

# TLC139, TLC339, TLC339Q LinCMOS™ MICROPOWER QUAD COMPARATORS

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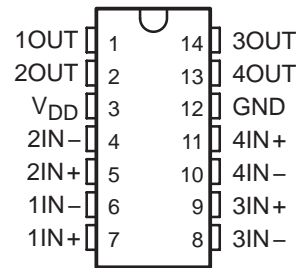
- Very Low Power . . . 200  $\mu$ W Typ at 5 V
- Fast Response Time . . . 2.5  $\mu$ s Typ With 5-mV Overdrive
- Single Supply Operation:
  - TLC139M . . . 4 V to 16 V
  - TLC339M . . . 4 V to 16 V
  - TLC339C . . . 3 V to 16 V
  - TLC339I . . . 3 V to 16 V
- High Input Impedance . . .  $10^{12}$   $\Omega$  Typ
- Input Offset Voltage Change at Worst Case Input at Condition Typically 0.23  $\mu$ V/Month Including the First 30 Days
- On-Chip ESD Protection

## description

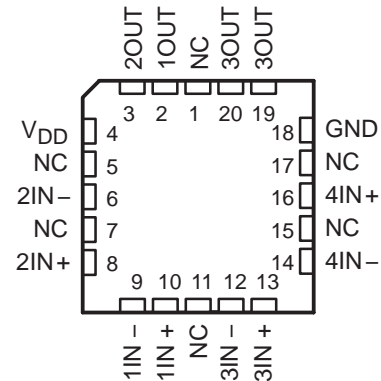
The TLC139/TLC339 consists of four independent differential-voltage comparators designed to operate from a single supply. It is functionally similar to the LM139/LM339 family but uses 1/20th the power for similar response times. The open-drain MOS output stage interfaces to a variety of leads and supplies, as well as wired logic functions. For a similar device with a push-pull output configuration, see the TLC3704 data sheet.

The 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.

D, J, N, OR PW PACKAGE  
(TOP VIEW)

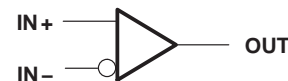


FK PACKAGE  
(TOP VIEW)



NC – No internal connection

## symbol (each comparator)



## AVAILABLE OPTIONS

T <sub>A</sub>	V <sub>IO</sub> max AT 25°C	PACKAGE				
		SMALL OUTLINE (D)	CHIP CARRIER (FK)	CERAMIC DIP (J)	PLASTIC DIP (P)	TSSOP (PW)
0°C to 70°C	5 mV	TLC339CD	—	—	TLC339CN	TLC339CPW
-40°C to 85°C	5 mV	TLC339ID	—	—	TLC339IN	TLC339IPW
-40°C to 125°C	5 mV	TLC339QD	—	—	TLC339QN	—
-55°C to 125°C	5 mV	TLC339MD	TLC139MFK	TLC139MJ	TLC339MN	—

The D and PW packages are available taped and reeled. Add the suffix R to the device type (e.g., TLC339CDR or TLC339CPWR).

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# TLC139, TLC339, TLC339Q LinCMOS™ MICROPOWER QUAD COMPARATORS

## description (continued)

The TLC139M and TLC339M are characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The TLC339C is characterized for operation over the commercial temperature range of  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ . The TLC339I is characterized for operation over the industrial temperature range of  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ . The TLC339Q is characterized for operation over the extended industrial temperature range of  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ .

## output schematic



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

Supply voltage range, $V_{DD}$ (see Note 1)	$-0.3\text{ V to }18\text{ V}$
Differential input voltage, $V_{ID}$ (see Note 2)	$\pm 18\text{ V}$
Input voltage range, $V_I$	$-0.3\text{ V to }V_{DD}$
Output voltage range, $V_O$	$-0.3\text{ V to }V_{DD}$
Input current, $I_I$	$\pm 5\text{ mA}$
Output current, $I_O$ (each output)	$20\text{ mA}$
Total supply current into $V_{DD}$	$40\text{ mA}$
Total current out of GND	$60\text{ mA}$
Continuous total dissipation	See Dissipation Rating Table
Operating free-air temperature range, $T_A$ : TLC139M	$-55^{\circ}\text{C to }125^{\circ}\text{C}$
TLC339C	$0^{\circ}\text{C to }70^{\circ}\text{C}$
TLC339I	$-40^{\circ}\text{C to }85^{\circ}\text{C}$
TLC339M	$-55^{\circ}\text{C to }125^{\circ}\text{C}$
TLC339Q	$-40^{\circ}\text{C to }125^{\circ}\text{C}$
Storage temperature range	$-65^{\circ}\text{C to }150^{\circ}\text{C}$
Case temperature for 60 seconds: FK package	$260^{\circ}\text{C}$
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D or N package	$260^{\circ}\text{C}$
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: J package	$300^{\circ}\text{C}$

† 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	$T_A \leq 25^{\circ}\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^{\circ}\text{C}$	$T_A = 70^{\circ}\text{C}$ POWER RATING	$T_A = 85^{\circ}\text{C}$ POWER RATING	$T_A = 125^{\circ}\text{C}$ POWER RATING
D	950 mW	7.6 mW/ $^{\circ}\text{C}$	608 mW	494 mW	190 mW
FK	1375 mW	11.0 mW/ $^{\circ}\text{C}$	880 mW	715 mW	275 mW
J	1375 mW	11.0 mW/ $^{\circ}\text{C}$	880 mW	715 mW	275 mW
N	1150 mW	9.2 mW/ $^{\circ}\text{C}$	736 mW	598 mW	230 mW
PW	700 mW	5.6 mW/ $^{\circ}\text{C}$	448 mW	364 mW	140 mW

**recommended operating conditions**

	TLC139M, TLC339M			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 CONDITIONS†	$T_A$	TLC139M, TLC339M			UNIT
			MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{IC} = V_{ICRmin}$ , See Note 3	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 $V_{DD}-1.5$			
CMRR 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 (four comparators)	Outputs low, No load	25°C	44	80	μA	
		-55°C to 125°C	175			

† 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 with a 2.5-kΩ load to  $V_{DD}$ .

