



TS393C,I,M

MICROPOWER DUAL CMOS VOLTAGE COMPARATORS

- EXTREMELY LOW SUPPLY CURRENT : **9 μ A typ / comparator**
- WIDE SINGLE SUPPLY RANGE **2.7V TO 16V** OR DUAL SUPPLIES ($\pm 1.35V$ TO $\pm 8V$)
- EXTREMELY LOW INPUT BIAS CURRENT : **1pA typ**
- EXTREMELY LOW INPUT OFFSET CURRENTS : **1pA typ**
- INPUT COMMON-MODE VOLTAGE RANGE INCLUDES GND
- HIGH INPUT IMPEDANCE : 10¹² Ω typ
- FAST RESPONSE TIME : 2.5 μ s typ for 5mV overdrive
- PIN-TO-PIN AND FUNCTIONALLY COMPATIBLE WITH BIPOLAR LM393

DESCRIPTION

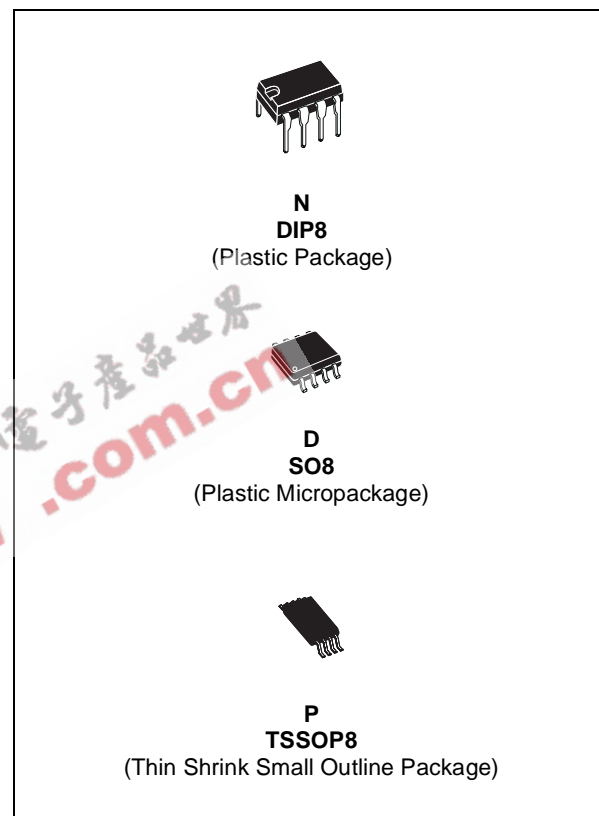
The TS393 is a micropower CMOS dual voltage comparator with extremely low consumption of 9 μ A typ / comparator (20 times less than bipolar LM393). Similar performances are offered by the dual micropower comparator TS3702 with a push-pull CMOS output.

Thus response times remain similar to the LM393.

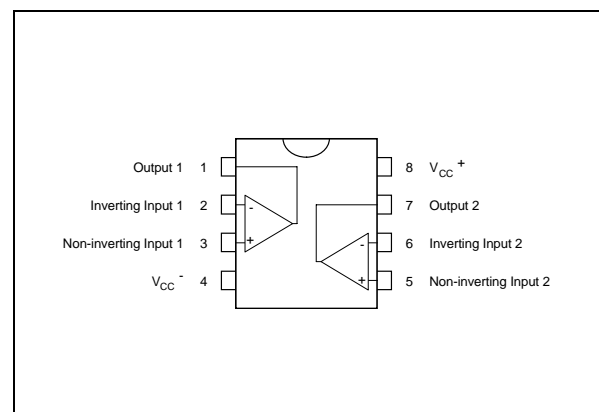
ORDER CODE

| Part Number | Temperature Range | Package | | |
|-------------|-------------------|---------|---|---|
| | | N | D | P |
| TS393C | 0°C, +70°C | • | • | • |
| TS393I | -40°C, +125°C | • | • | • |
| TS393M | -55°C, +125°C | • | • | • |

N = Dual in Line Package (DIP)
D = Small Outline Package (SO) - also available in Tape & Reel (DT)
P = Thin Shrink Small Outline Package (TSSOP) - only available in Tape & Reel (PT)

