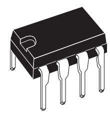
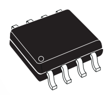
TS271

CMOS Programmable
Low Power Single Operational Amplifier

- **Offset null capability (by external compensation)**
- **Dynamic characteristics adjustable I_{SET}**
- **Consumption current and dynamic parameters are stable regarding the voltage power supply variations**
- **Output voltage can swing to ground**
- **Very large I_{SET} range**
- **Stable and low offset voltage**
- **Three input offset voltage selections**



N
DIP8
(Plastic Package)



D
SO-8
(Plastic Micropackage)

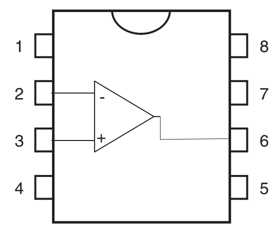
Description

The TS271 is a low cost, low power single operational amplifier designed to operate with single or dual supplies. This operational amplifier uses the ST silicon gate CMOS process giving it an excellent consumption-speed ratio. This amplifier is ideally suited for low consumption applications.

The power supply is externally programmable with a resistor connected between pins 8 and 4. It allows to choose the best consumption-speed ratio and supply current can be minimized according to the required speed. This device is specified for the following I_{SET} current values: 1.5µA, 25µA, 130µA.

This CMOS amplifier offers very high input impedance and extremely low input currents. The major advantage versus JFET devices is the very low input currents drift with temperature see *Figure 8*, *Figure 19*, *Figure 30*.

Pin Connections (top view)



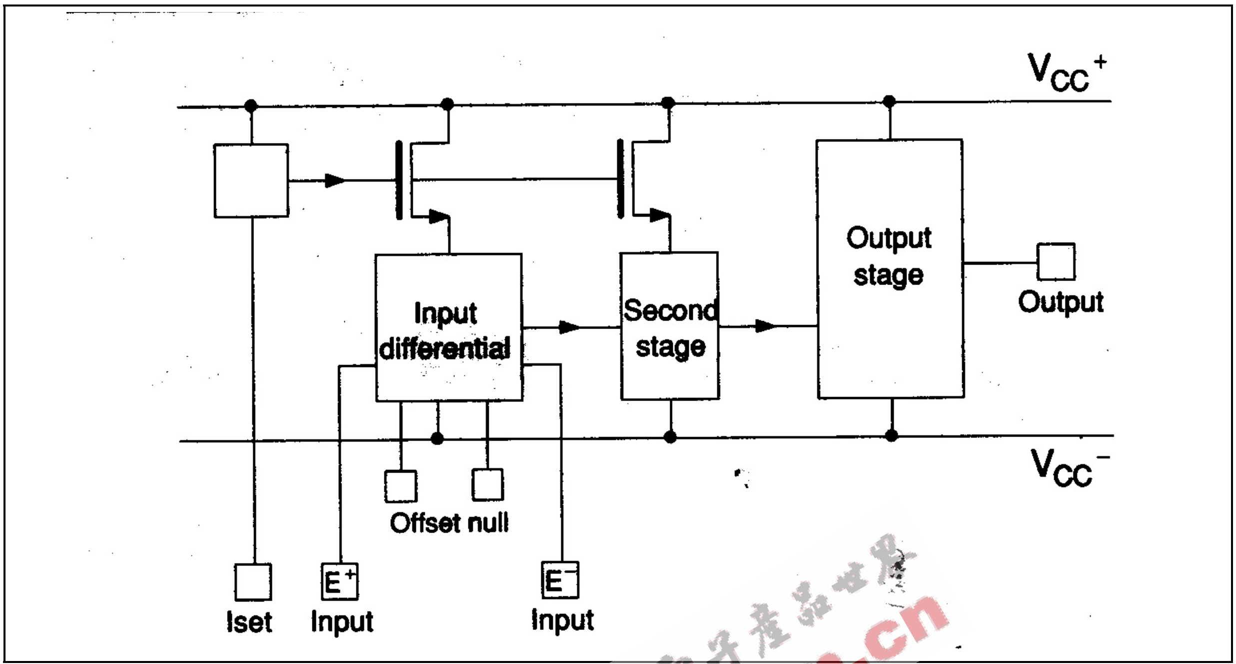
1 - Offset Null 1
2 - Inverting Input 1
3 - Non-inverting Input 1
4 - V_{CC}^-
5 - Offset Null 2
6 - Output
7 - V_{CC}^+
8 - I_{Set}

Order Codes

Part Number	Temperature Range	Package	Packaging
TS271CN/ACN	0°C, +70°C	DIP	Tube
TS271CD/CDT/ACD/ACDT		SO	Tube and Tape & Reel
TS271IN/AIN/	-40°C, +125°C	DIP	Tube
TS271ID/IDT/AID/AIDT/BID/BIDT		SO	Tube and Tape & Reel
TS271BMD	-55°C, +125°C	SO	Tube

1 Block Diagram

Figure 1. Application block diagram



2 Absolute Maximum Ratings

Table 1. Key parameters and their absolute maximum ratings

Symbol	Parameter	TS271C/AC/BC	TS271I/AI/BI	TS271M/AM/BM	Unit
VCC+	Supply Voltage [1]	18			V
Vid	Differential Input Voltage [2]	±18			V
V_i	Input Voltage [3]	-0.3 to 18			V
I_o	Output Current for $V_{CC}^+ \geq 15V$	±30			mA
I_{in}	Input Current	±5			mA
T_{oper}	Operating Free-Air Temperature Range	0 to +70	-40 to +125	-55 to +125	°C
T_{stg}	Storage Temperature Range	-65 to +150			°C

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

2) Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.

3) The magnitude of the input and the output voltages must never exceed the magnitude of the positive supply voltage.

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}^+	Supply Voltage	3 to 16	V
V_{icm}	Common Mode Input Voltage Range	0 to V_{CC}^+ - 1.5	V

