

TLC193, TLC393 DUAL MICROPOWER LinCMOS™ VOLTAGE COMPARATOR

SLCS115D – DECEMBER 1986 – REVISED JANUARY 1999

- **Very Low Power . . . 110 μ W Typ at 5 V**
- **Fast Response Time . . . $t_{PLH} = 2.5 \mu$ s Typ With 5-mV Overdrive**
- **Single Supply Operation:**
 - TLC393C . . . 3 V to 16 V
 - TLC393I . . . 3 V to 16 V
 - TLC393Q . . . 4 V to 16 V
 - TLC393M . . . 4 V to 16 V
 - TLC193M . . . 4 V to 16 V
- **On-Chip ESD Protection**

description

The TLC193 and TLC393 consist of dual independent micropower voltage comparators designed to operate from a single supply. They are functionally similar to the LM393 but uses one-twentieth the power for similar response times. The open-drain MOS output stage interfaces to a variety of loads and supplies. For a similar device with a push-pull output configuration (see the TLC3702 data sheet).

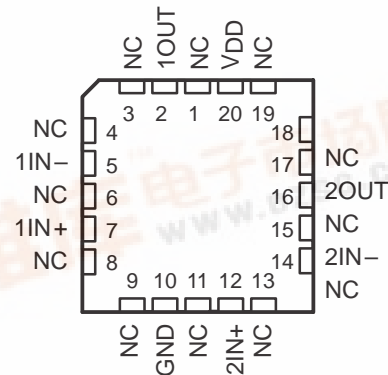
Texas Instruments LinCMOS™ process offers superior analog performance to standard CMOS processes. Along with the standard CMOS advantages of low power without sacrificing speed, high input impedance, and low bias currents, the LinCMOS™ process offers extremely stable input offset voltages, even with differential input stresses of several volts. This characteristic makes it possible to build reliable CMOS comparators.

The TLC393C is characterized for operation over the commercial temperature range of $T_A = 0^\circ\text{C}$ to 70°C . The TLC393I is characterized for operation over the extended industrial temperature range of $T_A = -40^\circ\text{C}$ to 85°C . The TLC393Q is characterized for operation over the full automotive temperature range of $T_A = -40^\circ\text{C}$ to 125°C . The TLC193M and TLC393M are characterized for operation over the full military temperature range of $T_A = -55^\circ\text{C}$ to 125°C .

D, JG, P, OR PW PACKAGE
(TOP VIEW)

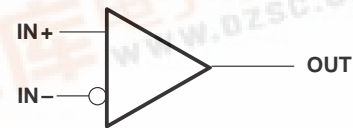


FK PACKAGE
(TOP VIEW)



NC – No internal connection

symbol (each comparator)



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

LinCMOS is a trademark of Texas Instruments Incorporated.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.



TLC193, TLC393

DUAL MICROWPOWER LinCMOS™ VOLTAGE COMPARATOR

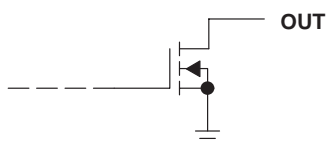
SLCS115D – DECEMBER 1986 – REVISED JANUARY 1999

AVAILABLE OPTIONS

T _A	V _{IOMax} at 25°C	PACKAGES				
		SMALL OUTLINE (D)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	PLASTIC DIP (P)	TSSOP (PW)
0°C to 70°C	5 mV	TLC393CD	—	—	TLC393CP	TLC393CPWLE
– 40°C to 85°C	5 mV	TLC393ID	—	—	TLC393IP	TLC393IPWLE
– 40°C to 125°C	5 mV	TLC393QD	—	—	—	—
– 55°C to 125°C	5 mV	TLC393MD	TLC193MFK	TLC193MJG	TLC393MP	—

† The D package is available taped and reeled. Add the suffix R to the device type (e.g., TLC393CDR).

schematic



OPEN-DRAIN CMOS OUTPUT

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage range, V _{DD} (see Note 1)	– 0.3 V to 18 V
Differential input voltage, V _{ID} (see Note 2)	±18 V
Input voltage range, V _I	– 0.3 V to V _{DD}
Output voltage range, V _O	– 0.3 V to 16 V
Input current, I _I	±5 mA
Output current, I _O (each output)	20 mA
Total supply current into V _{DD}	40 mA
Total current out of GND	40 mA
Continuous total power dissipation	See Dissipation Rating Table
Operating free-air temperature range:	
TLC393C	0°C to 70°C
TLC393I	– 40°C to 85°C
TLC393Q	– 40°C to 125°C
TLC393M	– 55°C to 125°C
TLC193M	– 55°C to 125°C
Storage temperature range	– 65°C to 150°C
Case temperature for 60 seconds: FK package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D or P package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: JG package	300°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES: 1. All voltage values, except differential voltages, are with respect to network ground.
2. Differential voltages are at IN+ with respect to IN–.

DISSIPATION RATING TABLE

PACKAGE	T _A ≤ 25°C POWER RATING	DERATING FACTOR ABOVE T _A = 25°C	T _A = 70°C POWER RATING	T _A = 85°C POWER RATING	T _A = 125°C POWER RATING
D	725 mW	5.8 mW/°C	464 mW	377 mW	145 mW
FK	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
JG	1050 mW	8.4 mW/°C	672 mW	546 mW	210 mW
P	1000 mW	8.0 mW/°C	640 mW	520 mW	—
PW	525 mW	4.2 mW/°C	336 mW	273 mW	—

TLC193, TLC393

DUAL MICROPOWER LinCMOS™ VOLTAGE COMPARATOR

SLCS115D – DECEMBER 1986 – REVISED JANUARY 1999

recommended operating conditions

	TLC393C			UNIT
	MIN	NOM	MAX	
Supply voltage, V_{DD}	3	5	16	V
Common-mode input voltage, V_{IC}	-0.2		$V_{DD} - 1.5$	V
Low-level output current, I_{OL}			20	mA
Operating free-air temperature, T_A	0		70	°C

electrical characteristics at specified operating free-air temperature, $V_{DD} = 5$ V (unless otherwise noted)

PARAMETER	TEST CONDITION†	T_A	TLC393C			UNIT
			MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = V_{ICRmin}$, $V_{DD} = 5$ V to 10 V, See Note 3	25°C		1.4	5	mV
		0°C to 70°C			6.5	
I_{IO} Input offset current	$V_{IC} = 2.5$ V	25°C		1		pA
		70°C			0.3	nA
I_{IB} Input bias current	$V_{IC} = 2.5$ V	25°C		5		pA
		70°C			0.6	nA
V_{ICR} Common-mode input voltage range		25°C	0 to $V_{DD} - 1$		V	
		0°C to 70°C	0 to $V_{DD} - 1.5$			
CMMR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$	25°C	84		dB	
		70°C	84			
		0°C	84			
k_{SVR} Supply-voltage rejection ratio	$V_{DD} = 5$ V to 10 V	25°C	85		dB	
		70°C	85			
		0°C	85			
V_{OL} Low-level output voltage	$V_{ID} = -1$ V, $I_{OL} = 6$ mA	25°C	300	400	mV	
		70°C	650			
I_{OH} High-level output current	$V_{ID} = 1$ V, $V_O = 5$ V	25°C	0.8	40	nA	
		70°C	1		μA	
I_{DD} Supply current (both comparators)	Outputs low, No load	25°C	22	40	μA	
		0°C to 70°C	50			

† All characteristics are measured with zero common-mode voltage unless otherwise noted.

NOTE 3: The offset voltage limits given are the maximum values required to drive the output up to 4.5 V or down to 0.3 V.

TLC193, TLC393

DUAL MICROPPOWER LinCMOS™ VOLTAGE COMPARATOR

SLCS115D – DECEMBER 1986 – REVISED JANUARY 1999

recommended operating conditions

	TLC393I			UNIT
	MIN	NOM	MAX	
Supply voltage, V_{DD}	3	5	16	V
Common-mode input voltage, V_{IC}	-0.2		$V_{DD} - 1.5$	V
Low-level output current, I_{OL}			20	mA
Operating free-air temperature, T_A	-40		85	°C

electrical characteristics at specified operating free-air temperature, $V_{DD} = 5\text{ V}$ (unless otherwise noted)

PARAMETER	TEST CONDITION†	T_A	TLC393I			UNIT
			MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = V_{ICRmin}$, $V_{DD} = 5\text{ V to }10\text{ V}$, See Note 3	25°C		1.4	5	mV
		-40°C to 85°C			7	
I_{IO} Input offset current	$V_{IC} = 2.5\text{ V}$	25°C		1		pA
		85°C			1	nA
I_{IB} Input bias current	$V_{IC} = 2.5\text{ V}$	25°C		5		pA
		85°C			2	nA
V_{ICR} Common-mode input voltage range		25°C	0 to $V_{DD} - 1$		V	
		-40°C to 85°C	0 to $V_{DD} - 1.5$			
CMMR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$	25°C	84		dB	
		85°C	84			
		-40°C	84			
k_{SVR} Supply-voltage rejection ratio	$V_{DD} = 5\text{ V to }10\text{ V}$	25°C	85		dB	
		85°C	85			
		-40°C	84			
V_{OL} Low-level output voltage	$V_{ID} = -1\text{ V}$, $I_{OL} = 6\text{ mA}$	25°C	300	400	mV	
		85°C	700			
I_{OH} High-level output current	$V_{ID} = 1\text{ V}$, $V_O = 5\text{ V}$	25°C	0.8	40	nA	
		85°C	1		μA	
I_{DD} Supply current (both comparators)	Outputs low, No load	25°C	22	40	μA	
		-40°C to 85°C	65			

† All characteristics are measured with zero common-mode voltage unless otherwise noted.

NOTE 3: The offset voltage limits given are the maximum values required to drive the output up to 4.5 V or down to 0.3 V.

