



**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

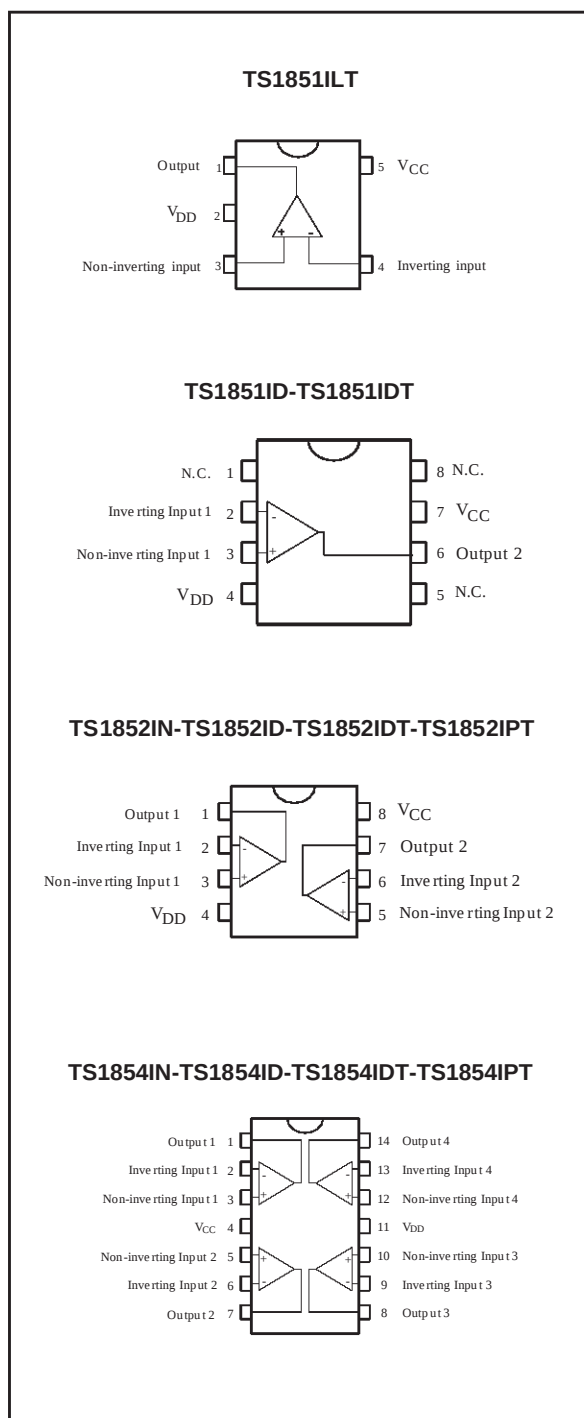
- Two-cell battery-powered systems
- Portable/Battery-powered electronic equipment
- Cordless phones
- Cellular phones
- Laptops
- PDAs

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 $+125$	$^{\circ}\text{C}$
T_{std}	Storage Temperature	-65 to $+150$	$^{\circ}\text{C}$
T_j	Maximum Junction Temperature	150	$^{\circ}\text{C}$
R_{thjc}	Thermal Resistance Junction to Case ⁴⁾ SOT23-5 DIP8 DIP14 SO8 SO14 TSSOP8 TSSOP14	81 42 32 28 22 26 21	$^{\circ}\text{C/W}$
R_{thja}	Thermal Resistance Junction to Ambient - SOT23-5	256	$^{\circ}\text{C/W}$
ESD	Human Body Model	2	kV
	Lead Temperature (soldering, 10sec)	260	$^{\circ}\text{C}$

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 $V_{CC} + 0.3\text{V}$.
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 $1.8 \leq V_{CC} \leq 6\text{V}$, V_{icm} is extended to $V_{ee} - 0.2\text{V}$, $V_{CC} + 0.2\text{V}$.
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

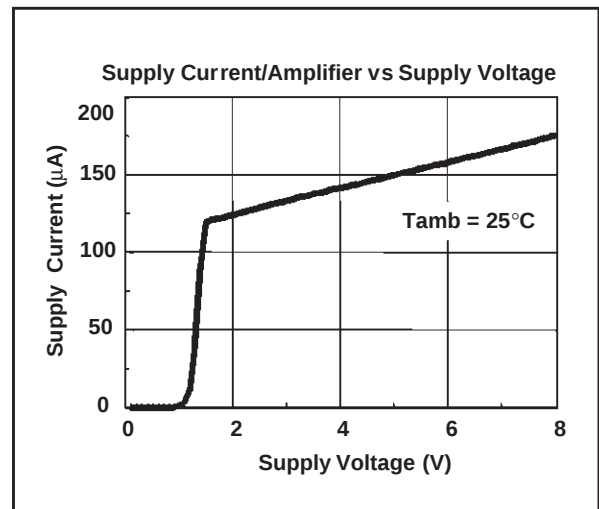
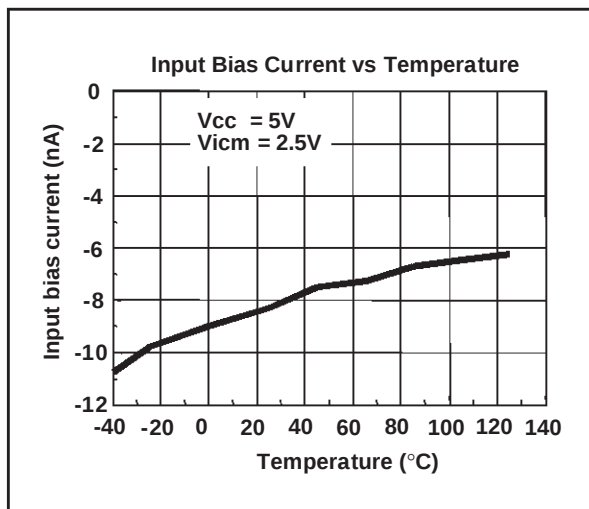
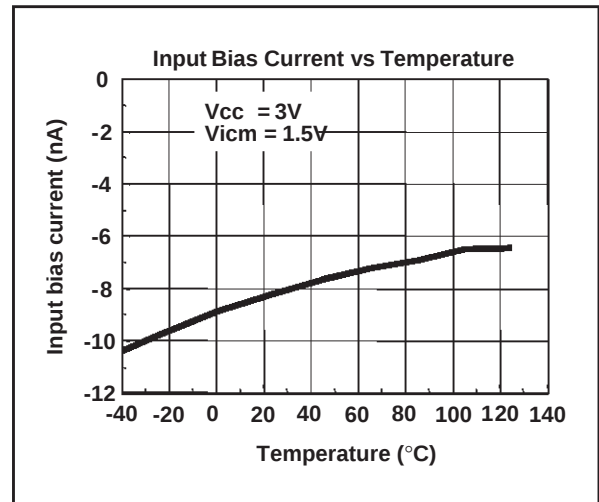
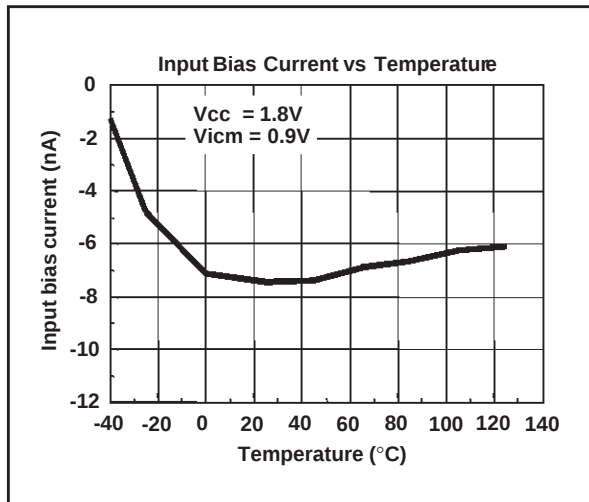
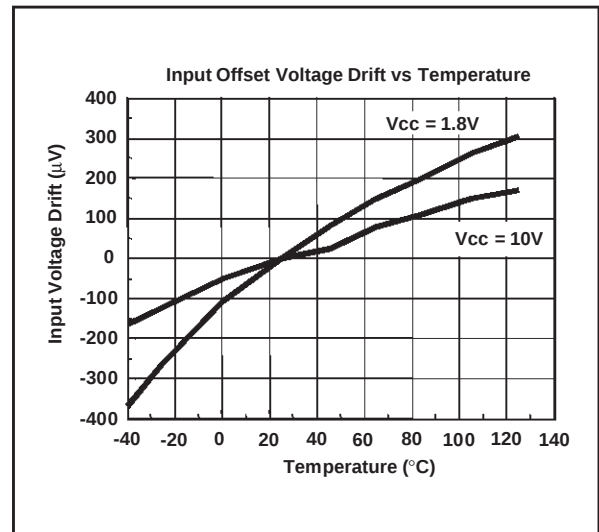
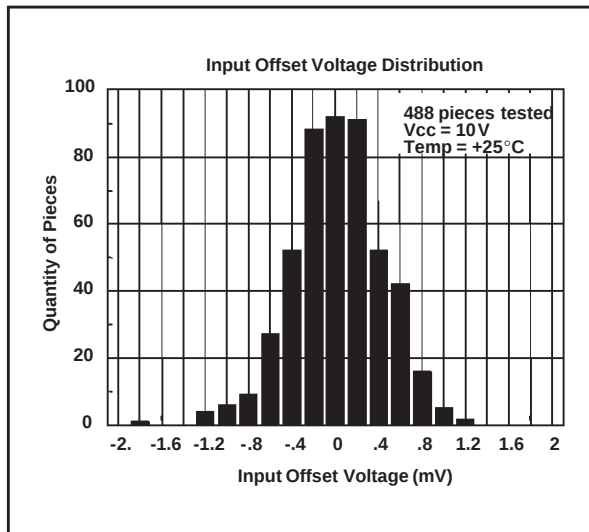
ELECTRICAL CHARACTERISTICS

