 0.130 | 0.150 |

6.2 SO-8 package information

Figure 22. SO-8 package outline

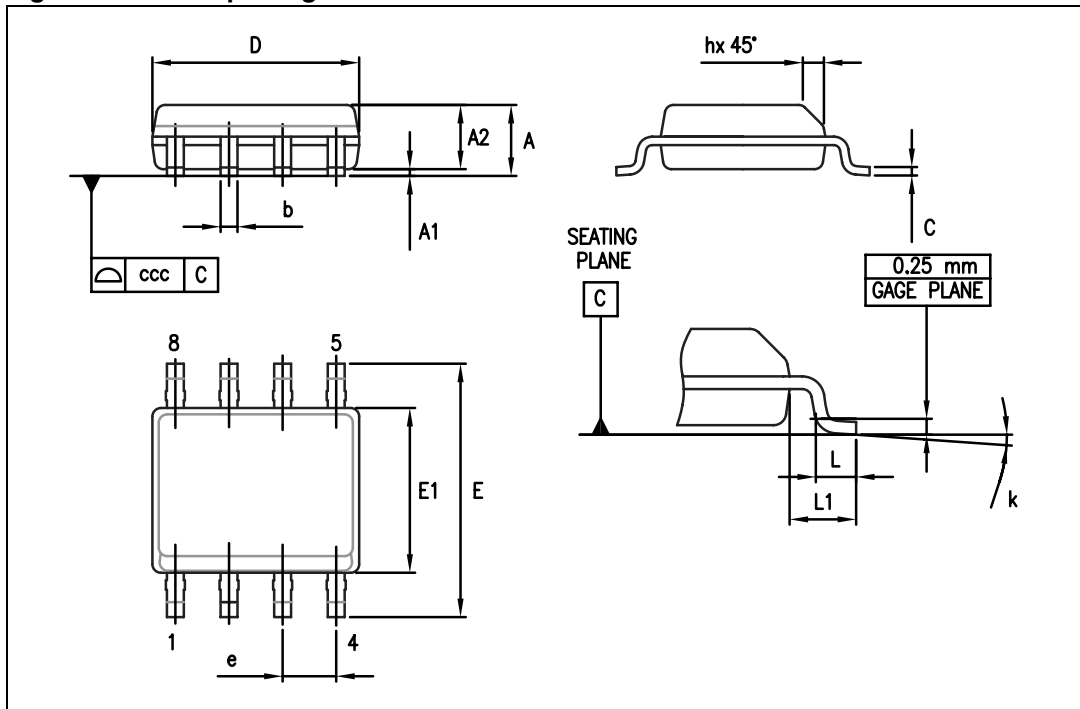


Table 5. SO-8 package mechanical data

| Symbol | Dimensions | | | | | |
|--------|-------------|------|------|--------|-------|-------|
| | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 1.75 | | | 0.069 |
| A1 | 0.10 | | 0.25 | 0.004 | | 0.010 |
| A2 | 1.25 | | | 0.049 | | |
| b | 0.28 | | 0.48 | 0.011 | | 0.019 |
| c | 0.17 | | 0.23 | 0.007 | | 0.010 |
| D | 4.80 | 4.90 | 5.00 | 0.189 | 0.193 | 0.197 |
| E | 5.80 | 6.00 | 6.20 | 0.228 | 0.236 | 0.244 |
| E1 | 3.80 | 3.90 | 4.00 | 0.150 | 0.154 | 0.157 |
| e | | 1.27 | | | 0.050 | |
| h | 0.25 | | 0.50 | 0.010 | | 0.020 |
| L | 0.40 | | 1.27 | 0.016 | | 0.050 |
| L1 | | 1.04 | | | 0.040 | |
| k | 0 | | 8° | 1° | | 8° |
| ccc | | | 0.10 | | | 0.004 |

