

## LMV331-N Single / LMV393-N Dual / LMV339-N Quad General Purpose, Low Voltage, Tiny Pack Comparators

Check for Samples: [LMV331-N](#), [LMV339-N](#), [LMV393-N](#)

### FEATURES

- (For 5V Supply, Typical Unless Otherwise Noted)
- **Guaranteed 2.7V and 5V Performance**
- **Industrial Temperature Range –40°C to +85°C**
- **Low Supply Current 60  $\mu$ A/Channel**
- **Input Common Mode Voltage Range Includes Ground**
- **Low Output Saturation Voltage 200 mV**
- **Propagation Delay 200 ns**
- **Space Saving 5-pin SC70 and 5-Pin SOT23 Packages**

### APPLICATIONS

- **Mobile Communications**
- **Notebooks and PDA's**
- **Battery Powered Electronics**
- **General Purpose Portable Device**
- **General Purpose Low Voltage Applications**

### DESCRIPTION

The LMV393-N and LMV339-N are low voltage (2.7-5V) versions of the dual and quad comparators, LM393/339, which are specified at 5-30V. The LMV331-N is the single version, which is available in space saving 5-pin SC70 and 5-pin SOT23 packages. The 5-pin SC70 is approximately half the size of the 5-pin SOT23.

The LMV393-N is available in 8-pin SOIC and VSSOP. The LMV339-N is available in 14-pin SOIC and TSSOP.

The LMV331-N/393-N/339-N is the most cost-effective solution where space, low voltage, low power and price are the primary specification in circuit design for portable consumer products. They offer specifications that meet or exceed the familiar LM393/339 at a fraction of the supply current.

The chips are built with TI's advanced Submicron Silicon-Gate BiCMOS process. The LMV331-N/393-N/339-N have bipolar input and output stages for improved noise performance.



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.

All trademarks are the property of their respective owners.

Typical Applications

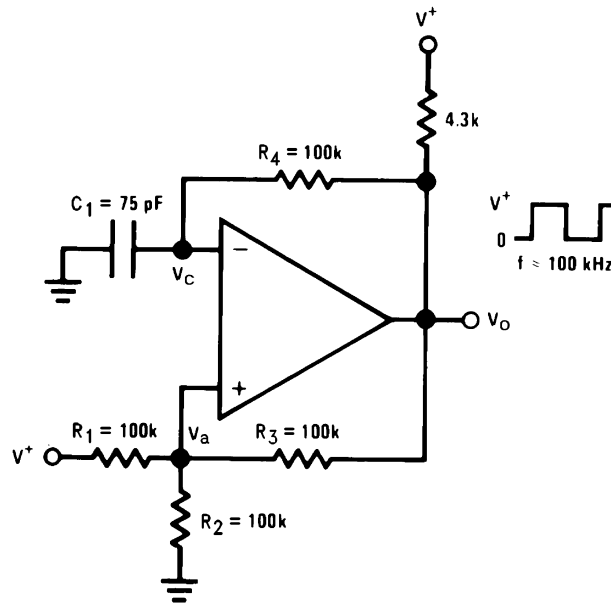


Figure 1. Squarewave Oscillator

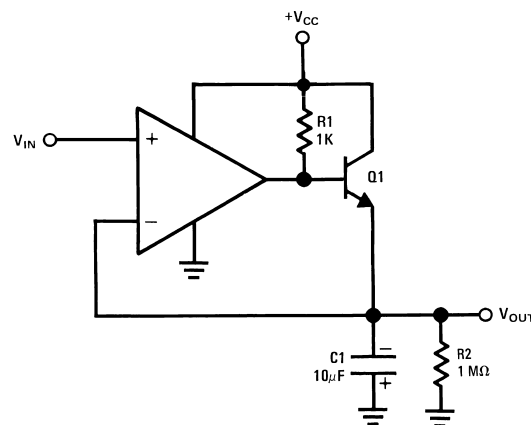
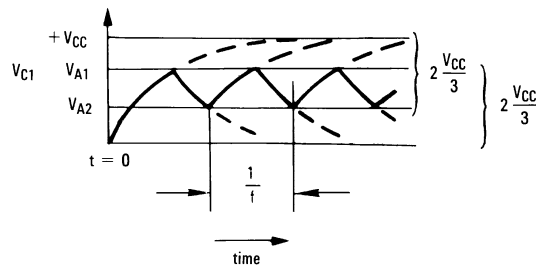