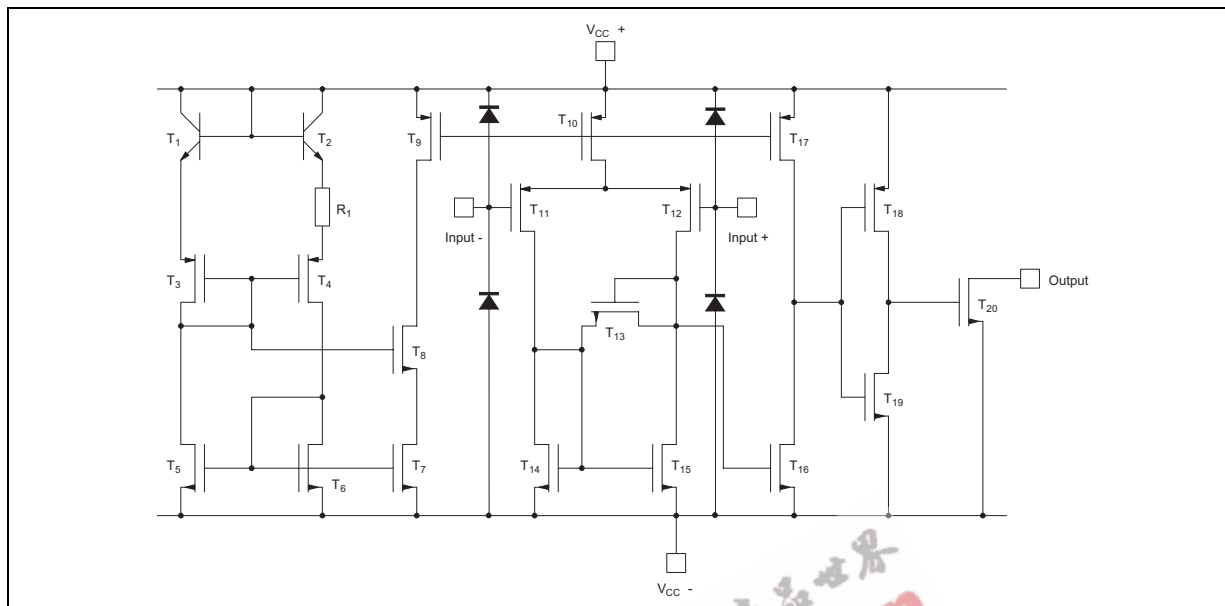


PIN CONNECTIONS (top view)



TS393C,I,M

SCHEMATIC DIAGRAM (for 1/2 TS393)



ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|------------|--|-------------|--------------------|
| V_{CC}^+ | Supply Voltage ¹⁾ | 18 | V |
| V_{id} | Differential Input Voltage ²⁾ | ± 18 | V |
| V_i | Input Voltage ³⁾ | 18 | V |
| V_o | Output Voltage | 18 | V |
| I_o | Output Current | 20 | mA |
| I_F | Forward Current in ESD Protection Diodes on Inputs ⁴⁾ | 50 | mA |
| P_d | Power Dissipation ⁵⁾ | DIP8 | 1250 |
| | | SO8 | 710 |
| | | TSSOP8 | 625 |
| T_{stg} | Storage Temperature Range | -65 to +150 | $^{\circ}\text{C}$ |

- All voltage values, except differential voltage, are with respect to network ground terminal.
- Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
- Excursions of input voltages may exceed the power supply level. As long as the common mode voltage $[V_{icm}=(V_{in}^+ + V_{in}^-)/2]$ remains within the specified range, the comparator will provide a stable output state. However, the maximum current through the ESD diodes (if) of the input stage must strictly be observed. The output must never exceed the power supply voltage.
- Guaranteed by design.
- P_d is calculated with $T_{amb} = +25^{\circ}\text{C}$, $T_j = +150^{\circ}\text{C}$ and $R_{thja} = 100^{\circ}\text{C/W}$ for DIP8 package
 $= 175^{\circ}\text{C/W}$ for SO8 package
 $= 200^{\circ}\text{C/W}$ for TSSOP8 package