6.3 TSSOP8 package information

Figure 23. TSSOP8 package outline

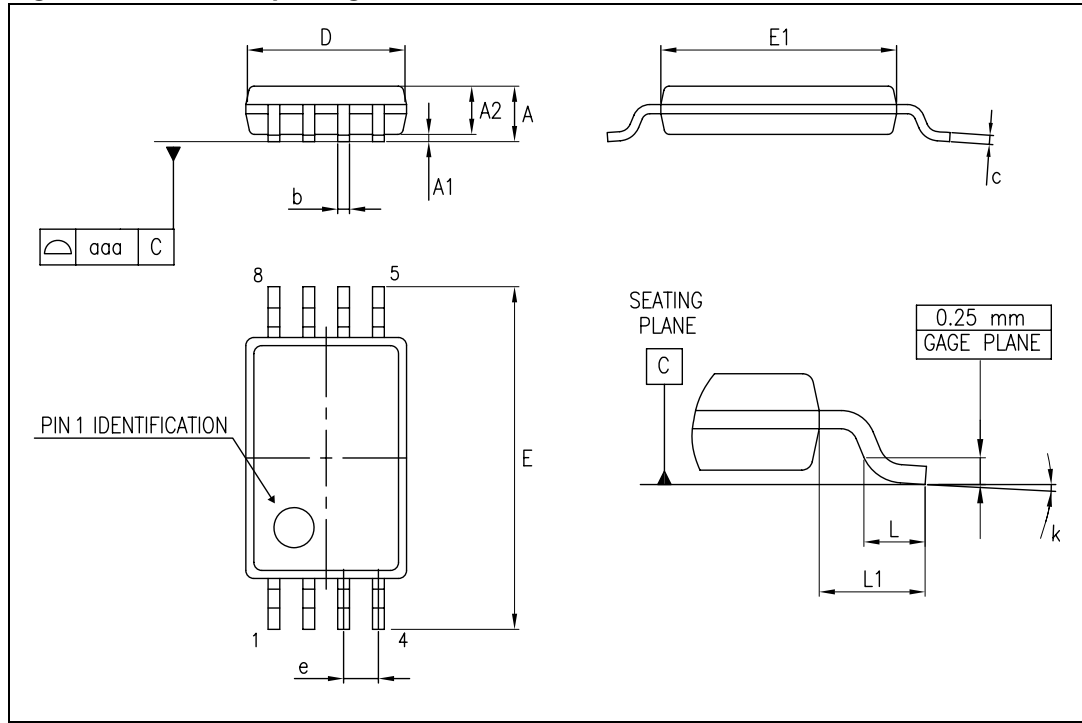


Table 6. TSSOP8 package mechanical data

| Symbol | Dimensions | | | | | |
|--------|-------------|------|------|--------|--------|-------|
| | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 1.20 | | | 0.047 |
| A1 | 0.05 | | 0.15 | 0.002 | | 0.006 |
| A2 | 0.80 | 1.00 | 1.05 | 0.031 | 0.039 | 0.041 |
| b | 0.19 | | 0.30 | 0.007 | | 0.012 |
| c | 0.09 | | 0.20 | 0.004 | | 0.008 |
| D | 2.90 | 3.00 | 3.10 | 0.114 | 0.118 | 0.122 |
| E | 6.20 | 6.40 | 6.60 | 0.244 | 0.252 | 0.260 |
| E1 | 4.30 | 4.40 | 4.50 | 0.169 | 0.173 | 0.177 |
| e | | 0.65 | | | 0.0256 | |
| k | 0° | | 8° | 0° | | 8° |
| L | 0.45 | 0.60 | 0.75 | 0.018 | 0.024 | 0.030 |
| L1 | | 1 | | | 0.039 | |
| aaa | | | 0.10 | | | 0.004 |

