



**TS1851
TS1852
TS1854**

1.8V INPUT/OUTPUT RAIL TO RAIL LOW POWER OPERATIONAL AMPLIFIERS

- OPERATING AT $V_{CC} = 1.8V$ to $6V$
- RAIL TO RAIL **INPUT & OUTPUT**
- EXTENDED V_{icm} ($V_{ee} - 0.2V$ to $V_{CC} + 0.2V$)
- LOW SUPPLY CURRENT ($120\mu A$)
- GAIN BANDWIDTH PRODUCT (**480kHz**)
- HIGH STABILITY (**able to drive 500pF**)
- ESD TOLERANCE (**2kV**)
- LATCH-UP IMMUNITY
- AVAILABLE IN **SOT23-5 MICROPACKAGE**

DESCRIPTION

The TS185x (Single, Dual & Quad) is operational amplifier able to operate with voltages as low as 1.8V and features both Input and Output Rail to Rail ($1.71 @ V_{CC} = 1.8V, R_L = 2k\Omega$), $120\mu A$ consumption current and 480kHz Gain Bandwidth Product.

With a such low consumption and a sufficient GBP for many applications, this Op-Amp is very well-suited for any kind of battery-supplied and portable equipment applications.

The TS1851 is housed in the space-saving 5 pin SOT23-5 package which simplifies the board design (outside dimensions are 2.8mm x 2.9mm).

APPLICATION

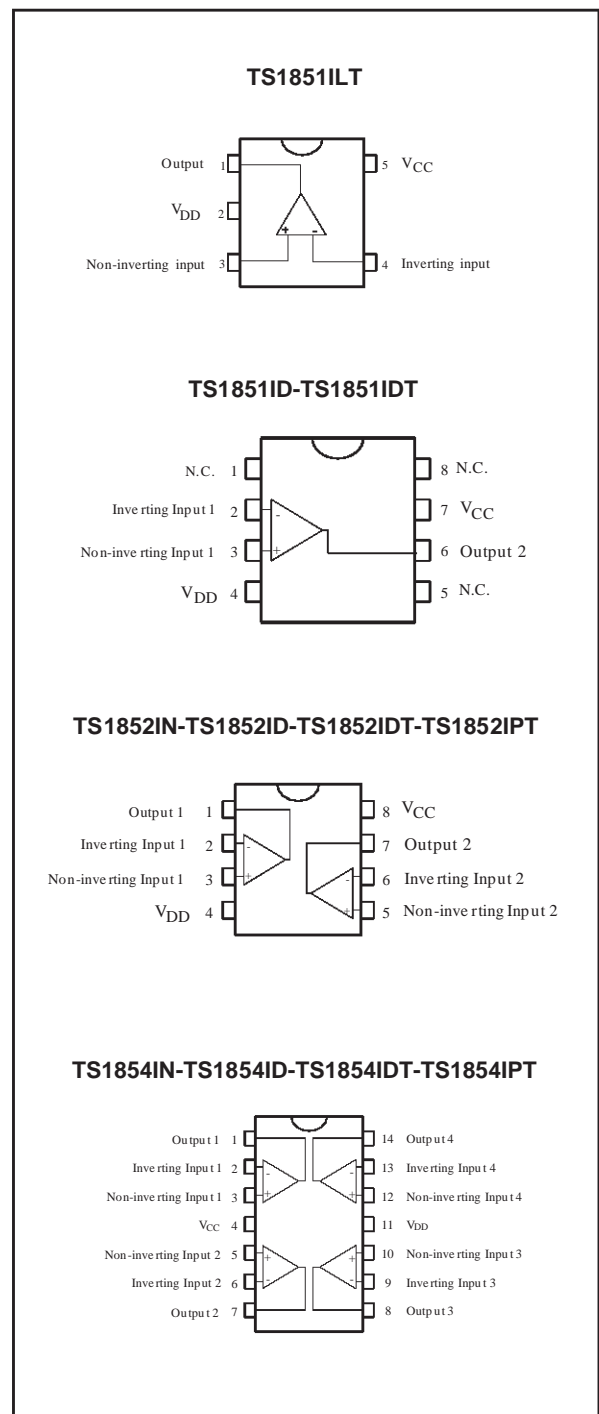
- Two-cell battery-powered systems
- Portable/Battery-powered electronic equipment
- Cordless phones
- Cellular phones
- Laptops
- PDAs

ORDER CODE

| Part Number | Temperature Range | Package | | | | SOT23 Marking |
|-------------|-------------------|---------|---|---|---|---------------|
| | | N | D | P | L | |
| TS1851I/AI | -40, +125°C | | • | | • | K161/K162 |
| TS1852I/AI | | • | • | • | | |
| TS1854I/AI | | • | • | • | | |

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)
 L = Tiny Package (SOT23-5) - only available in Tape & Reel (LT)

PIN CONNECTIONS (top view)



ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|------------|---|------------------------|------|
| V_{CC} | Supply voltage ¹⁾ | 7 | V |
| V_{id} | Differential Input Voltage ²⁾ | ± 1 | V |
| V_i | Input Voltage ³⁾ | -0.3 to $V_{CC} + 0.3$ | V |
| T_{oper} | Operating Free Air Temperature Range | -40 to + 125 | °C |
| T_{std} | Storage Temperature | -65 to +150 | °C |
| T_j | Maximum Junction Temperature | 150 | °C |
| R_{thjc} | Thermal Resistance Junction to Case ⁴⁾ | | °C/W |
| | SOT23-5 | 81 | |
| | DIP8 | 42 | |
| | DIP14 | 32 | |
| | SO8 | 28 | |
| | SO14 | 22 | |
| | TSSOP8 | 26 | |
| | TSSOP14 | 21 | |
| R_{thja} | Thermal Resistance Junction to Ambient - SOT23-5 | 256 | °C/W |
| ESD | Human Body Model | 2 | kV |
| | Lead Temperature (soldering, 10sec) | 260 | °C |

1. All voltages values, except differential voltage are with respect to network terminal.
2. Differential voltages are non-inverting input terminal with respect to the inverting input terminal.
3. The magnitude of input and output voltages must never exceed $V_{CC} + 0.3V$.
4. Short-circuits can cause excessive heating. Destructive dissipation can result from simultaneous short-circuit on all amplifiers

OPERATING CONDITIONS

| Symbol | Parameter | Value | Unit |
|-----------|---|----------------------------------|------|
| V_{CC} | Supply Voltage | 1.8 to 6 | V |
| V_{icm} | Common Mode Input Voltage Range ¹⁾ | $V_{ee} - 0.2$ to $V_{CC} + 0.2$ | V |
| V_{icm} | Common Mode Input Voltage Range ²⁾ | V_{ee} to V_{CC} | V |

1. At 25°C, for $1.8 \leq V_{CC} \leq 6V$, V_{icm} is extended to $V_{ee} - 0.2V$, $V_{CC} + 0.2V$.
2. In full temperature range, both Rails can be reached when V_{CC} does not exceed 5.5V.

TS1851-TS1852-TS1854

ELECTRICAL CHARACTERISTICS

$V_{CC} = +1.8V$, $V_{ee} = 0V$,

$T_{amb} = 25^{\circ}C$ (unless otherwise specified)

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|-----------------|---|-------------|-------------|----------|-------------------|
| V_{io} | Input Offset Voltage TS1851/2/4 TS1851A/2A/4A | | 0.1 | 3 1 | mV |
| ΔV_{io} | Input Offset Voltage Drift | | 2 | | $\mu V/^{\circ}C$ |
| I_{io} | Input Offset Current ¹⁾ | | 1 | 9 | nA |
| I_{ib} | Input Bias Current ¹⁾ | | 10 | 50 | nA |
| CMR | Common Mode Rejection Ratio $0 \leq V_{icm} \leq V_{CC}$ | 55 | 85 | | dB |
| SVR | Supply Voltage Rejection Ratio $V_{icm} = 0.5V$ | 70 | 80 | | dB |
| A_{vd} | Large Signal Voltage Gain $R_L = 10k\Omega$ $R_L = 2k\Omega$ | 80 70 | 100 88 | | dB |
| V_{OH} | High Level Output Voltage $R_L = 10k\Omega$ $R_L = 2k\Omega$ | 1.7 1.65 | 1.77 1.7 | | V |
| V_{OL} | Low Level Output Voltage $R_L = 10k\Omega$ $R_L = 2k\Omega$ | | 40 62 | 70 90 | mV |
| I_o | Output Source Current $V_{ID} = 100mV$, $V_O = V_{DD}$ Output Sink Current $V_{ID} = -100mV$, $V_O = V_{CC}$ | 2 2 | 29 46 | | mA |
| I_{CC} | Supply Current (per amplifier) $A_{VCL} = 1$, no load | | 120 | 170 | μA |
| GBP | Gain Bandwidth Product $R_L = 10k\Omega$, $C_L = 100pF$, $f = 100kHz$ | 300 | 480 | | kHz |
| SR | Slew Rate $R_L = 10k\Omega$, $C_L = 100pF$, $AV = 1$ | 0.1 | 0.18 | | $V/\mu s$ |
| ϕ_m | Phase Margin $C_L = 100pF$ | | 60 | | Degrees |
| en | Input Voltage Noise | | 40 | | nV/\sqrt{Hz} |
| THD | Total Harmonic Distortion | | 0.01 | | % |