OPERATING CONDITIONS

| Symbol | Parameter | Value | Unit |
|------------|--------------------------------------|-----------------------|-------------|
| V_{CC}^+ | Supply Voltage | TS393C,I | 2.7 to 16 |
| | | TS393M | 4 to 16 |
| V_{icm} | Common Mode Input Voltage Range | 0 to $V_{CC}^+ - 1.5$ | V |
| T_{oper} | Operating Free-Air Temperature range | TS393C | 0 to +70 |
| | | TS393I | -40 to +125 |
| | | TS393M | -55 to +125 |

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

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|-----------|---|--------|-------------|--------------------------------------|---------|
| V_{io} | Input Offset Voltage ¹⁾ $V_{ic} = 1.5V$ $T_{min.} \leq T_{amb} \leq T_{max.}$ | | | 5 6.5 | mV |
| I_{io} | Input Offset Current ²⁾ $V_{ic} = 1.5V$ $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 1 | 300 | pA |
| I_{ib} | Input Bias Current ²⁾ $V_{ic} = 1.5V$ $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 1 | 600 | pA |
| V_{icm} | Input Common Mode Voltage Range $T_{min.} \leq T_{amb} \leq T_{max.}$ | 0 0 | | $V_{CC}^+ - 1.2$ $V_{CC}^+ - 1.5$ | V |
| CMR | Common-mode Rejection Ratio $V_{ic} = V_{icm min.}$ | | 70 | | dB |
| SVR | Supply Voltage Rejection Ratio $V_{CC}^+ = 3V$ to $5V$ | | 70 | | dB |
| I_{OH} | High Level Output Current $V_{id} = +1V$, $V_{OH} = 3V$ $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 2 | 40 1000 | nA |
| V_{OL} | Low Level Output Voltage $V_{id} = -1V$, $I_{OL} = +6mA$ $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 400 | 550 800 | mV |
| I_{CC} | Supply Current (each comparator) No load - Outputs low $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 9 | 20 25 | μA |
| t_{PLH} | Response Time Low to High $V_{ic} = 0V$, $f = 10kHz$, $R_L = 5.1k\Omega$, $C_L = 50pF$, Overdrive = 5mV TTL Input | | 1.5 0.7 | | μs |
| t_{PHL} | Response Time High to Low $V_{ic} = 0V$, $f = 10kHz$, $R_L = 5.1k\Omega$, $C_L = 50pF$, Overdrive = 5mV TTL Input | | 2.5 0.08 | | μs |

1. The specified offset voltage is the maximum value required to drive the output up to 2.5V or down to 0.3V.

2. Maximum values including unavoidable inaccuracies of the industrial test.

TS393C,I,M

ELECTRICAL CHARACTERISTICS

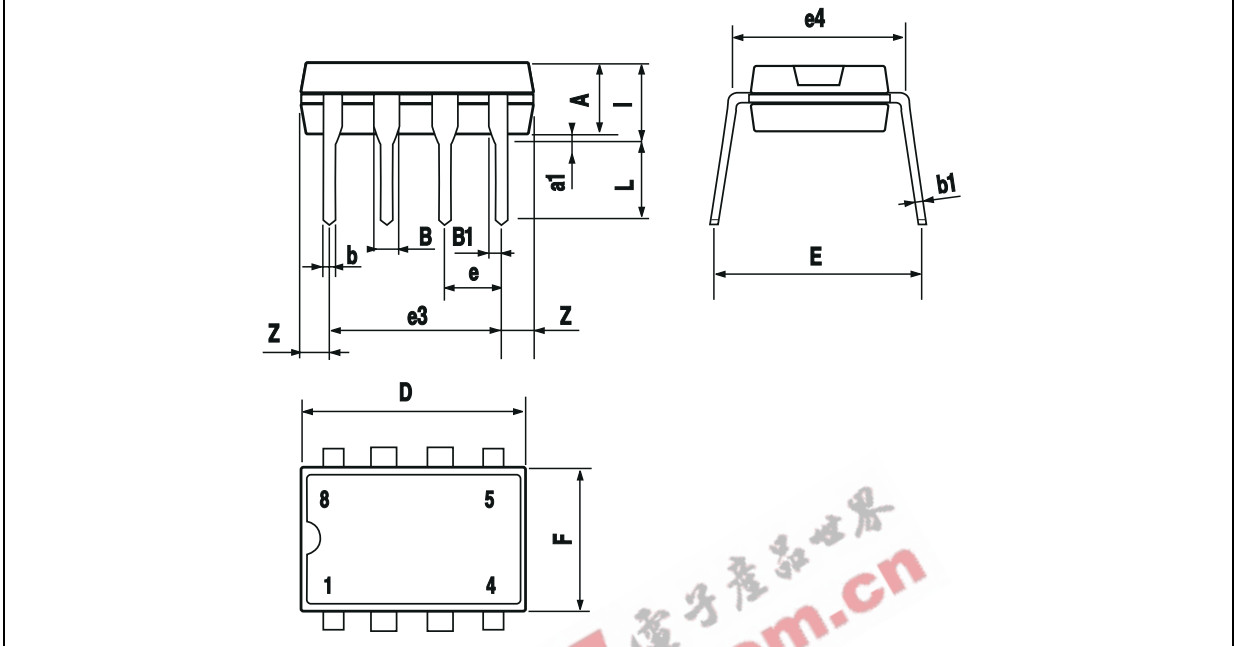
$V_{CC}^+ = 5V$, $V_{CC}^- = 0V$, $T_{amb} = 25^\circ C$ (unless otherwise specified)