TLC193, TLC393

DUAL MICROPOWER LinCMOS™ VOLTAGE COMPARATOR

SLCS115D – DECEMBER 1986 – REVISED JANUARY 1999

recommended operating conditions

	TLC393Q			UNIT
	MIN	NOM	MAX	
Supply voltage, V_{DD}	4	5	16	V
Common-mode input voltage, V_{IC}	0		$V_{DD} - 1.5$	V
Low-level output current, I_{OL}			20	mA
Operating free-air temperature, T_A	-40		125	°C

electrical characteristics at specified operating free-air temperature, $V_{DD} = 5$ V (unless otherwise noted)

PARAMETER	TEST CONDITIONS†	T_A	TLC393Q			UNIT
			MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = V_{ICRmin}$, $V_{DD} = 5$ V to 10 V, See Note 4	25°C		1.4	5	mV
		-40°C to 125°C			10	
I_{IO} Input offset current	$V_{IC} = 2.5$ V	25°C		1		pA
		125°C			15	nA
I_{IB} Input bias current	$V_{IC} = 2.5$ V	25°C		5		pA
		125°C			30	nA
V_{ICR} Common-mode input voltage range		25°C	0 to $V_{DD} - 1$		V	
		-40°C to 125°C	0 to $V_{DD} - 1.5$			
CMMR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$	25°C	84		dB	
		125°C	84			
		-40°C	84			
k_{SVR} Supply-voltage rejection ratio	$V_{DD} = 5$ V to 10 V	25°C	85		dB	
		125°C	84			
		-40°C	84			
V_{OL} Low-level output voltage	$V_{ID} = -1$ V, $I_{OL} = 6$ mA	25°C	300	400	mV	
		125°C	800			
I_{OH} High-level output current	$V_{ID} = 1$ V, $V_O = 5$ V	25°C	0.8	40	nA	
		125°C	1		μA	
I_{DD} Supply current (both comparators)	Outputs low, No load	25°C	22	40	μA	
		-40°C to 125°C	90			

† All characteristics are measured with zero common-mode voltage unless otherwise noted.

NOTE 4: The offset voltage limits given are the maximum values required to drive the output up to 4.5 V or down to 0.3 V (with a 2.5-kΩ load to V_{DD}).

TLC193, TLC393

DUAL MICROWPOWER LinCMOS™ VOLTAGE COMPARATOR

SLCS115D – DECEMBER 1986 – REVISED JANUARY 1999

recommended operating conditions

	TLC193M, TLC393M			UNIT
	MIN	NOM	MAX	
Supply voltage, V_{DD}	4	5	16	V
Common-mode input voltage, V_{IC}	0		$V_{DD} - 1.5$	V
Low-level output current, I_{OL}			20	mA
Operating free-air temperature, T_A	-55		125	°C

electrical characteristics at specified operating free-air temperature, $V_{DD} = 5$ V (unless otherwise noted)

PARAMETER	TEST CONDITION†	T_A	TLC193M, TLC393M			UNIT
			MIN	TYP	MAX	
V_{IO} Input offset voltage	$V_{IC} = V_{ICRmin}$, $V_{DD} = 5$ V to 10 V, See Note 4	25°C		1.4	5	mV
		-55°C to 125°C			10	
I_{IO} Input offset current	$V_{IC} = 2.5$ V	25°C		1		pA
		125°C			15	nA
I_{IB} Input bias current	$V_{IC} = 2.5$ V	25°C		5		pA
		125°C			30	nA
V_{ICR} Common-mode input voltage range		25°C	0 to $V_{DD} - 1$		V	
		-55°C to 125°C	0 to $V_{DD} - 1.5$			
CMMR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$	25°C	84		dB	
		125°C	84			
		-55°C	84			
k_{SVR} Supply-voltage rejection ratio	$V_{DD} = 5$ V to 10 V	25°C	85		dB	
		125°C	84			
		-55°C	84			
V_{OL} Low-level output voltage	$V_{ID} = -1$ V, $I_{OL} = 6$ mA	25°C	300	400	mV	
		125°C	800			
I_{OH} High-level output current	$V_{ID} = 1$ V, $V_O = 5$ V	25°C	0.8	40	nA	
		125°C	1		μA	
I_{DD} Supply current (both comparators)	Outputs low, No load	25°C	22	40	μA	
		-55°C to 125°C	90			

† All characteristics are measured with zero common-mode voltage unless otherwise noted.

NOTE 4: The offset voltage limits given are the maximum values required to drive the output up to 4.5 V or down to 0.3 V (with a 2.5-kΩ load to V_{DD}).

TLC193, TLC393 DUAL MICROPOWER LinCMOS™ VOLTAGE COMPARATOR

SLCS115D – DECEMBER 1986 – REVISED JANUARY 1999

switching characteristics, $V_{DD} = 5\text{ V}$, $T_A = 25^\circ\text{C}$ (see Figure 3)

PARAMETER	TEST CONDITIONS	TLC393C, TLC393I TLC393Q, TLC193M, TLC393M			UNIT
		MIN	TYP	MAX	
t_{PLH} Propagation delay time, low-to-high-level output	$f = 10\text{ kHz}$, $C_L = 15\text{ pF}$	Overdrive = 2 mV	4.5		μs
		Overdrive = 5 mV	2.5		
		Overdrive = 10 mV	1.7		
		Overdrive = 20 mV	1.2		
		Overdrive = 40 mV	1.1		
t_{PHL} Propagation delay time, high-to-low-level output	$f = 10\text{ kHz}$, $C_L = 15\text{ pF}$	$V_I = 1.4\text{-V}$ step at IN+	1.1		μs
		Overdrive = 2 mV	3.6		
		Overdrive = 5 mV	2.1		
		Overdrive = 10 mV	1.3		
		Overdrive = 20 mV	0.85		
		Overdrive = 40 mV	0.55		
		$V_I = 1.4\text{-V}$ step at IN+	0.10		
t_f Fall time, output	$f = 10\text{ kHz}$, $C_L = 15\text{ pF}$	Overdrive = 50 mV	22		ns

PARAMETER MEASUREMENT INFORMATION

The TLC393 contains a digital output stage which, if held in the linear region of the transfer curve, can cause damage to the device. Conventional operational amplifier/comparator testing incorporates the use of a servo loop that is designed to force the device output to a level within this linear region. Since the servo-loop method of testing cannot be used, the following alternatives for testing parameters such as input offset voltage, common-mode rejection ratio, etc., are suggested.

To verify that the input offset voltage falls within the limits specified, the limit value is applied to the input as shown in Figure 1(a). With the noninverting input positive with respect to the inverting input, the output should be high. With the input polarity reversed, the output should be low.

A similar test can be made to verify the input offset voltage at the common-mode extremes. The supply voltages can be slewed as shown in Figure 1(b) for the V_{ICR} test, rather than changing the input voltages, to provide greater accuracy.

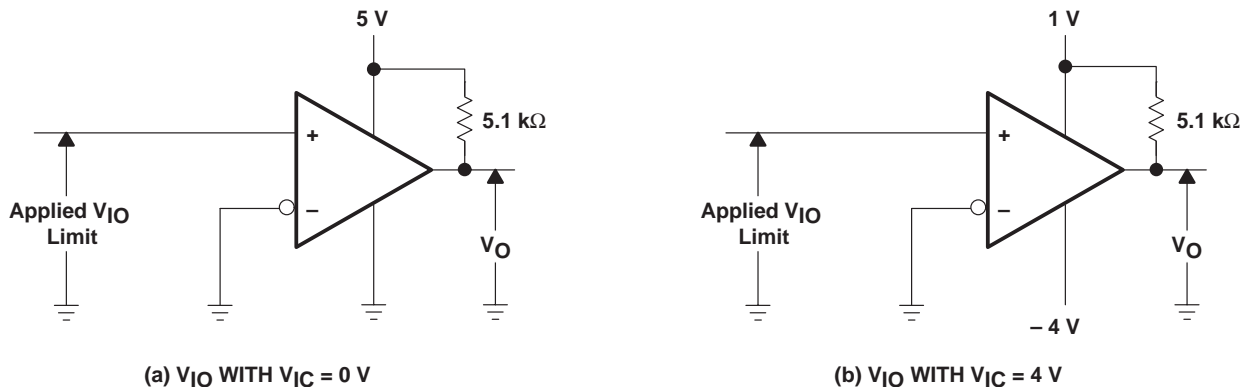


Figure 1. Method for Verifying That Input Offset Voltage Is Within Specified Limits

TLC193, TLC393 DUAL MICROWPOWER LinCMOS™ VOLTAGE COMPARATOR

SLCS115D – DECEMBER 1986 – REVISED JANUARY 1999

PARAMETER MEASUREMENT INFORMATION

A close approximation of the input offset voltage can be obtained by using a binary search method to vary the differential input voltage while monitoring the output state. When the applied input voltage differential is equal, but opposite in polarity, to the input offset voltage, the output changes states.

Figure 2 illustrates a practical circuit for direct dc measurement of input offset voltage that does not bias the comparator in the linear region. The circuit consists of a switching-mode servo loop in which U1A generates a triangular waveform of approximately 20-mV amplitude. U1B acts as a buffer, with C2 and R4 removing any residual dc offset. The signal is then applied to the inverting input of the comparator under test, while the noninverting input is driven by the output of the integrator formed by U1C through the voltage divider formed by R9 and R10. The loop reaches a stable operating point when the output of the comparator under test has a duty cycle of exactly 50%, which can only occur when the incoming triangle wave is sliced symmetrically or when the voltage at the noninverting input exactly equals the input offset voltage.

The voltage divider formed by R9 and R10 provides an increase in input offset voltage by a factor of 100 to make measurement easier. The values of R5, R8, R9, and R10 can significantly influence the accuracy of the reading; therefore, it is suggested that their tolerance level be 1% or lower.

Measuring the extremely low values of input current requires isolation from all other sources of leakage current and compensation for the leakage of the test socket and board. With a good picoammeter, the socket and board leakage can be measured with no device in the socket. Subsequently, this open-socket leakage value can be subtracted from the measurement obtained with a device in the socket to obtain the actual input current of the device.