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

ELECTRICAL CHARACTERISTICS

$V_{CC} = +3V$, $V_{EE} = 0V$,

$T_{amb} = 25^{\circ}C$ (unless otherwise specified)

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|-----------------|---|-------------|--------------|-----------|-------------------|
| V_{io} | Input Offset Voltage TS1851/2/4 TS1851A/2A/4A | | 0.1 | 3 1 | mV |
| ΔV_{io} | Input Offset Voltage Drift | | 2 | | $\mu V/^{\circ}C$ |
| I_{io} | Input Offset Current ¹⁾ | | 1 | 9 | nA |
| I_{ib} | Input Bias Current ¹⁾ | | 10 | 55 | nA |
| CMR | Common Mode Rejection Ratio $0 \leq V_{icm} \leq V_{CC}$ | 60 | 90 | | dB |
| SVR | Supply Voltage Rejection Ratio $V_{icm} = V_{CC}/2$ | 70 | 85 | | dB |
| A_{vd} | Large Signal Voltage Gain $R_L = 10k\Omega$ $R_L = 2k\Omega$ | 83 74 | 99 90 | | dB |
| V_{OH} | High Level Output Voltage $R_L = 10k\Omega$ $R_L = 2k\Omega$ | 2.9 2.85 | 2.96 2.94 | | V |
| V_{OL} | Low Level Output Voltage $R_L = 10k\Omega$ $R_L = 2k\Omega$ | | 10 46 | 90 100 | mV |
| I_o | Output Source Current $V_{ID} = 100mV$, $V_O = V_{DD}$ Output Sink Current $V_{ID} = -100mV$, $V_O = V_{CC}$ | 2 2 | 47 47 | | mA |
| I_{CC} | Supply Current (per amplifier) $A_{VCL} = 1$, no load | | 150 | 200 | μA |
| GBP | Gain Bandwidth Product $R_L = 10k\Omega$, $C_L = 100pF$, $f = 100kHz$ | 370 | 600 | | kHz |
| SR | Slew Rate $R_L = 10k\Omega$, $C_L = 100pF$, $AV = 1$ | 0.12 | 0.2 | | V/ μs |
| ϕ_m | Phase Margin $C_L = 100pF$ | | 60 | | Degrees |
| en | Input Voltage Noise | | 40 | | nV/ \sqrt{Hz} |
| THD | Total Harmonic Distortion | | 0.01 | | % |

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

TS1851-TS1852-TS1854

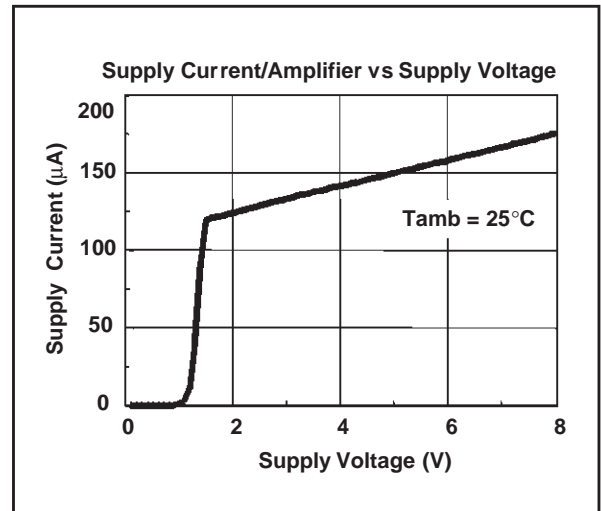
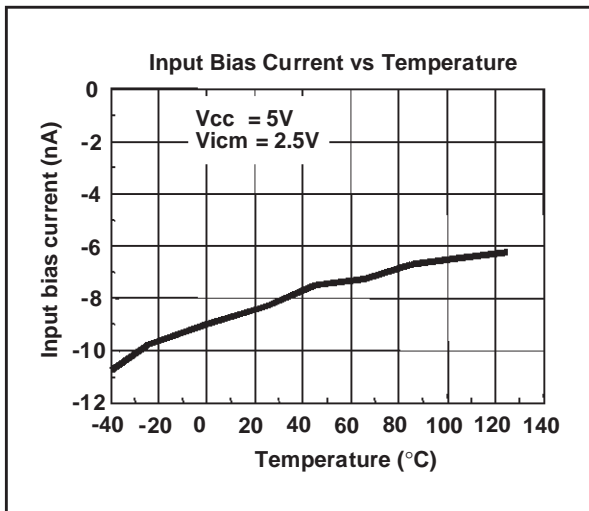
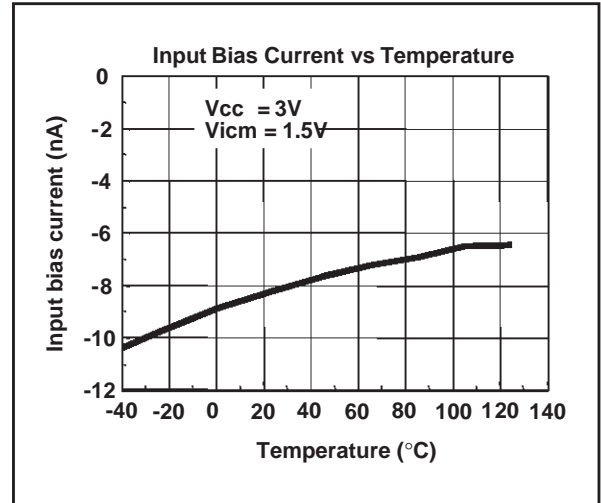
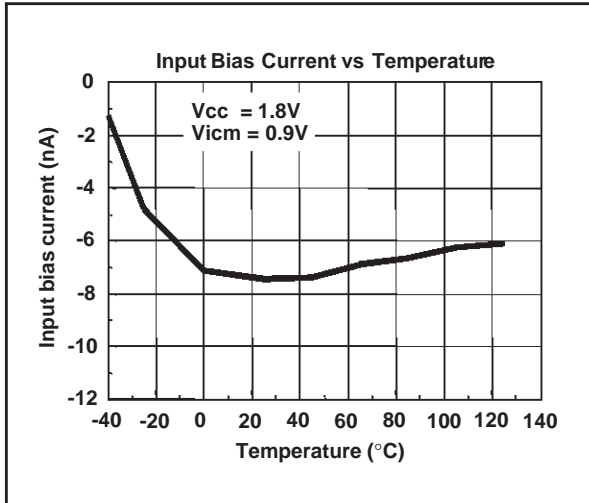
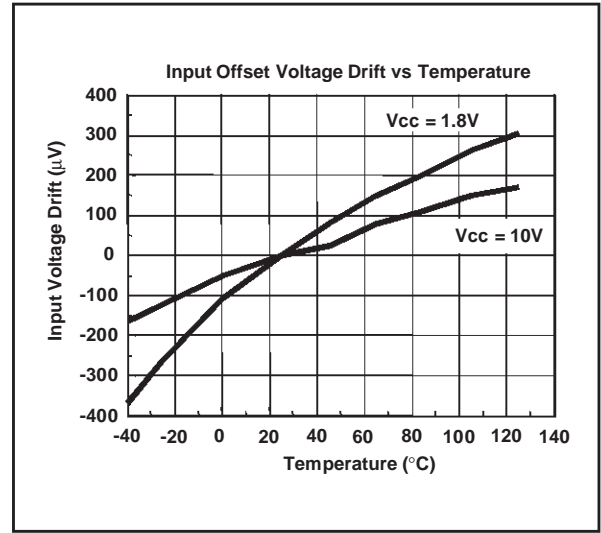
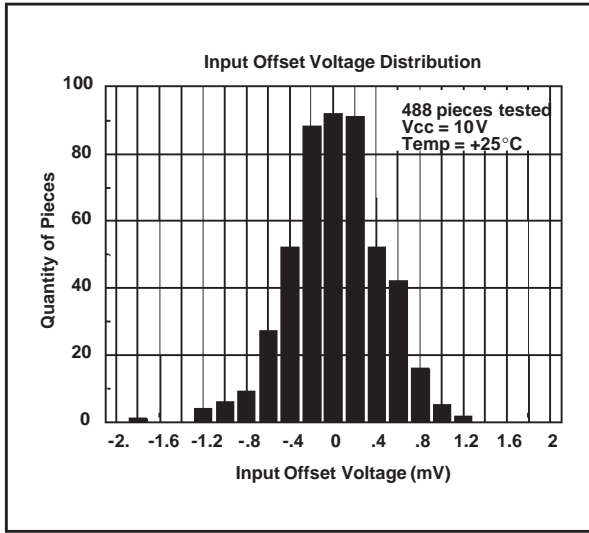
ELECTRICAL CHARACTERISTICS