6.4 MiniSO-8 package information

Figure 24. MiniSO-8 package outline

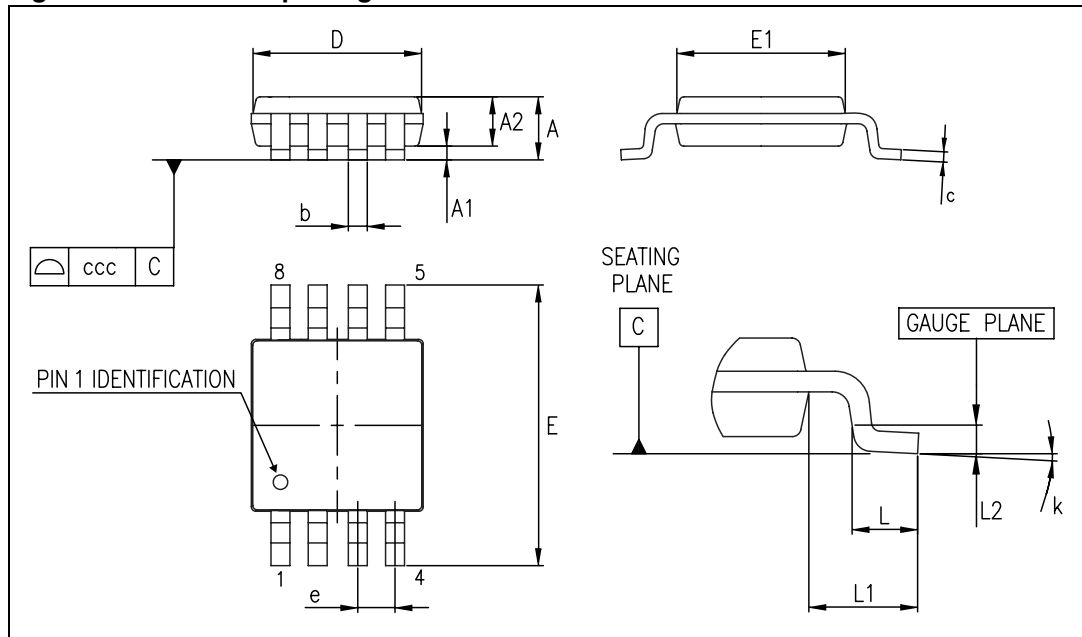


Table 7. MiniSO-8 package mechanical data

| Symbol | Dimensions | | | | | |
|--------|-------------|------|------|--------|-------|-------|
| | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 1.1 | | 0.043 | |
| A1 | 0 | | 0.15 | 0 | | 0.006 |
| A2 | 0.75 | 0.85 | 0.95 | 0.030 | 0.033 | 0.037 |
| b | 0.22 | | 0.40 | 0.009 | | 0.016 |
| c | 0.08 | | 0.23 | 0.003 | | 0.009 |
| D | 2.80 | 3.00 | 3.20 | 0.11 | 0.118 | 0.126 |
| E | 4.65 | 4.90 | 5.15 | 0.183 | 0.193 | 0.203 |
| E1 | 2.80 | 3.00 | 3.10 | 0.11 | 0.118 | 0.122 |
| e | | 0.65 | | | 0.026 | |
| L | 0.40 | 0.60 | 0.80 | 0.016 | 0.024 | 0.031 |
| L1 | | 0.95 | | | 0.037 | |
| L2 | | 0.25 | | | 0.010 | |
| k | 0° | | 8° | 0° | | 8° |
| ccc | | | 0.10 | | | 0.004 |

6.5 DFN8 package information

Figure 25. DFN8 2 x 2 x 0.6 mm package outline (pitch 0.5 mm)

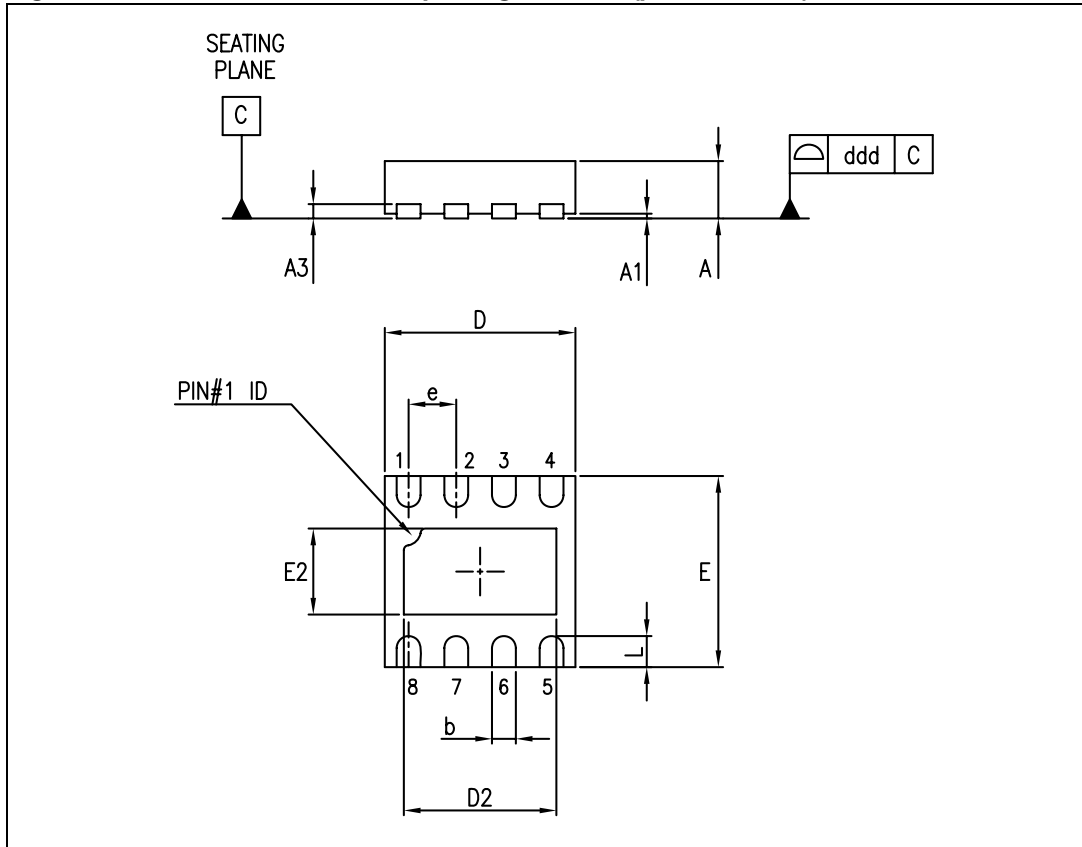


Table 8. DFN8 2 x 2 x 0.6 mm package mechanical data (pitch 0.5 mm)