Figure 2. Schematic Diagram

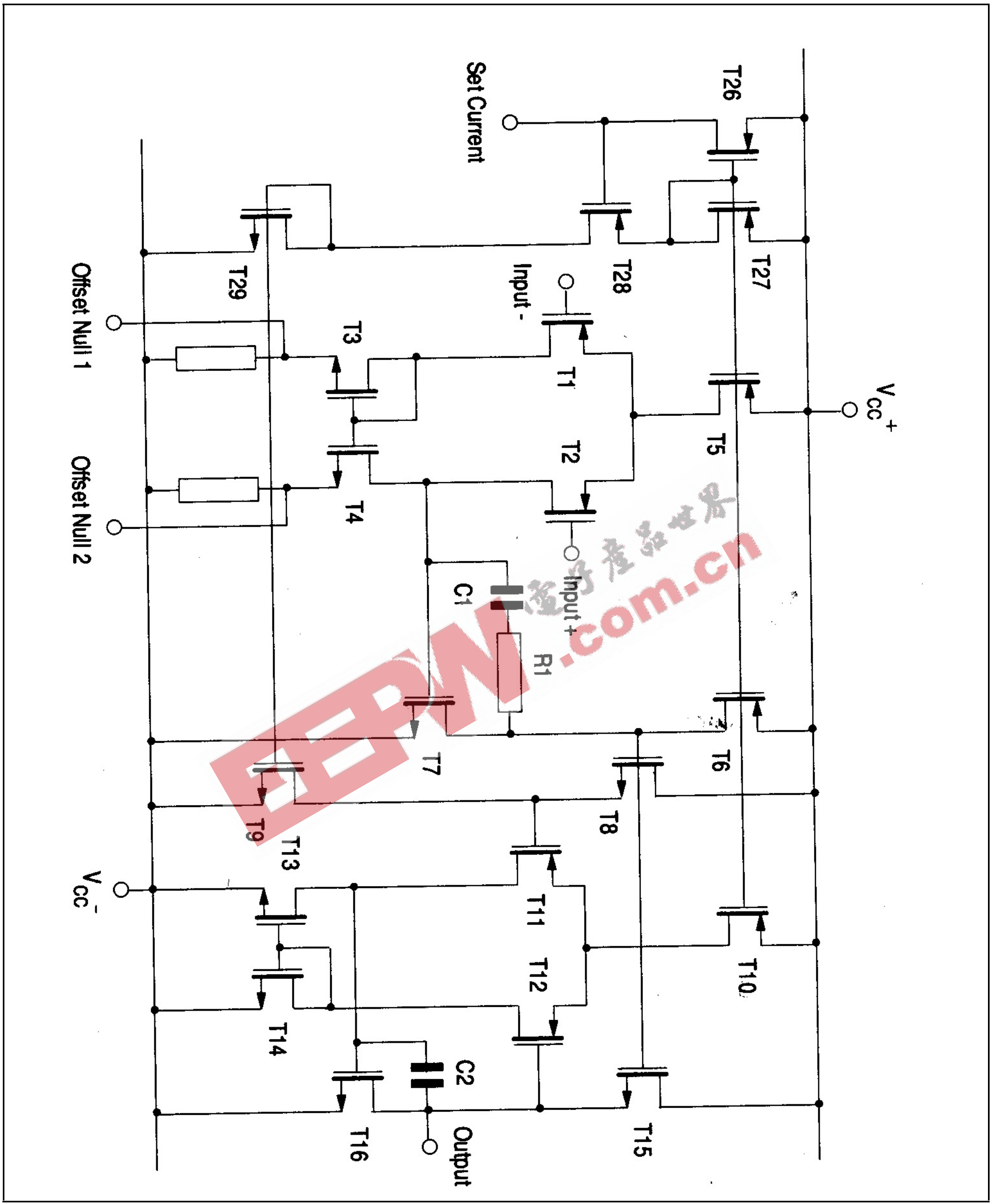


Figure 3. Offset voltage null circuit

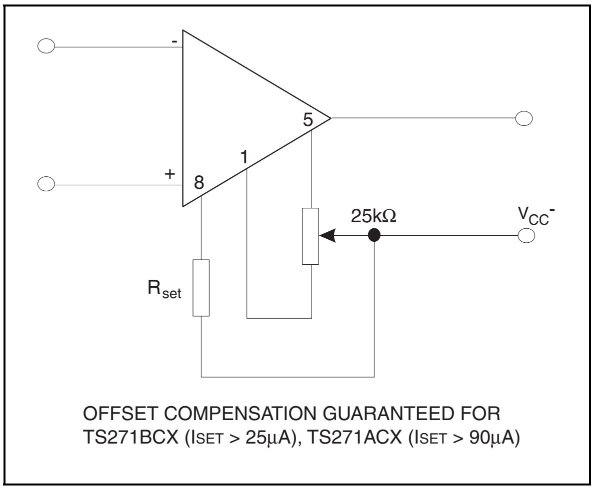


Figure 4. Offset voltage null circuit

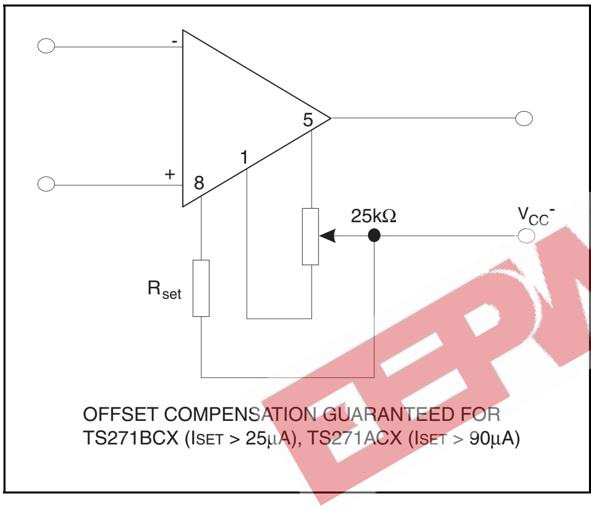


Figure 5. Resistor biasing

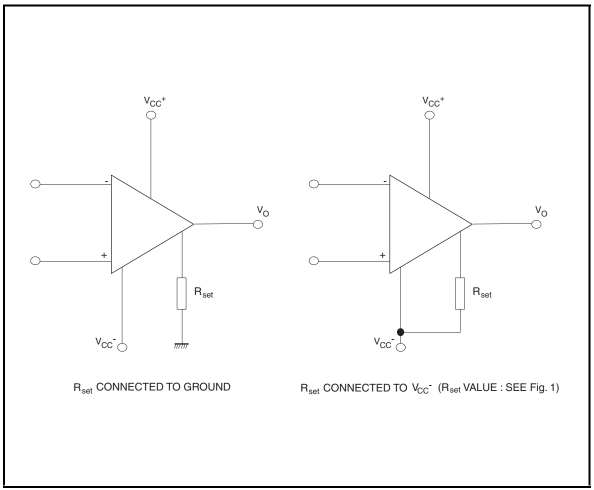
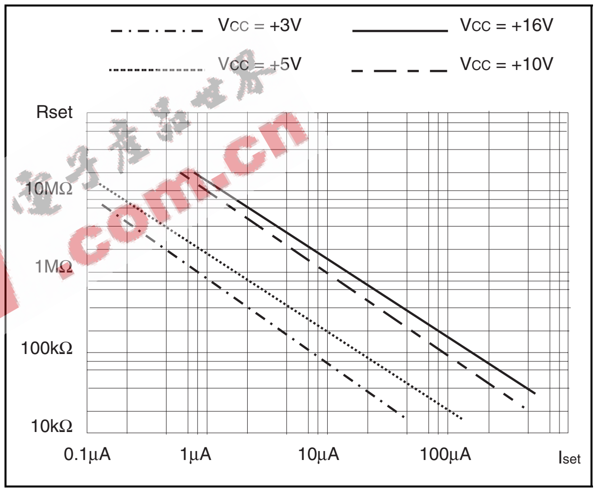


Figure 6. Rset connected to Vcc-



3 Electrical Characteristics

Table 3. for I_{SET} = 1.5µA - V_{CC}^+ = +10V, V_{CC}^- = 0V, T_{amb} = +25°C (unless otherwise specified)