Figure 2. Positive Peak Detector



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

**Absolute Maximum Ratings** <sup>(1)(2)</sup>

ESD Tolerance <sup>(3)</sup>	
Human Body Model	
LMV331-N/393-N/339-N	800V
Machine Model	
LMV331-N/339-N/393-N	120V
Differential Input Voltage	±Supply Voltage
Voltage on any pin (referred to V <sup>-</sup> pin)	5.5V
Soldering Information	
Infrared or Convection (20 sec)	235°C
Storage Temp. Range	-65°C to +150°C
Junction Temperature <sup>(4)</sup>	150°C

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical characteristics.
- (2) **If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office / Distributors for availability and specifications.**
- (3) Human Body Model, applicable std. MIL-STD-883, Method 3015.7. Machine Model, applicable std. JESD22-A115-A (ESD MM std. of JEDEC) Field-Induced Charge-Device Model, applicable std. JESD22-C101-C (ESD FICDM std. of JEDEC).
- (4) The maximum power dissipation is a function of  $T_{J(MAX)}$ ,  $\theta_{JA}$ . The maximum allowable power dissipation at any ambient temperature is  $P_D = (T_{J(MAX)} - T_A)/\theta_{JA}$ . All numbers apply for packages soldered directly onto a PC board.

**Operating Ratings** <sup>(1)</sup>

Supply Voltage	2.7V to 5.0V
Temperature Range <sup>(2)</sup>	
LMV393-N, LMV339-N, LMV331-N	-40°C to +85°C
Thermal Resistance ( $\theta_{JA}$ )	
5-Pin SC70	478°C/W
5-Pin SOT23	265°C/W
8-Pin SOIC	190°C/W
8-Pin VSSOP	235°C/W
14-Pin SOIC	145°C/W
14-Pin TSSOP	155°C/W

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical characteristics.
- (2) The maximum power dissipation is a function of  $T_{J(MAX)}$ ,  $\theta_{JA}$ . The maximum allowable power dissipation at any ambient temperature is  $P_D = (T_{J(MAX)} - T_A)/\theta_{JA}$ . All numbers apply for packages soldered directly onto a PC board.

**2.7V DC Electrical Characteristics**

Unless otherwise specified, all limits guaranteed for  $T_J = 25^\circ\text{C}$ ,  $V^+ = 2.7\text{V}$ ,  $V^- = 0\text{V}$ . **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min <sup>(1)</sup>	Typ <sup>(2)</sup>	Max <sup>(1)</sup>	Units
$V_{OS}$	Input Offset Voltage			1.7	7	mV
$TCV_{OS}$	Input Offset Voltage Average Drift			<b>5</b>		$\mu\text{V}/^\circ\text{C}$
$I_B$	Input Bias Current			10	250 <b>400</b>	nA
$I_{OS}$	Input Offset Current			5	50 <b>150</b>	nA

- (1) All limits are guaranteed by testing or statistical analysis.
- (2) Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration. The typical values are not tested and are not guaranteed on shipped production material.