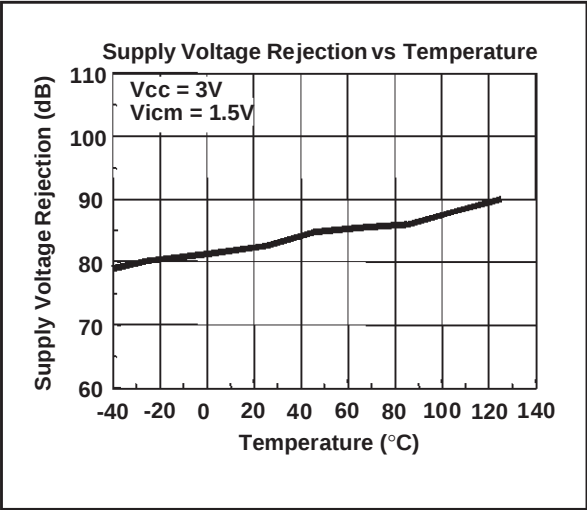
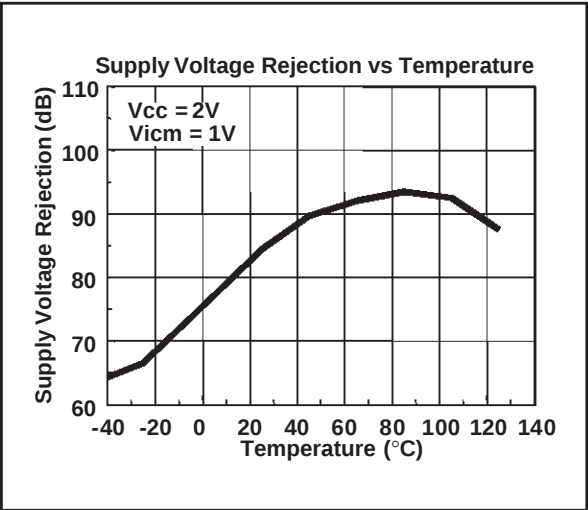
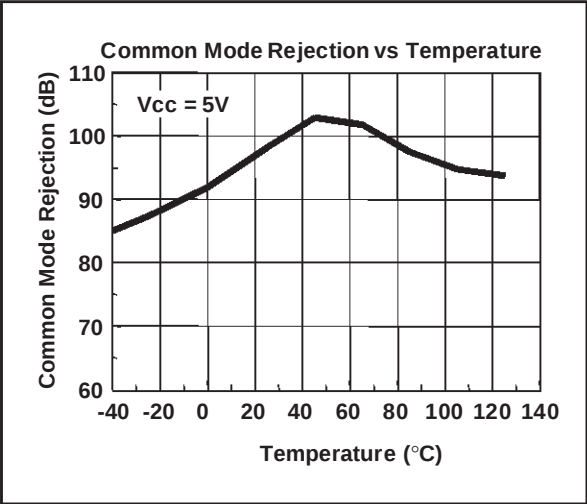
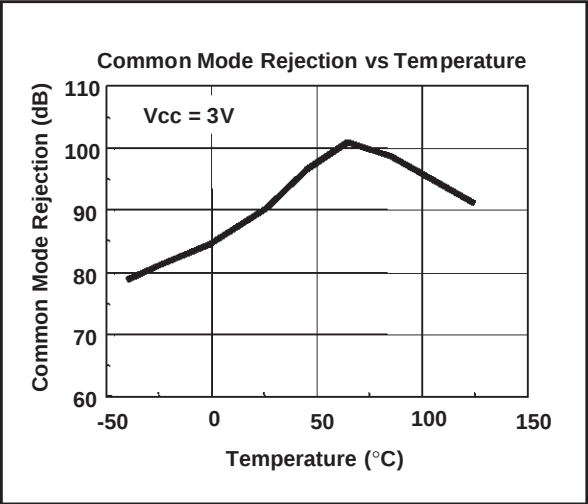
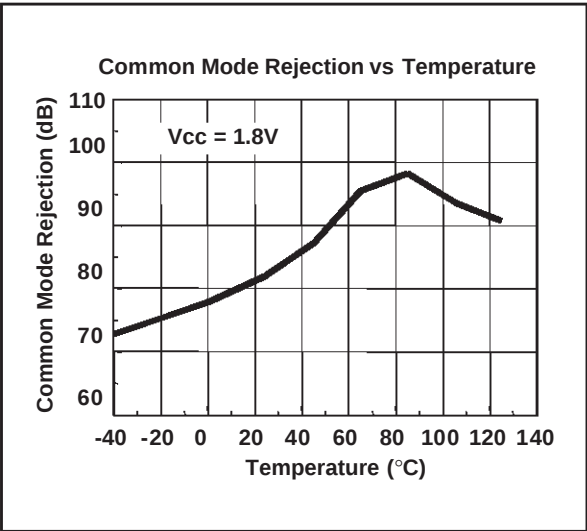
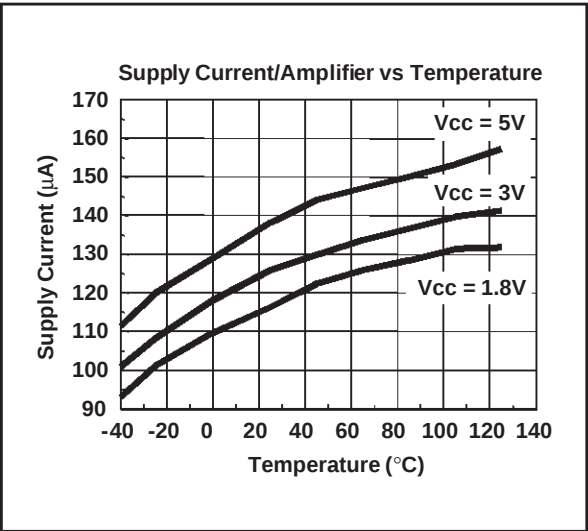
$V_{CC} = +5V$, $V_{EE} = 0V$,