Symbol	Parameter	TS271C/AC/BC			TS271I/AI/BI TS271M/AM/BM			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
V_{io}	Input Offset Voltage V_O = 1.4V, V_{ic} = 0V TS271C/I/M TS271AC/AI/AM TS271BC/BI/BM $T_{min} \le T_{amb} \le T_{max}$ TS271C/I/M TS271AC/AI/AM TS271BC/BI/BM		1.1 0.9 0.25	10 5 2 12 6.5 3		1.1 0.9 0.25	10 5 2 12 6.5 3.5	mV
DV_{io}	Input Offset Voltage Drift		2			2		µV/°C
I_{io}	Input Offset Current note [1] V_{ic} = 5V, V_O = 5V $T_{min} \le T_{amb} \le T_{max}$		1	100		1	200	pA
I_{ib}	Input Bias Current - see note 1 V_{ic} = 5V, V_O = 5V $T_{min} \le T_{amb} \le T_{max}$		1	150		1	300	pA
V_{OH}	High Level Output Voltage V_{id} = 100mV, R_L = 1MΩ $T_{min} \le T_{amb} \le T_{max}$	8.8 8.7	9		8.8 8.6	9		V
V_{OL}	Low Level Output Voltage V_{id} = -100mV			50			50	mV
A_{vd}	Large Signal Voltage Gain V_{iC} = 5V, R_L = 1MΩ, V_o = 1V to 6V $T_{min} \le T_{amb} \le T_{max}$	30 20	100		30 20	100		V/mV
GBP	Gain Bandwidth Product A_v = 40dB, R_L = 1MΩ, C_L = 100pF, f_{in} = 100kHz		0.1			0.1		MHz
CMR	Common Mode Rejection Ratio V_{iC} = 1V to 7.4V, V_o = 1.4V	60	80		60	80		dB
SVR	Supply Voltage Rejection Ratio V_{CC}^+ = 5V to 10V, V_o = 1.4V	60	80		60	80		dB
I_{CC}	Supply Current (per amplifier) A_v = 1, no load, V_o = 5V $T_{min} \le T_{amb} \le T_{max}$		10	15 17		10	15 18	µA
I_o	Output Short Circuit Current V_o = 0V, V_{id} = 100mV		60			60		mA
I_{sink}	Output Sink Current V_o = V_{CC}, V_{id} = -100mV		45			45		mA
SR	Slew Rate at Unity Gain R_L = 1MΩ, C_L = 100pF, V_i = 3 to 7V		0.04			0.04		V/µs
ϕm	Phase Margin at Unity Gain A_v = 40dB, R_L = 1MΩ C_L = 10pF C_L = 100pF		35 10			35 10		Degrees
K_{OV}	Overshoot Factor A_v = 40dB, R_L = 1MΩ C_L = 10pF C_L = 100pF		40 70			40 70		%
e_n	Equivalent Input Noise Voltage f = 1kHz, R_s = 100Ω		30			30		$\frac{nV}{\sqrt{Hz}}$

