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 Vicm (V_{DD} - 0.2V to V_{CC} + 0.2V)**
- **Low supply current (120µA)**
- **Gain bandwidth product (480kHz)**
- **High stability (able to drive 500pF)**
- **ESD tolerance (2kV)**
- **Latch-up immunity**
- **Available in SOT23-5 micropackage**

Description

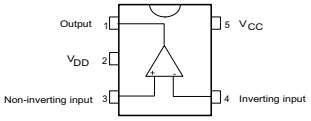
The TS185x (single, dual & quad) is operational amplifier able to operate with voltages as low as 1.8V and features both input and output rail-to-rail (1.71 @ V_{CC} = 1.8V, R_L = 2kΩ), 120µA consumption current and 480kHz gain bandwidth product.

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.

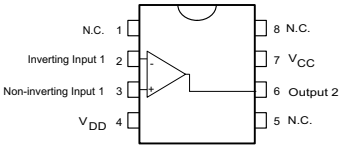
The TS1851 is housed in the space-saving 5 pin SOT23-5 package which simplifies the board design (outside dimensions are 2.8mm x 2.9mm).

Pin Connections (top view)

TS1851ILT



TS1851ID



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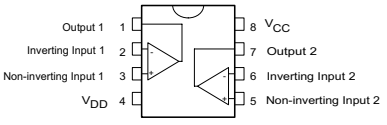

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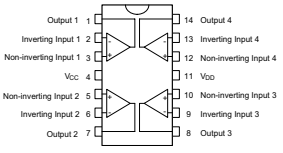


Applications

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

Order Codes

Part Number	Temperature Range	Package	Packaging	Marking
TS1851ID/IDT/AID/AIDT	-40°C, +125°C	SO	Tube or Tape & Reel	
TS1851ILT/AILT		SOT23-5L	Tape & Reel	K161/K162
TS1852IN/AIN		DIP	Tube	
TS1852ID/IDT/AID/AIDT		SO	Tube or Tape & Reel	
TS1852IPT/AIPT		TSSOP (Thin Shrink Outline Package)	Tape & Reel	
TS1852IST/AIST		mini SO	Tape & Reel	
TS1854IN/AIN		DIP	Tube	
TS1854ID/IDT/AID/AIDT		SO	Tube or Tape & Reel	
TS1854IPT/AIPT		TSSOP (Thin Shrink Outline Package)	Tape & Reel	

1 Absolute Maximum Ratings

Table 1: Key parameters and their 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	V_{dd}-0.3 to V_{cc}+0.3	V
T_{oper}	Operating Free Air Temperature Range	-40 to + 125	°C
T_{stg}	Storage Temperature	-65 to +150	°C
T_j	Maximum Junction Temperature	150	°C
R_{thja}	Thermal Resistance Junction to Ambient [3] SOT23-5 DIP8 DIP14 miniSO8 SO8 SO14 TSSOP8 TSSOP14	 250 85 66 190 125 103 120 100	°C/W
ESD	HBM: Human Body Model[4]	2	kV
	MM: Machine Model[5]	200	V
	CDM: Charged Device Model	1.5	kV
	Lead Temperature (soldering, 10sec)	250	°C
	Output Short Circuit Duration	see note[6]	

1) All voltages values, except differential voltage are with respect to network terminal.

2) Differential voltages are the non-inverting input terminal with respect to the inverting input terminal. If Vid > ±1V, the maximum input current must not exceed ±1mA. In this case (Vid > ±1V) an input serie resistor must be added to limit input current.

3) Short-circuits can cause excessive heating. Destructive dissipation can result from simultaneous short-circuit on all amplifiers

4) Human body model, 100pF discharged through a 1.5kΩ resistor into pin of device.

5) Machine model ESD, a 200pF cap is charged to the specified voltage, then discharged directly into the IC with no external series resistor (internal resistor < 5Ω), into pin to pin of device.

6) Short-circuits from the output to V_{cc} can cause excessive heating. The maximum output current is approximately 48mA, independent of the magnitude of V_{cc}. Destructive dissipation can result from simultaneous short-circuits on all amplifiers.

Table 2: Operating Conditions

Symbol	Parameter	Value	Unit
VCC	Supply Voltage	1.8 to 6	V
Vicm	Common Mode Input Voltage Range [1]	V_{dd} -0.2 to V_{CC} + 0.2	V
Vicm	Common Mode Input Voltage Range [2]	V_{dd} to V_{CC}	V
T_{oper}	Operating Free Air Temperature Range	-40 to + 125	°C

1) At 25°C, for $1.8 \leq V_{CC} \leq 6V$, V_{icm} is extended to V_{dd} - 0.2V, V_{CC} + 0.2V.

2) In full temperature range, both Rails can be reached when V_{CC} does not exceed 5.5V.

2 Electrical Characteristics

Table 3: V_{CC} = +1.8V, V_{dd} = 0V, T_{amb} = 25°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		µV/°C
I_{io}	Input Offset Current [1]		1	9	nA
I_{ib}	Input Bias Current [1)]		10	50	nA
CMR	Common Mode Rejection Ratio $0 \le V_{icm} \le V_{CC}$	55	85		dB
SVR	Supply Voltage Rejection Ratio V_{icm} = 0.5V	70	80		dB
A_{vd}	Large Signal Voltage Gain R_L = 1Okω R_L = 2kω	80 70	100 88		dB
V_{OH}	High Level Output Voltage R_L = 10kω R_L = 2kω	1.7 1.65	1.77 1.7		V
V_{OL}	Low Level Output Voltage R_L = 10kω R_L = 2kω		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 = 10kω, C_L = 100pF, f = 100kHz	300	480		kHz
SR	Slew Rate R_L = 10kω, C_L = 100pF, AV = 1	0.1	0.18		V/µs
ϕm	Phase Margin C_L = 100pF		60		Degrees
en	Input Voltage Noise		40		nV/√Hz
THD	Total Harmonic Distortion		0.01		%

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

Table 4: V_{CC} = +3V, V_{dd} = 0V, T_{amb} = 25°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		µV/°C
I_{io}	Input Offset Current [1]		1	9	nA
I_{ib}	Input Bias Current [1)]		10	55	nA
CMR	Common Mode Rejection Ratio $0 \le V_{icm} \le V_{CC}$	60	90		dB
SVR	Supply Voltage Rejection Ratio $V_{icm} = V_{CC/2}$	70	85		dB
A_{vd}	Large Signal Voltage Gain R_L = 1Okω R_L = 2kω	83 74	99 90		dB
V_{OH}	High Level Output Voltage R_L = 10kω R_L = 2kω	2.9 2.85	2.96 2.94		V
V_{OL}	Low Level Output Voltage R_L = 10kω R_L = 2kω		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 = 10kω, C_L = 100pF, f = 100kHz	370	600		kHz
SR	Slew Rate R_L = 10kω, C_L = 100pF, AV = 1	0.12	0.2		V/µs
ϕm	Phase Margin C_L = 100pF		60		Degrees
en	Input Voltage Noise		40		nV/√Hz
THD	Total Harmonic Distortion		0.01		%

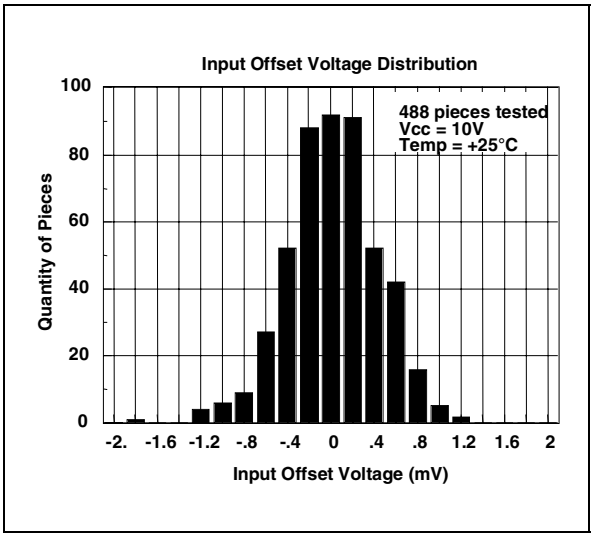
1) Maximum values including unavoidable inaccuracies of the industrial test.