# TLC139, TLC339, TLC339Q

## LinCMOS™ MICROPOWER QUAD COMPARATORS

### recommended operating conditions

	TLC339C			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, $I_{OL}$		8	20	mA
Operating free-air temperature, $T_A$	0		70	°C

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

PARAMETER	TEST CONDITION†	$T_A$	TLC339C			UNIT
			MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{IC} = V_{ICRmin}$ , See Note 3	25°C		1.4	5	mV
		0°C to 70°C			6.5	
$I_{IO}$ Input offset current	$V_{IC} = 2.5\text{ V}$	25°C		1		pA
		70°C			0.3	nA
$I_{IB}$ Input bias current	$V_{IC} = 2.5\text{ V}$	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 $V_{DD}-1.5$		
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$	25°C		84		dB
		70°C		84		
		0°C		84		
$k_{SVR}$ Supply-voltage rejection ratio	$V_{DD} = 5\text{ V to }10\text{ V}$	25°C		85		dB
		70°C		85		
		0°C		85		
$V_{OL}$ Low-level output voltage	$V_{ID} = -1\text{ V}$ , $I_{OL} = 6\text{ mA}$	25°C		300	400	mV
		70°C			650	
$I_{OH}$ High-level output current	$V_{ID} = -1\text{ V}$ , $V_O = 5\text{ V}$	25°C		0.8	40	nA
		70°C			1	μA
$I_{DD}$ Supply current (four comparators)	Outputs low, No load	25°C		44	80	μA
		0°C to 70°C			100	

† 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  $V_{DD}$ .

**recommended operating conditions**

	TLC339I			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, $I_{OL}$		8	20	mA
Operating free-air temperature, $T_A$	0		70	°C

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

PARAMETER		TEST CONDITIONST	$T_A$	TLC339I			UNIT
				MIN	TYP	MAX	
$V_{IO}$	Input offset voltage	$V_{IC} = V_{ICRmin}$ , 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 $V_{DD}-1.5$			
CMRR	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 (four comparators)	Outputs low, No load	25°C		44	80	μA
			-40°C to 85°C			125	

† 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 with a 2.5-kΩ load to  $V_{DD}$ .

# TLC139, TLC339, TLC339Q

## LinCMOS™ MICROPOWER QUAD COMPARATORS

### recommended operating conditions

	TLC339Q			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, $V_{DD} = 5\text{ V}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS†	$T_A$	TLC339Q			UNIT
			MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{IC} = V_{ICRmin}$ , See Note 3	25°C		1.4	5	mV
		-40°C to 125°C			10	
$I_{IO}$ Input offset current	$V_{IC} = 2.5\text{ V}$	25°C		1		pA
		125°C			15	nA
$I_{IB}$ Input bias current	$V_{IC} = 2.5\text{ V}$	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 $V_{DD}-1.5$		
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$	25°C		84		dB
		125°C		84		
		-40°C		84		
$k_{SVR}$ Supply-voltage rejection ratio	$V_{DD} = 5\text{ V to }10\text{ V}$	25°C		85		dB
		125°C		84		
		-40°C		84		
$V_{OL}$ Low-level output voltage	$V_{ID} = -1\text{ V}$ , $I_{OL} = 6\text{ mA}$	25°C		300	400	mV
		125°C			800	
$I_{OH}$ High-level output current	$V_{ID} = -1\text{ V}$ , $V_O = 5\text{ V}$	25°C		0.8	40	nA
		125°C			1	μA
$I_{DD}$ Supply current (four comparators)	Outputs low, No load	25°C		44	80	μA
		-40°C to 125°C			125	

† 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  $V_{DD}$ .

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

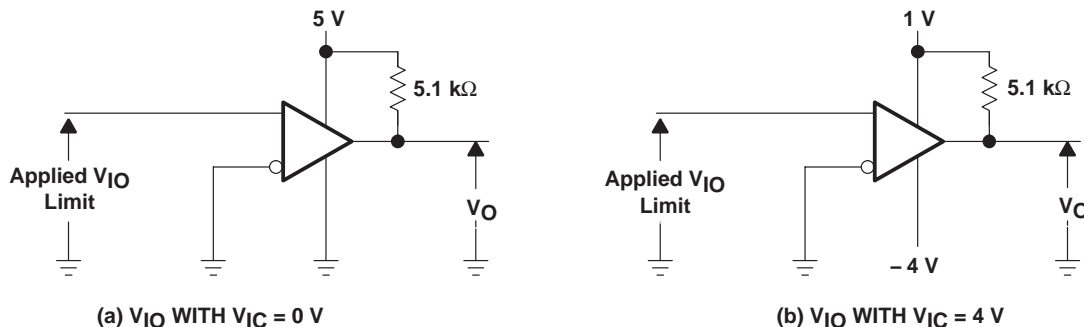
PARAMETER	TEST CONDITIONS	TLC139M, TLC339C TLC339I, TLC339M TLC339Q			UNIT
		MIN	TYP	MAX	
$t_{PLH}$ Propagation delay time, low-to-high output	$f = 10\text{ kHz}$ , $C_L = 15\text{ pF}$	Overdrive = 2 mV	4.5		$\mu\text{s}$
		Overdrive = 5 mV	2.5		
		Overdrive = 10 mV	1.7		
		Overdrive = 20 mV	1.2		
		Overdrive = 40 mV	1.0		
	$V_I = 1.4\text{ V}$ step at $IN+$	1.1			
$t_{PHL}$ Propagation delay time, high-to-low level output	$f = 10\text{ kHz}$ , $C_L = 15\text{ pF}$	Overdrive = 2 mV	3.6		$\mu\text{s}$
		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			
$t_{THL}$ Transition time, high-to-low level output	$f = 10\text{ kHz}$ , $C_L = 15\text{ pF}$	Overdrive = 50 mV	20		ns

### PARAMETER MEASUREMENT INFORMATION

The TLC139 and TLC339 contain a digital output stage that, 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, 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.