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|-----------|--|--------|----------------------------------|--------------------------------------|---------|
| V_{io} | Input Offset Voltage $V_{ic} = 2.5V$, $V_{CC}^+ = 5V$ to $10V$ ¹⁾ $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 1.4 | 5 6.5 | mV |
| I_{io} | Input Offset Current ²⁾ $V_{ic} = 2.5V$ $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 1 | 300 | pA |
| I_{ib} | Input Bias Current ²⁾ $V_{ic} = 2.5V$ $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 1 | 600 | pA |
| V_{icm} | Input Common Mode Voltage Range $T_{min.} \leq T_{amb} \leq T_{max.}$ | 0 0 | | $V_{CC}^+ - 1.2$ $V_{CC}^+ - 1.5$ | V |
| CMR | Common-mode Rejection Ratio $V_{ic} = V_{icm min.}$ | | 71 | | dB |
| SVR | Supply Voltage Rejection Ratio $V_{CC}^+ = +5V$ to $+10V$ | | 80 | | dB |
| I_{OH} | High Level Output Current $V_{id} = 1V$, $V_{OH} = +5V$ $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 2 | 40 1000 | nA |
| V_{OL} | Low Level Output Voltage $V_{id} = -1V$, $I_{OL} = 6mA$ $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 260 | 400 650 | mV |
| I_{CC} | Supply Current (each comparator) No load - Outputs low $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 10 | 20 25 | μA |
| t_{PLH} | Response Time Low to High $V_{ic} = 0V$, $f = 10kHz$, $R_L = 5.1k\Omega$, $C_L = 50pF$, Overdrive = 5mV Overdrive = 10mV Overdrive = 20mV Overdrive = 40mV TTL Input | | 1.5 1.2 1.0 0.8 0.7 | | μs |
| t_{PHL} | Response Time High to Low $V_{ic} = 0V$, $f = 10kHz$, $R_L = 5.1k\Omega$, $C_L = 50pF$, Overdrive = 5mV Overdrive = 10mV Overdrive = 20mV Overdrive = 40mV TTL Input | | 2.5 1.9 1.2 0.8 0.08 | | μs |
| t_f | Fall time $f = 10kHz$, $C_L = 50pF$, $R_L = 5.1k\Omega$, Overdrive 50mV | | 25 | | ns |