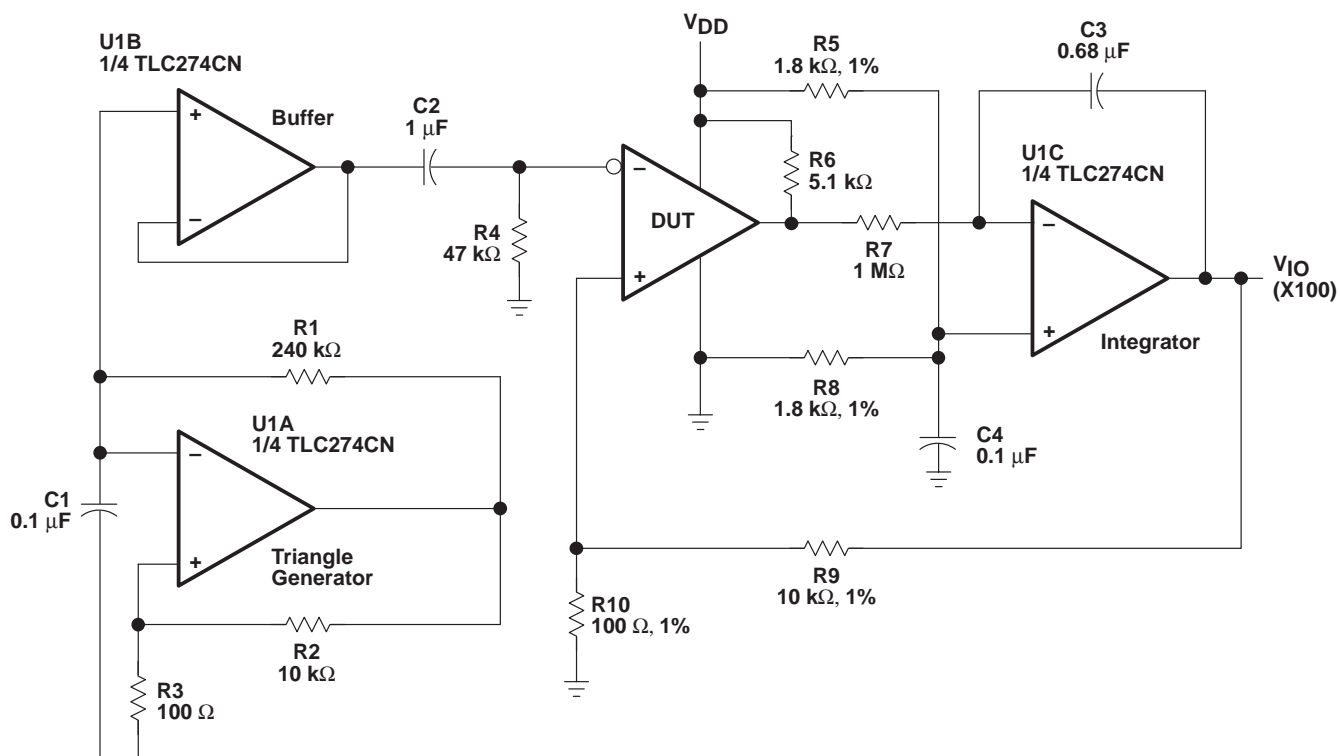


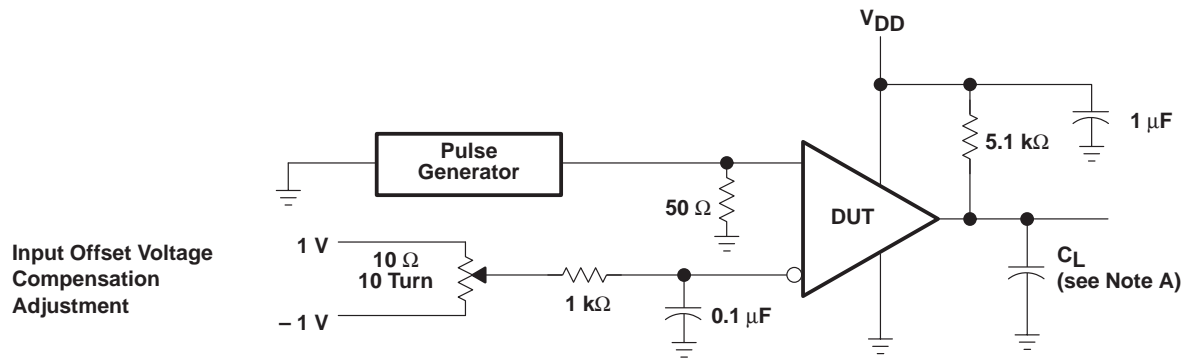
Figure 2. Circuit for Input Offset Voltage Measurement

TLC193, TLC393 DUAL MICROWPOWER LinCMOS™ VOLTAGE COMPARATOR

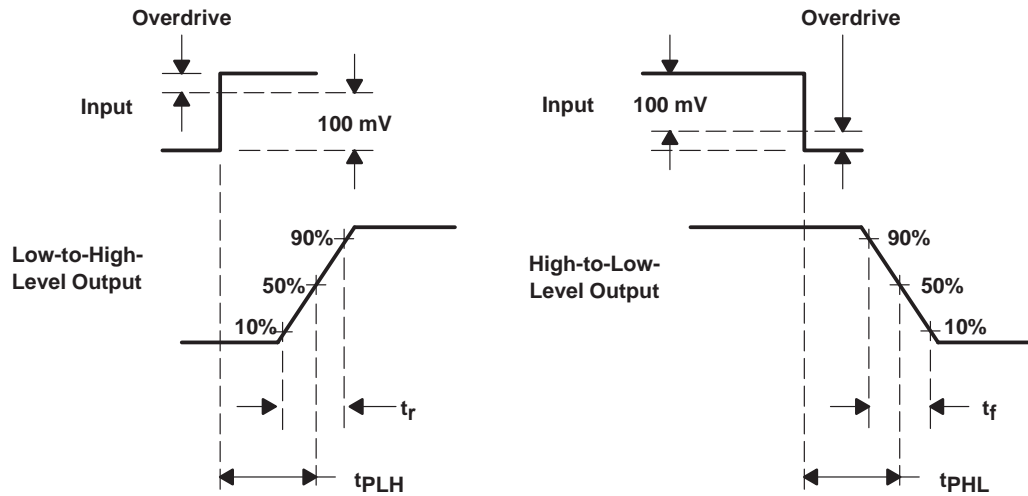
SLCS115D – DECEMBER 1986 – REVISED JANUARY 1999

PARAMETER MEASUREMENT INFORMATION

Propagation delay time is defined as the interval between the application of an input step function and the instant when the output reaches 50% of its maximum value. Propagation delay time, low-to-high-level output, is measured from the leading edge of the input pulse, while propagation delay time, high-to-low-level output, is measured from the trailing edge of the input pulse. Propagation delay time measurement at low input signal levels can be greatly affected by the input offset voltage. The offset voltage should be balanced by the adjustment at the inverting input (as shown in Figure 3) so that the circuit is just at the transition point. Then a low signal, for example, 105 mV or 5 mV overdrive, causes the output to change state.



TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTE A: C_L includes probe and jig capacitance.

Figure 3. Propagation Delay, Rise Time, and Fall Time Circuit and Voltage Waveforms

TLC193, TLC393 DUAL MICROWPOWER LinCMOS™ VOLTAGE COMPARATOR

SLCS115D – DECEMBER 1986 – REVISED JANUARY 1999

TYPICAL CHARACTERISTICS

Table of Graphs

			FIGURE
V_{IO}	Input offset voltage	Distribution	4
I_{IB}	Input bias current	vs Free-air temperature	5
CMRR	Common-mode rejection ratio	vs Free-air temperature	6
k_{SVR}	Supply-voltage rejection ratio	vs Free-air temperature	7
V_{OL}	Low-level output voltage	vs Low-level output current vs Free-air temperature	8 9
I_{OH}	Low-level output current	vs High-level output voltage vs Free-air temperature	10 11
I_{DD}	Supply current	vs Supply voltage vs Free-air temperature	12 13
t_{PLH}	Low-to-high level output propagation delay time	vs Supply voltage	14
t_{PHL}	High-to-low level output propagation delay time	vs Supply voltage	15
	Low-to-high-level output response	Low-to-high level output propagation delay time	16
	High-to-low level output response	High-to-low level output propagation delay time	17
t_f	Fall time	vs Supply voltage	18

DISTRIBUTION OF INPUT
OFFSET VOLTAGE†

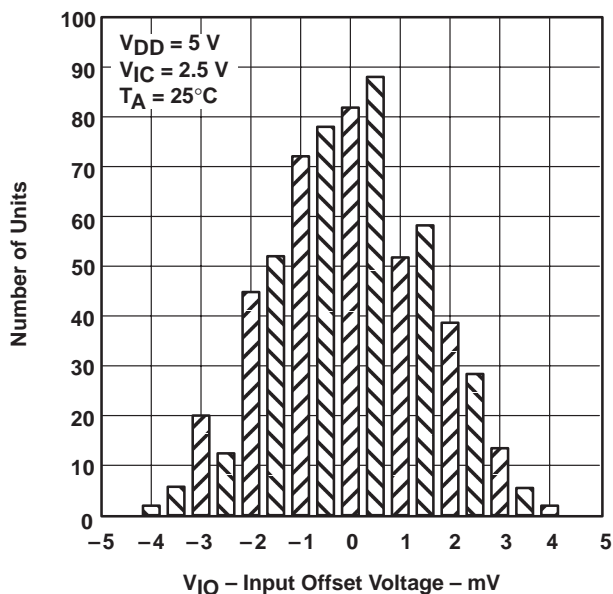


Figure 4

INPUT BIAS CURRENT
vs
FREE-AIR TEMPERATURE†

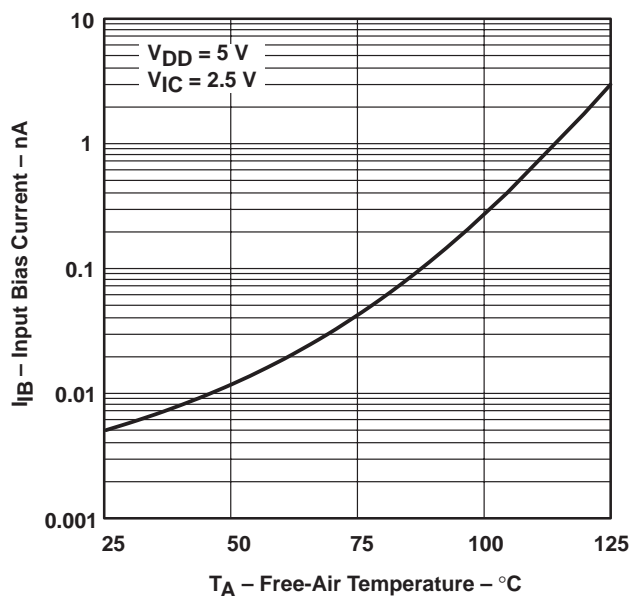


Figure 5

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TLC193, TLC393 DUAL MICROPOWER LinCMOS™ VOLTAGE COMPARATOR