Table 5: V_{CC} = +5V, V_{dd} = 0V, T_{amb} = 25°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		µV/°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 = 1Okω R_L = 2kω	85 77	97 93		dB
V_{OH}	High Level Output Voltage R_L = 10kω R_L = 2kω	4.85 4.8	4.95 4.91		V
V_{OL}	Low Level Output Voltage R_L = 10kω R_L = 2kω		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 = 10kΩ, C_L = 100pF, f = 100kHz	380	630		kHz
SR	Slew Rate R_L = 10kΩ, C_L = 100pF, AV = 1	0.13	0.25		V/µs
ϕm	Phase Margin C_L = 100pF		60		Degrees
en	Input Voltage Noise		40		nV/√Hz
THD	Total Harmonic Distortion		0.01		%

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

Figure 1 :



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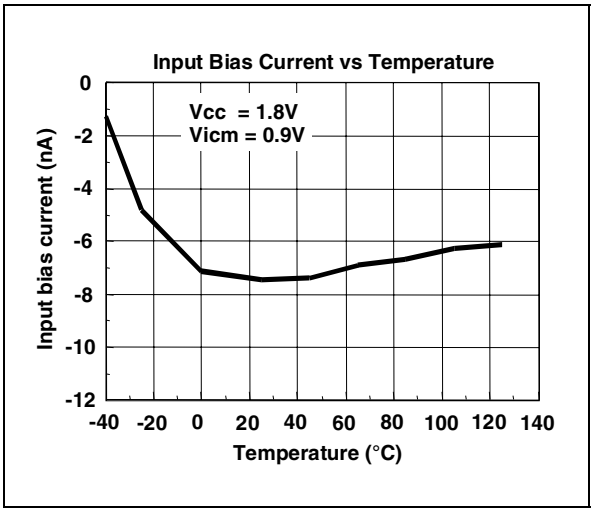

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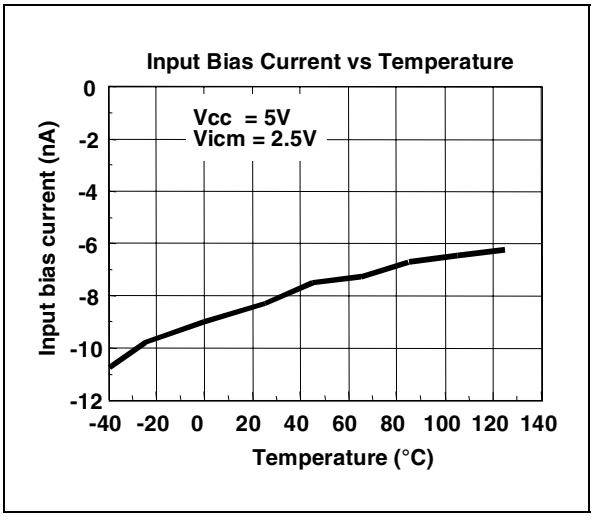

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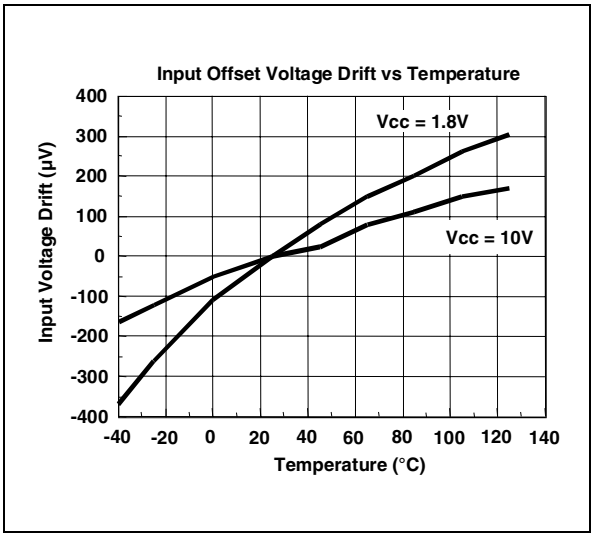

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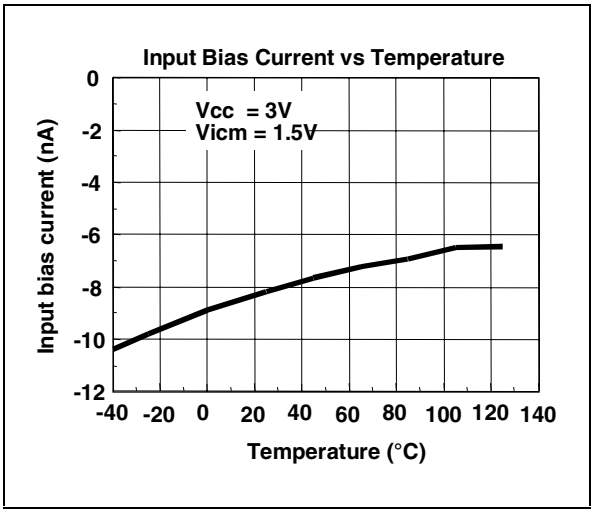

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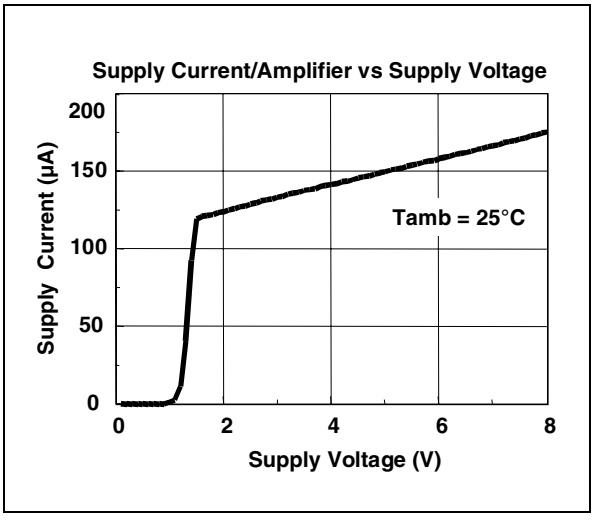

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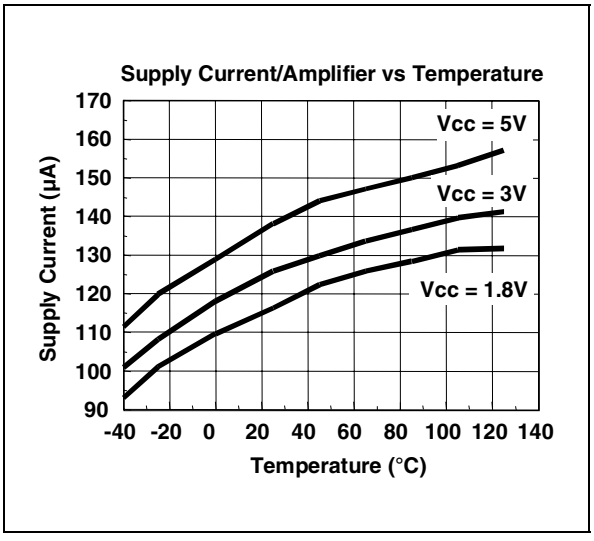

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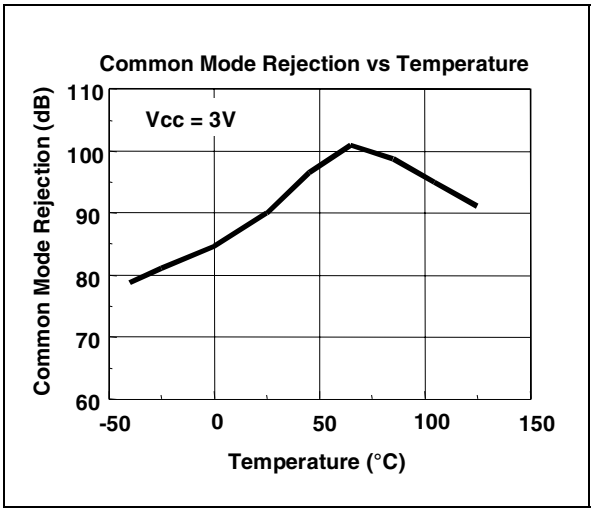