1. The specified offset voltage is the maximum value required to drive the output up to 4.5V or down to 0.3V.

2. Maximum values including unavoidable inaccuracies of the industrial test.

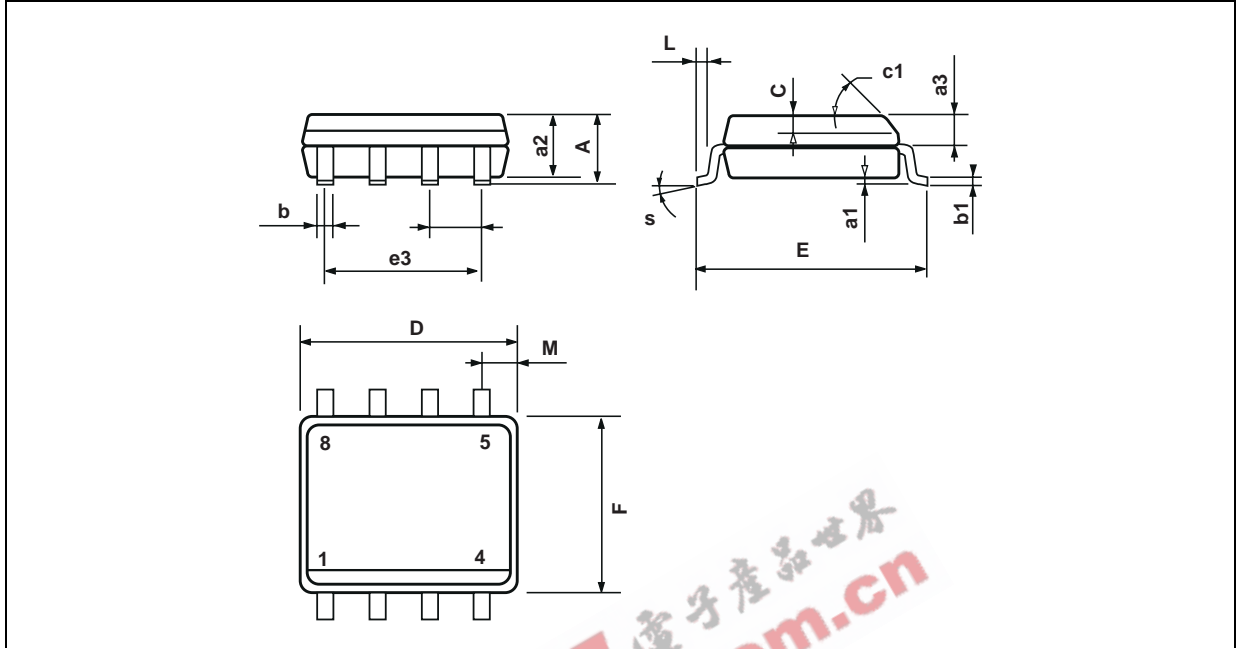
PACKAGE MECHANICAL DATA
 8 PINS - PLASTIC DIP



| Dimensions | Millimeters | | | Inches | | |
|------------|-------------|------|-------|--------|-------|-------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | 3.32 | | | 0.131 | |
| a1 | 0.51 | | | 0.020 | | |
| B | 1.15 | | 1.65 | 0.045 | | 0.065 |
| b | 0.356 | | 0.55 | 0.014 | | 0.022 |
| b1 | 0.204 | | 0.304 | 0.008 | | 0.012 |
| D | | | 10.92 | | | 0.430 |
| E | 7.95 | | 9.75 | 0.313 | | 0.384 |
| e | | 2.54 | | | 0.100 | |
| e3 | | 7.62 | | | 0.300 | |
| e4 | | 7.62 | | | 0.300 | |
| F | | | 6.6 | | | 0.260 |
| i | | | 5.08 | | | 0.200 |
| L | 3.18 | | 3.81 | 0.125 | | 0.150 |
| Z | | | 1.52 | | | 0.060 |