SLCS115D – DECEMBER 1986 – REVISED JANUARY 1999

TYPICAL CHARACTERISTICS†

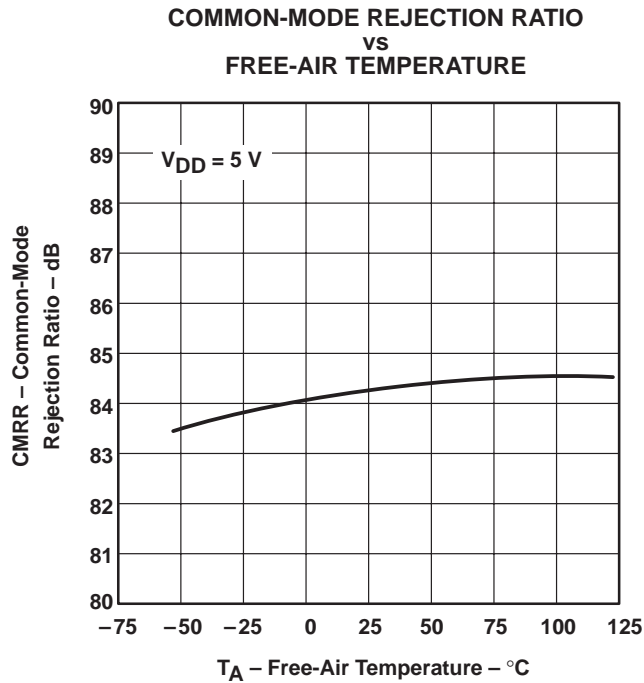


Figure 6

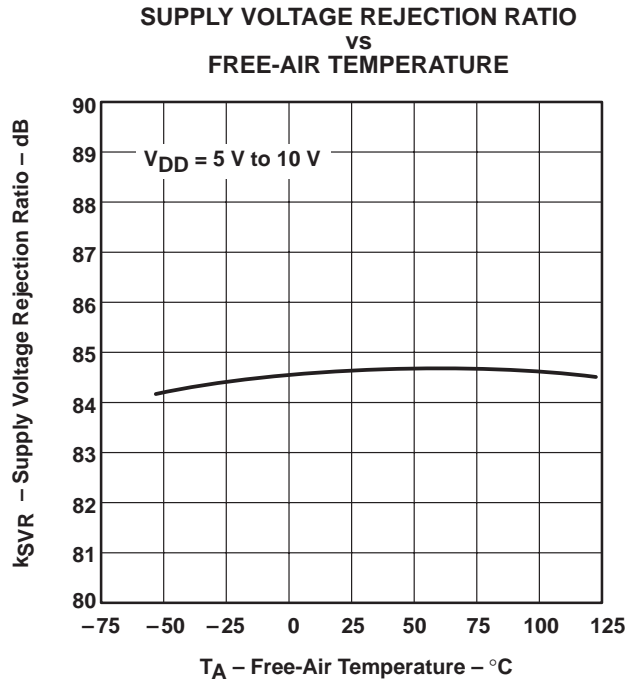


Figure 7

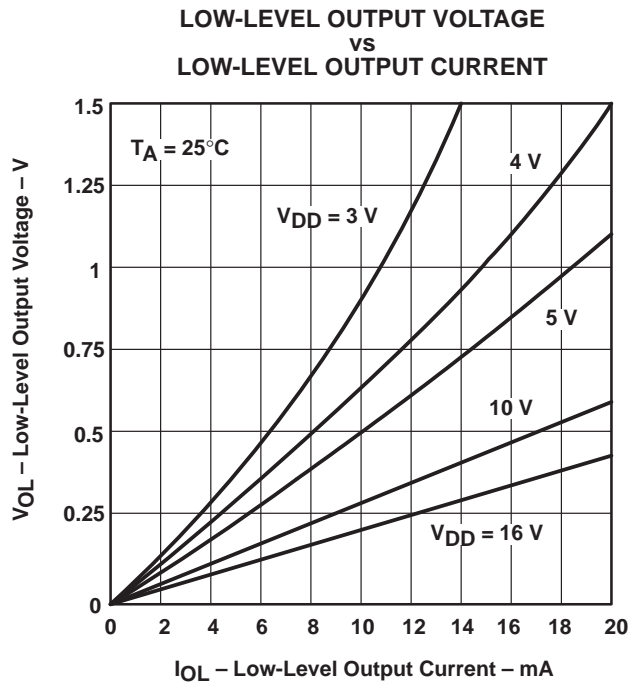


Figure 8

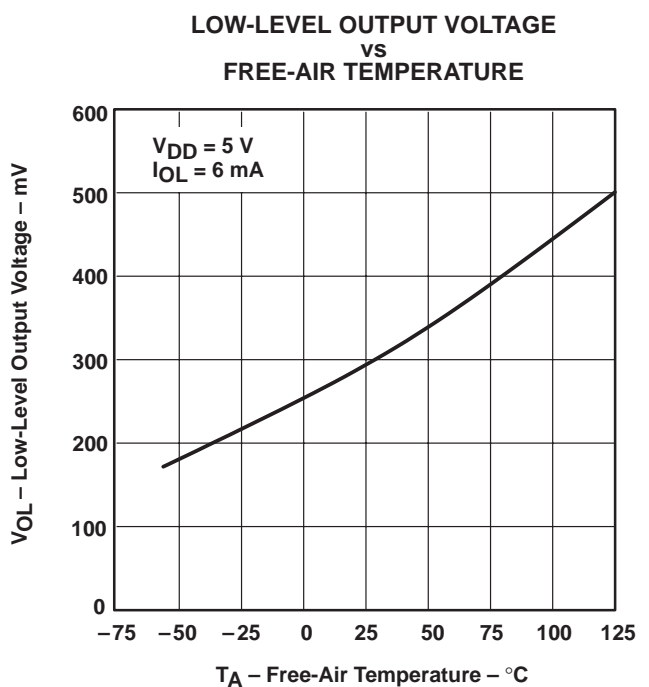


Figure 9

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TLC193, TLC393 DUAL MICROWPOWER LinCMOS™ VOLTAGE COMPARATOR

SLCS115D – DECEMBER 1986 – REVISED JANUARY 1999

TYPICAL CHARACTERISTICS†

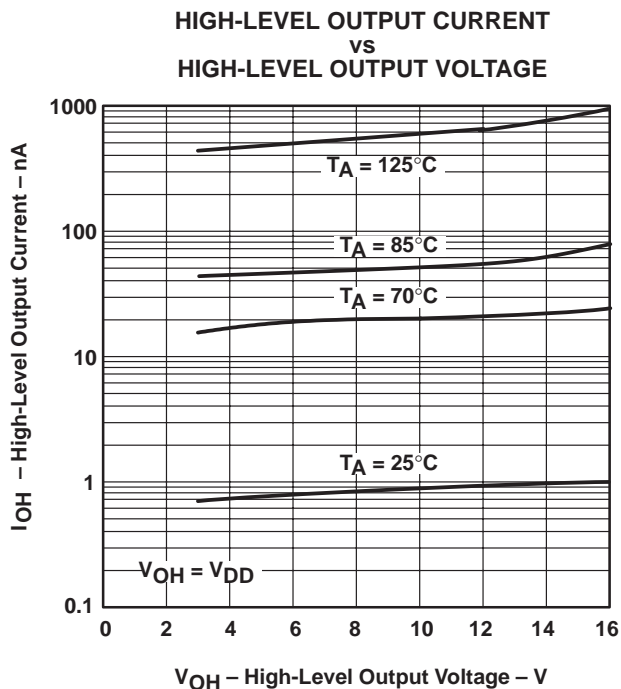


Figure 10

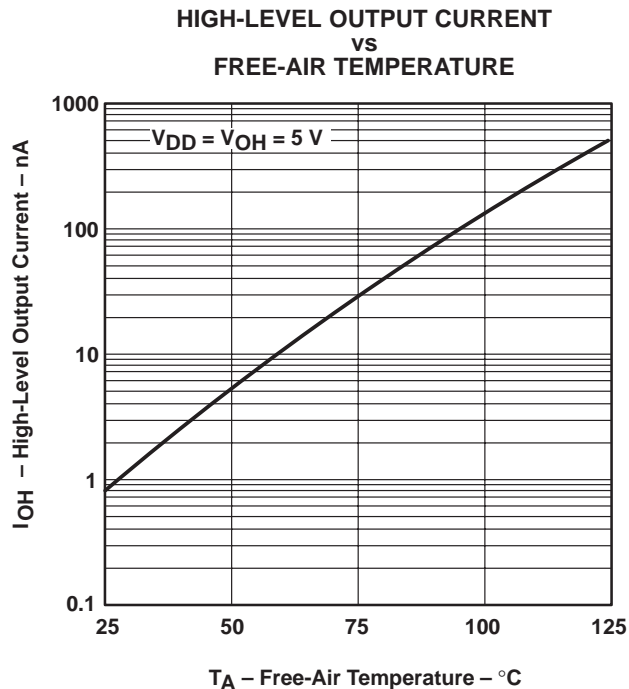


Figure 11

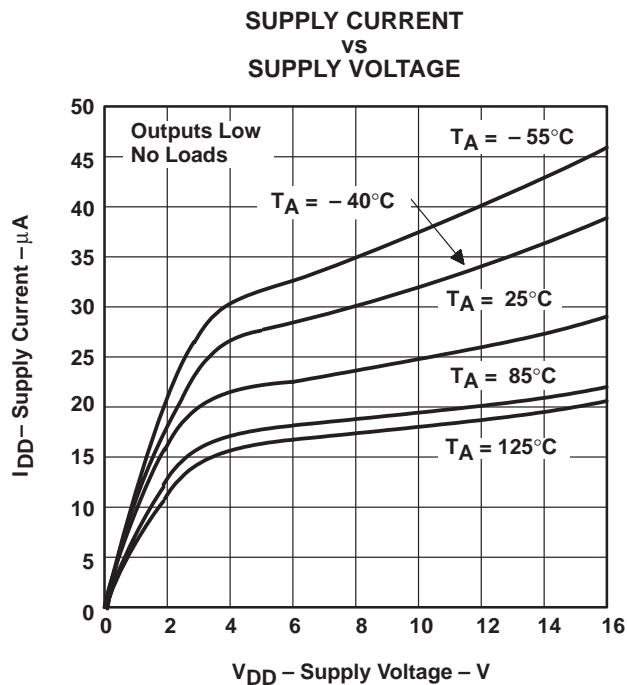


Figure 12

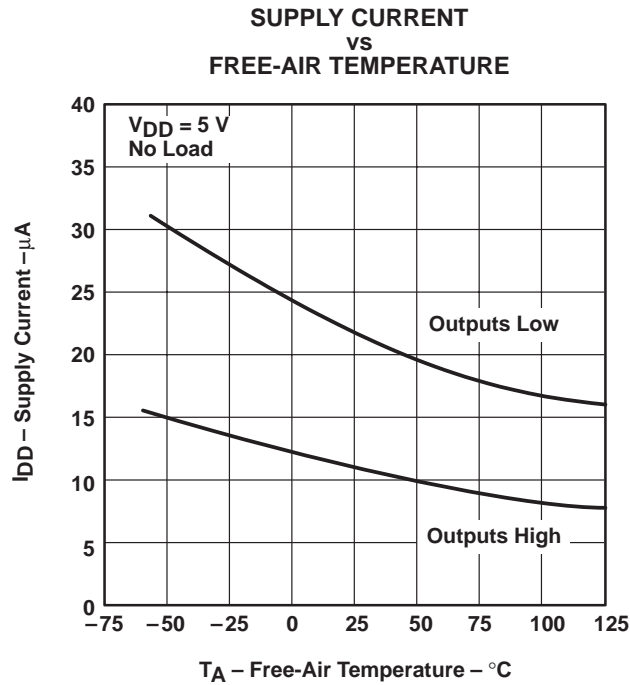


Figure 13

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TLC193, TLC393 DUAL MICROPOWER LinCMOS™ VOLTAGE COMPARATOR