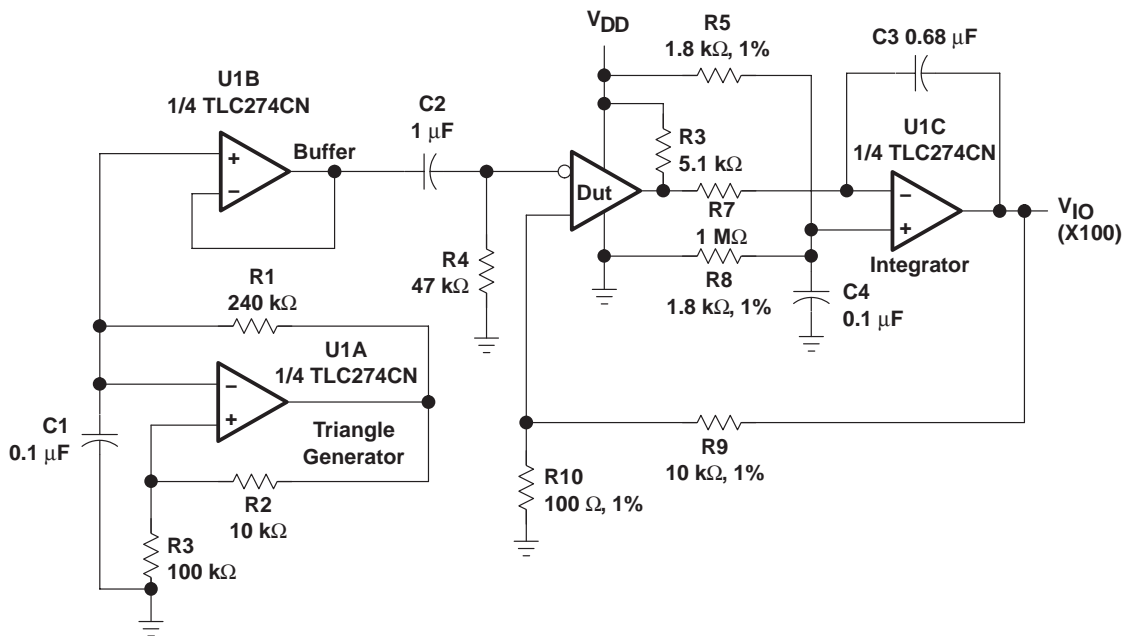
**Figure 1. Method for Verifying That Input Offset Voltage Is Within Specified Limits**

**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 state.

Figure 2 illustrates a practical circuit for direct dc measurement of input offset voltage that does not bias the comparator into 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.

Voltage divider R9 and R10 provides a step-up of the 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.



**Figure 2. Circuit for Input Offset Voltage Measurement**

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.



**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.



NOTE A:  $C_L$  includes probe and jig capacitance.

**Figure 3. Propagation Delay, Rise, and Fall Times Test Circuit and Voltage Waveforms**

**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
$I_{OH}$	High-level output current	vs High-level output voltage	8
		vs Free-air temperature	9
$V_{OL}$	Low-level output voltage	vs Low-level output current	10
		vs Free-air temperature	11
$I_{DD}$	Supply current	vs Supply voltage	12
		vs Free-air temperature	13
$t_{PLH}$	Low-to-high level output propagation delay time	vs Supply voltage	14
$t_{PHL}$	Low-to-high level output propagation delay time	vs Supply voltage	15
		Overdrive voltage	vs Low-to-high-level output propagation delay time
$t_f$	Output fall time	vs Supply voltage	17
		Overdrive voltage	vs High-to-low-level output propagation delay time