TS393C,I,M

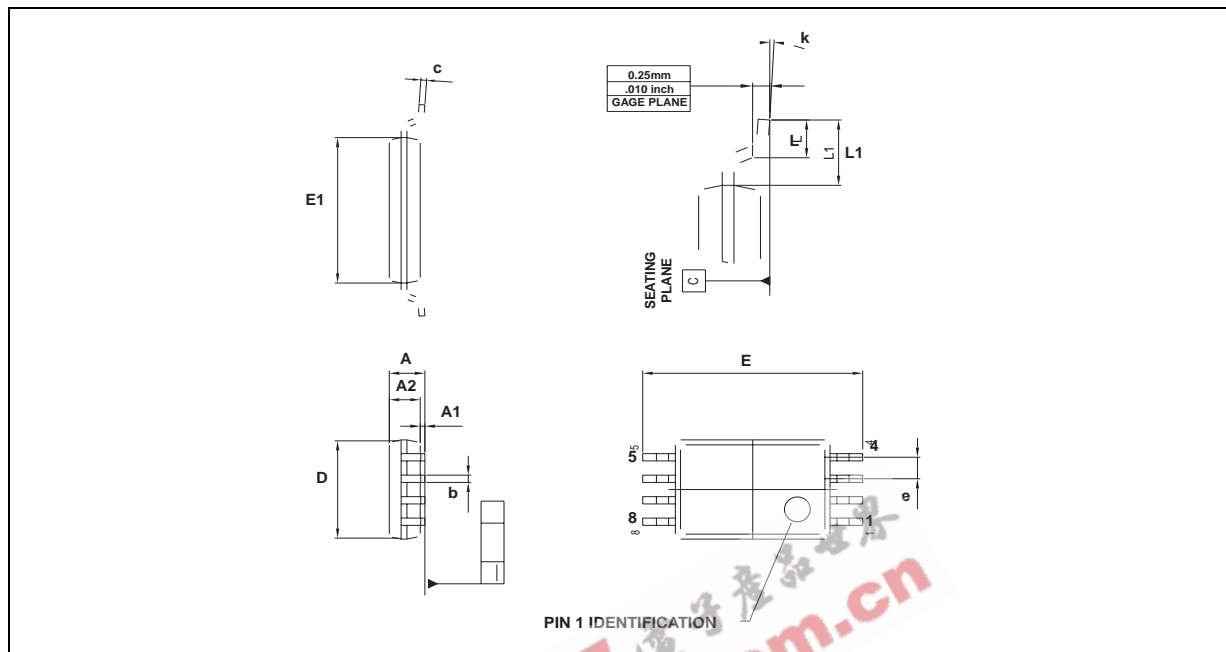
PACKAGE MECHANICAL DATA 8 PINS - PLASTIC MICROPACKAGE (SO)



| Dimensions | Millimeters | | | Inches | | |
|------------|-------------|------|------|--------|-------|-------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 1.75 | | | 0.069 |
| a1 | 0.1 | | 0.25 | 0.004 | | 0.010 |
| a2 | | | 1.65 | | | 0.065 |
| a3 | 0.65 | | 0.85 | 0.026 | | 0.033 |
| b | 0.35 | | 0.48 | 0.014 | | 0.019 |
| b1 | 0.19 | | 0.25 | 0.007 | | 0.010 |
| C | 0.25 | | 0.5 | 0.010 | | 0.020 |
| c1 | 45° (typ.) | | | | | |
| D | 4.8 | | 5.0 | 0.189 | | 0.197 |
| E | 5.8 | | 6.2 | 0.228 | | 0.244 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 3.81 | | | 0.150 | |
| F | 3.8 | | 4.0 | 0.150 | | 0.157 |
| L | 0.4 | | 1.27 | 0.016 | | 0.050 |
| M | | | 0.6 | | | 0.024 |
| S | 8° (max.) | | | | | |

PACKAGE MECHANICAL DATA

8 PINS - THIN SHRINK SMALL OUTLINE PACKAGE (TSSOP)



| Dimensions | Millimeters | | | Inches | | |
|------------|-------------|-------|------|--------|--------|-------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 1.20 | | | 0.05 |
| A1 | 0.05 | | 0.15 | 0.01 | | 0.006 |
| A2 | 0.80 | 1.00 | 1.05 | 0.031 | 0.039 | 0.041 |
| b | 0.19 | | 0.30 | 0.007 | | 0.15 |
| c | 0.09 | | 0.20 | 0.003 | | 0.012 |
| D | 2.90 | 3.00 | 3.10 | 0.114 | 0.118 | 0.122 |
| E | | 6.40 | | | 0.252 | |
| E1 | 4.30 | 4.40 | 4.50 | 0.169 | 0.173 | 0.177 |
| e | | 0.65 | | | 0.025 | |
| k | 0° | | 8° | 0° | | 8° |
| l | 0.50 | 0.60 | 0.75 | 0.09 | 0.0236 | 0.030 |
| L | 0.45 | 0.600 | 0.75 | 0.018 | 0.024 | 0.030 |
| L1 | | 1.000 | | | 0.039 | |

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