SLCS115D – DECEMBER 1986 – REVISED JANUARY 1999

TYPICAL CHARACTERISTICS

**LOW-TO-HIGH-LEVEL
OUTPUT RESPONSE TIME
vs
SUPPLY VOLTAGE**

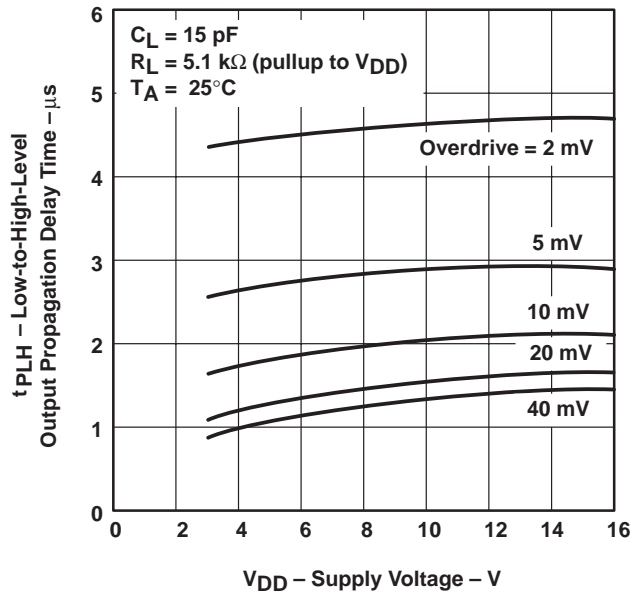


Figure 14

**HIGH-TO-LOW-LEVEL
OUTPUT RESPONSE TIME
vs
SUPPLY VOLTAGE**

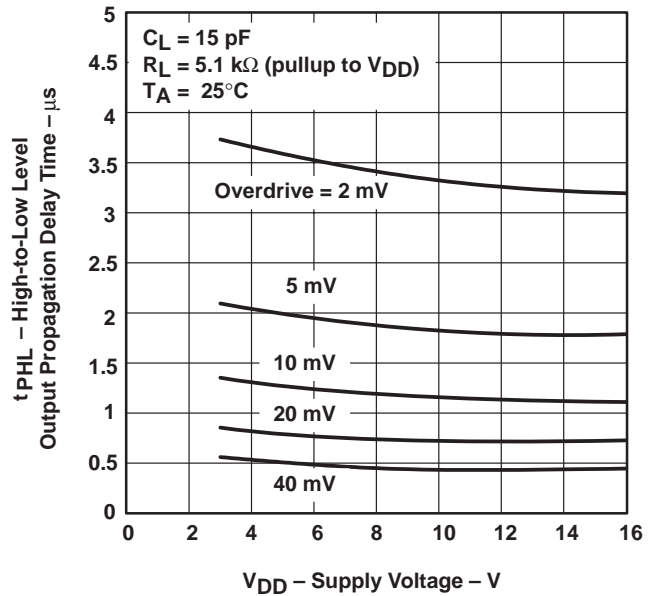


Figure 15

**LOW-TO-HIGH-LEVEL OUTPUT
PROPAGATION DELAY
FOR VARIOUS INPUT OVERDRIVES**

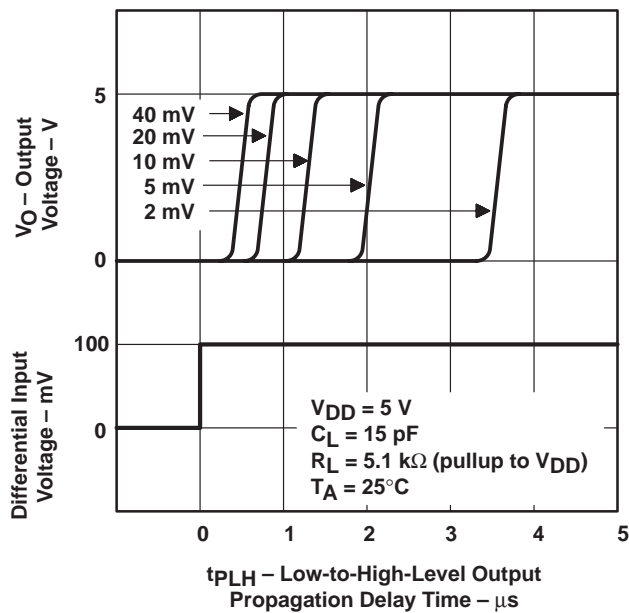


Figure 16

**HIGH-TO-LOW-LEVEL OUTPUT
PROPAGATION DELAY
FOR VARIOUS INPUT OVERDRIVES**

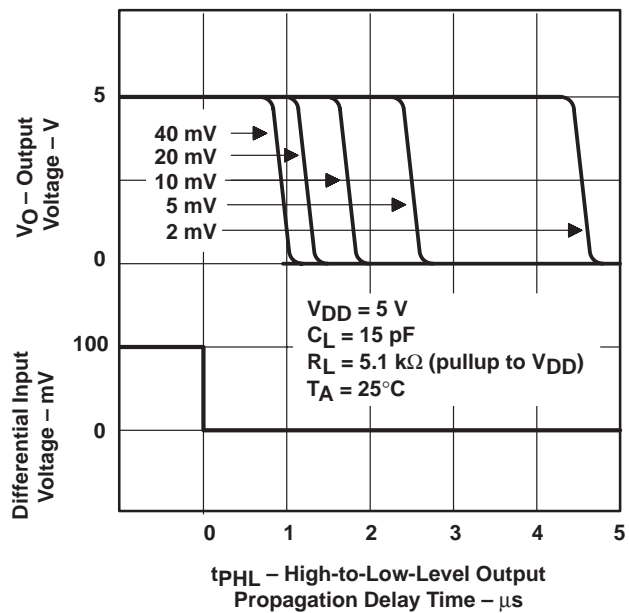


Figure 17

TLC193, TLC393 DUAL MICROPPOWER LinCMOS™ VOLTAGE COMPARATOR

SLCS115D – DECEMBER 1986 – REVISED JANUARY 1999

TYPICAL CHARACTERISTICS

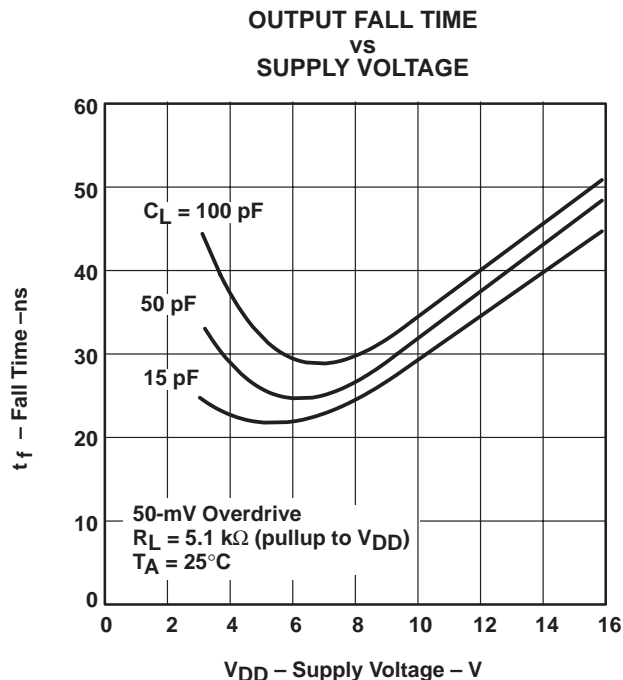


Figure 18

APPLICATION INFORMATION

The input should always remain within the supply rails in order to avoid forward biasing the diodes in the electrostatic discharge (ESD) protection structure. If either input exceeds this range, the device will not be damaged as long as the input current is limited to less than 5 mA. To maintain the expected output state, the inputs must remain within the common-mode range. For example, at 25°C with $V_{DD} = 5\text{ V}$, both inputs must remain between -0.2 V and 4 V to assure proper device operation.

To assure reliable operation, the supply should be decoupled with a capacitor ($0.1\text{-}\mu\text{F}$) positioned as close to the device as possible.

The TLC393 has internal ESD-protection circuits that prevent functional failures at voltages up to 2000 V as tested under MIL-STD-883C, Method 3015.2; however, care should be exercised in handling these devices, as exposure to ESD may result in the degradation of the device parametric performance.