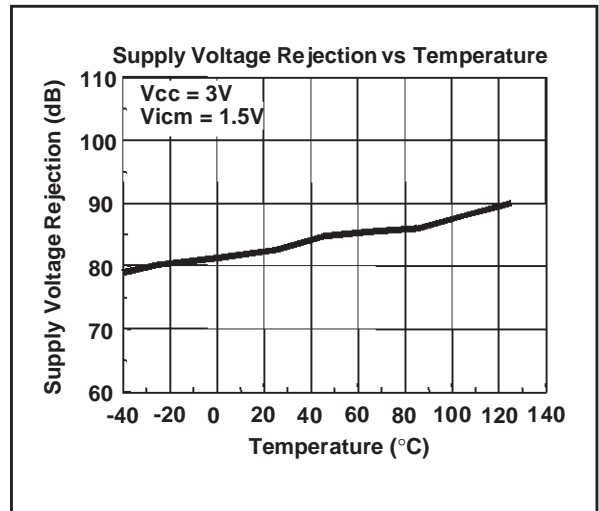
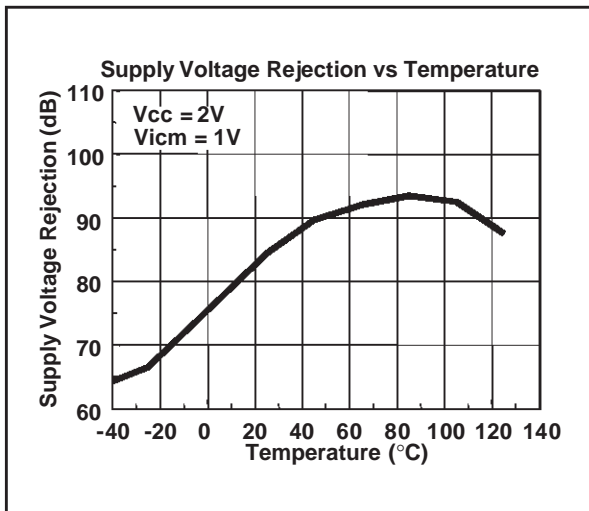
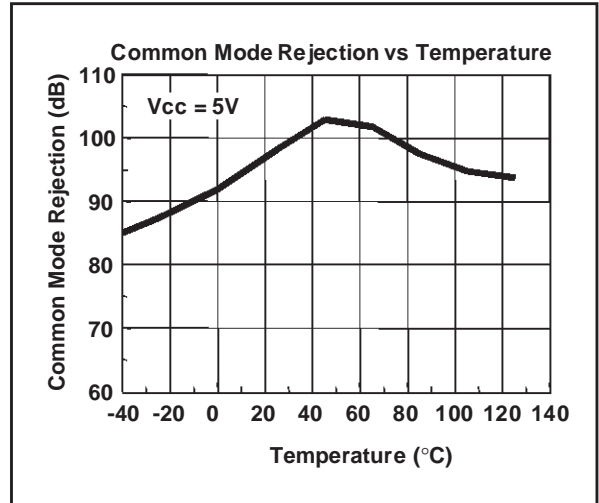
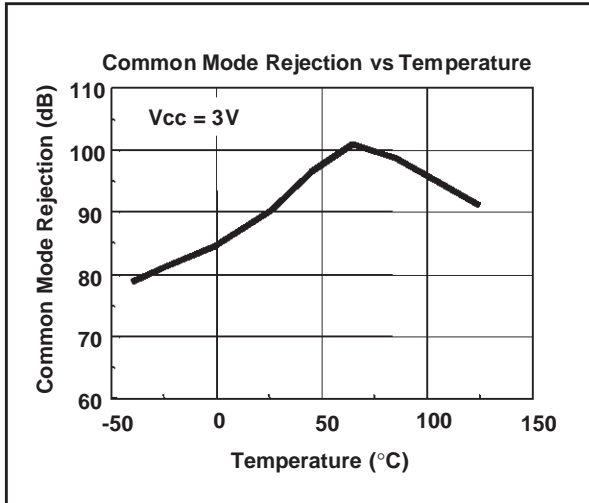
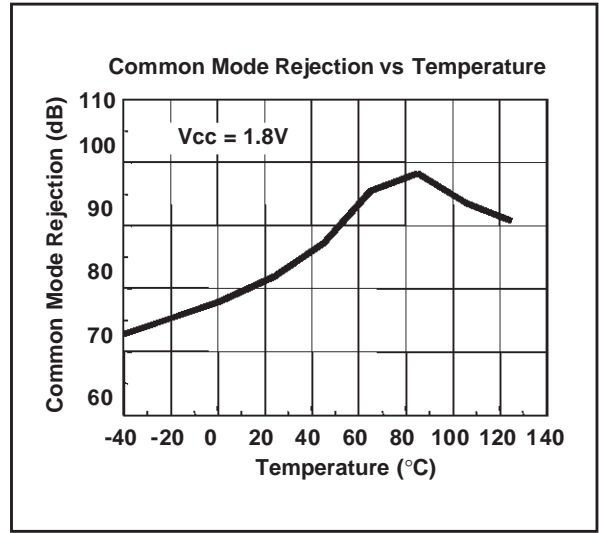
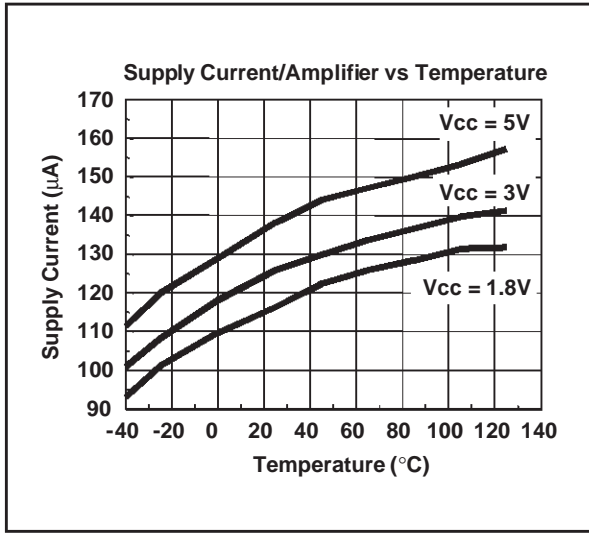
$V_{CC} = +5V$, $V_{EE} = 0V$,