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

Typical characteristics for $I_{SET} = 1.5\mu A$

Figure 7. Supply current versus supply voltage

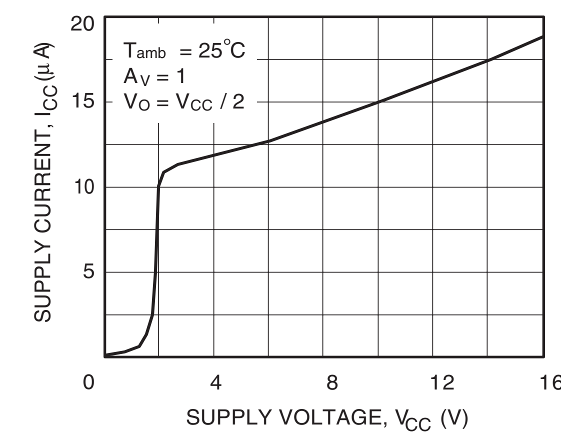


Figure 8. Input bias current versus free air temperature

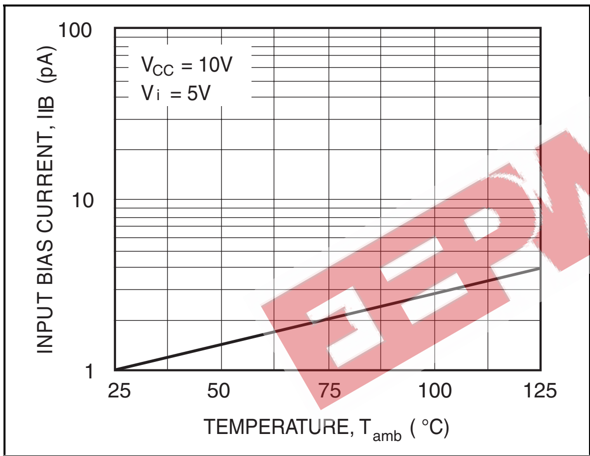


Figure 9. High level output voltage versus high level output current

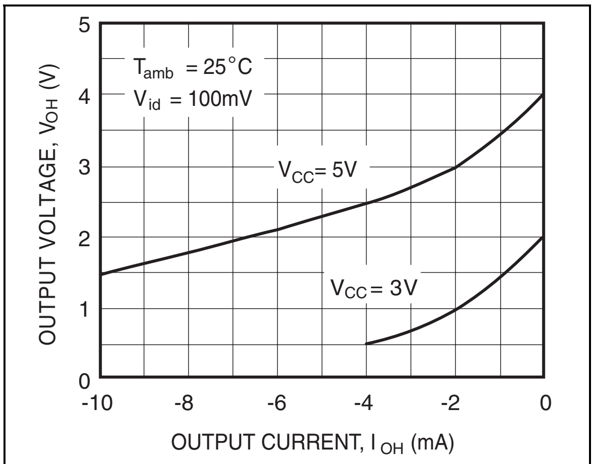


Figure 10. High level output voltage versus high level output current

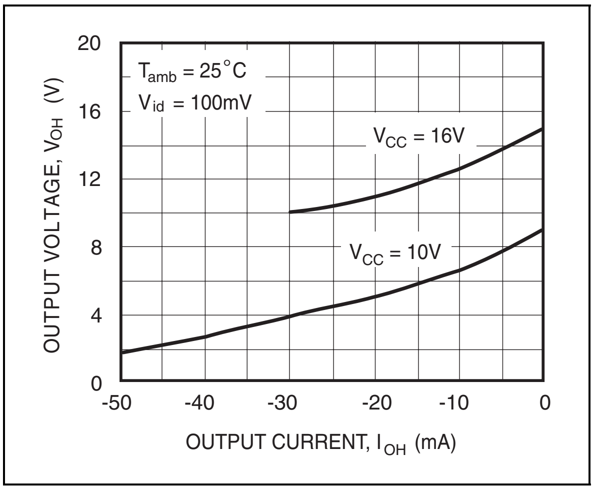


Figure 11. Low level output voltage versus low level output current

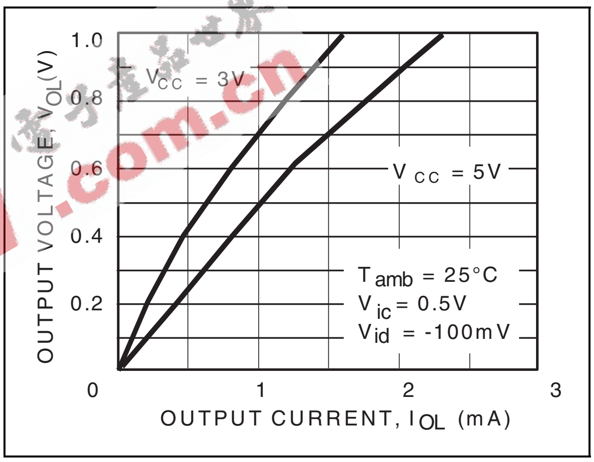


Figure 12. Low level output voltage versus low level output current

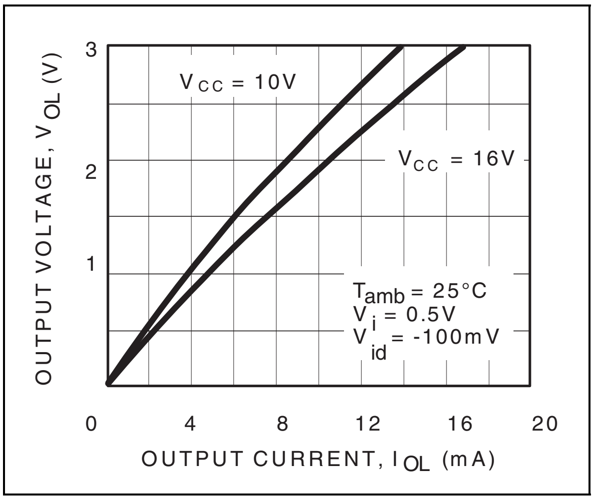


Figure 13. Open loop frequency response and phase shift

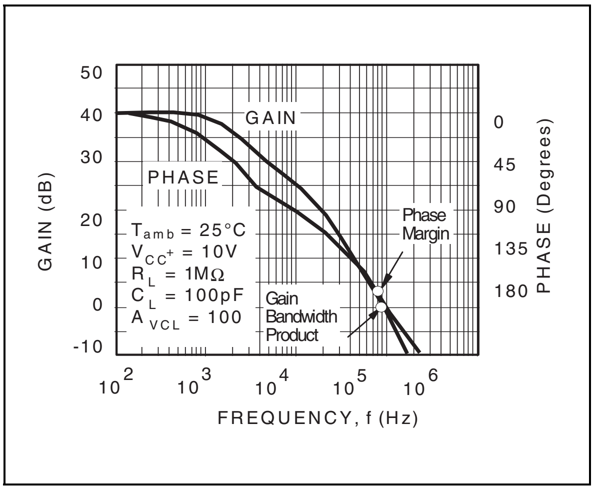


Figure 14. Gain bandwidth product versus supply voltage

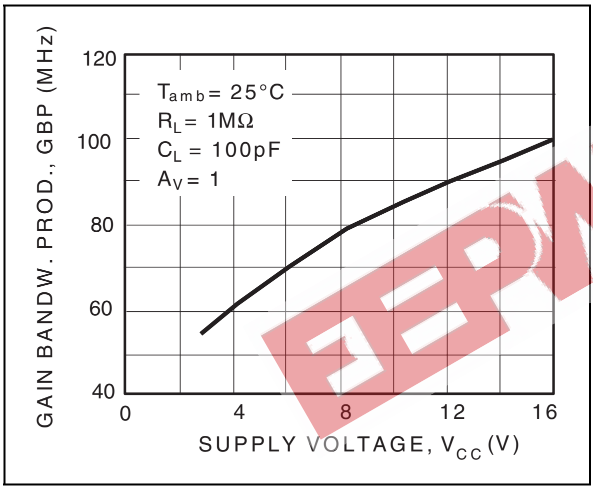


Figure 15. Phase margin versus supply voltage

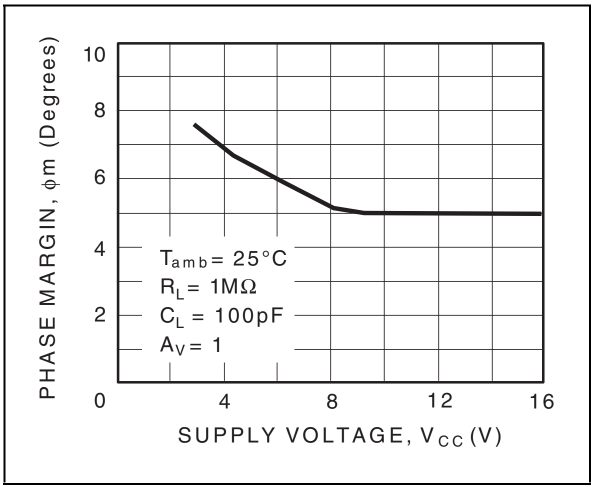


Figure 16. Phase margin versus capacitive load

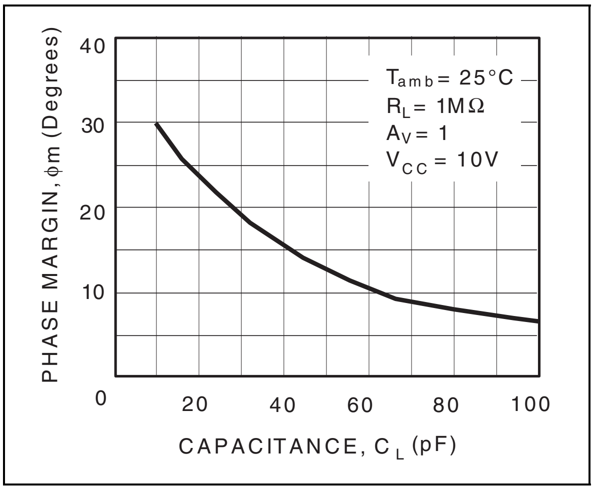
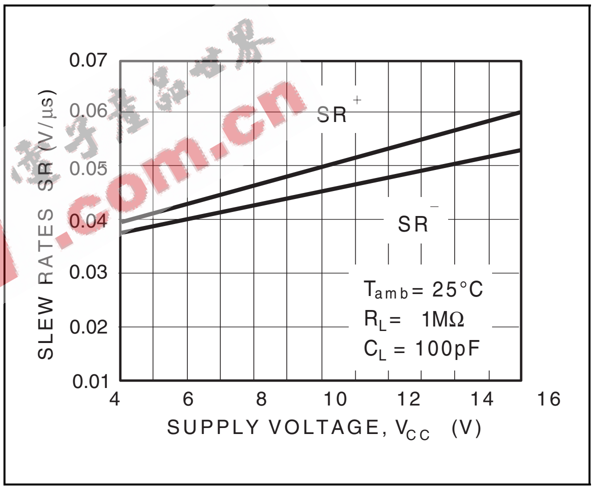


Figure 17. Slew rate versus supply voltage



4 Electrical Characteristics

Table 4. for I_{SET} = 25µA - V_{CC}^+ = +10V, V_{CC}^- = 0V, T_{amb} = +25°C (unless otherwise specified)