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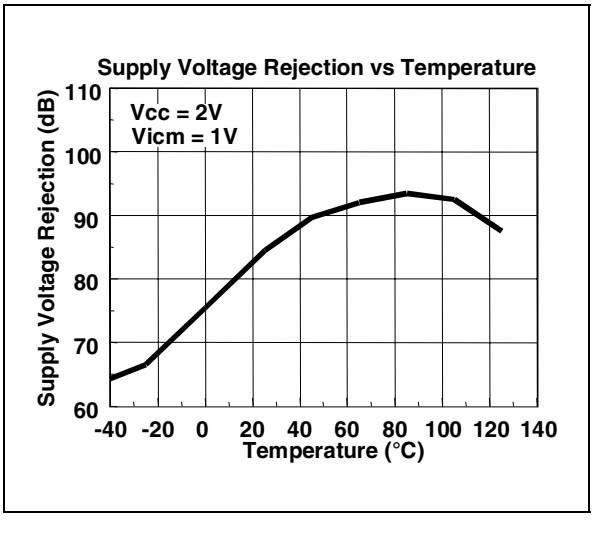

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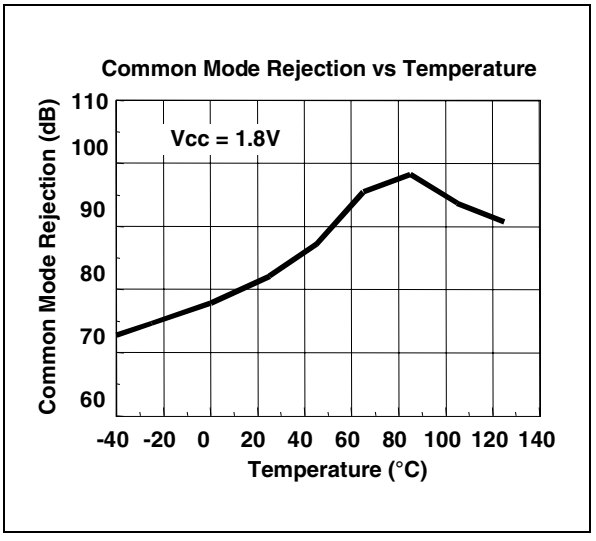

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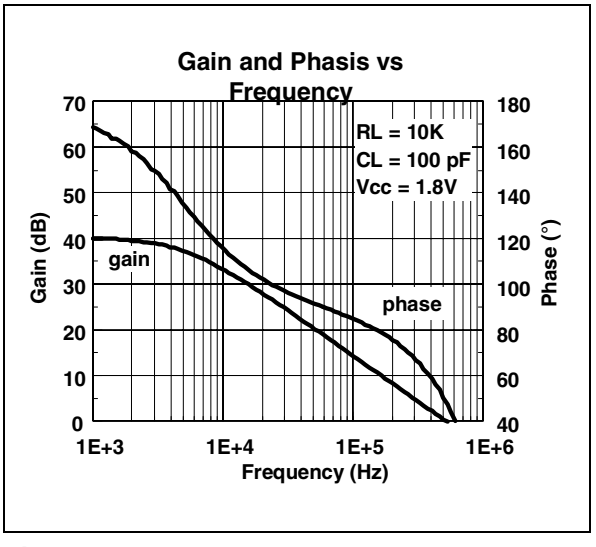

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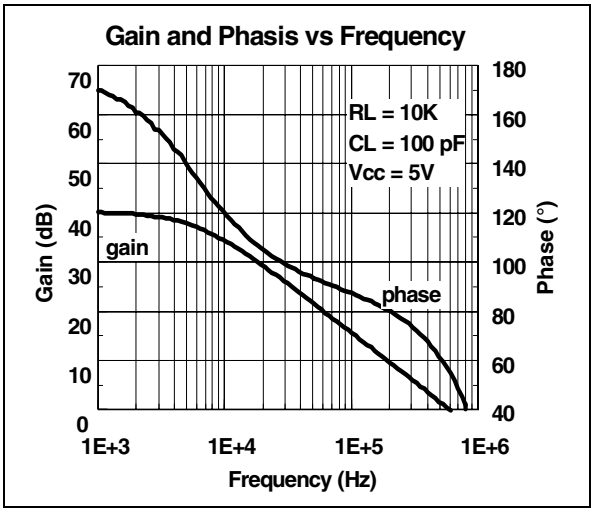

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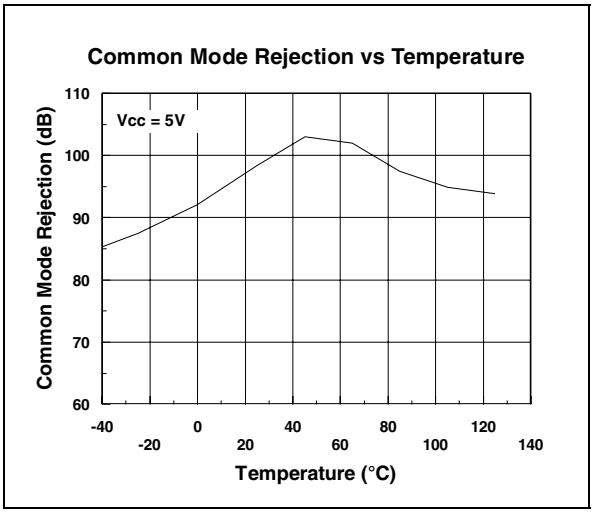

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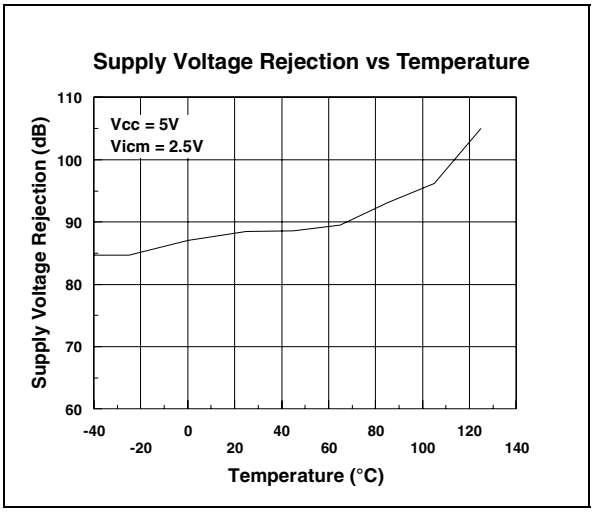

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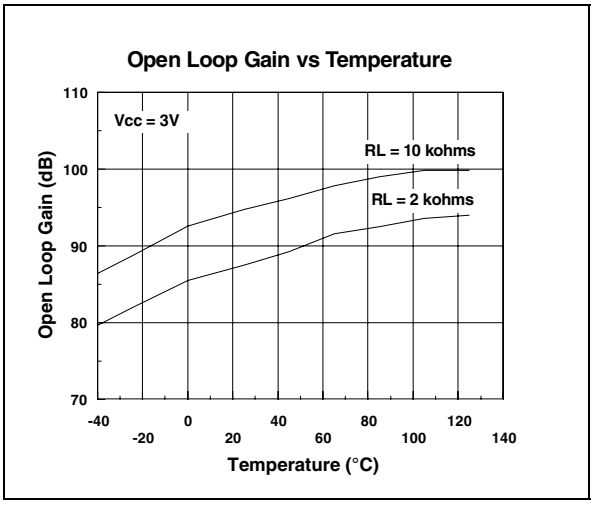

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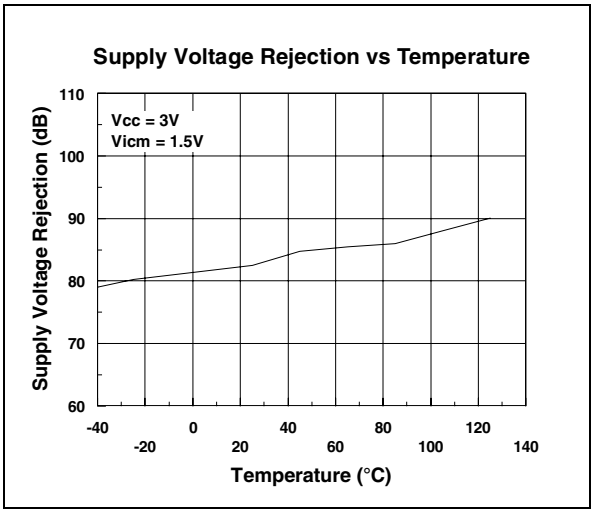