| Symbol | Dimensions | | | | | |
|--------|-------------|------|------|--------|-------|-------|
| | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | 0.51 | 0.55 | 0.60 | 0.020 | 0.022 | 0.024 |
| A1 | | | 0.05 | | | 0.002 |
| A3 | | 0.15 | | | 0.006 | |
| b | 0.18 | 0.25 | 0.30 | 0.007 | 0.010 | 0.012 |
| D | 1.85 | 2.00 | 2.15 | 0.073 | 0.079 | 0.085 |
| D2 | 1.45 | 1.60 | 1.70 | 0.057 | 0.063 | 0.067 |
| E | 1.85 | 2.00 | 2.15 | 0.073 | 0.079 | 0.085 |
| E2 | 0.75 | 0.90 | 1.00 | 0.030 | 0.035 | 0.039 |
| e | | 0.50 | | | 0.020 | |
| L | | | 0.50 | | | 0.020 |
| ddd | | | 0.08 | | | 0.003 |

Figure 26. DFN8 2 x 2 footprint recommendation



7 Ordering information

Table 9. Order codes

| Order code | Temperature range | Package | Packing | Marking |
|---------------------|-------------------|------------|--------------------------|---------|
| LM193AD LM193ADT | -55 °C, +125 °C | SO-8 | Tube or tape and reel | 193A |
| LM193D LM193DT | | | | 193 |
| LM193AN | | DIP8 | Tube | LM193AN |
| LM193N | | | | LM193N |
| LM293AD LM293ADT | -40 °C, +105 °C | SO-8 | Tube or tape and reel | 293A |
| LM293D LM293DT | | | | 293 |
| LM293AN | | DIP8 | Tube | LM293AN |
| LM293N | | | | LM293N |
| LM293PT | | TSSOP8 | Tape and reel | 293 |
| LM293ST | | MiniSO-8 | Tape and reel | K512 |
| LM293QT | | DFN8 2 x 2 | Tape and reel | K59 |
| LM393AD LM393ADT | 0 °C, +70 °C | SO-8 | Tube or tape and reel | 393A |
| LM393D LM393DT | | | | 393 |
| LM393AN | | DIP8 | Tube | LM393AN |
| LM393N | | | | LM393N |
| LM393PT | | TSSOP8 | Tape and reel | 393 |
| LM393ST | | MiniSO-8 | Tape and reel | M393 |
| LM393QT | | DFN8 2 x 2 | Tape and reel | K5C |

8 Revision history

Table 10. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 02-Jul-2002 | 1 | First release. |
| 02-Jan-2005 | 2 | Class A of the product included in the datasheet. |
| 02-May-2005 | 3 | PPAP references inserted in the datasheet, see Table 7: Ordering information on page 18 . |
| 02-Jul-2005 | 4 | Modification on PPAP references - Errors on part numbers, see Table 7: Ordering information on page 18 . |
| 22-Nov-2005 | 5 | Modification on Table 3 on page 6 . LM293,A must be -40/+105°C instead of -40/+125°C. |
| 16-Feb-2006 | 6 | Unit error for V_{OI} parameter see Table 3 on page 6 . |
| 23-Aug-2007 | 7 | Corrected error in DIP8 package information related to lead thickness, see Figure 21 on page 12 . Added values for R_{thja} and R_{thjc} , and ESD parameters in Table 1: Absolute maximum ratings . |
| 08-Nov-2007 | 8 | Updated MiniSO-8 package information. Reformatted package information. Added automotive grade order codes. |
| 19-Feb-2008 | 9 | Corrected error in SO-8 package mechanical data: E dimension in drawing was marked with an F in table. |
| 15-Dec-2008 | 10 | Corrected heading in Figure 5 . |
| 22-Feb-2010 | 11 | Deleted automotive grade order codes for LM293 and LM393. |
| 22-Jun-2011 | 12 | Updated typical performance curves. Updated typical values on Table 3 on page 6 . Updated ESD parameters with ESD classes in Table 1: Absolute maximum ratings . Added DFN8 2x2mm package mechanical drawing. Added DFN8 2x2mm recommended footprint. Added DFN8 2x2mm order codes in Table 9 . |
| 27-Jun-2012 | 13 | Updated Features (added package information), Description (added RPNs), Figure 1: Pin connections (top view) moved to page 3, added Contents , updated marking of the LM293QT device in Table 9 , minor text corrections throughout document. |
| 18-Jan-2013 | 14 | Updated Table 8 (added dimensions in inches). |

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(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



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