## 2.7V DC Electrical Characteristics (continued)

Unless otherwise specified, all limits guaranteed for  $T_J = 25^\circ\text{C}$ ,  $V^+ = 2.7\text{V}$ ,  $V^- = 0\text{V}$ . **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (1)	Typ (2)	Max (1)	Units
$V_{\text{CM}}$	Input Voltage Range			-0.1		V
				2.0		V
$V_{\text{SAT}}$	Saturation Voltage	$I_{\text{SINK}} \leq 1\text{ mA}$		120		mV
$I_{\text{O}}$	Output Sink Current	$V_{\text{O}} \leq 1.5\text{V}$	5	23		mA
$I_{\text{S}}$	Supply Current	LMV331-N		40	100	$\mu\text{A}$
		LMV393-N Both Comparators		70	140	$\mu\text{A}$
		LMV339-N All four Comparators		140	200	$\mu\text{A}$
	Output Leakage Current			.003	<b>1</b>	$\mu\text{A}$

## 2.7V AC Electrical Characteristics

$T_J = 25^\circ\text{C}$ ,  $V^+ = 2.7\text{V}$ ,  $R_L = 5.1\text{ k}\Omega$ ,  $V^- = 0\text{V}$ .

Symbol	Parameter	Conditions	Min (1)	Typ (2)	Max (1)	Units
$t_{\text{PHL}}$	Propagation Delay (High to Low)	Input Overdrive = 10 mV		1000		ns
		Input Overdrive = 100 mV		350		ns
$t_{\text{PLH}}$	Propagation Delay (Low to High)	Input Overdrive = 10 mV		500		ns
		Input Overdrive = 100 mV		400		ns

(1) All limits are guaranteed by testing or statistical analysis.

(2) Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration. The typical values are not tested and are not guaranteed on shipped production material.

## 5V DC Electrical Characteristics

Unless otherwise specified, all limits guaranteed for  $T_J = 25^\circ\text{C}$ ,  $V^+ = 5\text{V}$ ,  $V^- = 0\text{V}$ . **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (1)	Typ (2)	max (1)	Units
$V_{\text{OS}}$	Input Offset Voltage			1.7	<b>7</b> <b>9</b>	mV
$\text{TCV}_{\text{OS}}$	Input Offset Voltage Average Drift			5		$\mu\text{V}/^\circ\text{C}$
$I_{\text{B}}$	Input Bias Current			25	250 <b>400</b>	nA
$I_{\text{OS}}$	Input Offset Current			2	50 <b>150</b>	nA
$V_{\text{CM}}$	Input Voltage Range			-0.1		V
				4.2		V
$A_{\text{V}}$	Voltage Gain		20	50		V/mV
$V_{\text{sat}}$	Saturation Voltage	$I_{\text{SINK}} \leq 4\text{ mA}$		200	400 <b>700</b>	mV
$I_{\text{O}}$	Output Sink Current	$V_{\text{O}} \leq 1.5\text{V}$		84	10	mA

(1) All limits are guaranteed by testing or statistical analysis.

(2) Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration. The typical values are not tested and are not guaranteed on shipped production material.

### 5V DC Electrical Characteristics (continued)

Unless otherwise specified, all limits guaranteed for  $T_J = 25^\circ\text{C}$ ,  $V^+ = 5\text{V}$ ,  $V^- = 0\text{V}$ . **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (1)	Typ (2)	max (1)	Units
$I_S$	Supply Current	LMV331-N		60	120 <b>150</b>	$\mu\text{A}$
		LMV393-N Both Comparators		100	200 <b>250</b>	$\mu\text{A}$
		LMV339-N All four Comparators		170	300 <b>350</b>	$\mu\text{A}$
	Output Leakage Current			.003	<b>1</b>	$\mu\text{A}$

### 5V AC Electrical Characteristics

$T_J = 25^\circ\text{C}$ ,  $V^+ = 5\text{V}$ ,  $R_L = 5.1\text{ k}\Omega$ ,  $V^- = 0\text{V}$ .