Symbol	Parameter	TS271C/AC/BC			TS271I/AI/BI TS271M/AM/BM			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
V_{io}	Input Offset Voltage V_O = 1.4V, V_{ic} = 0V TS271C/I/M TS271AC/AI/AM TS271BC/BI/BM $T_{min} \le T_{amb} \le T_{max}$ TS271B/C/I/M TS271AC/AI/AM TS271BC/BI/BM		1.1 0.9 0.25	10 5 2 12 6.5 3		1.1 0.9 0.25	10 5 2 12 6.5 3.5	mV
DV_{io}	Input Offset Voltage Drift		2			2		µV/°C
I_{io}	Input Offset Current note [1] V_{ic} = 5V, V_O = 5V $T_{min} \le T_{amb} \le T_{max}$		1	 100		1	 200	pA
I_{ib}	Input Bias Current - see note 1 V_{ic} = 5V, V_O = 5V $T_{min} \le T_{amb} \le T_{max}$		1	 150		1	 300	pA
V_{OH}	High Level Output Voltage V_{id} = 100mV, R_L = 100kΩ $T_{min} \le T_{amb} \le T_{max}$	8.7 8.6	8.9		8.7 8.5	8.9		V
V_{OL}	Low Level Output Voltage V_{id} = -100mV			50			50	mV
A_{vd}	Large Signal Voltage Gain V_{iC} = 5V, R_L = 100kΩ, V_o = 1V to 6V $T_{min} \le T_{amb} \le T_{max}$	30 20	50		30 10	50		V/mV
GBP	Gain Bandwidth Product A_v = 40dB, R_L = 100kΩ, C_L = 100pF, f_{in} = 100kHz		0.7			0.7		MHz
CMR	Common Mode Rejection Ratio V_{iC} = 1V to 7.4V, V_o = 1.4V	60	80		60	80		dB
SVR	Supply Voltage Rejection Ratio V_{CC}^+ = 5V to 10V, V_o = 1.4V	60	80		60	80		dB
I_{CC}	Supply Current (per amplifier) A_v = 1, no load, V_o = 5V $T_{min} \le T_{amb} \le T_{max}$		150	200 250		150	200 300	µA
I_o	Output Short Circuit Current V_o = 0V, V_{id} = 100mV		60			60		mA
I_{sink}	Output Sink Current V_o = V_{CC}, V_{id} = -100mV		45			45		mA
SR	Slew Rate at Unity Gain R_L = 100kΩ, C_L = 100pF, V_i = 3 to 7V		0.6			0.6		V/µs
φm	Phase Margin at Unity Gain A_v = 40dB, R_L = 100kΩ C_L = 10pF C_L = 100pF		50 30			50 30		Degrees
K_{OV}	Overshoot Factor A_v = 40dB, R_L = 100kΩ C_L = 10pF C_L = 100pF		30 50			30 50		%
e_n	Equivalent Input Noise Voltage f = 1kHz, R_s = 100Ω		38			38		$\frac{nV}{\sqrt{Hz}}$