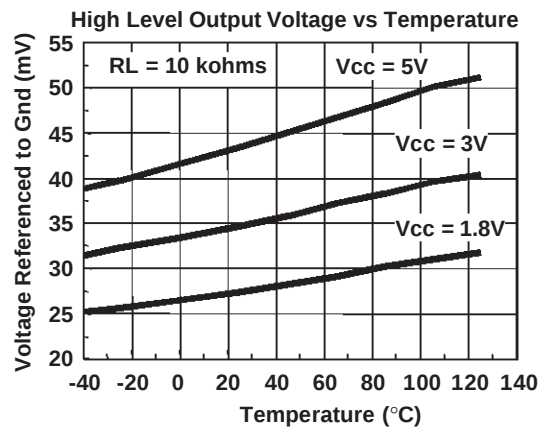
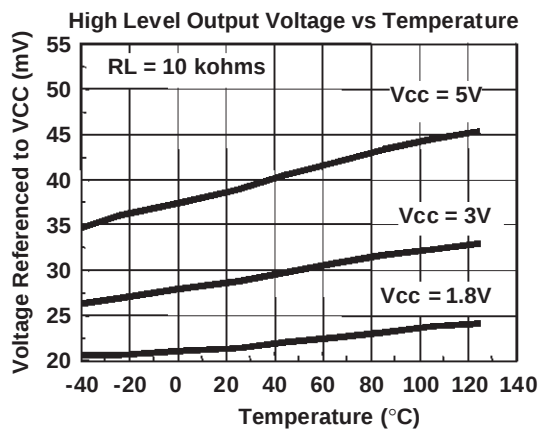
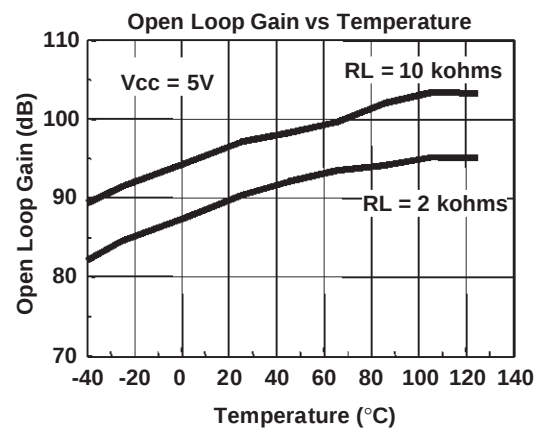
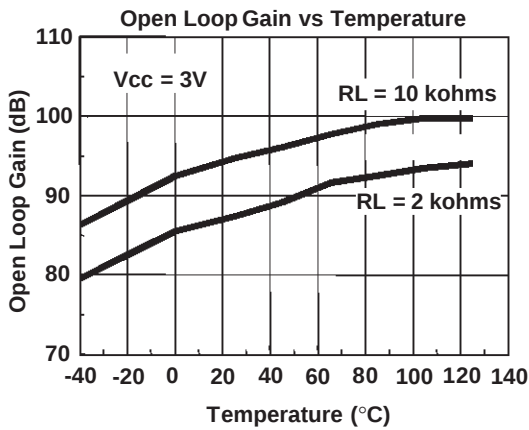
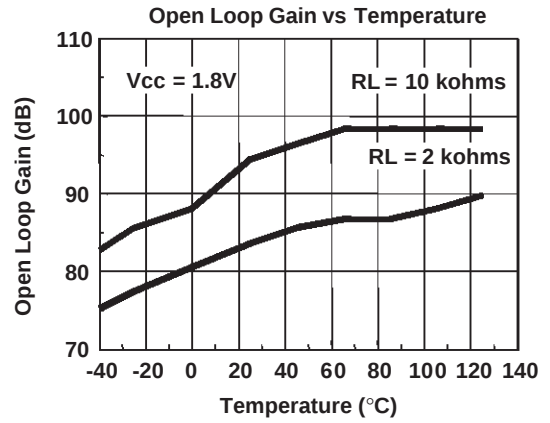
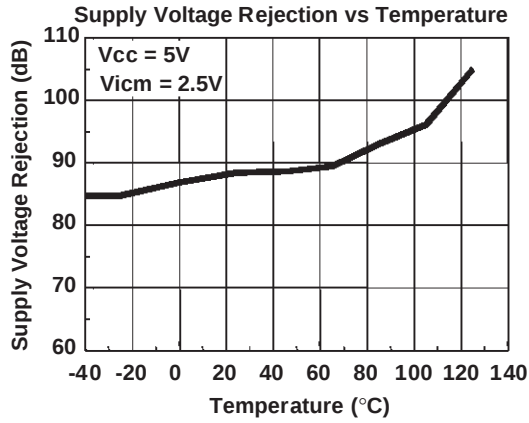
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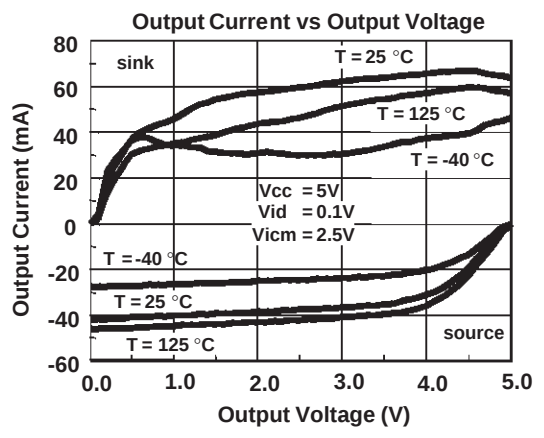
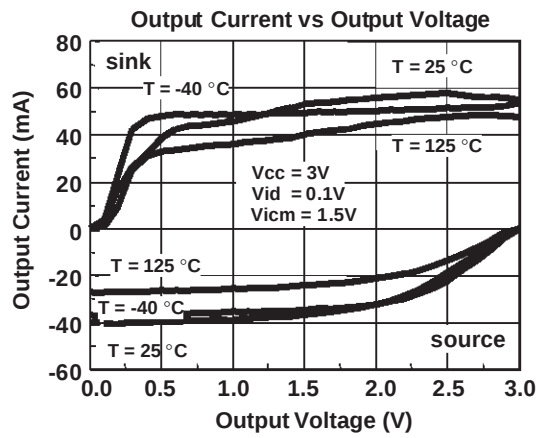
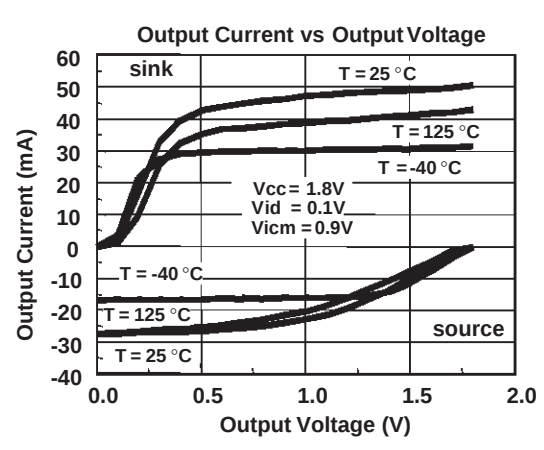
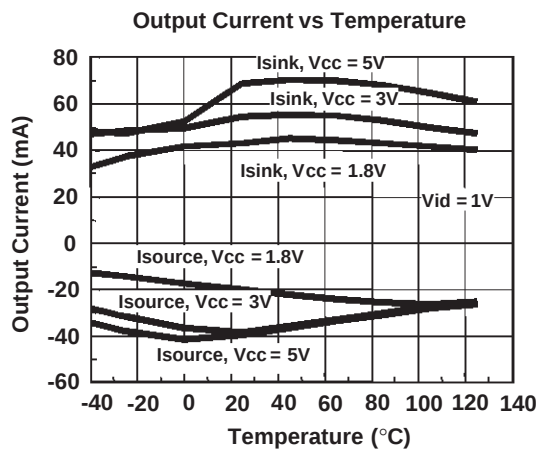
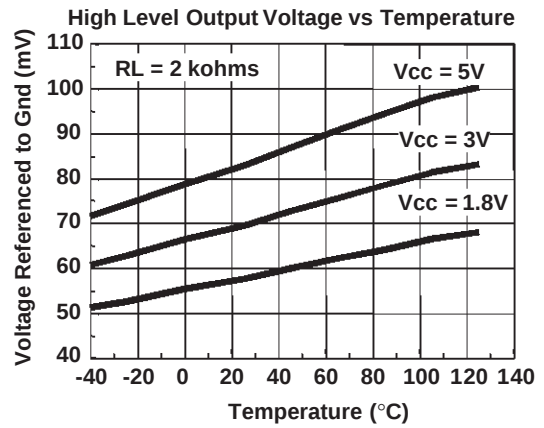
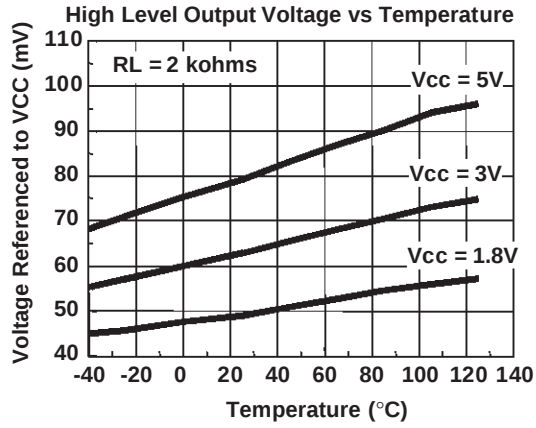
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V_{io}	Input Offset Voltage TS1851/2/4 TS1851A/2A/4A		0.1	3 1	mV
ΔV_{io}	Input Offset Voltage Drift		2		$\mu V/^{\circ}C$
I_{io}	Input Offset Current ¹⁾		1	9	nA
I_{ib}	Input Bias Current ¹⁾		16	63	nA
CMR	Common Mode Rejection Ratio $0 \leq V_{icm} \leq V_{CC}$	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/ μs
ϕ_m	Phase Margin $C_L = 100pF$		60		Degrees
en	Input Voltage Noise		40		nV/ $\sqrt{Hz}$
THD	Total Harmonic Distortion		0.01		%