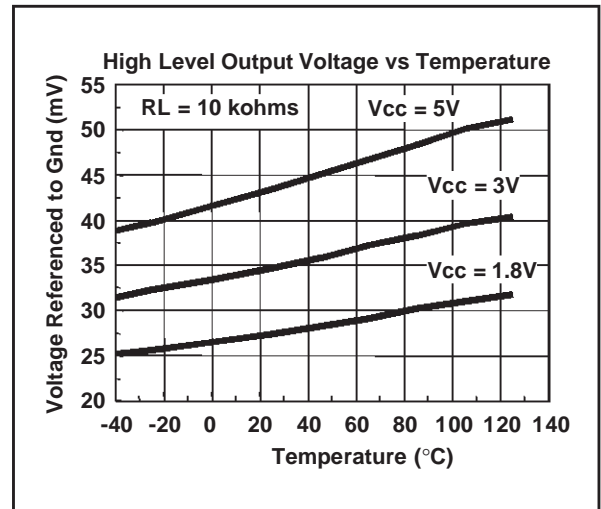
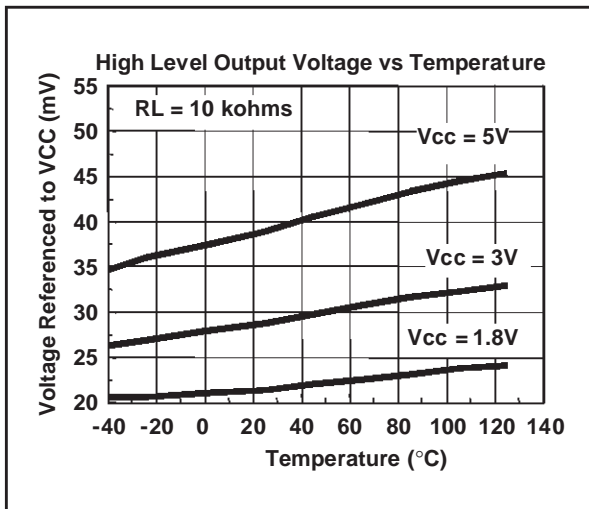
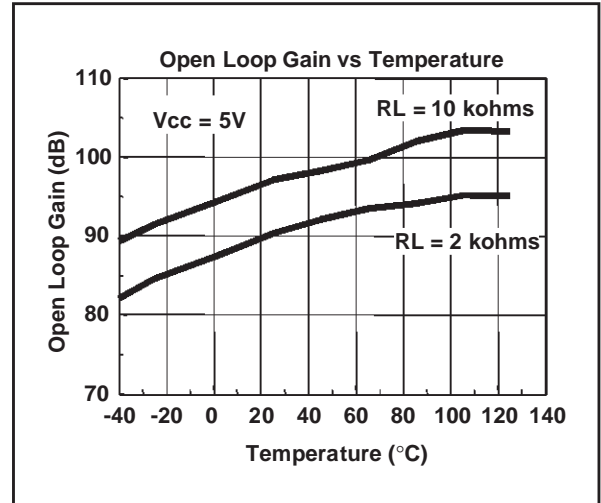
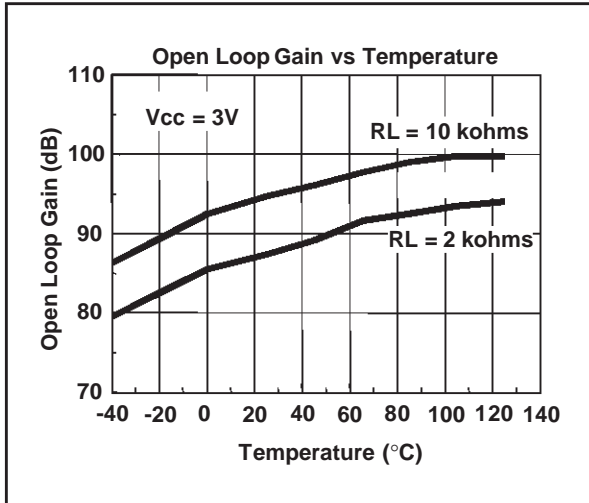
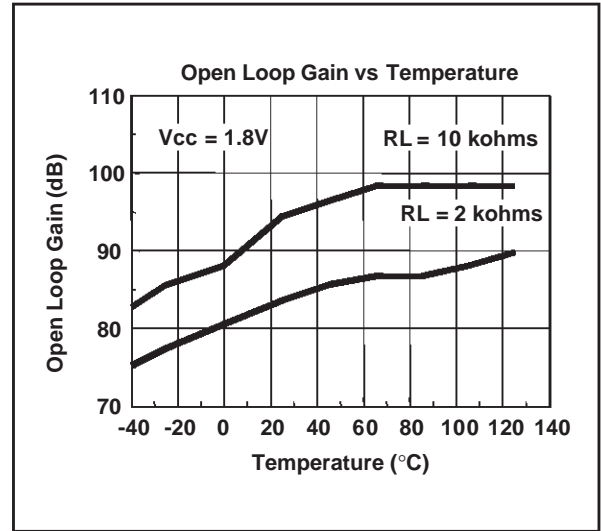
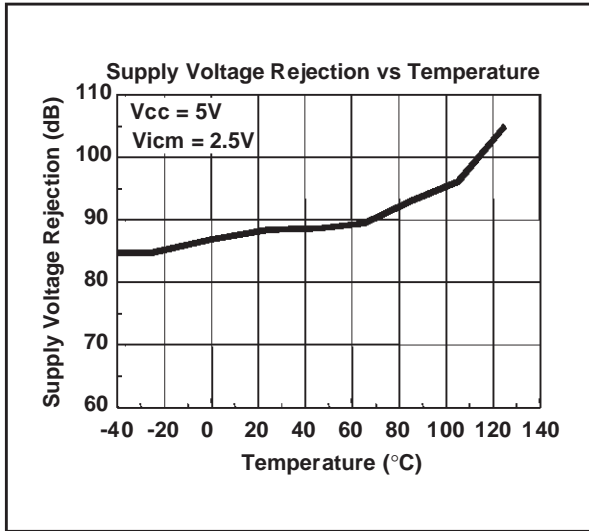
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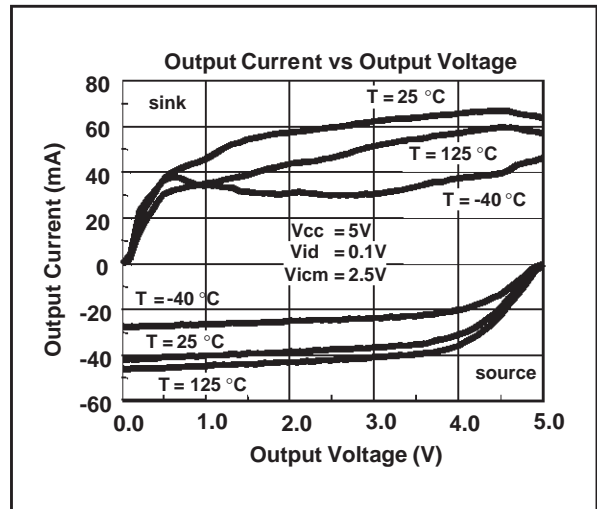
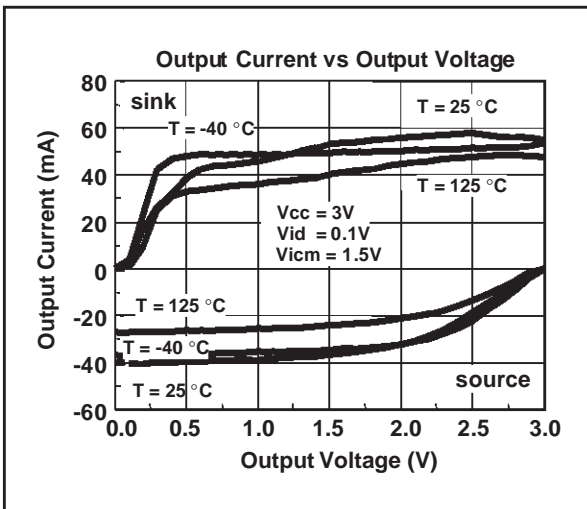
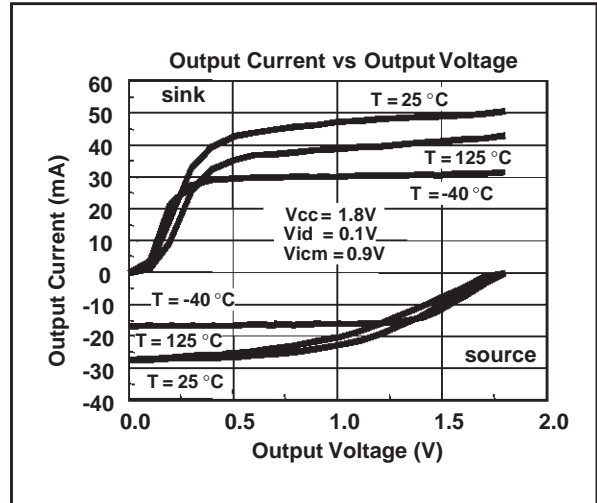
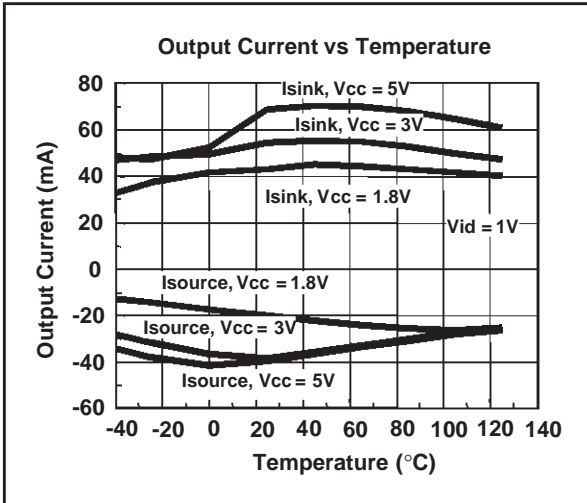
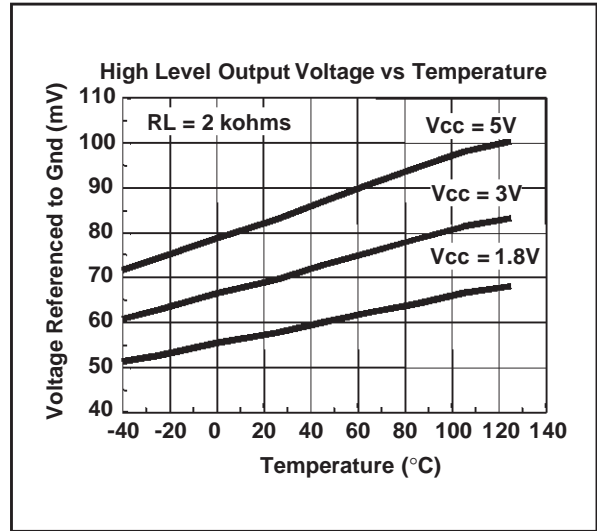
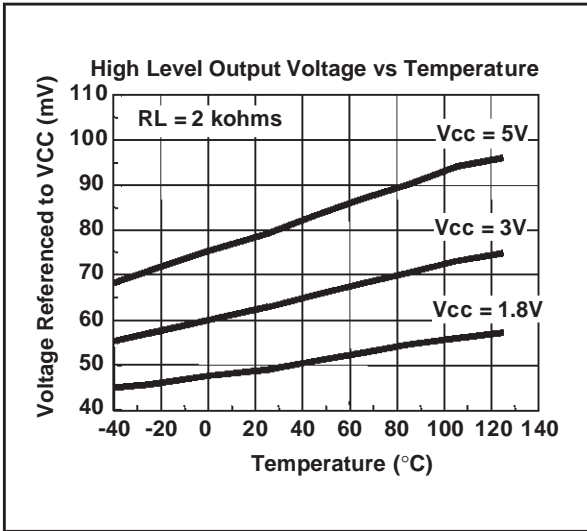
| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|-----------------|---|-------------|--------------|------------|-------------------|
| V_{io} | Input Offset Voltage TS1851/2/4 TS1851A/2A/4A | | 0.1 | 3 1 | mV |
| ΔV_{io} | Input Offset Voltage Drift | | 2 | | $\mu V/^{\circ}C$ |
| I_{io} | Input Offset Current ¹⁾ | | 1 | 9 | nA |
| I_{ib} | Input Bias Current ¹⁾ | | 16 | 63 | nA |
| CMR | Common Mode Rejection Ratio $0 \leq V_{icm} \leq V_{CC}$ | 65 | 95 | | dB |
| SVR | Supply Voltage Rejection Ratio $V_{icm} = V_{CC}/2$ | 70 | 90 | | dB |
| A_{vd} | Large Signal Voltage Gain $R_L = 10k\Omega$ $R_L = 2k\Omega$ | 85 77 | 97 93 | | dB |
| V_{OH} | High Level Output Voltage $R_L = 10k\Omega$ $R_L = 2k\Omega$ | 4.85 4.8 | 4.95 4.91 | | V |
| V_{OL} | Low Level Output Voltage $R_L = 10k\Omega$ $R_L = 2k\Omega$ | | 40 80 | 180 200 | mV |
| I_o | Output Source Current $V_{ID} = 100mV$, $V_O = V_{DD}$ Output Sink Current $V_{ID} = -100mV$, $V_O = V_{CC}$ | 2 2 | 48 48 | | mA |
| I_{CC} | Supply Current (per amplifier) $A_{VCL} = 1$, no load | | 162 | 220 | μA |
| GBP | Gain Bandwidth Product $R_L = 10k\Omega$, $C_L = 100pF$, $f = 100kHz$ | 380 | 630 | | kHz |
| SR | Slew Rate $R_L = 10k\Omega$, $C_L = 100pF$, $AV = 1$ | 0.13 | 0.25 | | $V/\mu s$ |
| ϕ_m | Phase Margin $C_L = 100pF$ | | 60 | | Degrees |
| en | Input Voltage Noise | | 40 | | nV/\sqrt{Hz} |
| THD | Total Harmonic Distortion | | 0.01 | | % |