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

Typical characteristics for $I_{SET} = 25\mu A$

Figure 18. Supply current versus supply voltage

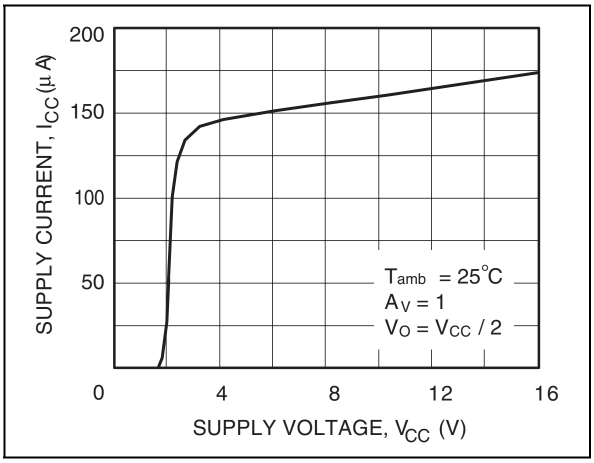


Figure 19. Input bias current versus free air temperature

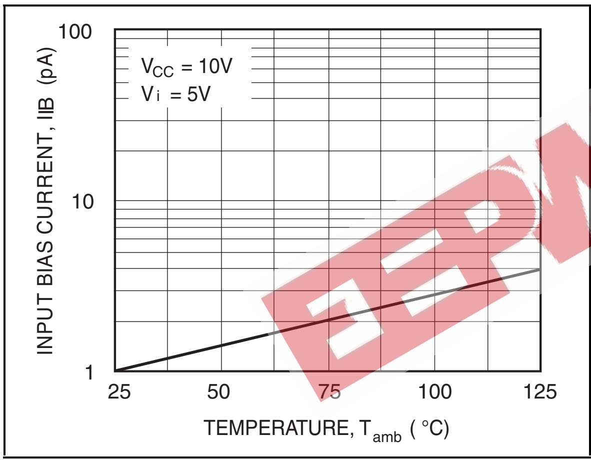


Figure 20. High level output voltage versus high level output current

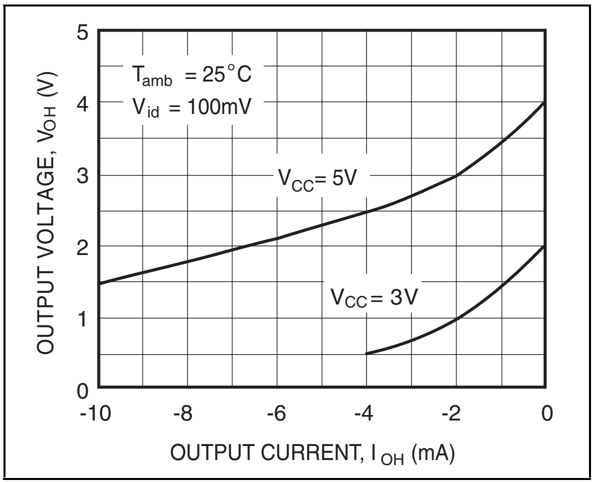


Figure 21. High level output voltage versus high level output current

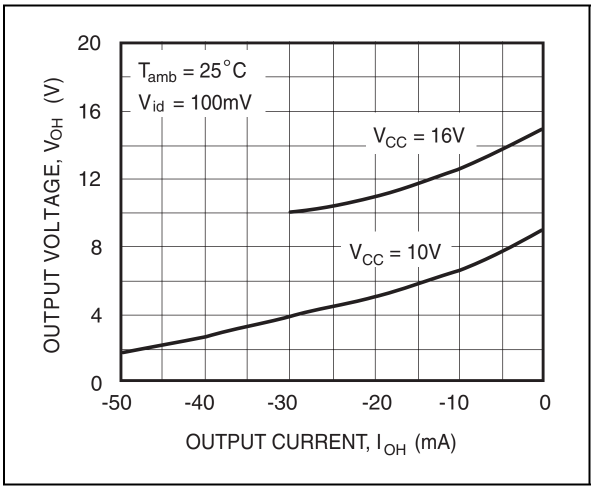


Figure 22. Low level output voltage versus low level output current

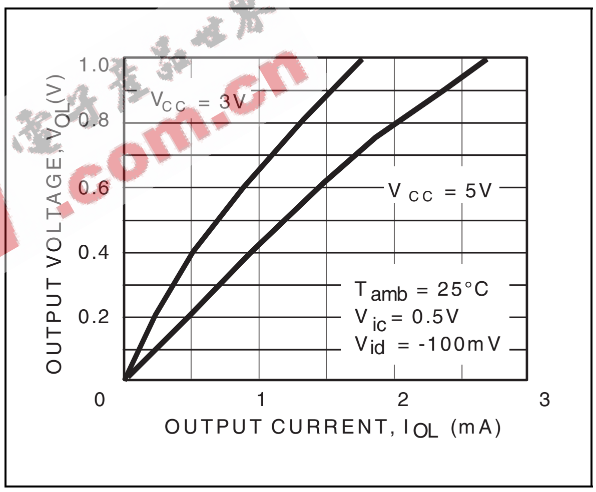


Figure 23. Low level output voltage versus low level output current

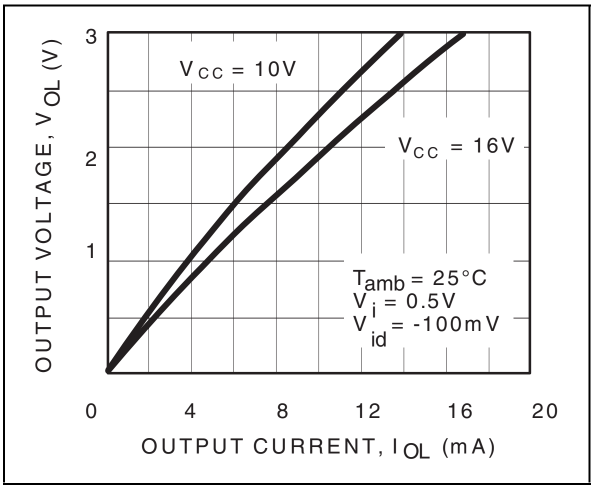


Figure 24. Open loop frequency response and phase shift

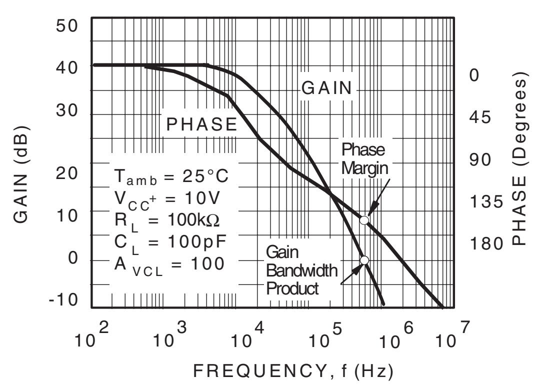


Figure 25. Gain bandwidth product versus supply voltage

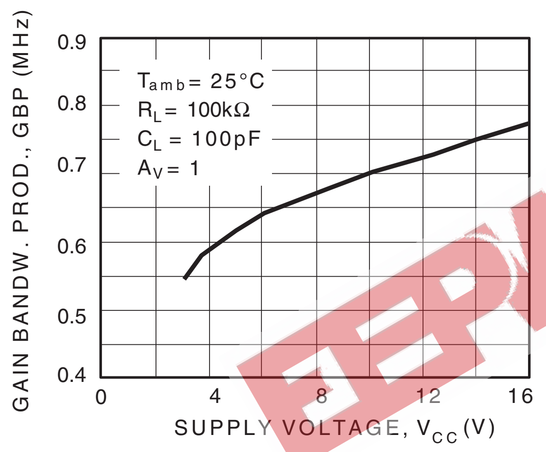


Figure 26. Phase margin versus supply voltage

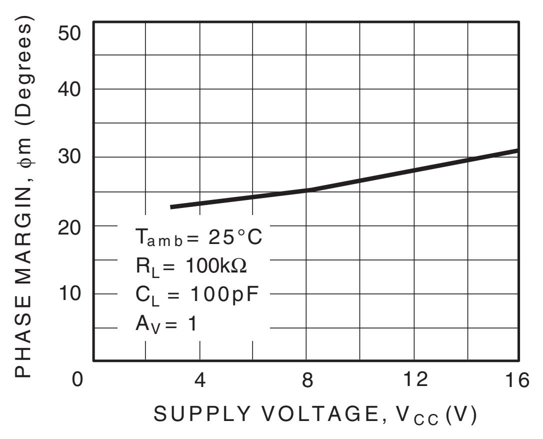


Figure 27. Phase margin versus capacitive load

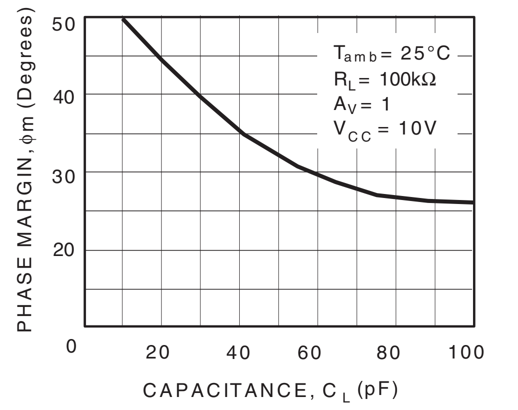
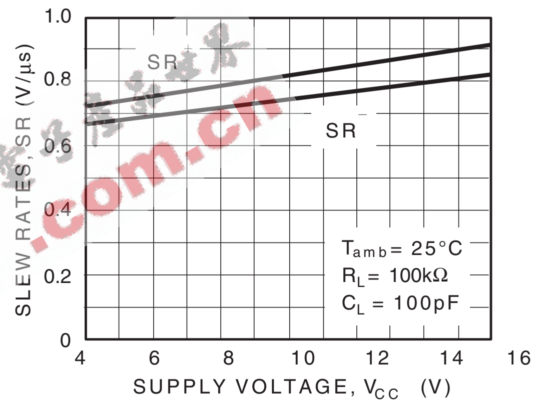


Figure 28. Slew rate versus supply voltage



5 Electrical Characteristics

Table 5. for I_{SET} = 130µA - V_{CC}^{+} = +10V, V_{CC}^{-}= 0V, T_{amb} = +25°C (unless otherwise specified)

Symbol	Parameter	TS271C/AC/BC			TS271I/AI/BI TS271M/AM/BM			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
V_{io}	Input Offset Voltage V_O = 1.4V, V_{ic} = 0V TS271C/I/M TS271AC/AI/AM TS271BC/BI/BM $T_{min} \le T_{amb} \le T_{max}$ TS271B/C/I/M TS271AC/AI/AM TS271BC/BI/BM		1.1 0.9 0.25	10 5 2 12 6.5 3		1.1 0.9 0.25	10 5 2 12 6.5 3.5	mV
DV_{io}	Input Offset Voltage Drift		2			2		µV/°C
I_{io}	Input Offset Current note [1] V_{ic} = 5V, V_O = 5V $T_{min} \le T_{amb} \le T_{max}$		1	100		1	200	pA
I_{ib}	Input Bias Current - see note 1 V_{ic} = 5V, V_O = 5V $T_{min} \le T_{amb} \le T_{max}$		1	150		1	300	pA
V_{OH}	High Level Output Voltage V_{id} = 100mV, R_L = 10kΩ $T_{min} \le T_{amb} \le T_{max}$	8.2 8.1	8.4		8.2 8	8.4		V
V_{OL}	Low Level Output Voltage V_{id} = -100mV			50			50	mV
A_{vd}	Large Signal Voltage Gain V_{iC} = 5V, R_L = 10kΩ, V_o = 1V to 6V $T_{min} \le T_{amb} \le T_{max}$	10 7	15		10 6	15		V/mV
GBP	Gain Bandwidth Product A_v = 40dB, R_L = 10kΩ, C_L = 100pF, f_{in} = 100kHz		2.3			2.3		MHz
CMR	Common Mode Rejection Ratio V_{iC} = 1V to 7.4V, V_o = 1.4V	60	80		60	80		dB
SVR	Supply Voltage Rejection Ratio V_{CC}^{+} = 5V to 10V, V_o = 1.4V	60	70		60	70		dB
I_{CC}	Supply Current (per amplifier) A_v = 1, no load, V_o = 5V $T_{min} \le T_{amb} \le T_{max}$		800	1300 1400		800	1300 1500	µA
I_o	Output Short Circuit Current V_o = 0V, V_{id} = 100mV		60			60		mA
I_{sink}	Output Sink Current V_o = V_{CC}, V_{id} = -100mV		45			45		mA
SR	Slew Rate at Unity Gain R_L = 10kΩ, C_L = 100pF, V_i = 3 to 7V		4.5			4.5		V/µs
ϕm	Phase Margin at Unity Gain A_v = 40dB, R_L = 10kΩ C_L = 10pF C_L = 100pF		65 30			65 30		Degrees
K_{OV}	Overshoot Factor A_v = 40dB, R_L = 10kΩ C_L = 10pF C_L = 100pF		30 50			30 50		%
e_n	Equivalent Input Noise Voltage f = 1kHz, R_s = 100Ω		30			30		$\frac{nV}{\sqrt{Hz}}$