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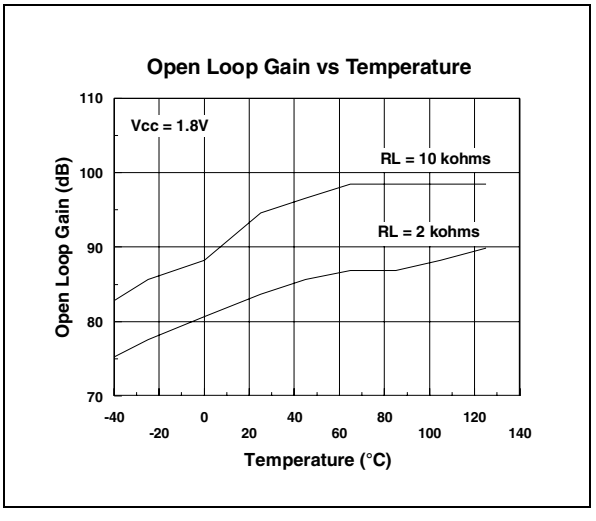

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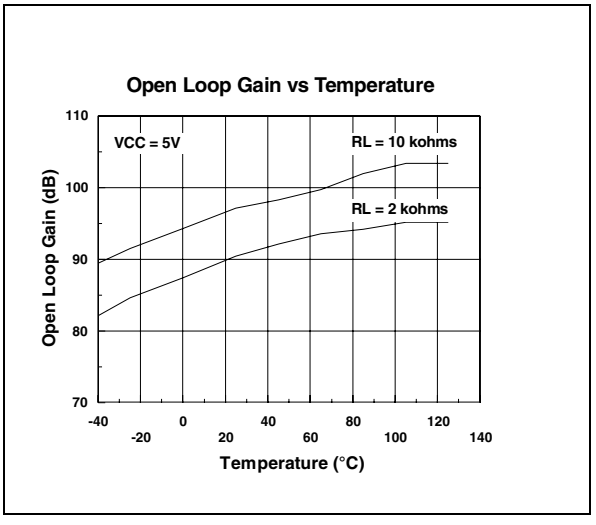

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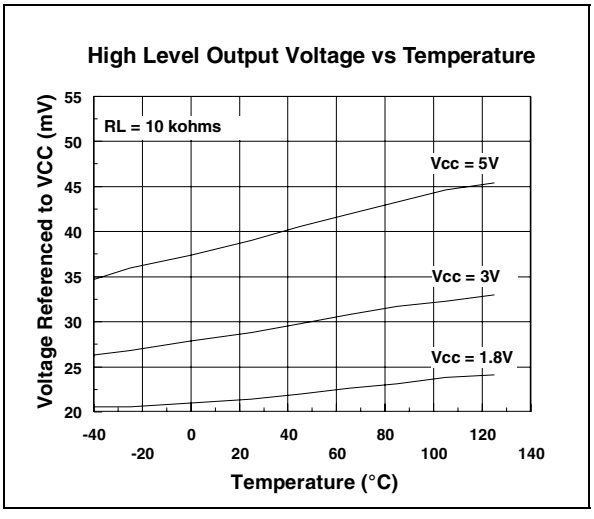

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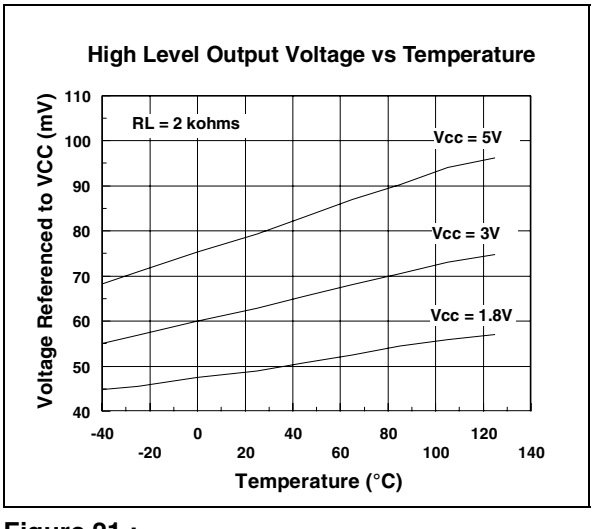

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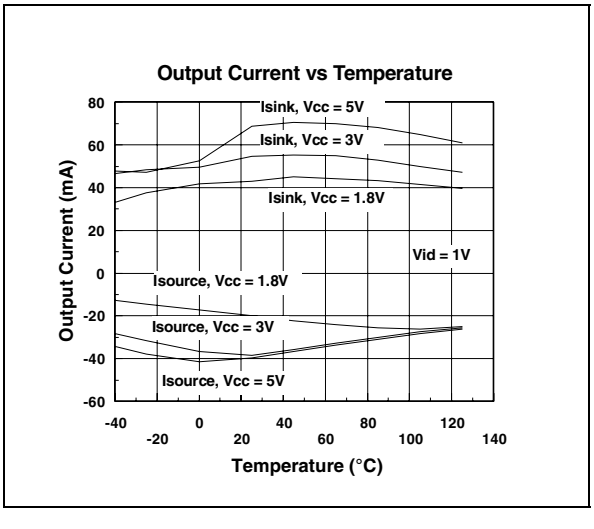

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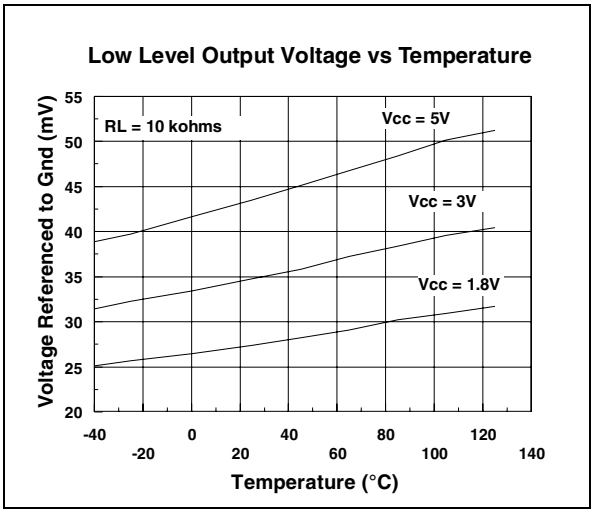

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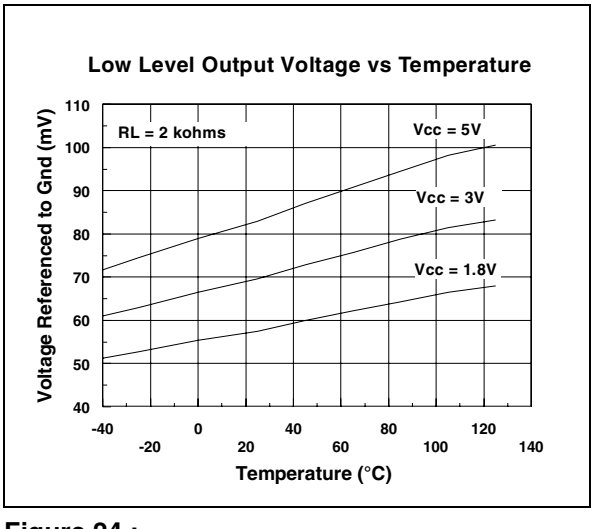

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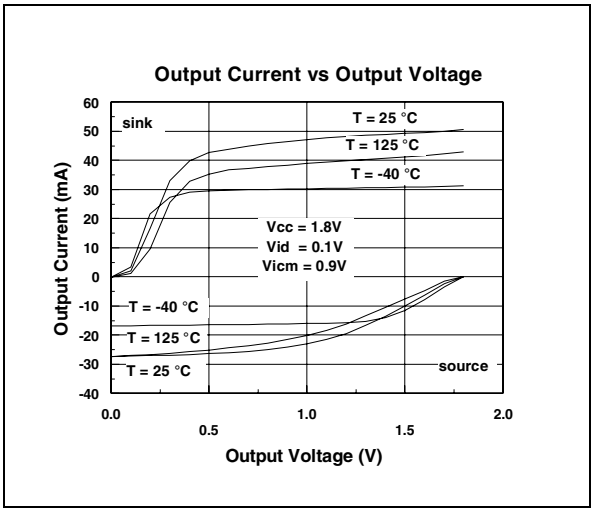