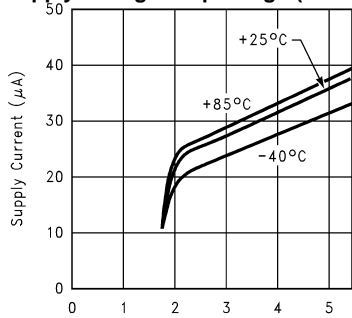
Symbol	Parameter	Conditions	Min (1)	Typ (2)	Max (1)	Units
$t_{PHL}$	Propagation Delay (High to Low)	Input Overdrive = 10 mV		600		ns
		Input Overdrive = 100 mV		200		ns
$t_{PLH}$	Propagation Delay (Low to High)	Input Overdrive = 10 mV		450		ns
		Input Overdrive = 100 mV		300		ns

- (1) All limits are guaranteed by testing or statistical analysis.
- (2) Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration. The typical values are not tested and are not guaranteed on shipped production material.

### TYPICAL PERFORMANCE CHARACTERISTICS

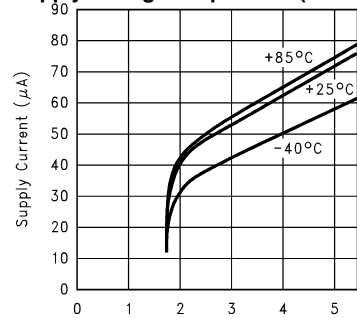
Unless otherwise specified,  $V_S = +5V$ , single supply,  $T_A = 25^\circ C$

**Supply Current vs. Supply Voltage Output High (LMV331-N)**



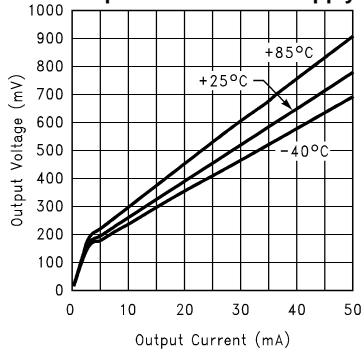
**Figure 3.**

**Supply Current vs. Supply Voltage Output Low (LMV331-N)**



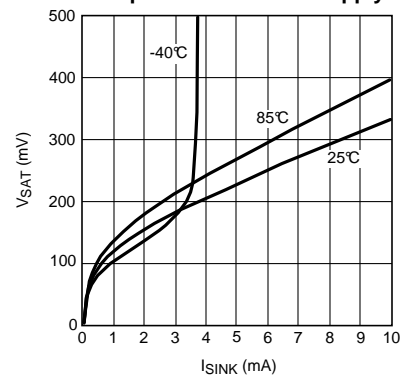
**Figure 4.**

**Output Voltage vs. Output Current at 5V Supply**



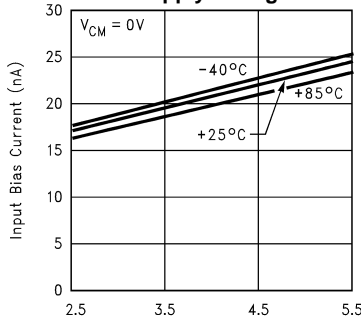
**Figure 5.**

**Output Voltage vs. Output Current at 2.7 Supply**



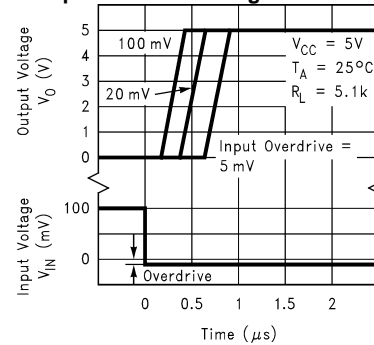
**Figure 6.**

**Input Bias Current vs. Supply Voltage**



**Figure 7.**

**Response Time vs. Input Overdrives Negative Transition**

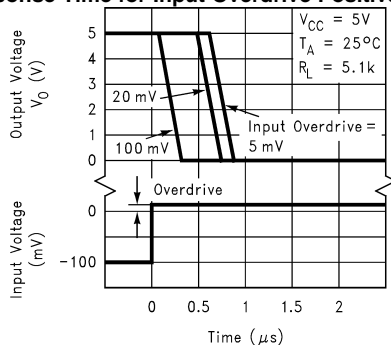


**Figure 8.**

**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**

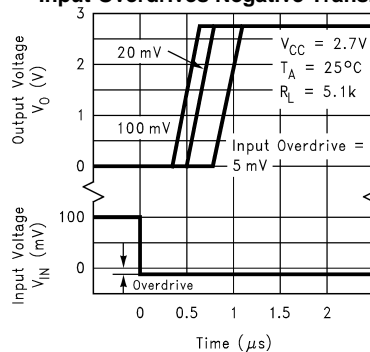
Unless otherwise specified,  $V_S = +5V$ , single supply,  $T_A = 25^\circ C$