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

Typical characteristics for $I_{SET} = 130\mu A$

Figure 29. Supply current (each amplifier) versus supply voltage

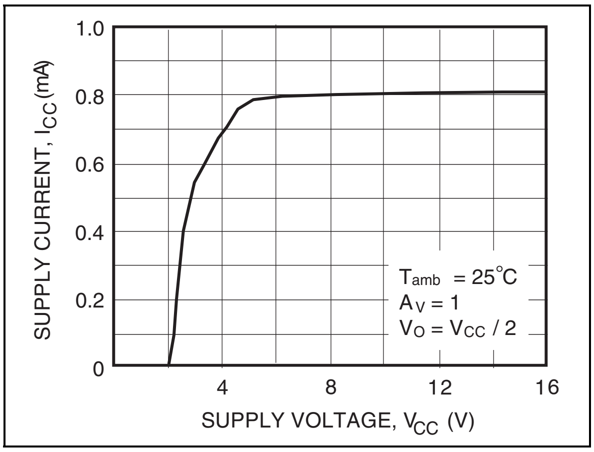


Figure 30. Input bias current versus free air temperature

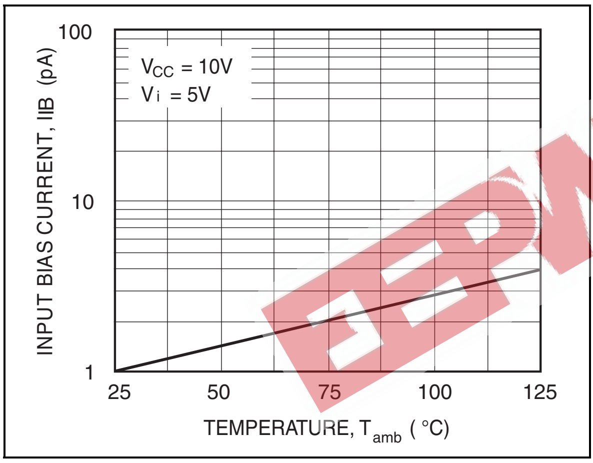


Figure 31. High level output voltage versus high level output current

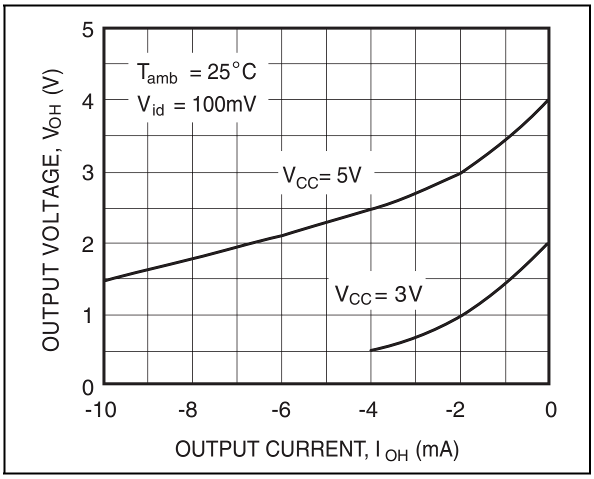


Figure 32. High level output voltage versus high level output current

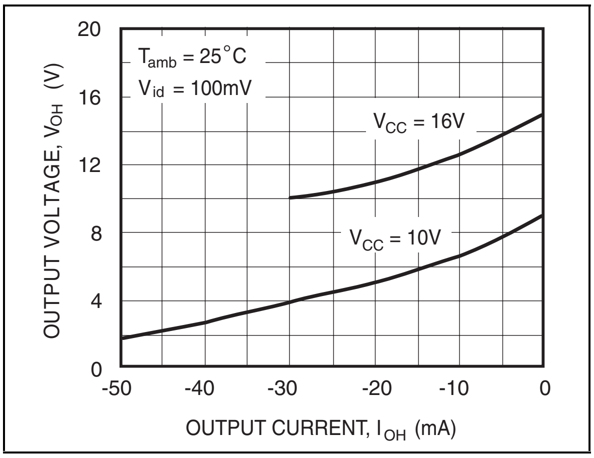


Figure 33. Low level output voltage versus low level output current

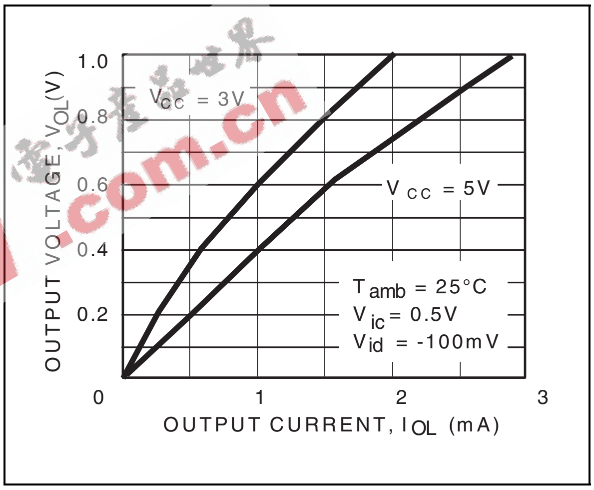


Figure 34. Low level output voltage versus low level output current

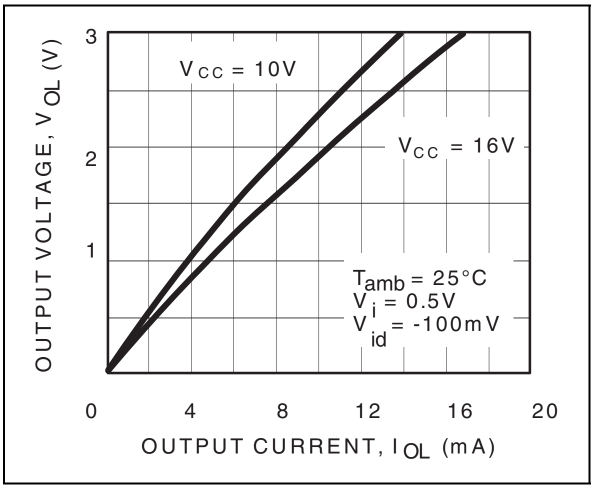


Figure 35. Open loop frequency response and phase shift

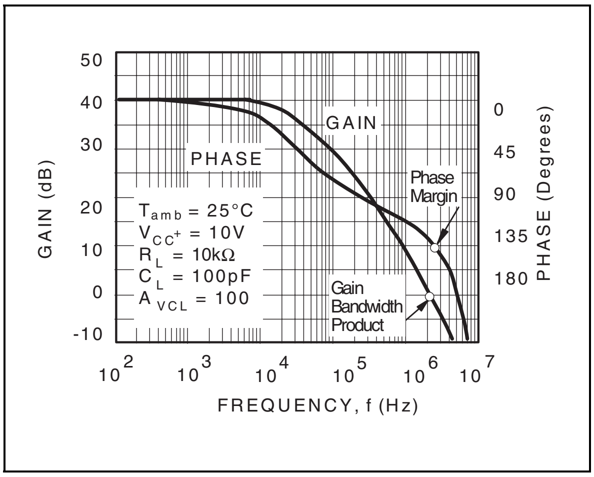


Figure 36. Gain bandwidth product versus supply voltage

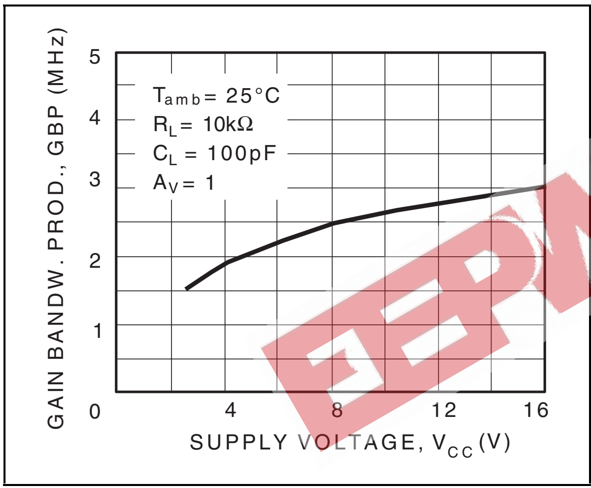


Figure 37. Phase margin versus supply voltage