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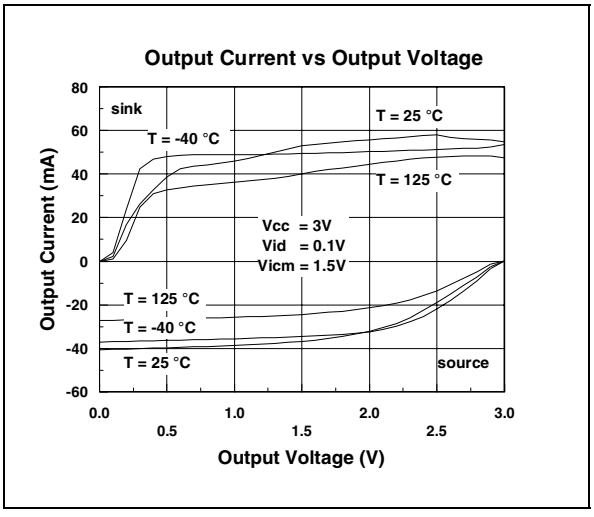

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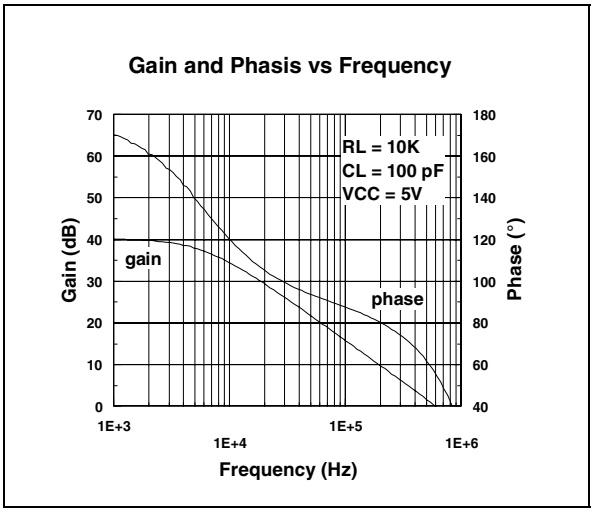

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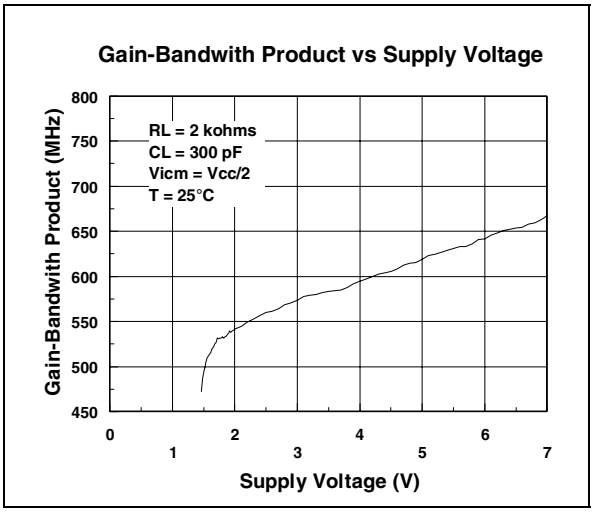

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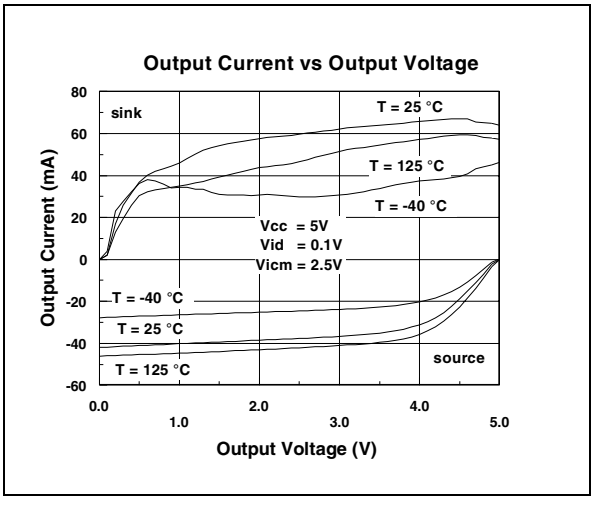

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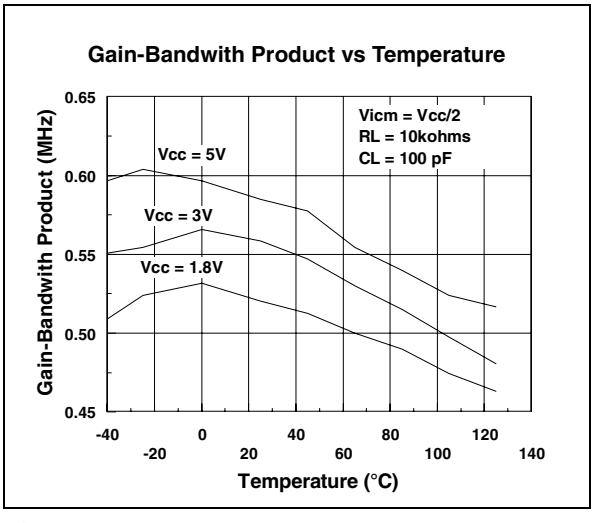

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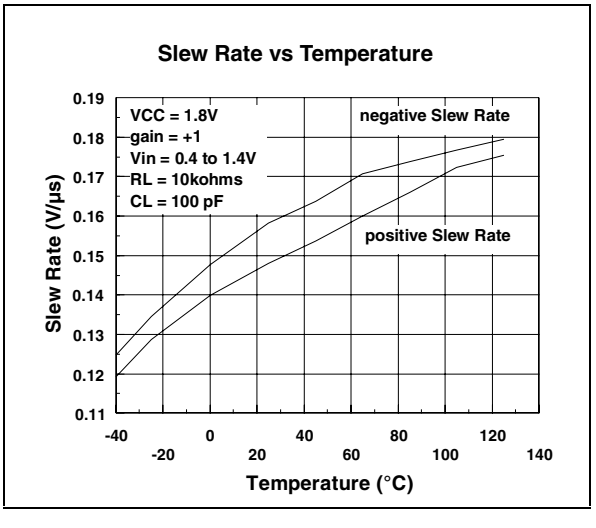

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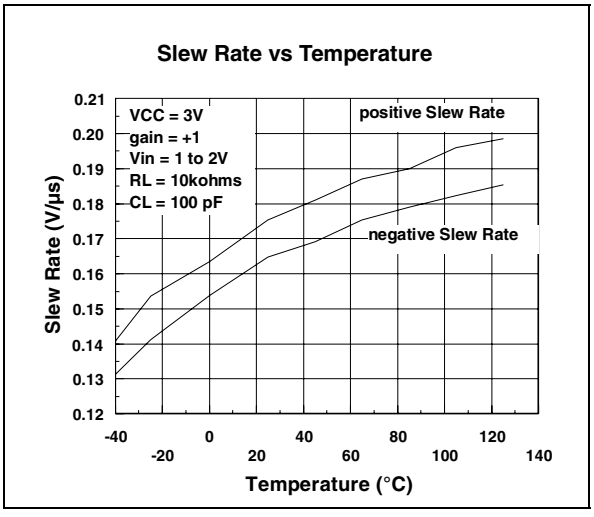

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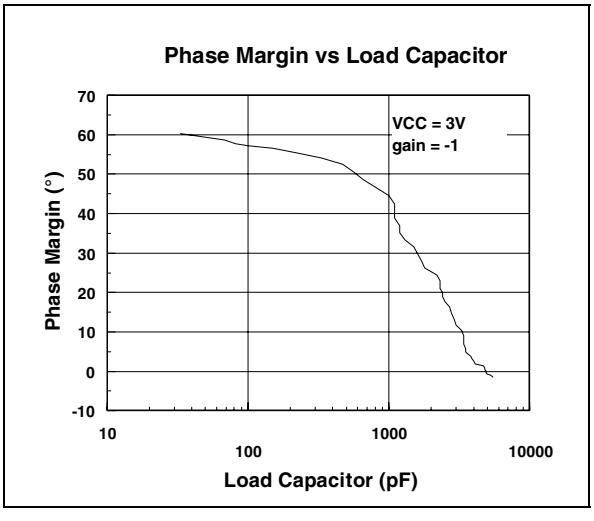