TYPICAL CHARACTERISTICS†

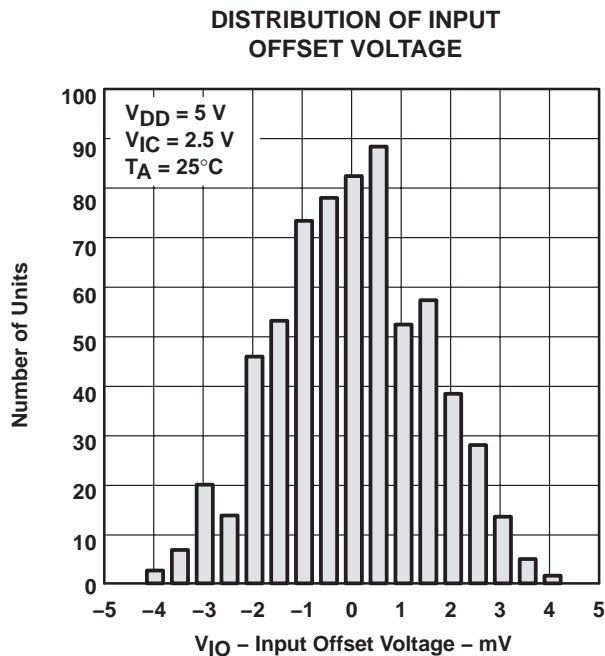


Figure 4

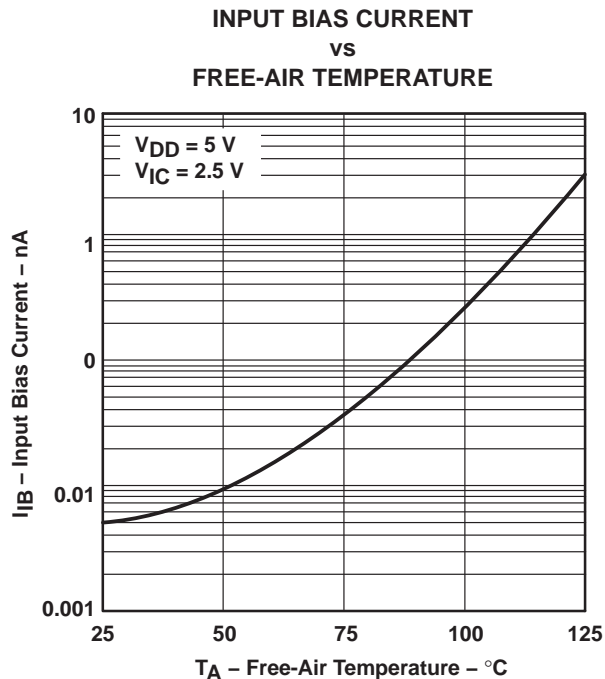


Figure 5

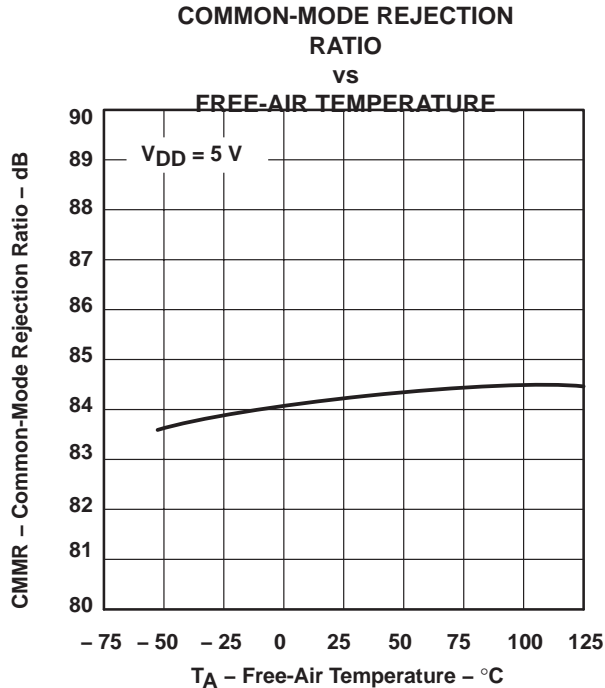


Figure 6

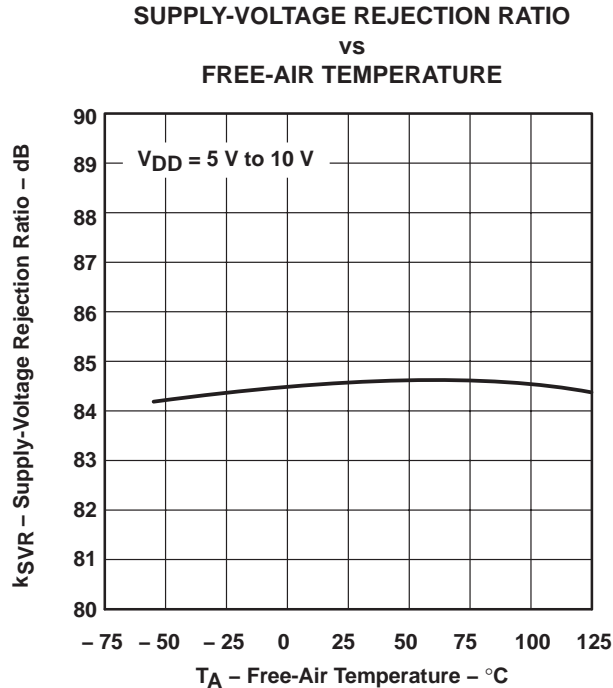


Figure 7

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

TYPICAL CHARACTERISTICS†

HIGH-LEVEL OUTPUT CURRENT  
 vs  
 HIGH-LEVEL OUTPUT VOLTAGE

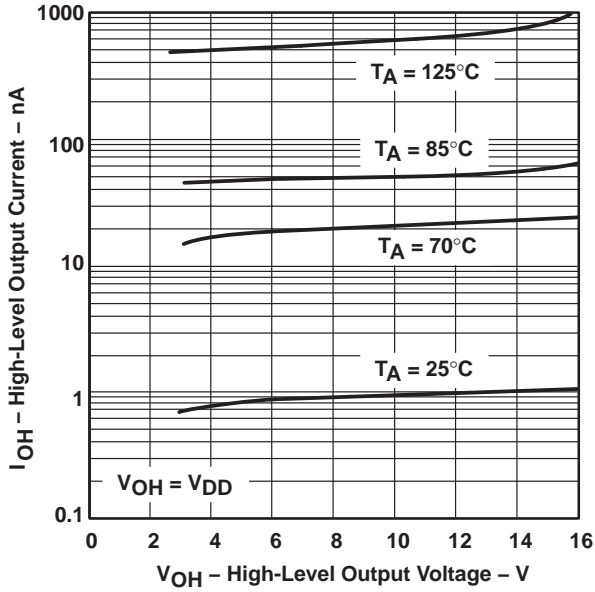


Figure 8

HIGH-LEVEL OUTPUT CURRENT  
 vs  
 FREE-AIR TEMPERATURE

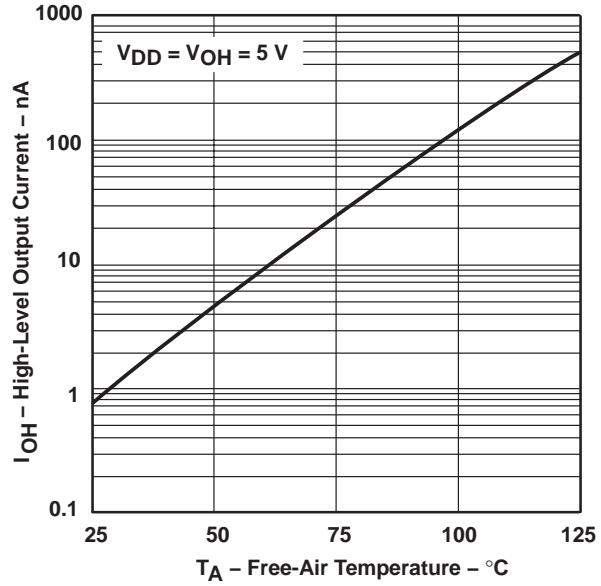


Figure 9

LOW-LEVEL OUTPUT VOLTAGE  
 vs  
 LOW-LEVEL OUTPUT CURRENT

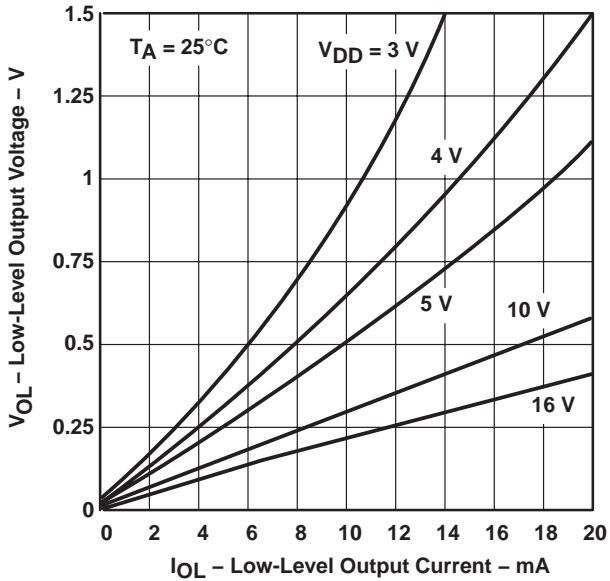


Figure 10

LOW-LEVEL OUTPUT VOLTAGE  
 vs  
 FREE-AIR TEMPERATURE

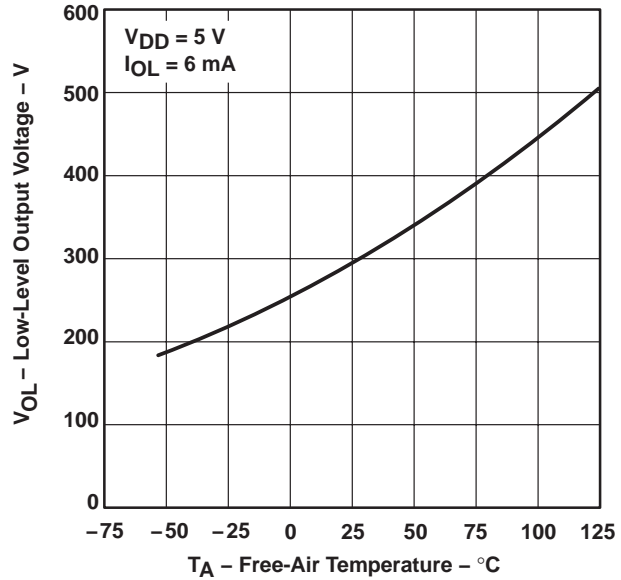


Figure 11