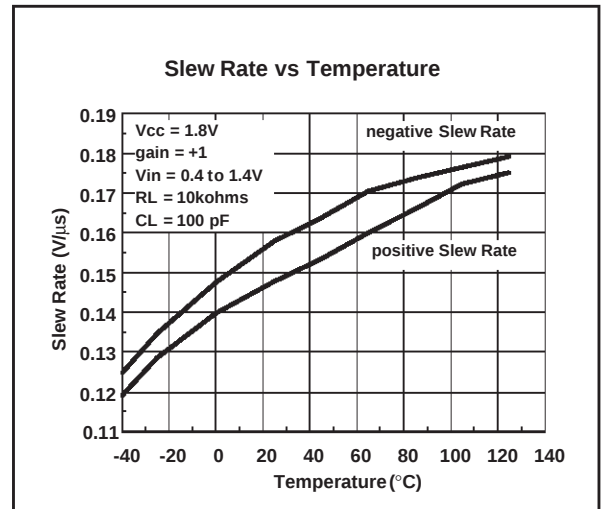
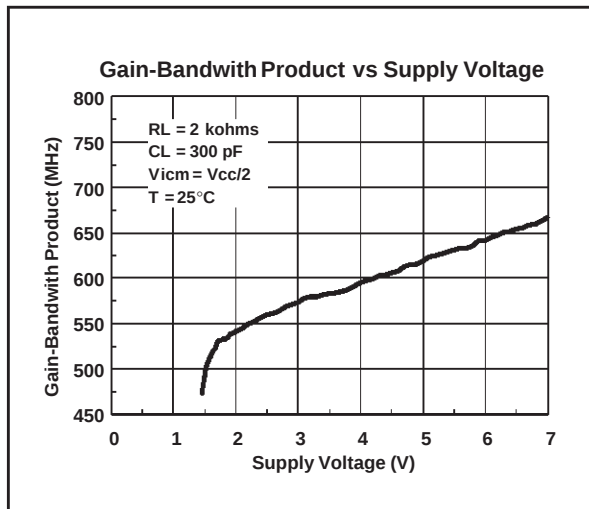
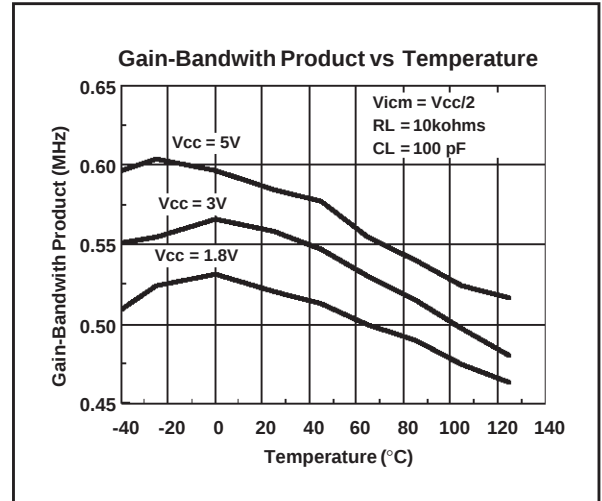
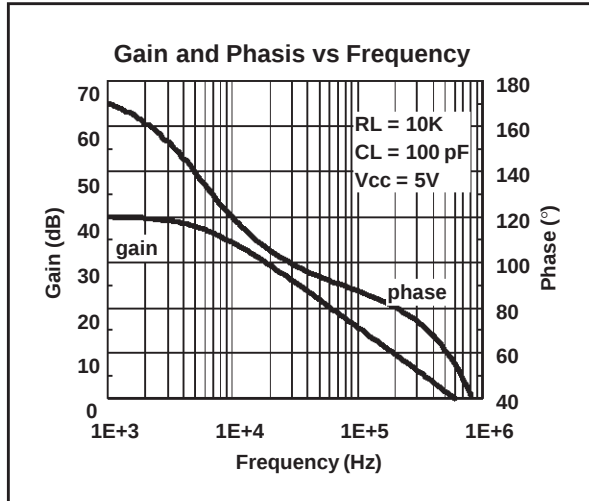
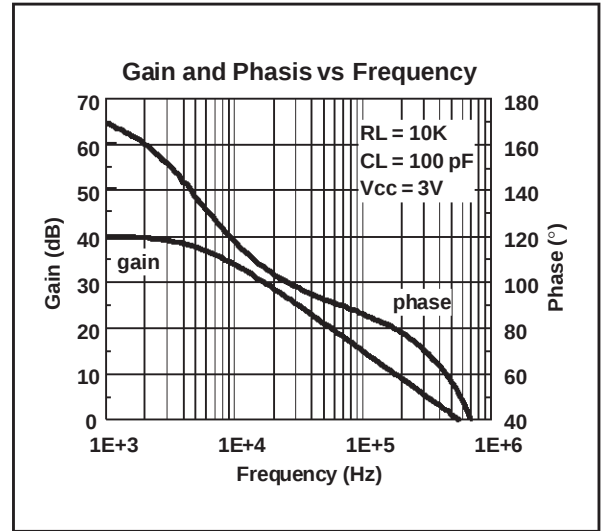
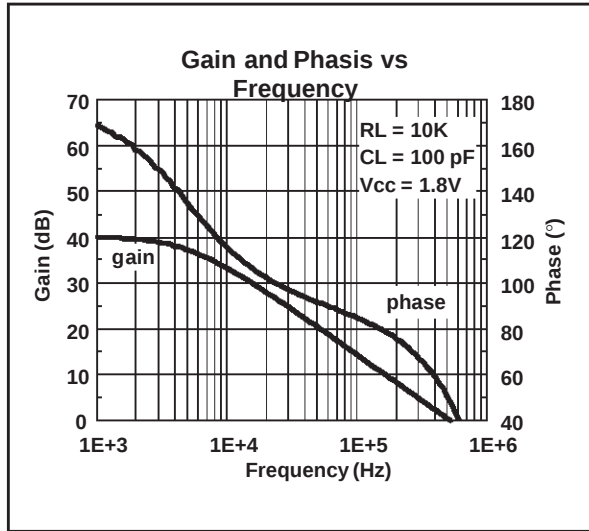