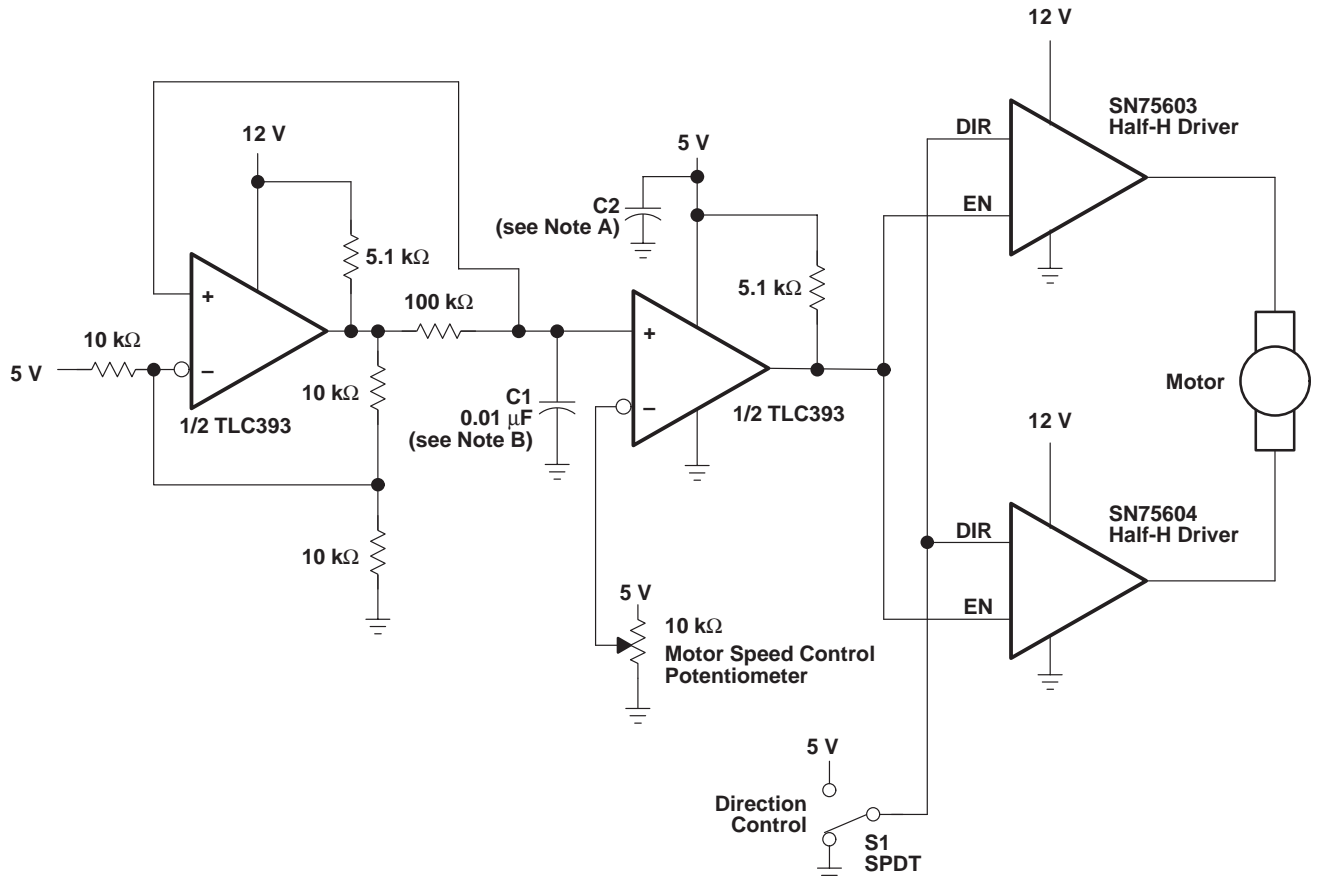
Table of Applications

	FIGURE
Pulse-width-modulated motor speed controller	19
Enhanced supply supervisor	20
Two-phase nonoverlapping clock generator	21
Micropower switching regulator	28

TLC193, TLC393 DUAL MICROWPOWER LinCMOS™ VOLTAGE COMPARATOR

SLCS115D – DECEMBER 1986 – REVISED JANUARY 1999

APPLICATION INFORMATION



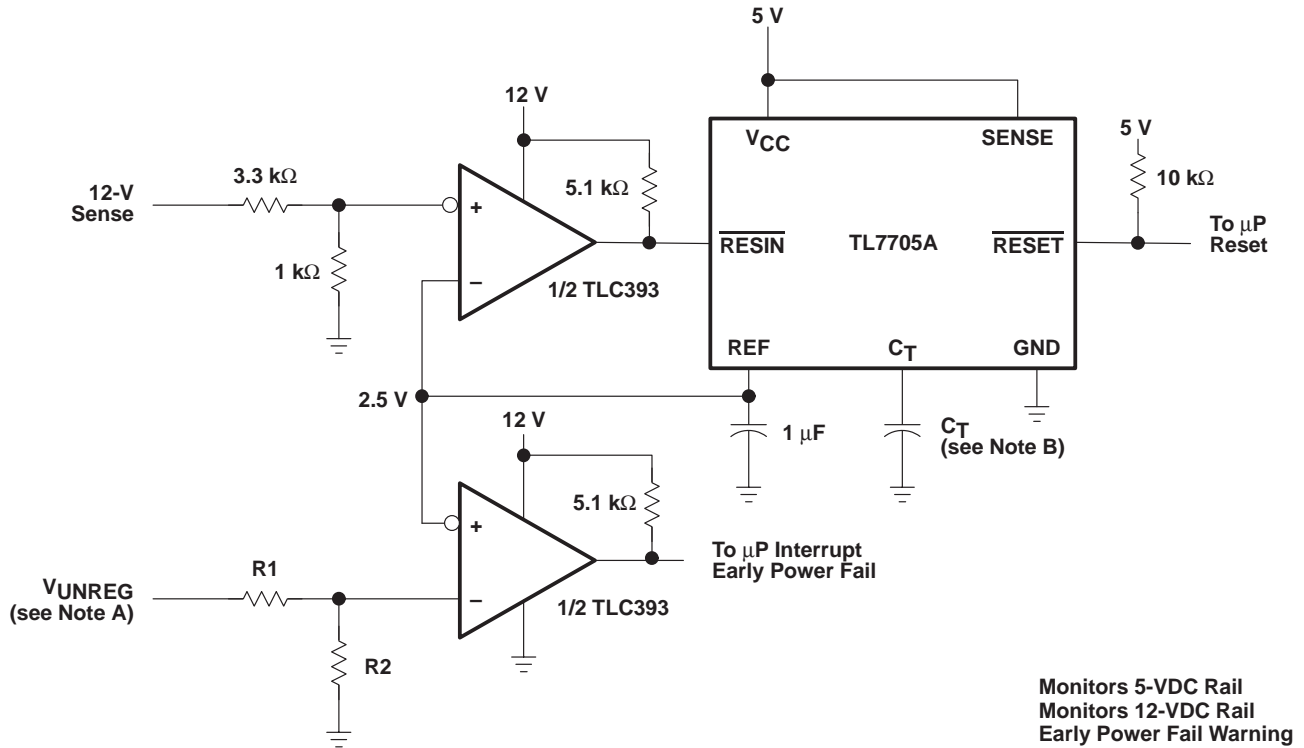
- NOTES: A. The recommended minimum capacitance is 10 μF to eliminate common ground switching noise.
 B. Adjust C1 for change in oscillator frequency.

Figure 19. Pulse-Width-Modulated Motor Speed Controller

TLC193, TLC393 DUAL MICROPPOWER LinCMOS™ VOLTAGE COMPARATOR

SLCS115D – DECEMBER 1986 – REVISED JANUARY 1999

APPLICATION INFORMATION



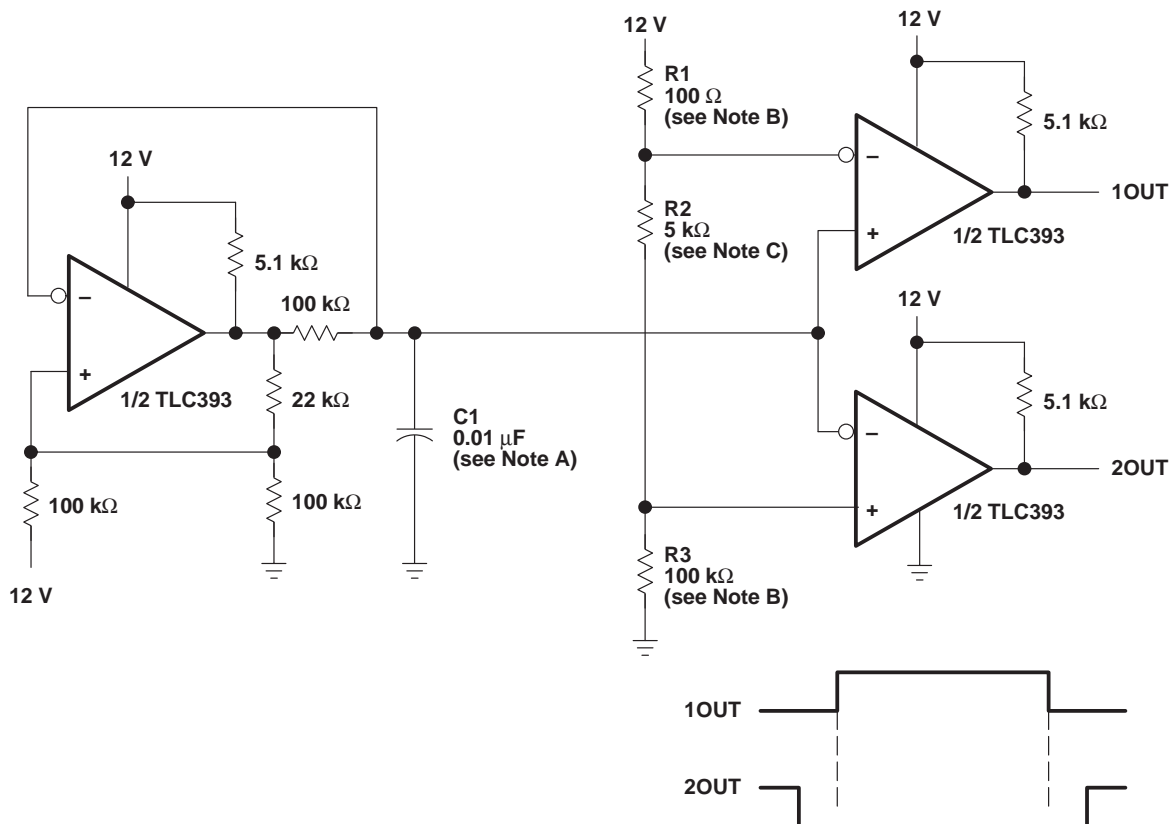
- NOTES: A. $V_{UNREG} = 2.5 \frac{(R1 + R2)}{R2}$
 B. The value of C_T determines the time delay of reset.