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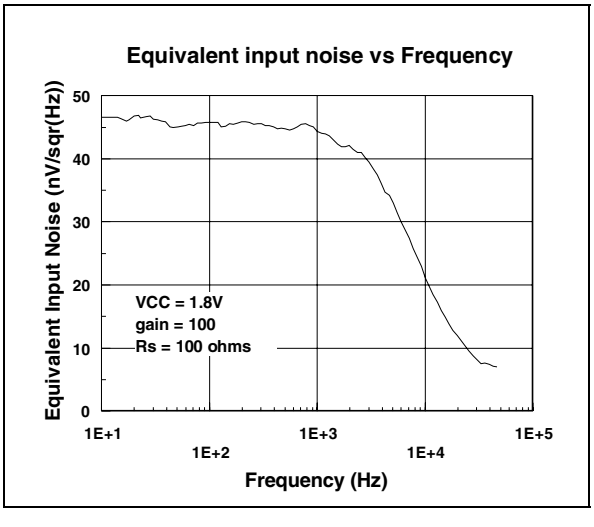


Figure 34 :

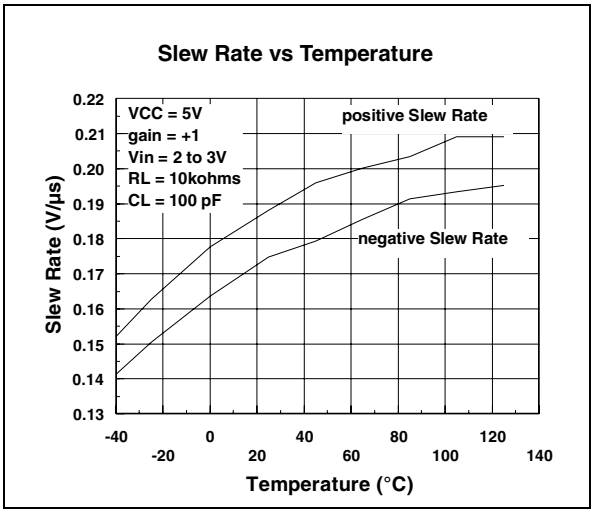


Figure 35 :

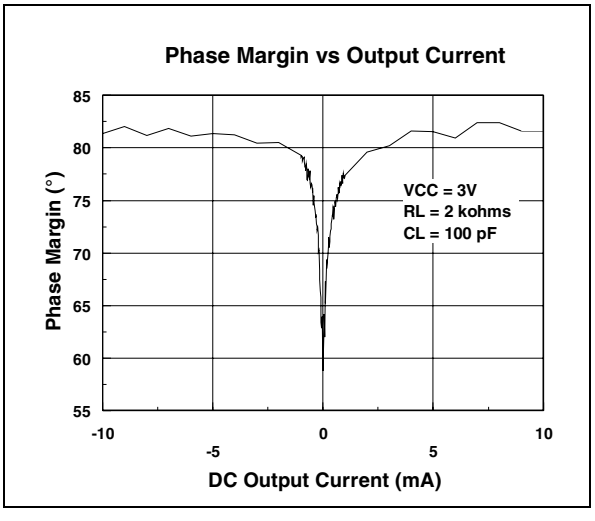


Figure 36 :

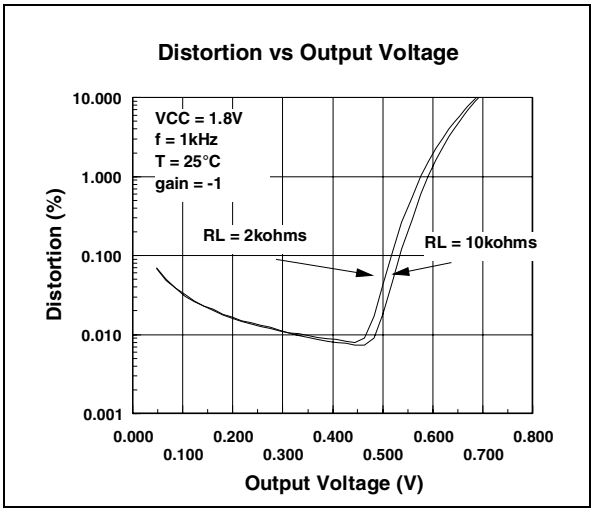


Figure 37 :

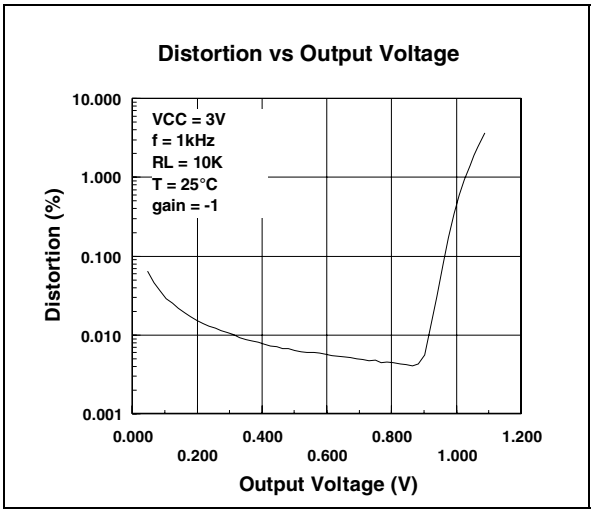


Figure 38 :

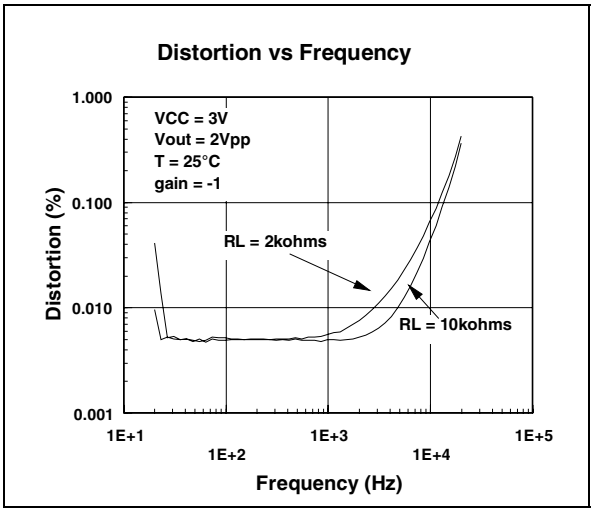
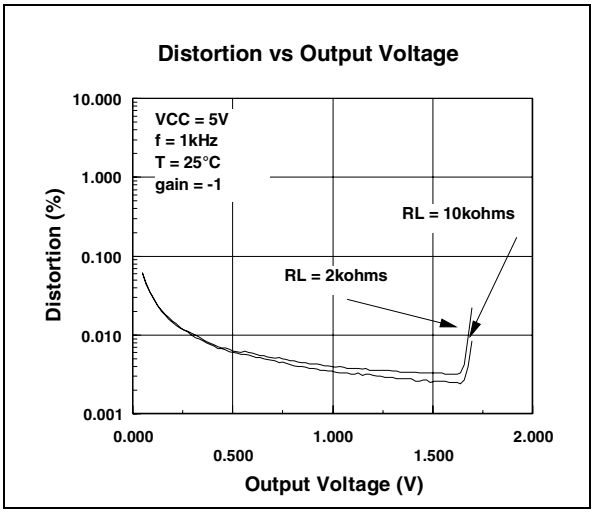


Figure 39 :

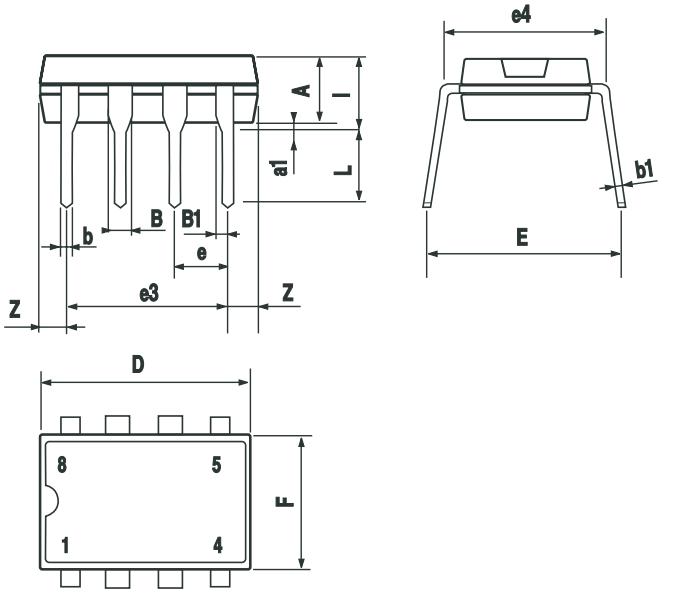


3 Package Mechanical Data

3.1 DIP8 package

Plastic DIP-8 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A		3.3			0.130	
a1	0.7			0.028		
B	1.39		1.65	0.055		0.065
B1	0.91		1.04	0.036		0.041
b		0.5			0.020	
b1	0.38		0.5	0.015		0.020
D			9.8			0.386
E		8.8			0.346	
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			7.1			0.280
I			4.8			0.189
L		3.3			0.130	
Z	0.44		1.6	0.017		0.063