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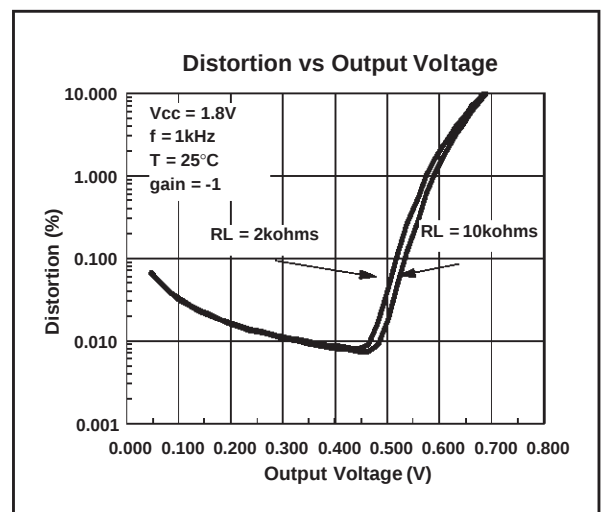
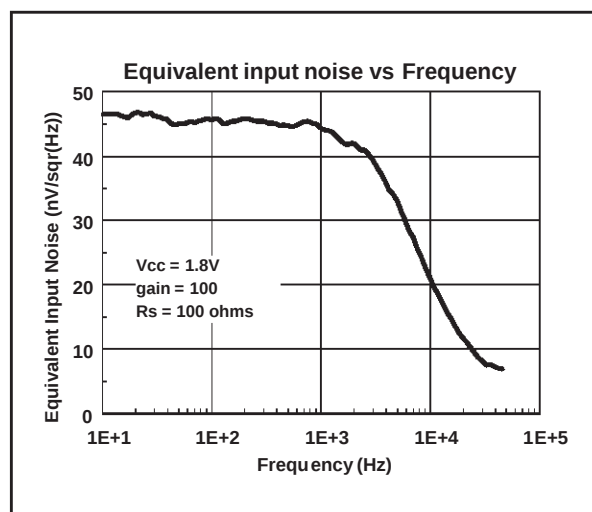
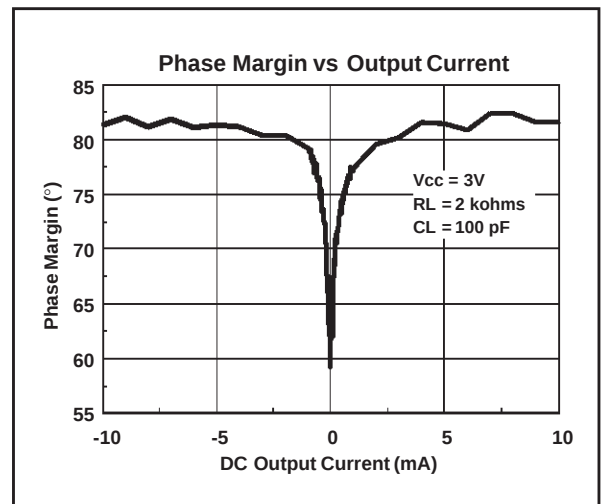
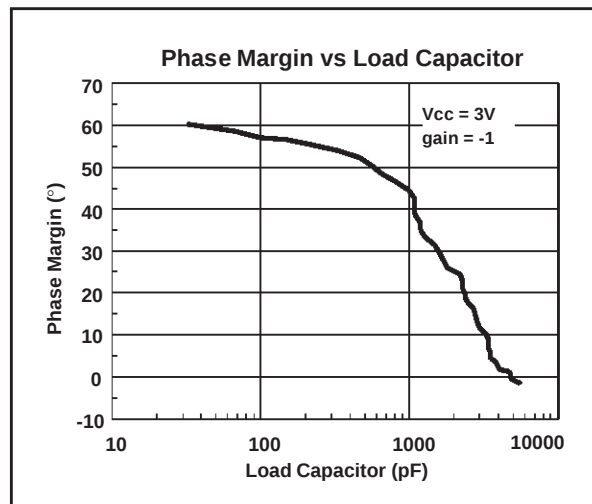
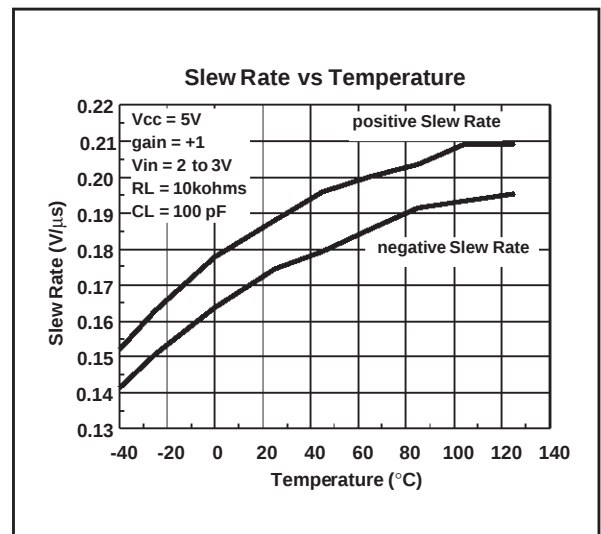
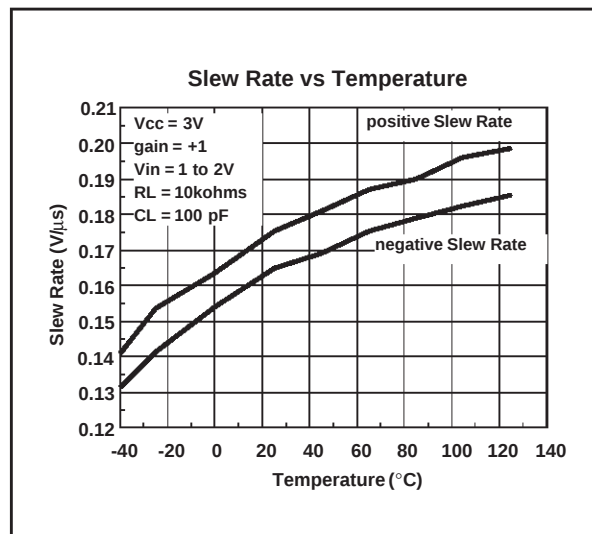