Figure 20. Enhanced Supply Supervisor

TLC193, TLC393 DUAL MICROPOWER LinCMOS™ VOLTAGE COMPARATOR

SLCS115D – DECEMBER 1986 – REVISED JANUARY 1999

APPLICATION INFORMATION



- NOTES: A. Adjust C1 for a change in oscillator frequency where:
 $1/f = 1.85(100 \text{ k}\Omega)C1$
 B. Adjust R1 and R3 to change duty cycle
 C. Adjust R2 to change deadtime

Figure 21. Two-Phase Nonoverlapping Clock Generator

TLC193, TLC393 DUAL MICROWPOWER LinCMOS™ VOLTAGE COMPARATOR

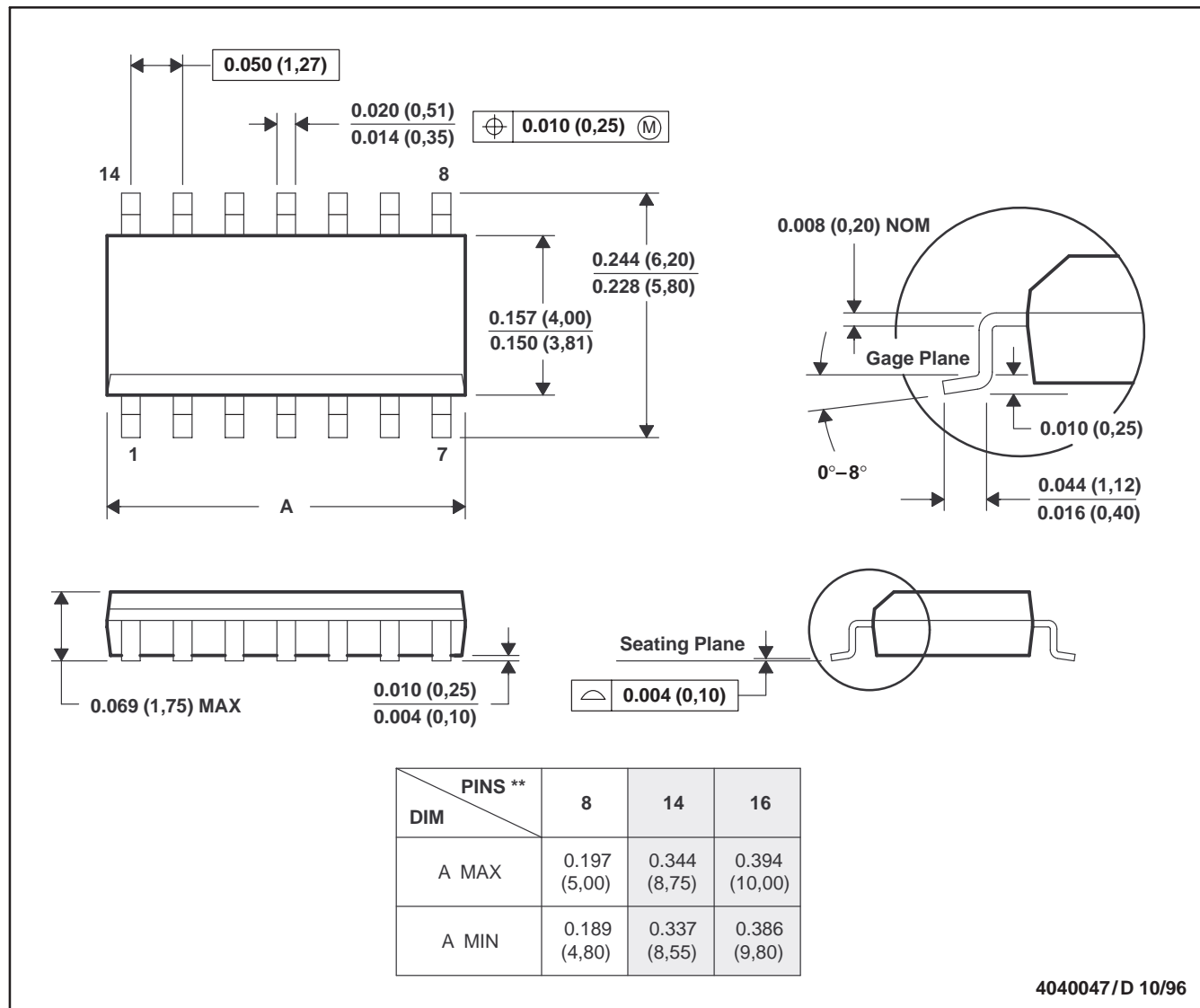
SLCS115D – DECEMBER 1986 – REVISED JANUARY 1999

MECHANICAL DATA

D (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 PIN SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).
 D. Falls within JEDEC MS-012

TLC193, TLC393 DUAL MICROPOWER LinCMOS™ VOLTAGE COMPARATOR

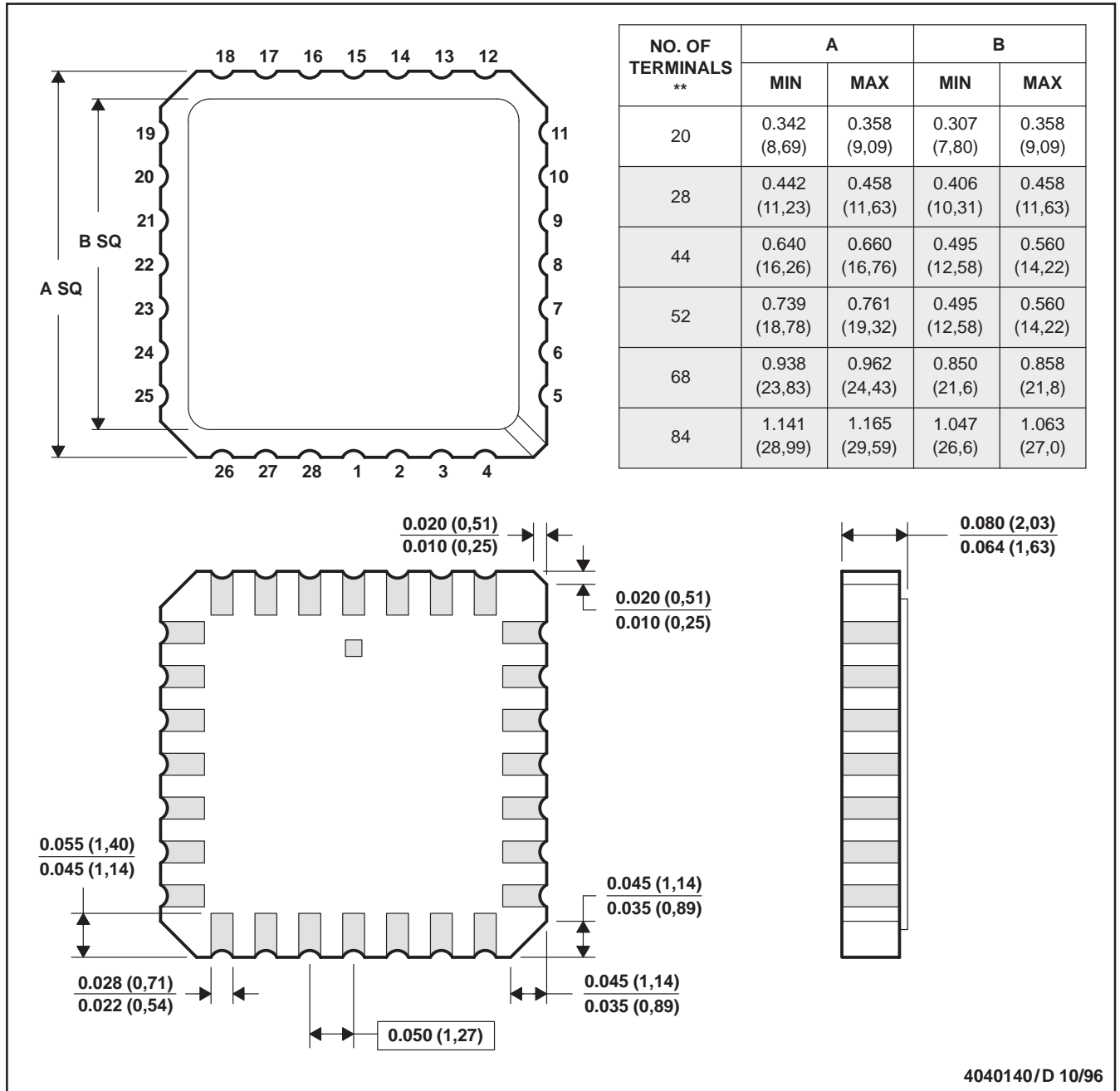
SLCS115D – DECEMBER 1986 – REVISED JANUARY 1999

MECHANICAL DATA

FK (S-CQCC-N)**

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. This package can be hermetically sealed with a metal lid.
 - D. The terminals are gold plated.
 - E. Falls within JEDEC MS-004

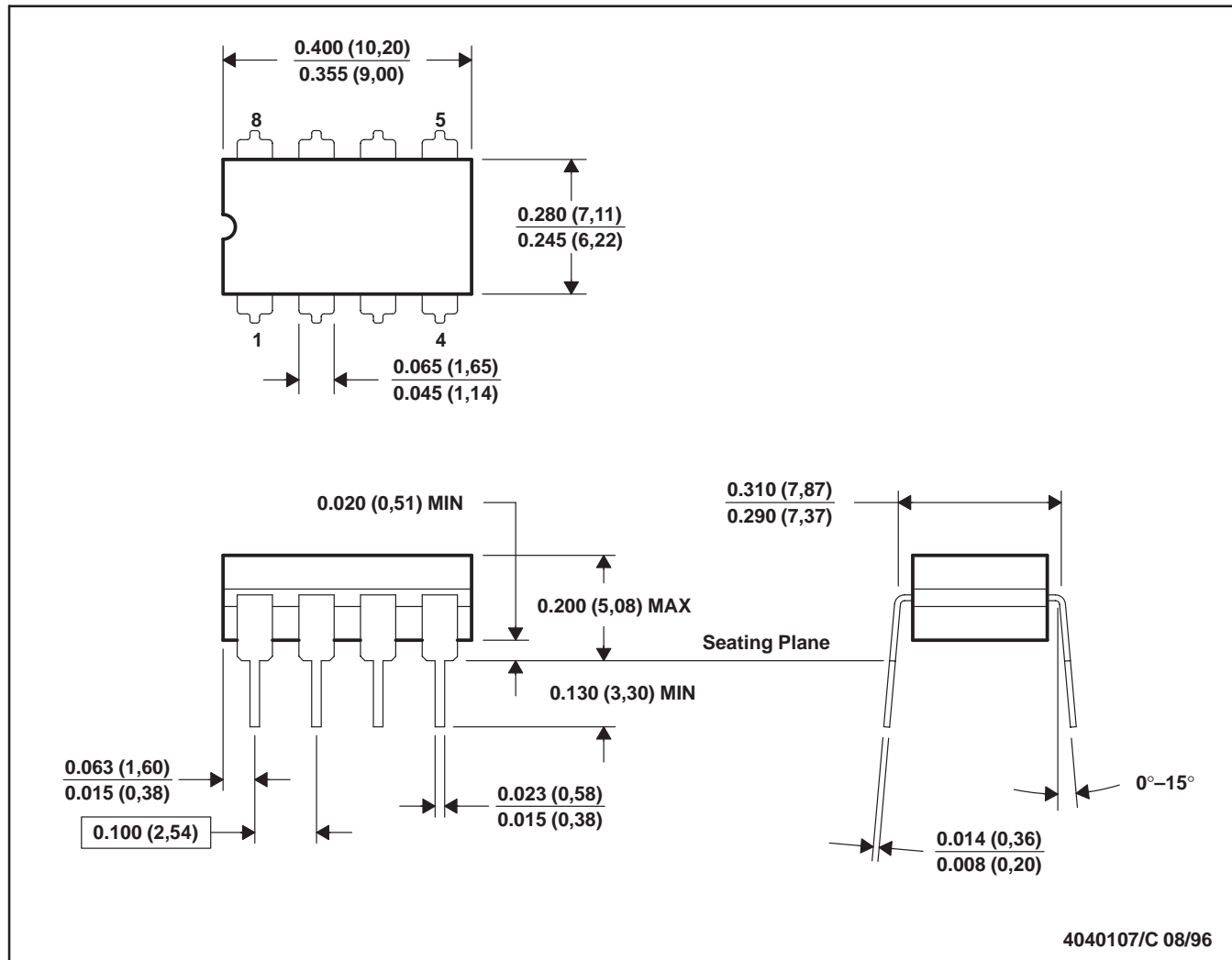
TLC193, TLC393 DUAL MICROWPOWER LinCMOS™ VOLTAGE COMPARATOR