**Response Time for Input Overdrive Positive Transition**



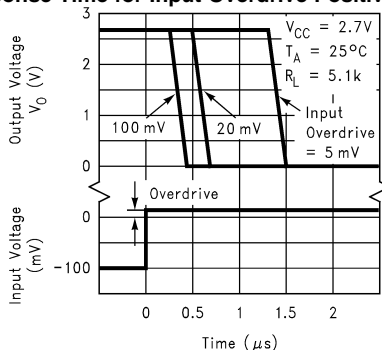
**Figure 9.**

**Response Time vs. Input Overdrives Negative Transition**



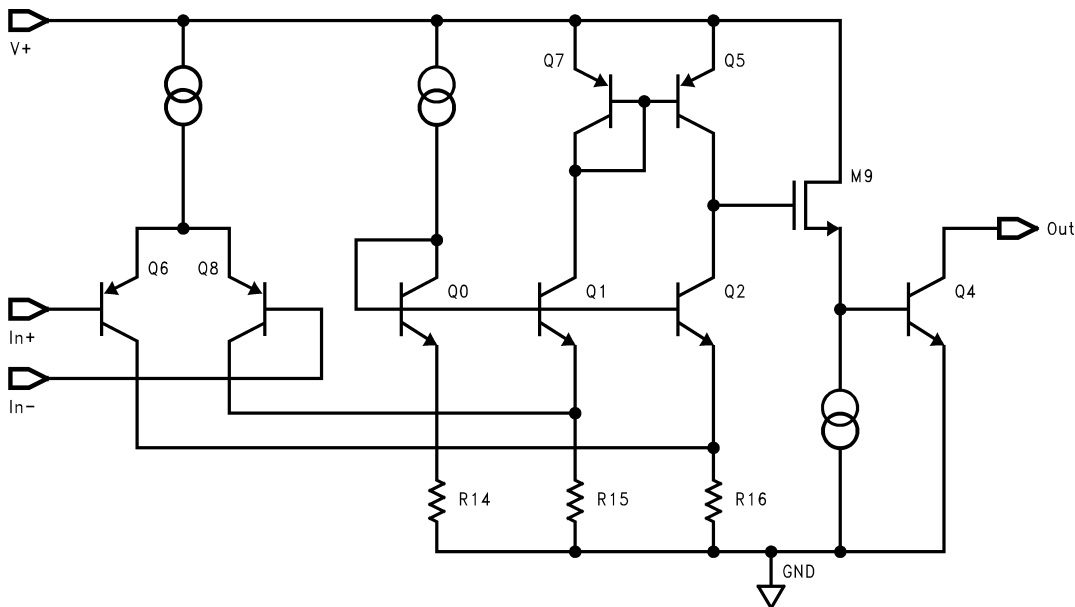
**Figure 10.**

**Response Time for Input Overdrive Positive Transition**



**Figure 11.**

**SIMPLIFIED SCHEMATIC**



## APPLICATION CIRCUITS

### BASIC COMPARATOR

A basic comparator circuit is used for converting analog signals to a digital output. The LMV331-N/393-N/339-N have an open-collector output stage, which requires a pull-up resistor to a positive supply voltage for the output to switch properly. When the internal output transistor is off, the output voltage will be pulled up to the external positive voltage.

The output pull-up resistor should be chosen high enough so as to avoid excessive power dissipation yet low enough to supply enough drive to switch whatever load circuitry is used on the comparator output. On the LMV331-N/393-N/339-N the pull-up resistor should range between 1k to 10k $\Omega$ .