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

TYPICAL CHARACTERISTICS†

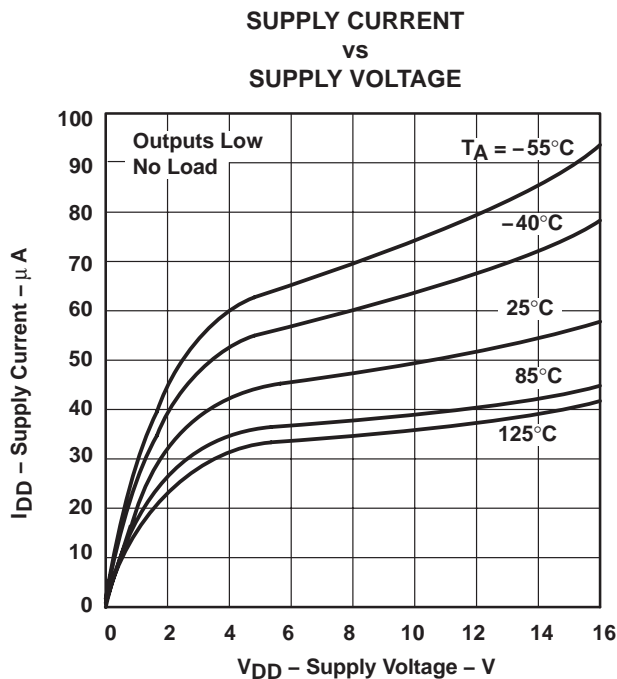


Figure 12

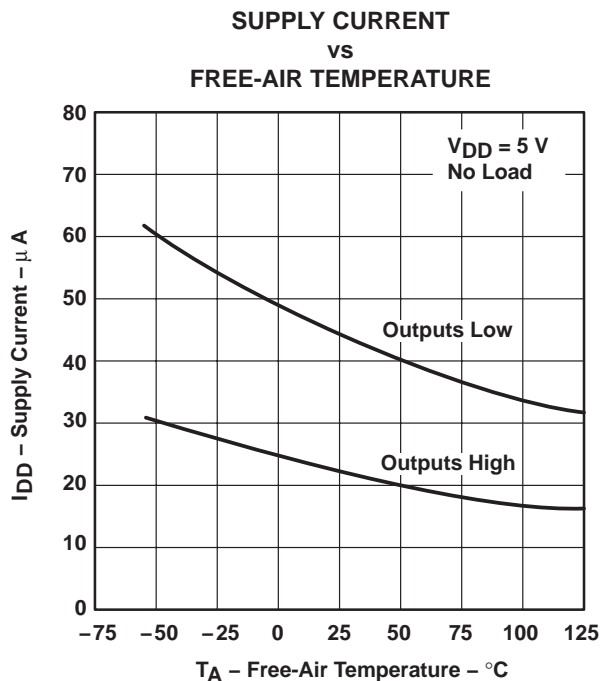


Figure 13

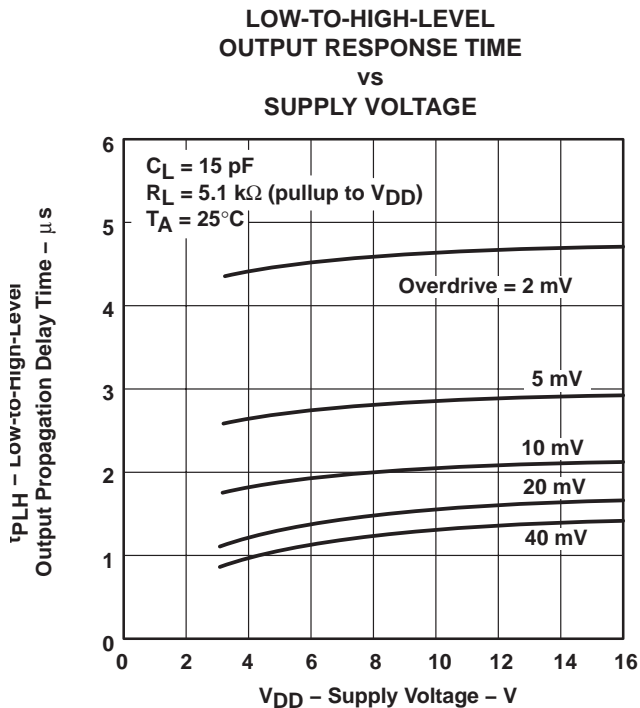


Figure 14

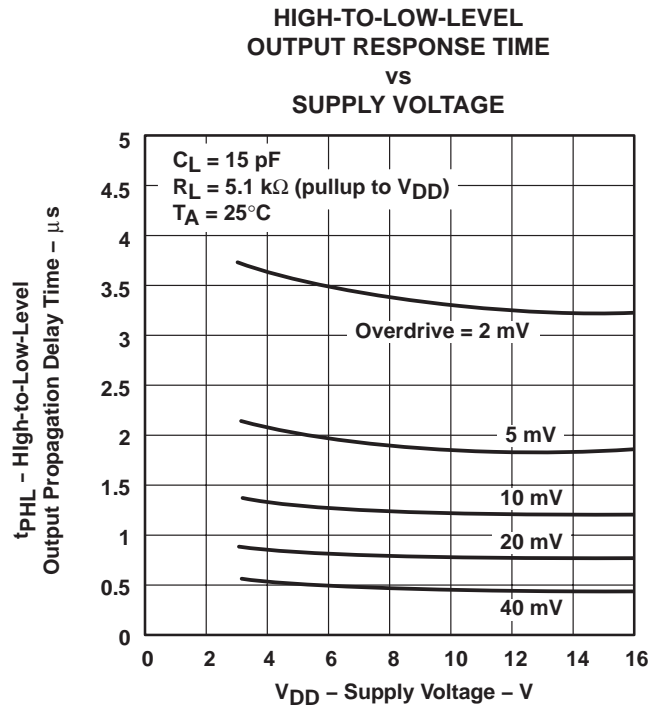


Figure 15

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

TYPICAL CHARACTERISTICS

LOW-TO-HIGH-LEVEL OUTPUT  
 PROPAGATION DELAY  
 FOR VARIOUS OVERDRIVE VOLTAGES



Figure 16

OUTPUT FALL TIME  
 vs  
 SUPPLY VOLTAGE

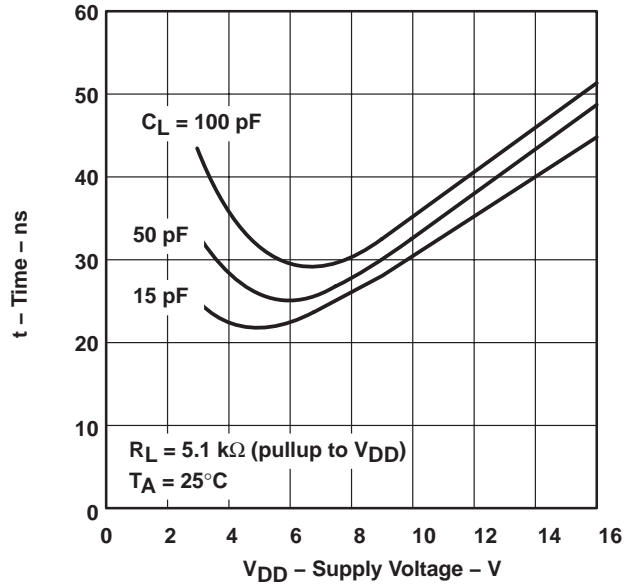


Figure 17

HIGH-TO-LOW-LEVEL OUTPUT  
 PROPAGATION DELAY  
 FOR VARIOUS OVERDRIVE VOLTAGES

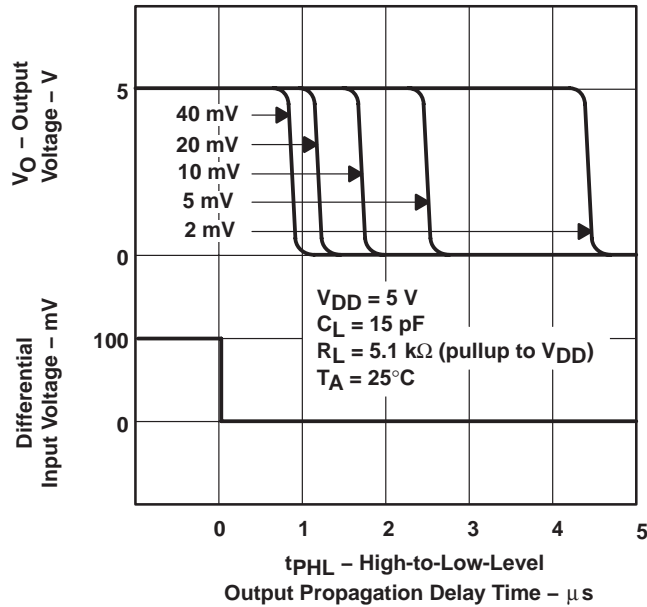


Figure 18

**APPLICATION INFORMATION**

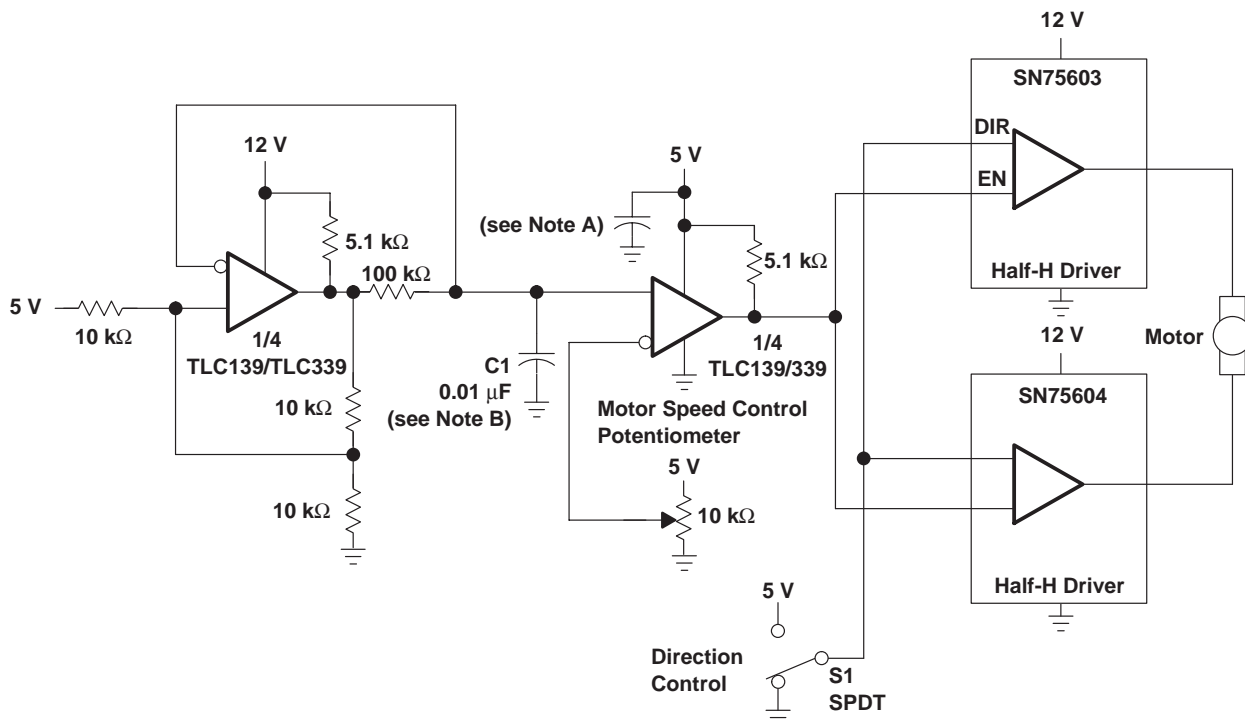
The inputs should always remain within the supply rails in order to avoid forward biasing the diodes in the electrostatic discharge (ESD) protection structure. If either input exceeds this range, the device is not damaged as long as the input current is limited to less than 5 mA. To maintain the expected 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  $-0.2\text{ V}$  and  $4\text{ V}$  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 output and supply currents require close observation since the TLC139/TLC339 does not provide current protection. For example, each output can source or sink a maximum of 20 mA; however, the total current to ground has an absolute maximum of 60 mA. This prohibits sinking 20 mA from each of the four outputs simultaneously since the total current to ground would be 80 mA.