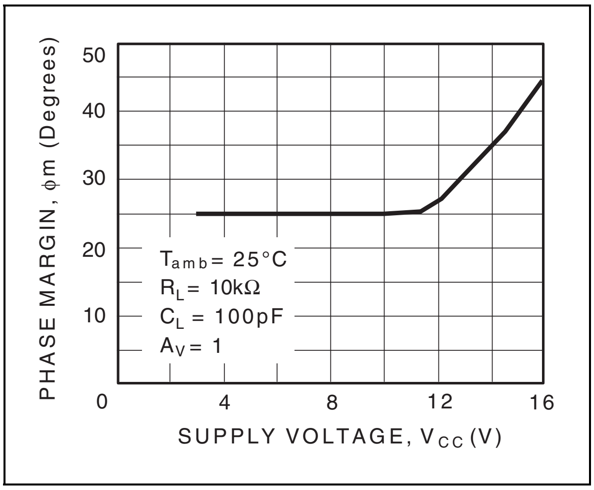


Figure 38. Phase margin versus capacitive load

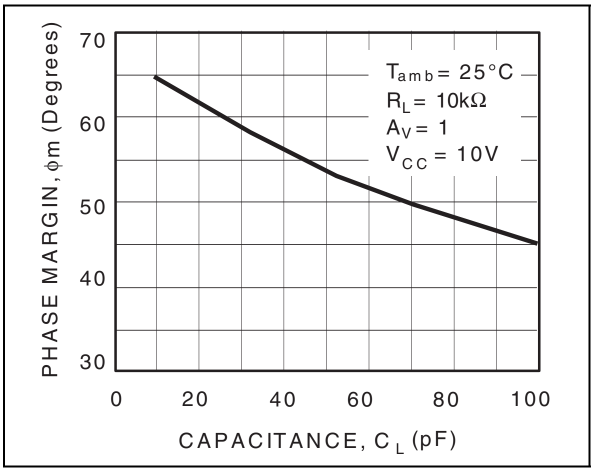
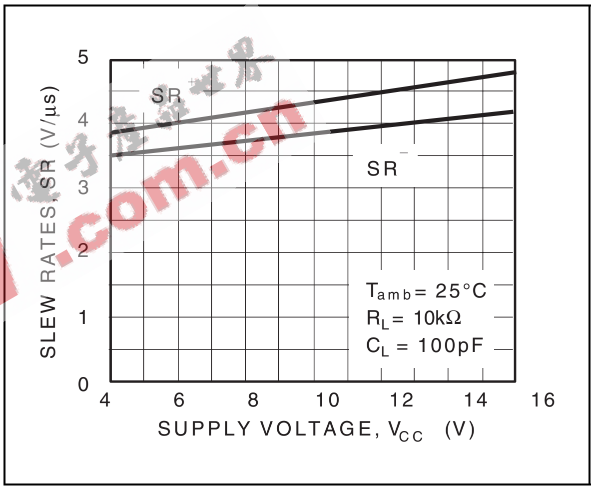


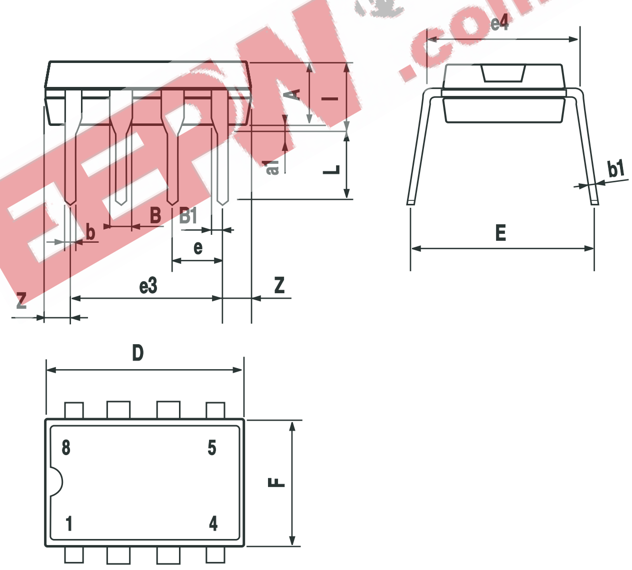
Figure 39. Slew rate versus supply voltage



6 Package Mechanical Data

Plastic DIP-8 MECHANICAL DATA

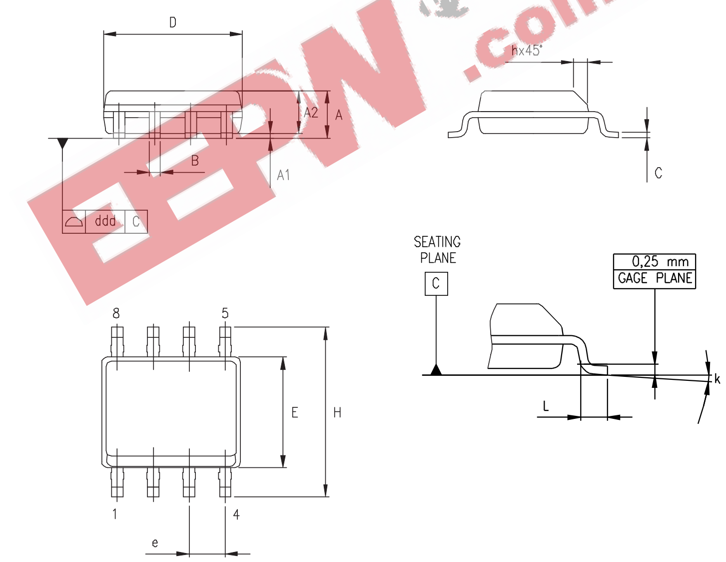
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A		3.3			0.130	
a1	0.7			0.028		
B	1.39		1.65	0.055		0.065
B1	0.91		1.04	0.036		0.041
b		0.5			0.020	
b1	0.38		0.5	0.015		0.020
D			9.8			0.386
E		8.8			0.346	
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			7.1			0.280
I			4.8			0.189
L		3.3	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



P001F

Package Mechanical Data

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



0016023/C

7 Revision History

Date	Revision	Description of Changes
01 Nov. 2001	1	First Release
01 March 2005	2	• Application block diagram updated on *Figure 2 on page 4* • Schematic Diagram updated on *Figure 4 on page 5*