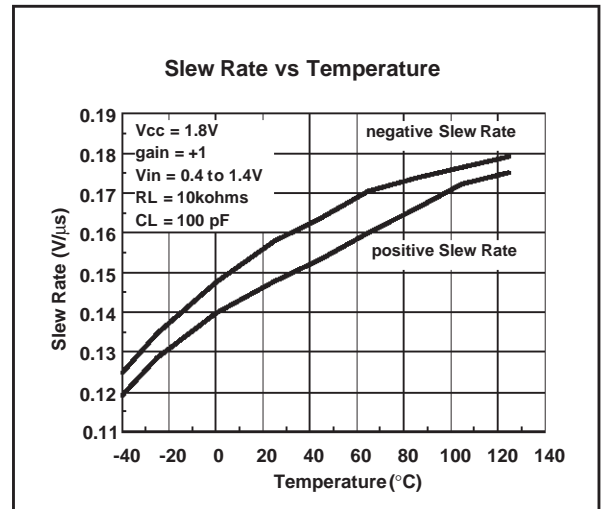
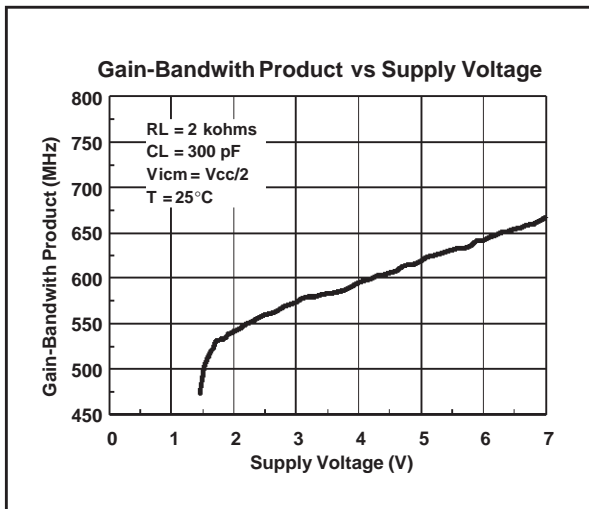
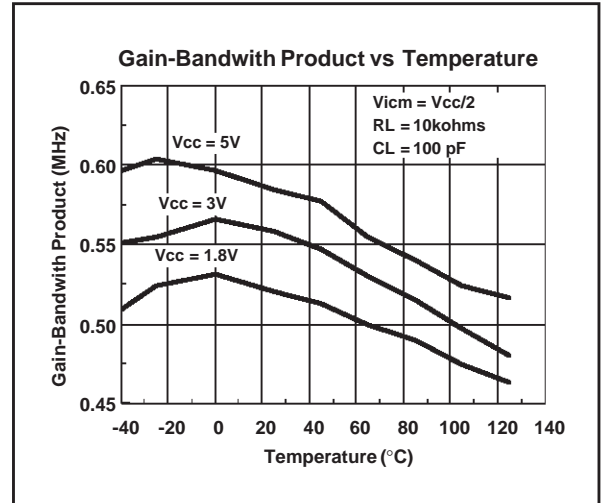
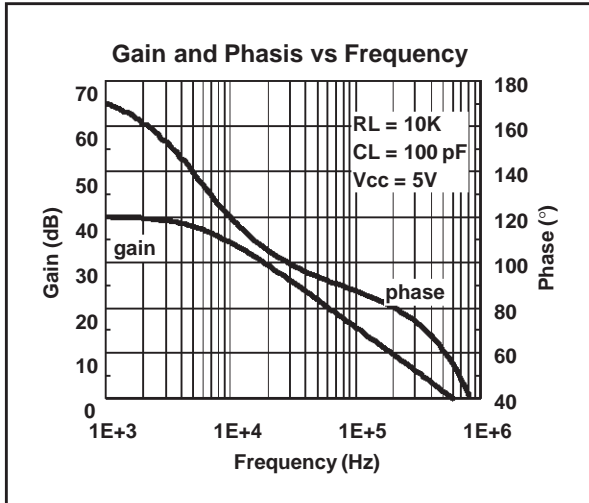
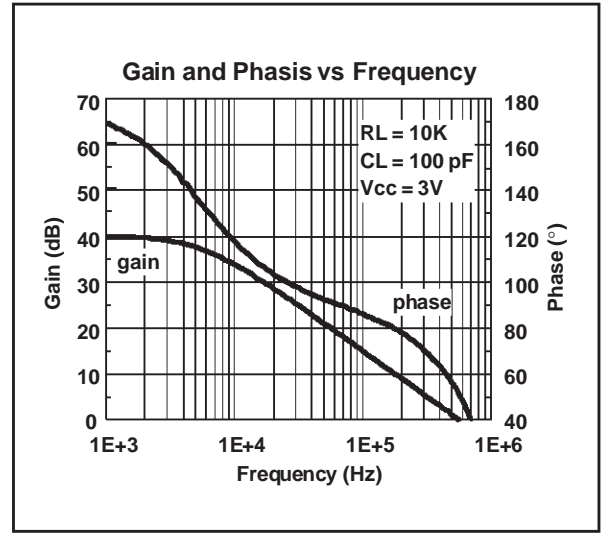
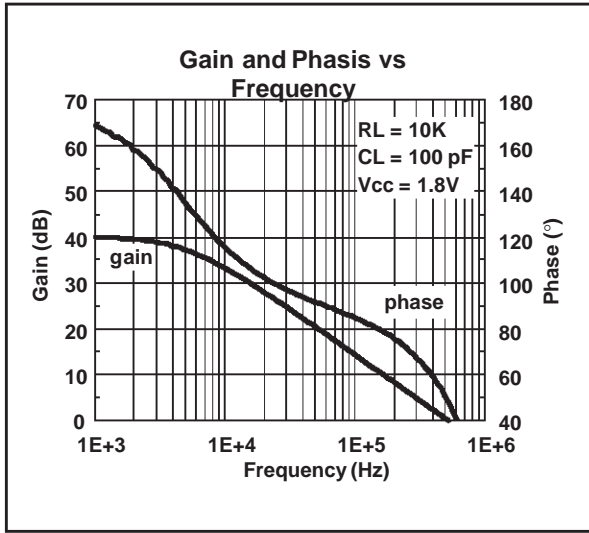
1. Maximum values including unavoidable inaccuracies of the industrial test.