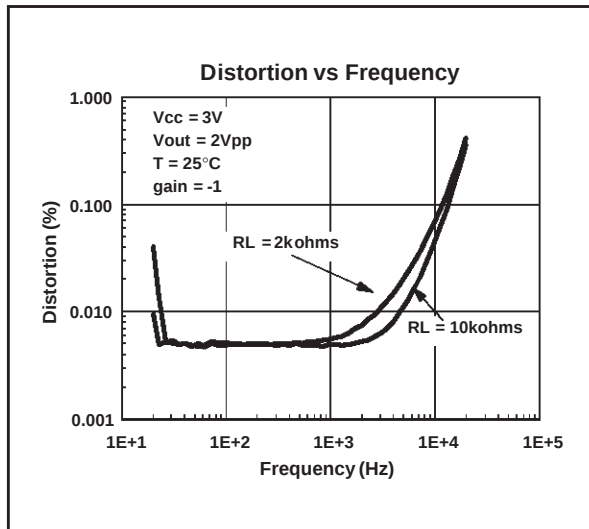
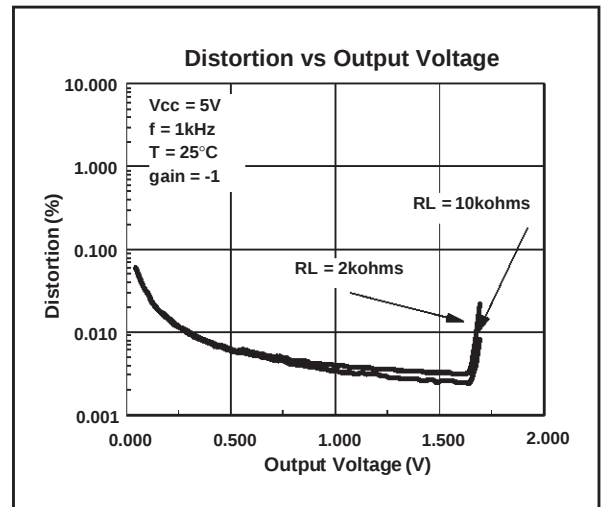
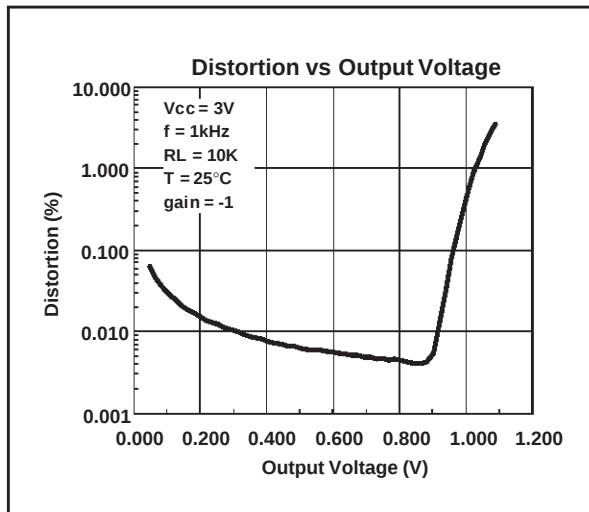