The TLC139 and TLC339 have internal ESD-protection circuits that prevent functional failures at voltages up to 2000 V as tested under MIL-STD-883C, Method 3015.2; however, exercise care when handling these devices as exposure to ESD may result in the degradation of the device parametric performance.

**Table of Applications**

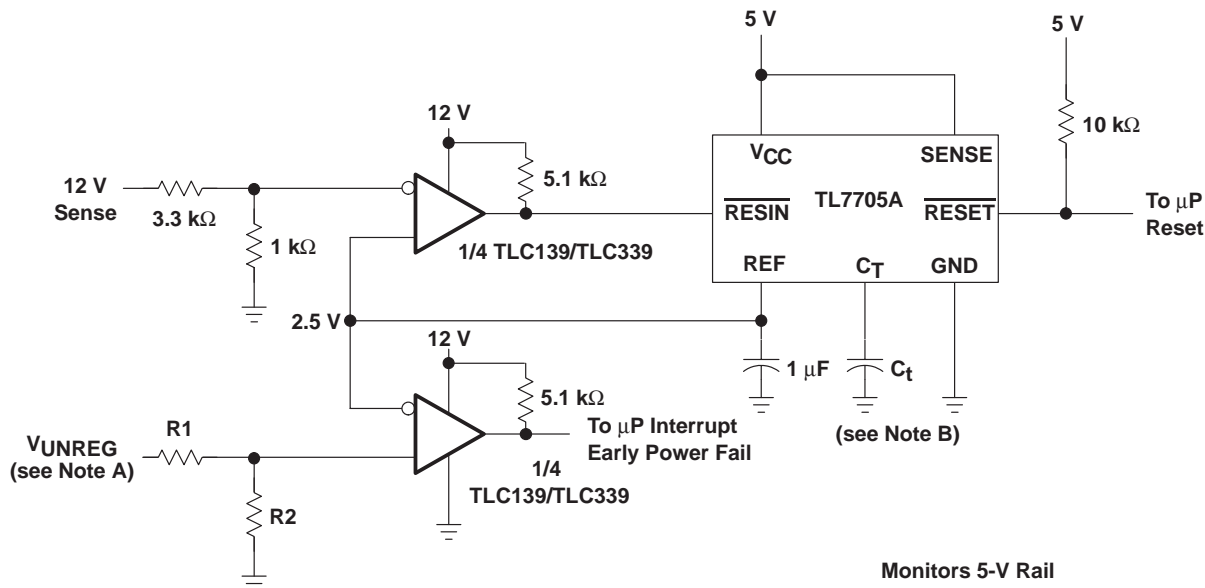
	<b>FIGURE</b>
Pulse-width-modulated motor speed controller	19
Enhanced supply supervisor	20
Two-phase nonoverlapping clock generator	21



- NOTES: A. The recommended minimum capacitance is 10  $\mu\text{F}$  to eliminate common ground switching noise.  
 B. Select C1 for change in oscillator frequency.

**Figure 19. Pulse-Width-Modulated Motor Speed Controller**

**TYPICAL APPLICATION DATA**

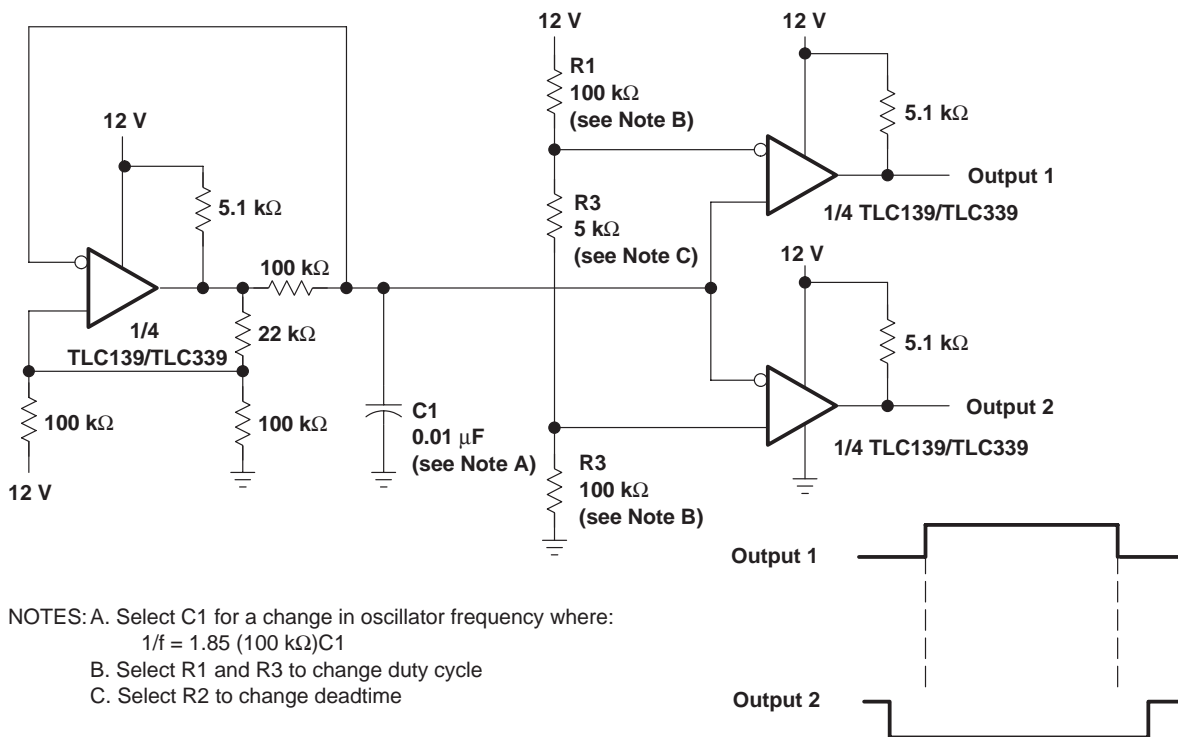


Monitors 5-V Rail  
 Monitors 12-V Rail  
 Early Power Fail Warning

NOTES:A.  $V_{UNREG} = 2.5 \left( \frac{R1 + R2}{R2} \right)$

B. The value of  $C_t$  determines the time delay of reset.

**Figure 20. Enhanced Supply Supervisor**



- NOTES:A. Select  $C_1$  for a change in oscillator frequency where:  
 $1/f = 1.85 (100 \text{ k}\Omega)C_1$   
 B. Select  $R_1$  and  $R_3$  to change duty cycle  
 C. Select  $R_2$  to change deadtime