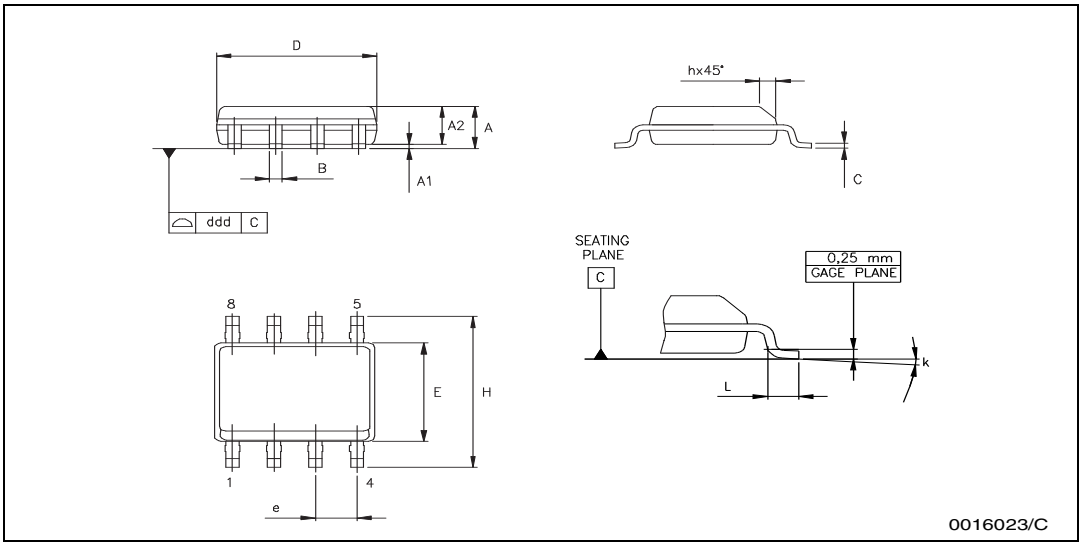


P001F

3.2 SO8 package

SO-8 MECHANICAL DATA

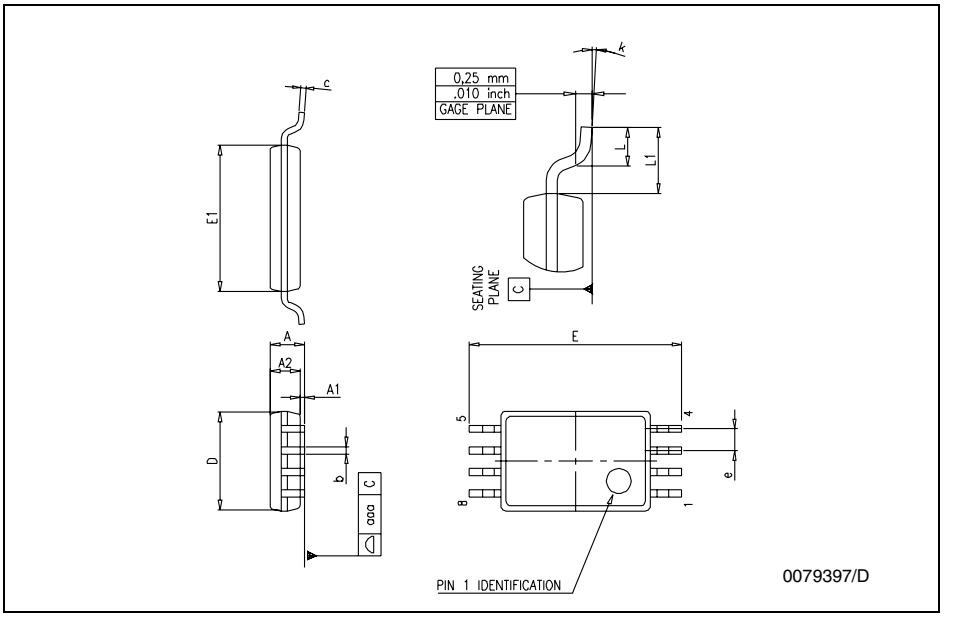
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	1.35		1.75	0.053		0.069
A1	0.10		0.25	0.04		0.010
A2	1.10		1.65	0.043		0.065
B	0.33		0.51	0.013		0.020
C	0.19		0.25	0.007		0.010
D	4.80		5.00	0.189		0.197
E	3.80		4.00	0.150		0.157
e		1.27			0.050	
H	5.80		6.20	0.228		0.244
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
k	8° (max.)					
ddd			0.1			0.04



3.3 TSSOP8 package

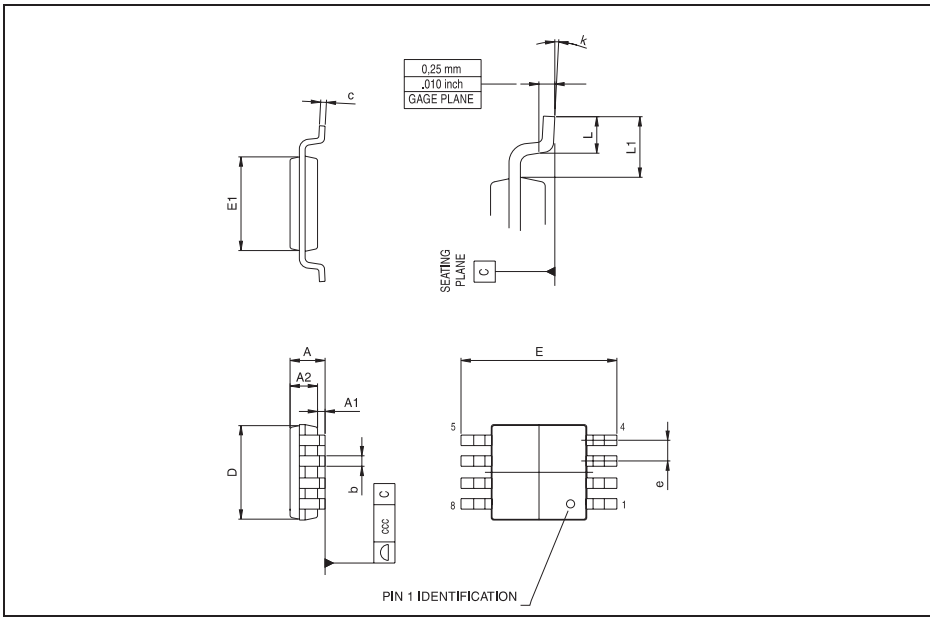
TSSOP8 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.2			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	



3.4 Mini SO8 package

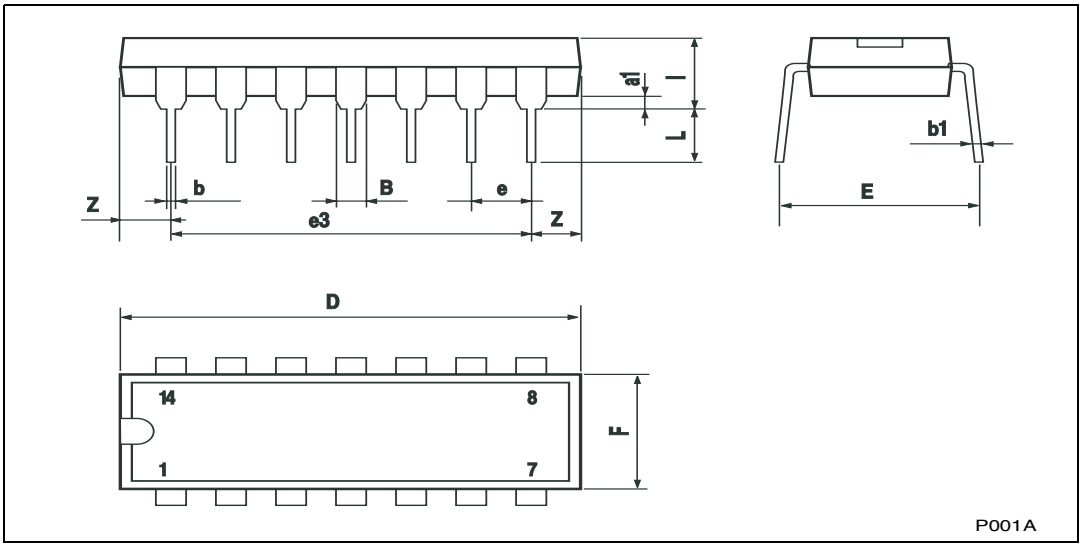
miniSO-8 MECHANICAL DATA						
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.1			0.043
A1	0.05	0.10	0.15	0.002	0.004	0.006
A2	0.78	0.86	0.94	0.031	0.031	0.037
b	0.25	0.33	0.40	0.010	0.13	0.013
c	0.13	0.18	0.23	0.005	0.007	0.009
D	2.90	3.00	3.10	0.114	0.118	0.122
E	4.75	4.90	5.05	0.187	0.193	0.199
E1	2.90	3.00	3.10	.0114	0.118	0.122
e		0.65			0.026	
K	0°		6°	0°		6°
L	0.40	0.55	0.70	0.016	0.022	0.028
L1			0.10			0.004