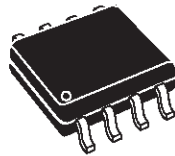




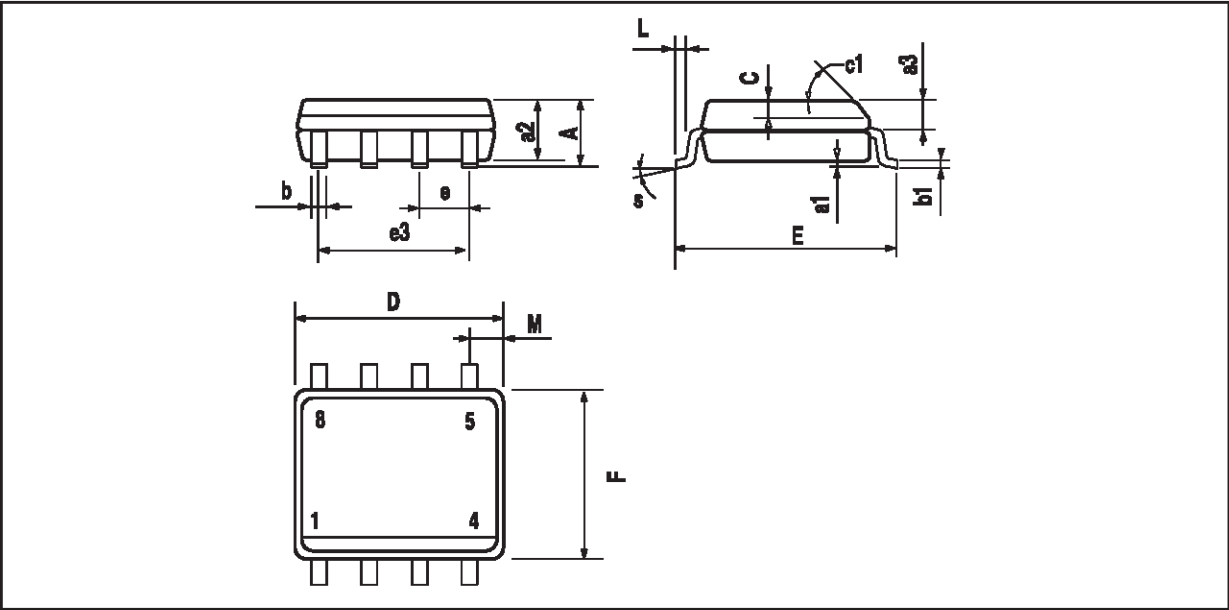


TS1851-TS1852-TS1854

TS1851ID - TS1852ID

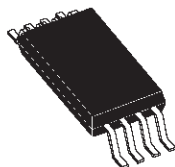


PACKAGE MECHANICAL DATA
8 PINS - PLASTIC MICROPACKAGE (SO)



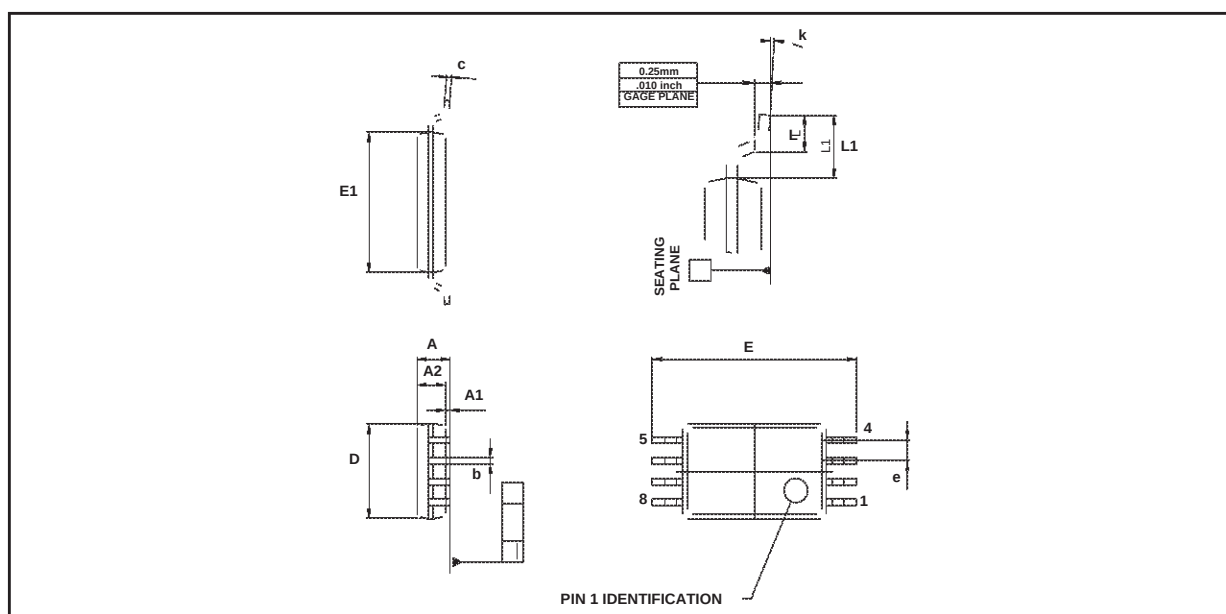
Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.25	0.004		0.010
a2			1.65			0.065
a3	0.65		0.85	0.026		0.033
b	0.35		0.48	0.014		0.019
b1	0.19		0.25	0.007		0.010
C	0.25		0.5	0.010		0.020
c1	45° (typ.)					
D	4.8		5.0	0.189		0.197
E	5.8		6.2	0.228		0.244
e		1.27			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

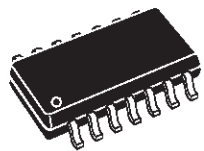
8 PINS - THIN SHRINK SMALL OUTLINE PACKAGE