**Figure 21. Two-Phase Nonoverlapping Clock Generator**



**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
5962-87659022A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type	-55 to 125	5962-87659022A TLC139MFKB	<a href="#">Samples</a>
5962-8765902CA	ACTIVE	CDIP	J	14	1	TBD	SNPB	N / A for Pkg Type	-55 to 125	5962-8765902CA TLC139MJB	<a href="#">Samples</a>
5962-9555001NXD	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM		QTLC139M	<a href="#">Samples</a>
5962-9555001NXDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM		QTLC139M	<a href="#">Samples</a>
TLC139MFKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type		5962-87659022A TLC139MFKB	<a href="#">Samples</a>
TLC139MJB	ACTIVE	CDIP	J	14	1	TBD	SNPB	N / A for Pkg Type		5962-8765902CA TLC139MJB	<a href="#">Samples</a>
TLC339CD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM		TLC339C	<a href="#">Samples</a>
TLC339CDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM		TLC339C	<a href="#">Samples</a>
TLC339CN	ACTIVE	PDIP	N	14	25	Green (RoHS & no Sb/Br)	NIPDAU	N / A for Pkg Type		TLC339CN	<a href="#">Samples</a>
TLC339CNSR	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM		TLC339	<a href="#">Samples</a>
TLC339CPW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM		P339	<a href="#">Samples</a>
TLC339CPWG4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM		P339	<a href="#">Samples</a>
TLC339CPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM		P339	<a href="#">Samples</a>
TLC339ID	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM		TLC339I	<a href="#">Samples</a>
TLC339IDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM		TLC339I	<a href="#">Samples</a>
TLC339IDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM		TLC339I	<a href="#">Samples</a>

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TLC339IN	ACTIVE	PDIP	N	14	25	Green (RoHS & no Sb/Br)	NIPDAU	N / A for Pkg Type		TLC339IN	<a href="#">Samples</a>
TLC339IPW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM		TLC339I	<a href="#">Samples</a>
TLC339IPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM		TLC339I	<a href="#">Samples</a>
TLC339MD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	-55 to 125	TLC339M	<a href="#">Samples</a>
TLC339MDG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	-55 to 125	TLC339M	<a href="#">Samples</a>
TLC339MDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	-55 to 125	TLC339M	<a href="#">Samples</a>
TLC339MDRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	-55 to 125	TLC339M	<a href="#">Samples</a>
TLC339MN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	NIPDAU	N / A for Pkg Type	-55 to 125	TLC339MN	<a href="#">Samples</a>

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

<sup>(5)</sup> Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

<sup>(6)</sup> Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
5962-9555001NXDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TLC339CDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TLC339CNSR	SO	NS	14	2000	330.0	16.4	8.2	10.5	2.5	12.0	16.0	Q1
TLC339CPWR	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
TLC339IDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TLC339IPWR	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
TLC339MDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TLC339MDRG4	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
5962-9555001NXDR	SOIC	D	14	2500	350.0	350.0	43.0
TLC339CDR	SOIC	D	14	2500	350.0	350.0	43.0
TLC339CNSR	SO	NS	14	2000	367.0	367.0	38.0
TLC339CPWR	TSSOP	PW	14	2000	853.0	449.0	35.0
TLC339IDR	SOIC	D	14	2500	333.2	345.9	28.6
TLC339IPWR	TSSOP	PW	14	2000	853.0	449.0	35.0
TLC339MDR	SOIC	D	14	2500	350.0	350.0	43.0
TLC339MDRG4	SOIC	D	14	2500	350.0	350.0	43.0

FK (S-CQCC-N\*\*)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



NO. OF TERMINALS **	A		B	
	MIN	MAX	MIN	MAX
20	0.342 (8,69)	0.358 (9,09)	0.307 (7,80)	0.358 (9,09)
28	0.442 (11,23)	0.458 (11,63)	0.406 (10,31)	0.458 (11,63)
44	0.640 (16,26)	0.660 (16,76)	0.495 (12,58)	0.560 (14,22)
52	0.740 (18,78)	0.761 (19,32)	0.495 (12,58)	0.560 (14,22)
68	0.938 (23,83)	0.962 (24,43)	0.850 (21,6)	0.858 (21,8)
84	1.141 (28,99)	1.165 (29,59)	1.047 (26,6)	1.063 (27,0)



4040140/D 01/11

- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - This package can be hermetically sealed with a metal lid.
  - Falls within JEDEC MS-004

## MECHANICAL DATA

NS (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



- 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.

N (R-PDIP-T\*\*)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - $\triangle C$  Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
  - $\triangle D$  The 20 pin end lead shoulder width is a vendor option, either half or full width.

4040049/E 12/2002



J 14

**GENERIC PACKAGE VIEW**  
**CDIP - 5.08 mm max height**  
CERAMIC DUAL IN LINE PACKAGE



Images above are just a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.

4040083-5/G

J0014A



# PACKAGE OUTLINE

CDIP - 5.08 mm max height

CERAMIC DUAL IN LINE PACKAGE



4214771/A 05/2017

NOTES:

1. All controlling linear dimensions are in inches. Dimensions in brackets are in millimeters. Any dimension in brackets or parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This package is hermetically sealed with a ceramic lid using glass frit.
4. Index point is provided on cap for terminal identification only and on press ceramic glass frit seal only.
5. Falls within MIL-STD-1835 and GDIP1-T14.

# EXAMPLE BOARD LAYOUT

J0014A

CDIP - 5.08 mm max height

CERAMIC DUAL IN LINE PACKAGE



LAND PATTERN EXAMPLE  
NON-SOLDER MASK DEFINED  
SCALE: 5X



4214771/A 05/2017

D (R-PDSO-G14)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  -  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
  -  Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
  - E. Reference JEDEC MS-012 variation AB.

D (R-PDSO-G14)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-7351 is recommended for alternate designs.
  - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

PW (R-PDSO-G14)

PLASTIC SMALL OUTLINE



4040064-3/G 02/11

- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
  - E. Falls within JEDEC MO-153

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