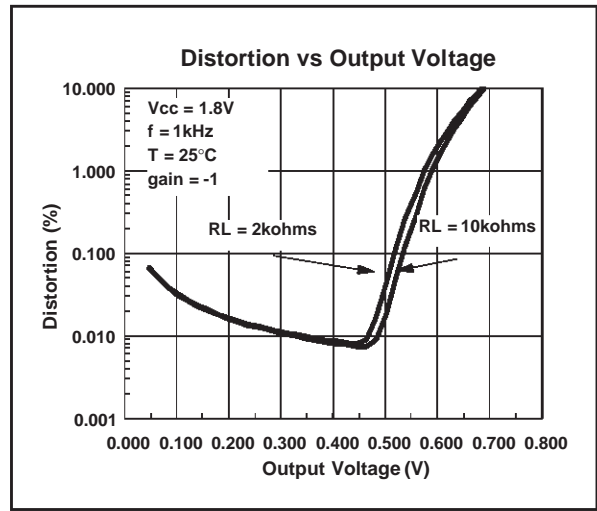
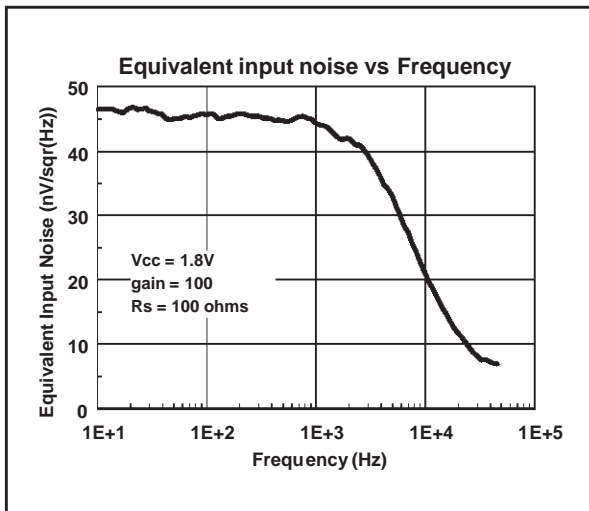
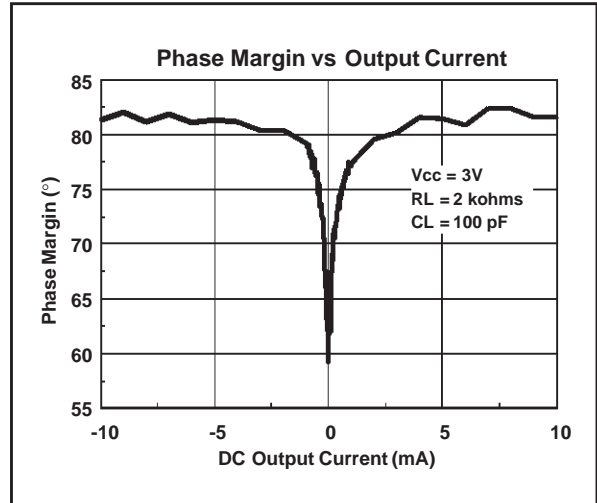
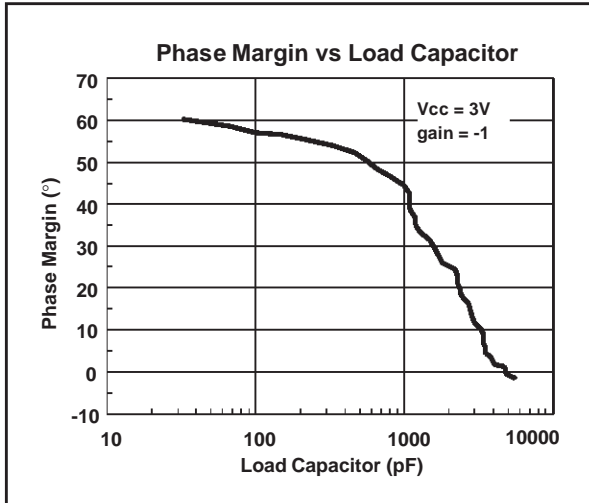
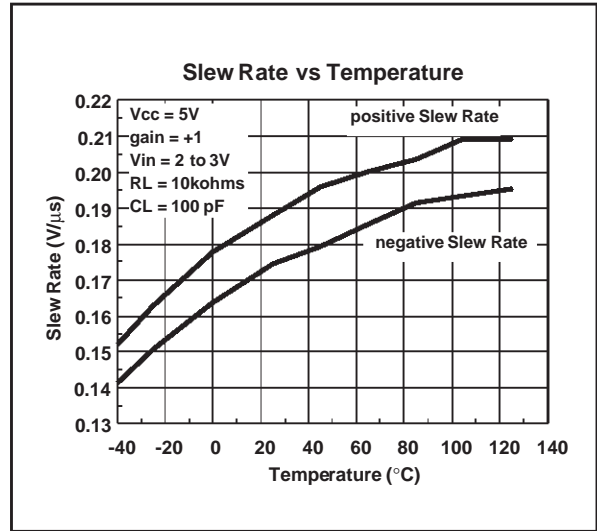
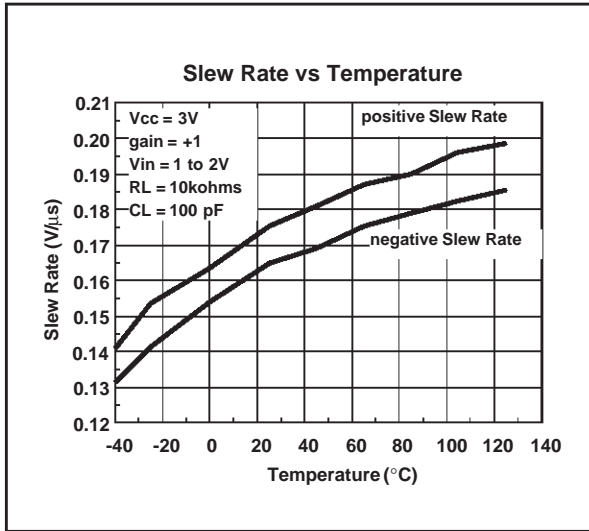


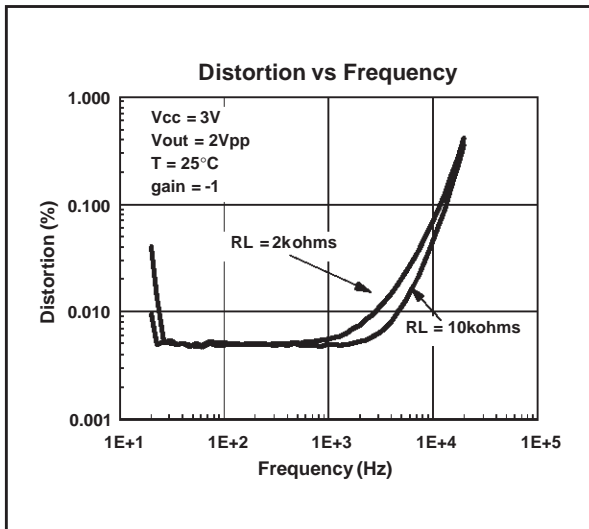
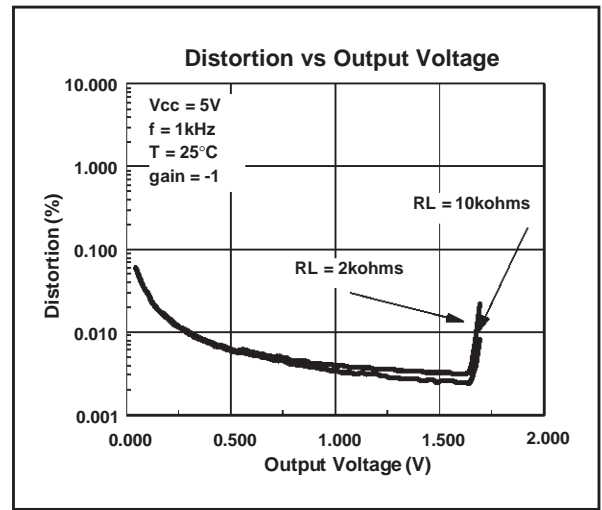
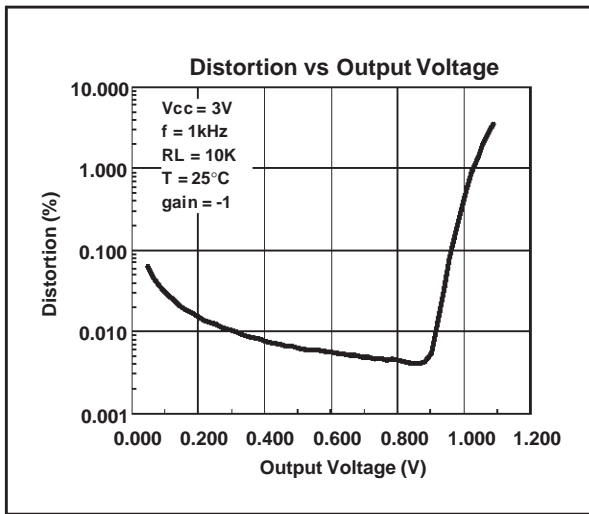