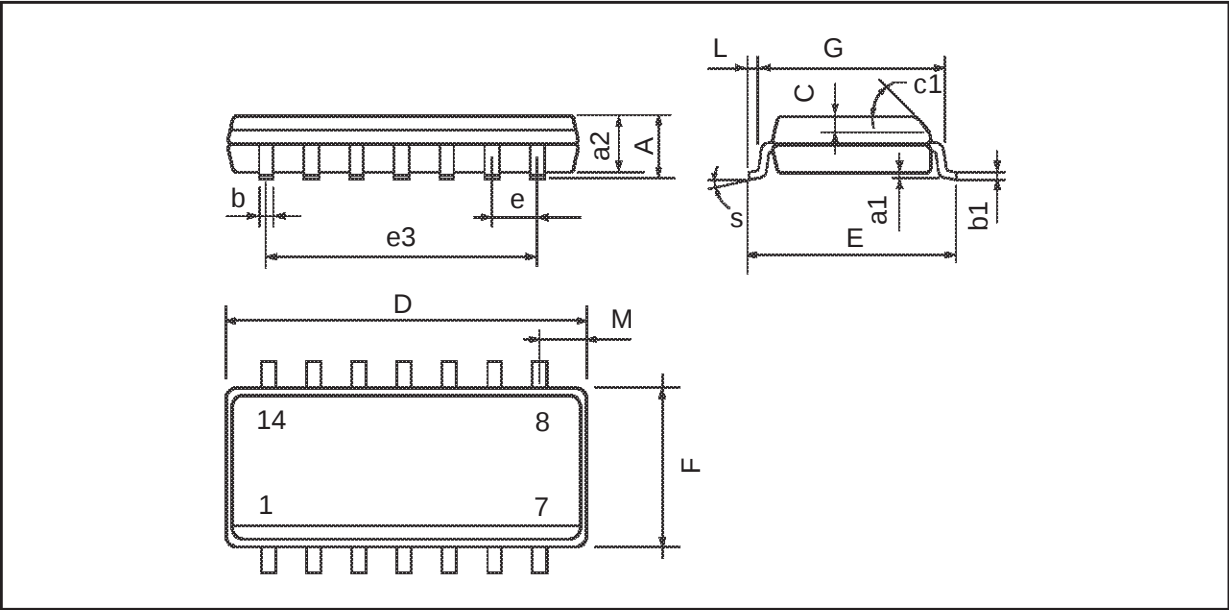
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	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.20			0.05
A1	0.05		0.15	0.01		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.15
c	0.09		0.20	0.003		0.012
D	2.90	3.00	3.10	0.114	0.118	0.122
E		6.40			0.252	
E1	4.30	4.40	4.50	0.169	0.173	0.177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

TS1851-TS1852-TS1854

TS1854ID



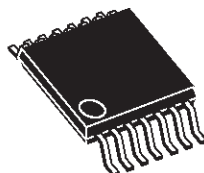
PACKAGE MECHANICAL DATA
14 PINS - PLASTIC MICROPACKAGE (SO)



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.)					

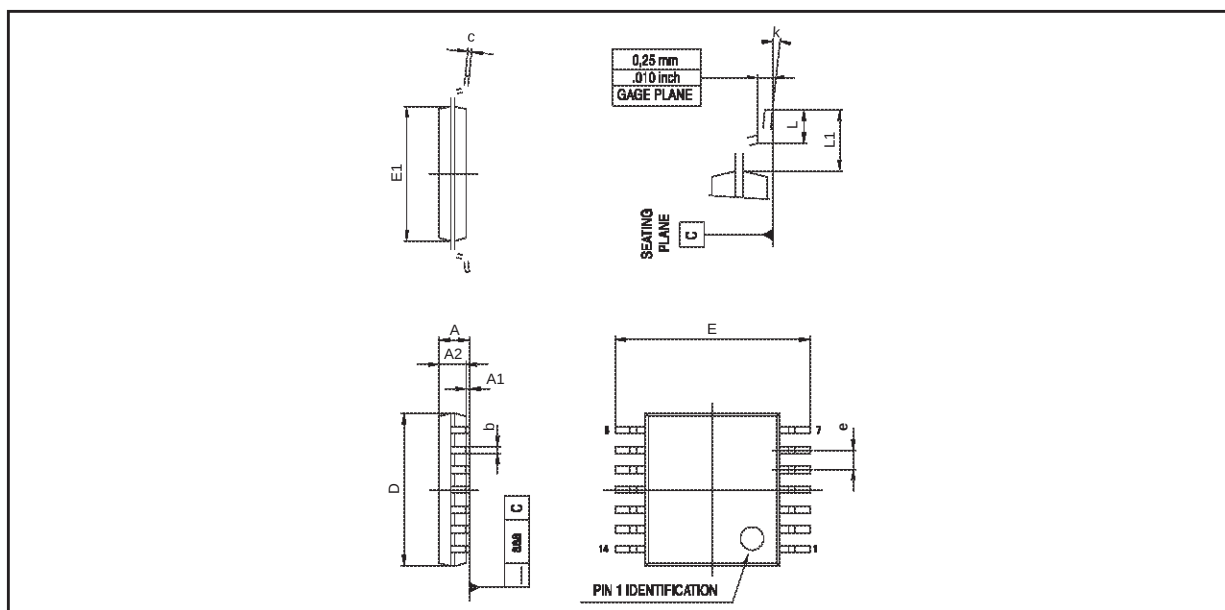
Note : (1) D and F do not include mold flash or protrusions - Mold flash or protrusions shall not exceed 0.15mm (.066 inc) ONLY FOR DATA BOOK.

TS1854IPT



PACKAGE MECHANICAL DATA

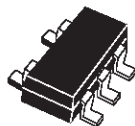
14 PINS - THIN SHRINK SMALL OUTLINE PACKAGE



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

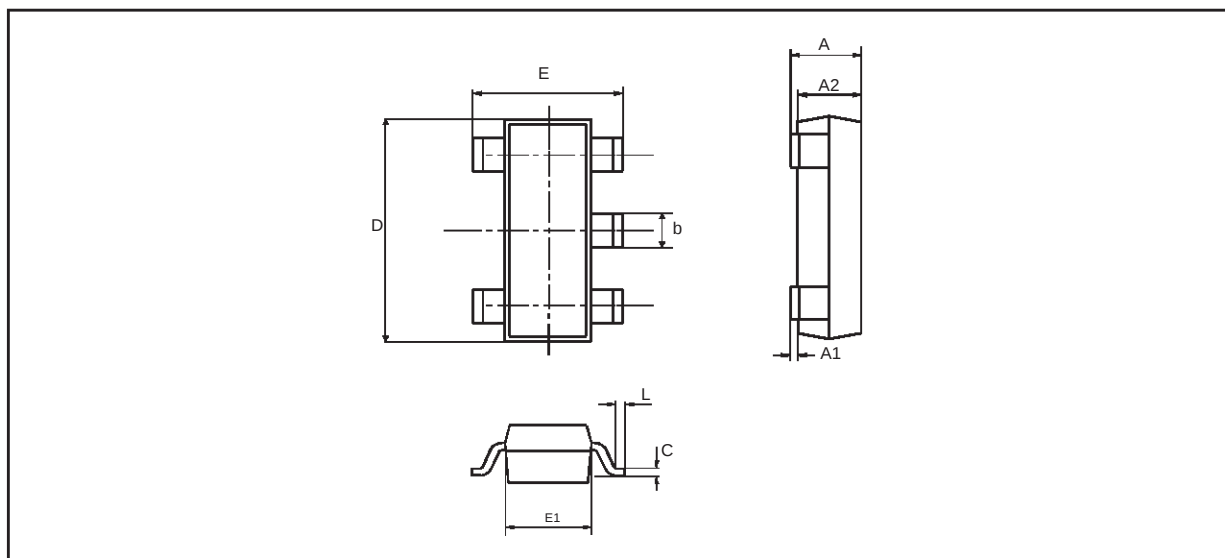
TS1851-TS1852-TS1854

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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