3.5 DIP14 package

Plastic DIP-14 MECHANICAL DATA

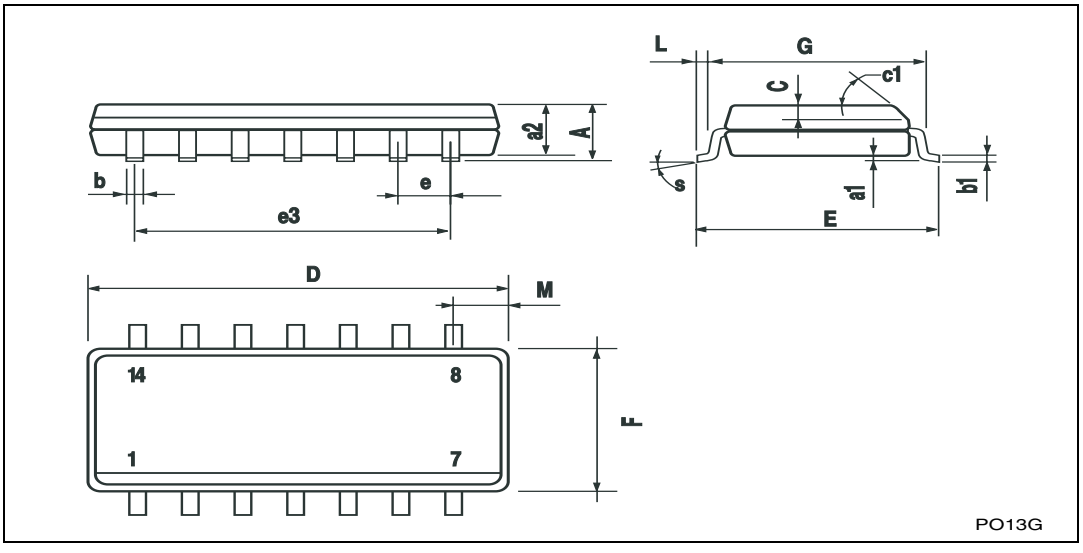
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
a1	0.51			0.020		
B	1.39		1.65	0.055		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		15.24			0.600	
F			7.1			0.280
I			5.1			0.201
L		3.3			0.130	
Z	1.27		2.54	0.050		0.100



3.6 SO14 package

SO-14 MECHANICAL DATA

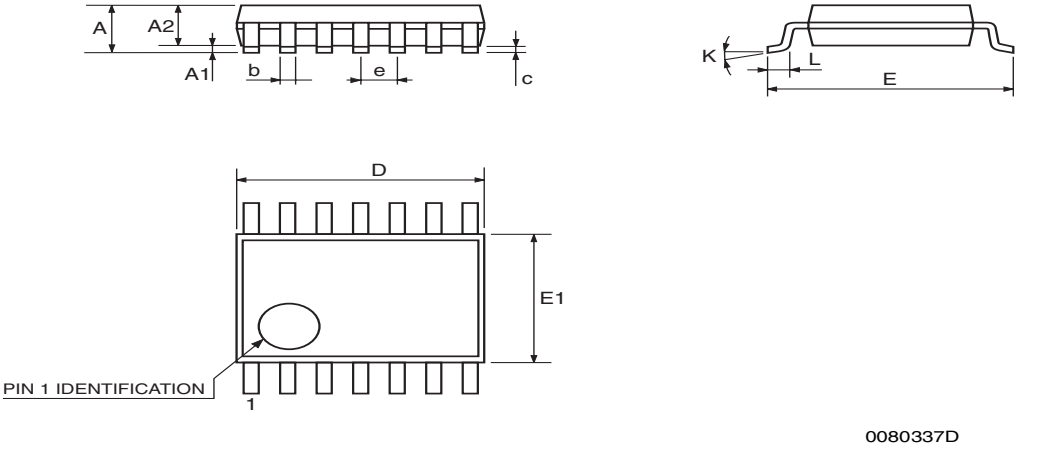
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.2	0.003		0.007
a2			1.65			0.064
b	0.35		0.46	0.013		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.019	
c1	45° (typ.)					
D	8.55		8.75	0.336		0.344
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F	3.8		4.0	0.149		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.019		0.050
M			0.68			0.026
S	8° (max.)					



3.7 TSSOP14 package

TSSOP14 MECHANICAL DATA

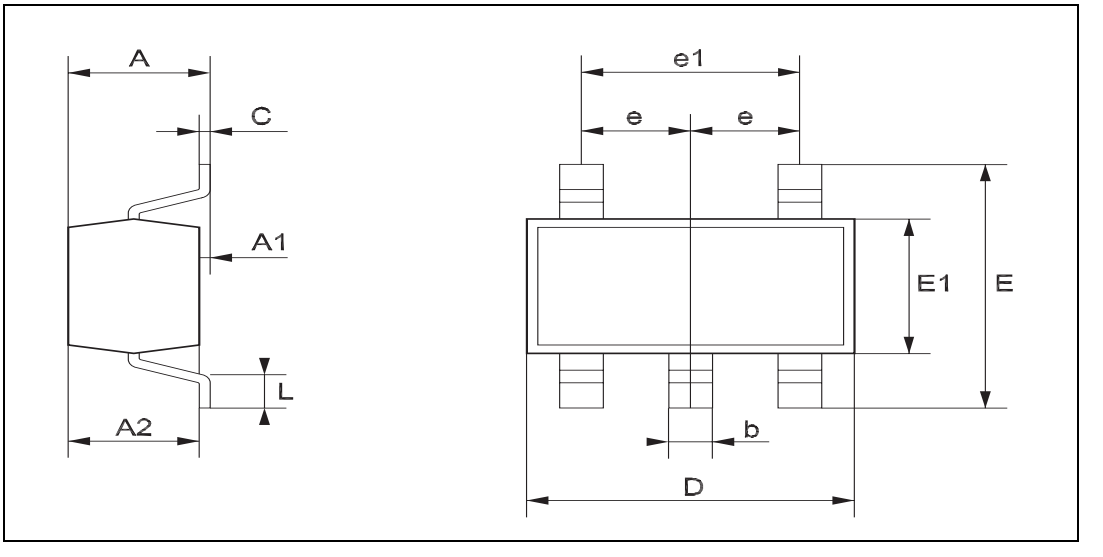
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.2			0.047
A1	0.05		0.15	0.002	0.004	0.006
A2	0.8	1	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.0089
D	4.9	5	5.1	0.193	0.197	0.201
E	6.2	6.4	6.6	0.244	0.252	0.260
E1	4.3	4.4	4.48	0.169	0.173	0.176
e		0.65 BSC			0.0256 BSC	
K	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030



3.8 SOT23-5 package

SOT23-5L MECHANICAL DATA

DIM.	mm.			mils		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	0.90		1.45	35.4		57.1
A1	0.00		0.15	0.0		5.9
A2	0.90		1.30	35.4		51.2
b	0.35		0.50	13.7		19.7
C	0.09		0.20	3.5		7.8
D	2.80		3.00	110.2		118.1
E	2.60		3.00	102.3		118.1
E1	1.50		1.75	59.0		68.8
e		0.95			37.4	
e1		1.9			74.8	
L	0.35		0.55	13.7		21.6



4 Summary of Changes

Date	Revision	Description of Changes
01 Feb. 2002	1	First Release
01 Jan. 05	2	Modifications on AMR *Table 1 on page 2* (explanation of Vid and Vi limits)