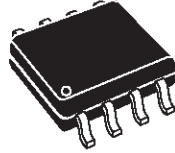




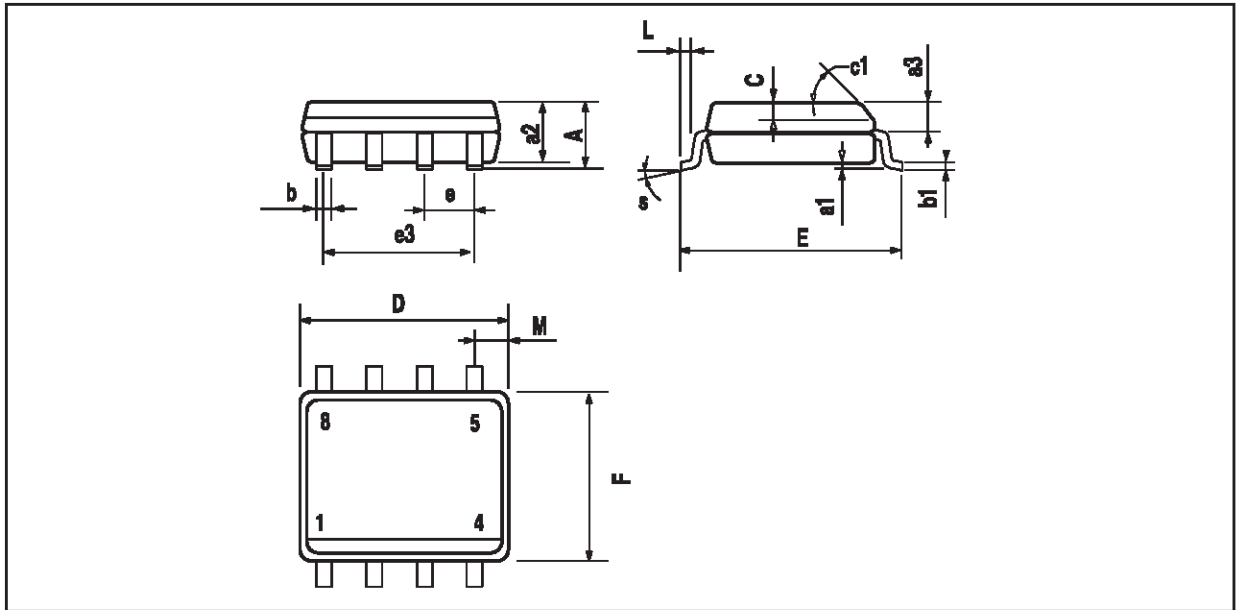


TS1851-TS1852-TS1854

TS1851ID - TS1852ID

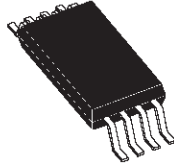


PACKAGE MECHANICAL DATA
8 PINS - PLASTIC MICROPACKAGE (SO)

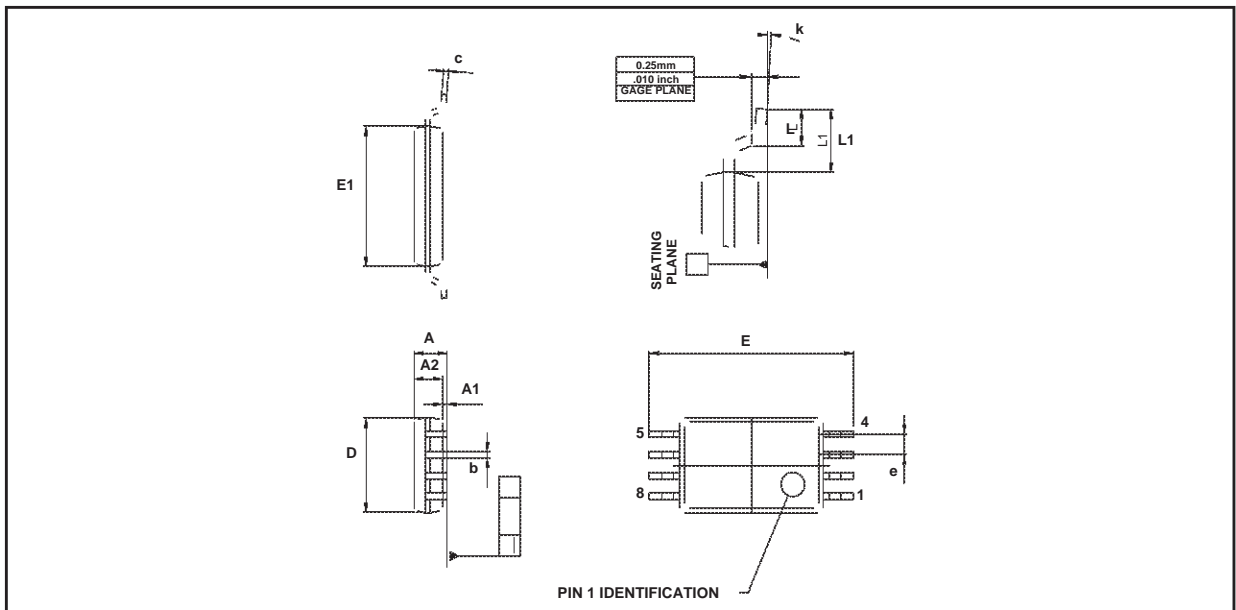


| Dim. | Millimeters | | | Inches | | |
|------|-------------|------|------|--------|-------|-------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 1.75 | | | 0.069 |
| a1 | 0.1 | | 0.25 | 0.004 | | 0.010 |
| a2 | | | 1.65 | | | 0.065 |
| a3 | 0.65 | | 0.85 | 0.026 | | 0.033 |
| b | 0.35 | | 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.) | | | | | |

TS1852IPT



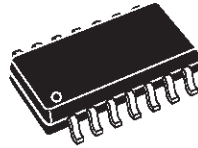
PACKAGE MECHANICAL DATA
8 PINS - THIN SHRINK SMALL OUTLINE PACKAGE



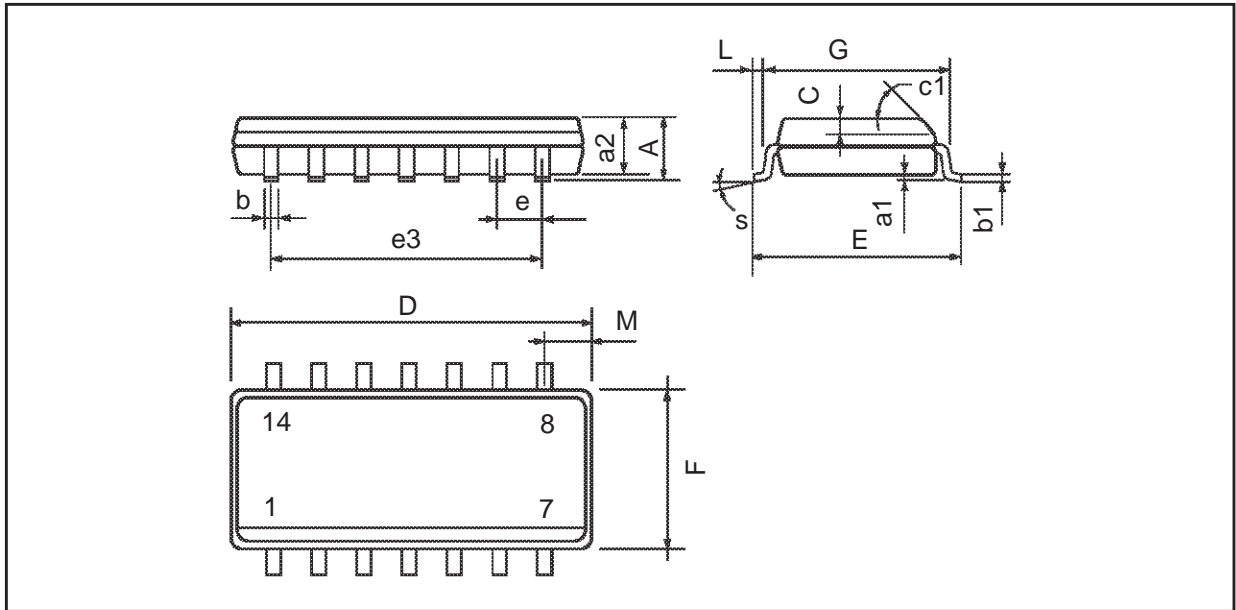
| Dim. | Millimeters | | | Inches | | |
|------|-------------|------|------|--------|--------|-------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 1.20 | | | 0.05 |
| A1 | 0.05 | | 0.15 | 0.01 | | 0.006 |
| A2 | 0.80 | 1.00 | 1.05 | 0.031 | 0.039 | 0.041 |
| b | 0.19 | | 0.30 | 0.007 | | 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 |