SLCS115D – DECEMBER 1986 – REVISED JANUARY 1999

MECHANICAL DATA

JG (R-GDIP-T8)

CERAMIC DUAL-IN-LINE PACKAGE



- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. This package can be hermetically sealed with a ceramic lid using glass frit.
 D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
 E. Falls within MIL-STD-1835 GDIP1-T8

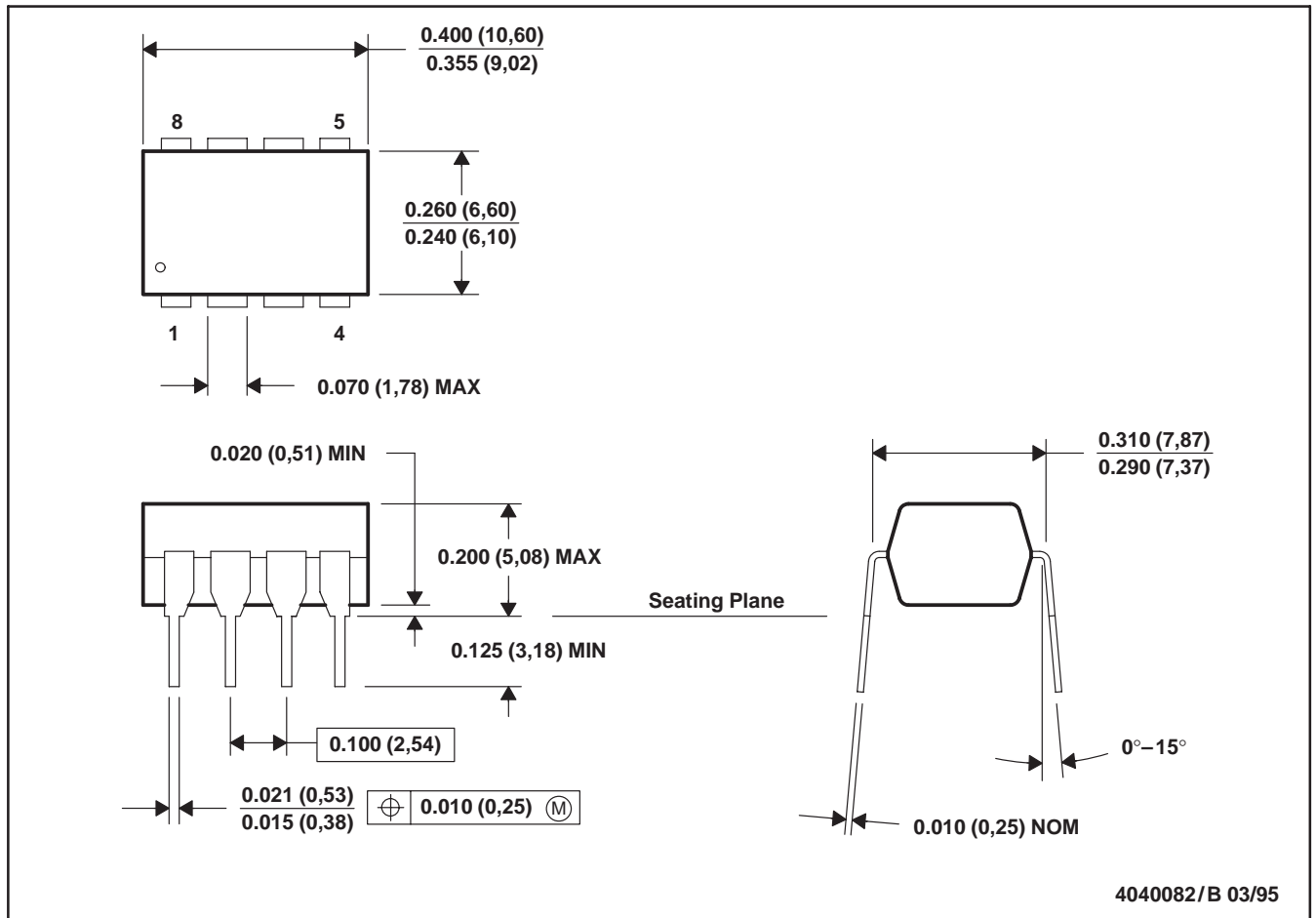
TLC193, TLC393 DUAL MICROPOWER LinCMOS™ VOLTAGE COMPARATOR

SLCS115D – DECEMBER 1986 – REVISED JANUARY 1999

MECHANICAL DATA

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE PACKAGE



- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. Falls within JEDEC MS-001

TLC193, TLC393 DUAL MICROWPOWER LinCMOS™ VOLTAGE COMPARATOR

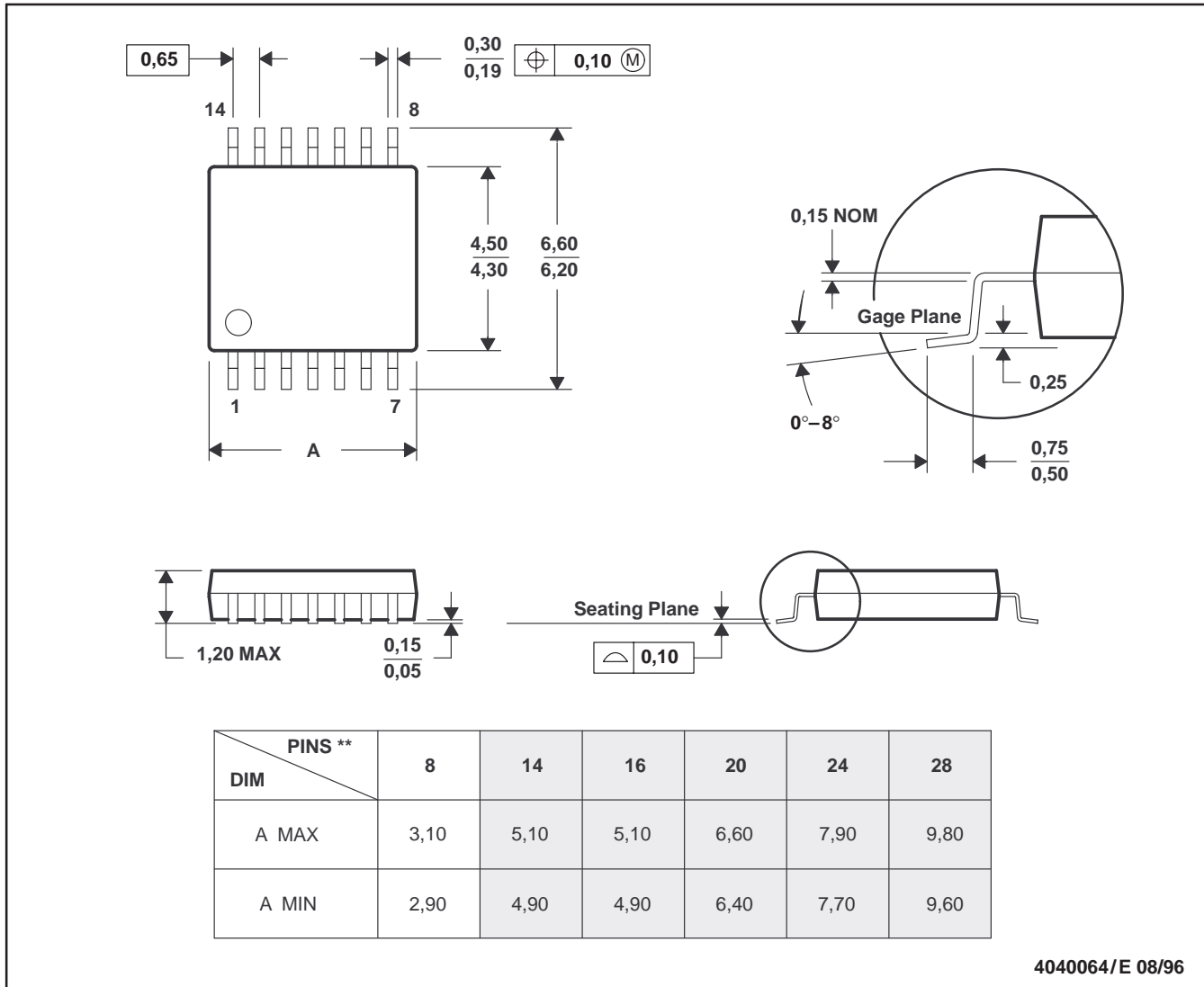
SLCS115D – DECEMBER 1986 – REVISED JANUARY 1999

MECHANICAL DATA

PW (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 PIN SHOWN



4040064/E 08/96

- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
 D. Falls within JEDEC MO-153

IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgement, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE ("CRITICAL APPLICATIONS"). TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF TI PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.