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TS1854ID



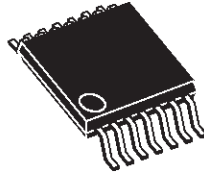
PACKAGE MECHANICAL DATA
14 PINS - PLASTIC MICROPACKAGE (SO)



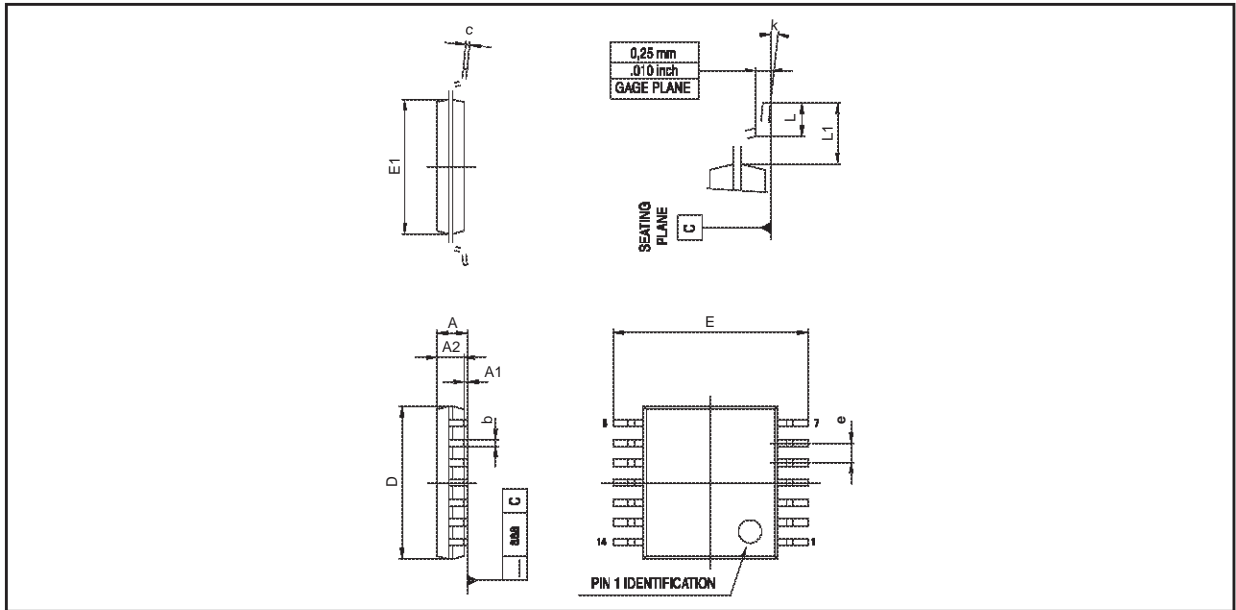
| Dim. | Millimeters | | | Inches | | |
|-------|-------------|------|------|--------|-------|-------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 1.75 | | | 0.069 |
| a1 | 0.1 | | 0.2 | 0.004 | | 0.008 |
| a2 | | | 1.6 | | | 0.063 |
| b | 0.35 | | 0.46 | 0.014 | | 0.018 |
| b1 | 0.19 | | 0.25 | 0.007 | | 0.010 |
| C | | 0.5 | | | 0.020 | |
| c1 | 45° (typ.) | | | | | |
| D (1) | 8.55 | | 8.75 | 0.336 | | 0.344 |
| E | 5.8 | | 6.2 | 0.228 | | 0.244 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 7.62 | | | 0.300 | |
| F (1) | 3.8 | | 4.0 | 0.150 | | 0.157 |
| G | 4.6 | | 5.3 | 0.181 | | 0.208 |
| L | 0.5 | | 1.27 | 0.020 | | 0.050 |
| M | | | 0.68 | | | 0.027 |
| S | 8° (max.) | | | | | |

Note : (1) D and F do not include mold flash or protrusions - Mold flash or protrusions shall not exceed 0.15mm (.066 inc) ONLY FOR DATA BOOK.

TS1854IPT



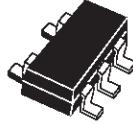
PACKAGE MECHANICAL DATA
14 PINS - THIN SHRINK SMALL OUTLINE PACKAGE



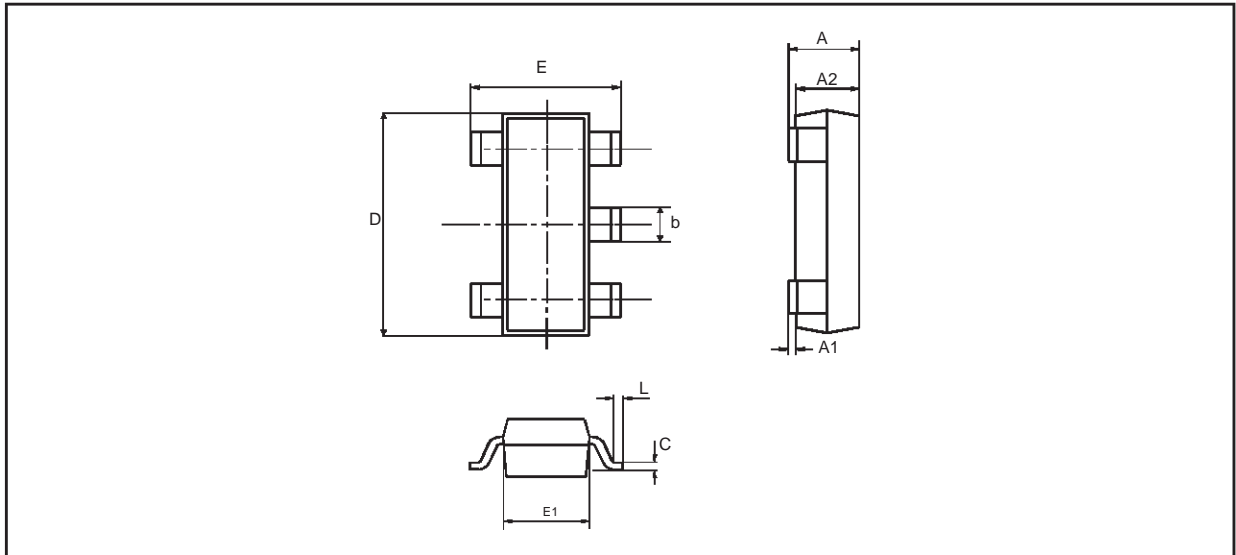
| Dim. | Millimeters | | | Inches | | |
|------|-------------|------|------|--------|--------|-------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 1.20 | | | 0.05 |
| A1 | 0.05 | | 0.15 | 0.01 | | 0.006 |
| A2 | 0.80 | 1.00 | 1.05 | 0.031 | 0.039 | 0.041 |
| b | 0.19 | | 0.30 | 0.007 | | 0.15 |
| c | 0.09 | | 0.20 | 0.003 | | 0.012 |
| D | 4.90 | 5.00 | 5.10 | 0.192 | 0.196 | 0.20 |
| 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 |

TS1851-TS1852-TS1854

TS1851ILT



PACKAGE MECHANICAL DATA
5 PINS - TINY PACKAGE (SOT23)



| Dim. | Millimeters | | | Inches | | |
|------|-------------|------|------|--------|-------|--------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | 0.90 | 1.20 | 1.45 | 0.035 | 0.047 | 0.057 |
| A1 | 0 | | 0.15 | | | 0.006 |
| A2 | 0.90 | 1.05 | 1.30 | 0.035 | 0.041 | 0.051 |
| B | 0.35 | 0.40 | 0.50 | 0.014 | 0.016 | 0.020 |
| C | 0.09 | 0.15 | 0.20 | 0.004 | 0.006 | 0.008 |
| D | 2.80 | 2.90 | 3.00 | 0.110 | 0.114 | 0.118 |
| D1 | | 1.90 | | | 0.075 | |
| e | | 0.95 | | | 0.037 | |
| E | 2.60 | 2.80 | 3.00 | 0.102 | 0.110 | 0.0118 |
| F | 1.50 | 1.60 | 1.75 | 0.059 | 0.063 | 0.069 |
| L | 0.10 | 0.5 | 0.60 | 0.004 | 0.014 | 0.024 |
| K | 0d | | 10d | 0d | | 10d |

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