The comparator compares the input voltage ( $V_{IN}$ ) at the non-inverting pin to the reference voltage ( $V_{REF}$ ) at the inverting pin. If  $V_{IN}$  is less than  $V_{REF}$ , the output voltage ( $V_O$ ) is at the saturation voltage. On the other hand, if  $V_{IN}$  is greater than  $V_{REF}$ , the output voltage ( $V_O$ ) is at  $V_{CC}$ .

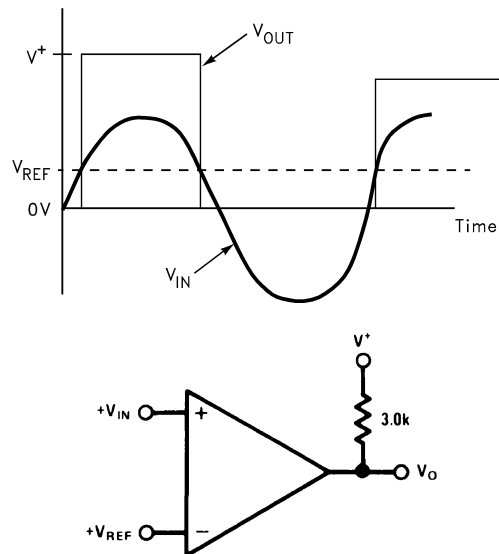


Figure 12. Basic Comparator

### COMPARATOR WITH HYSTERESIS

The basic comparator configuration may oscillate or produce a noisy output if the applied differential input voltage is near the comparator's offset voltage. This usually happens when the input signal is moving very slowly across the comparator's switching threshold. This problem can be prevented by the addition of hysteresis or positive feedback.

### INVERTING COMPARATOR WITH HYSTERESIS

The inverting comparator with hysteresis requires a three resistor network that are referenced to the supply voltage  $V_{CC}$  of the comparator. When  $V_{in}$  at the inverting input is less than  $V_a$ , the voltage at the non-inverting node of the comparator ( $V_{in} < V_a$ ), the output voltage is high (for simplicity assume  $V_O$  switches as high as  $V_{CC}$ ). The three network resistors can be represented as  $R_1//R_3$  in series with  $R_2$ . The lower input trip voltage  $V_{a1}$  is defined as

$$V_{a1} = \frac{V_{CC} R_2}{(R_1 // R_3) + R_2} \quad (1)$$

When  $V_{in}$  is greater than  $V_a$  ( $V_{in} > V_a$ ), the output voltage is low very close to ground. In this case the three network resistors can be presented as  $R_2//R_3$  in series with  $R_1$ . The upper trip voltage  $V_{a2}$  is defined as

$$V_{a2} = \frac{V_{CC} (R_2 // R_3)}{R_1 + (R_2 // R_3)} \quad (2)$$



The total hysteresis provided by the network is defined as

$$\Delta V_a = V_{a1} - V_{a2} \quad (3)$$

To assure that the comparator will always switch fully to  $V_{CC}$  and not be pulled down by the load the resistors values should be chosen as follow:

$$R_{PULL-UP} \ll R_{LOAD} \quad (4)$$

$$\text{and } R_1 > R_{PULL-UP} \quad (5)$$

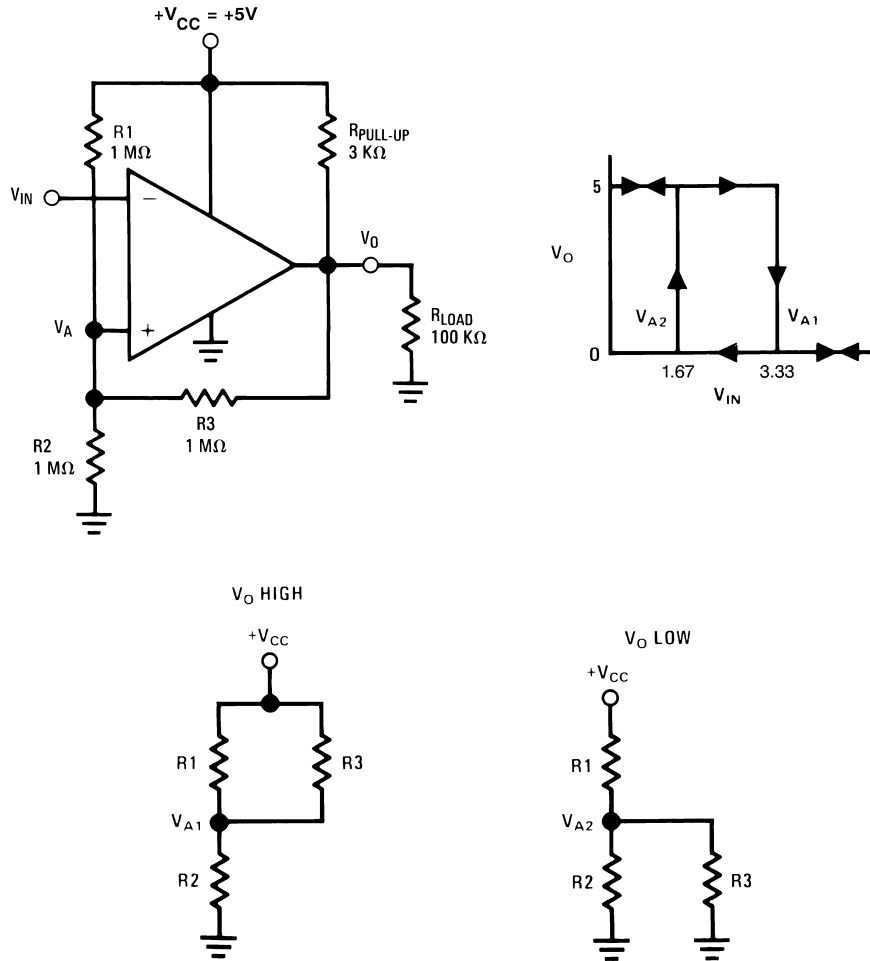


Figure 13. Inverting Comparator with Hysteresis

### NON-INVERTING COMPARATOR WITH HYSTERESIS

Non inverting comparator with hysteresis requires a two resistor network, and a voltage reference ( $V_{ref}$ ) at the inverting input. When  $V_{in}$  is low, the output is also low. For the output to switch from low to high,  $V_{in}$  must rise up to  $V_{in1}$  where  $V_{in1}$  is calculated by

$$V_{in1} = \frac{V_{ref}(R_1 + R_2)}{R_2} \quad (6)$$

When  $V_{in}$  is high, the output is also high, to make the comparator switch back to its low state,  $V_{in}$  must equal  $V_{ref}$  before  $V_A$  will again equal  $V_{ref}$ .  $V_{in}$  can be calculated by:

$$V_{in2} = \frac{V_{ref}(R_1 + R_2) - V_{CC}R_1}{R_2} \quad (7)$$

The hysteresis of this circuit is the difference between  $V_{in1}$  and  $V_{in2}$ .

$$\Delta V_{in} = V_{CC}R_1/R_2 \quad (8)$$

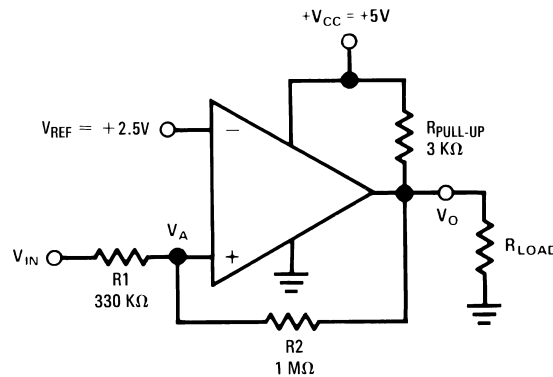


Figure 14.

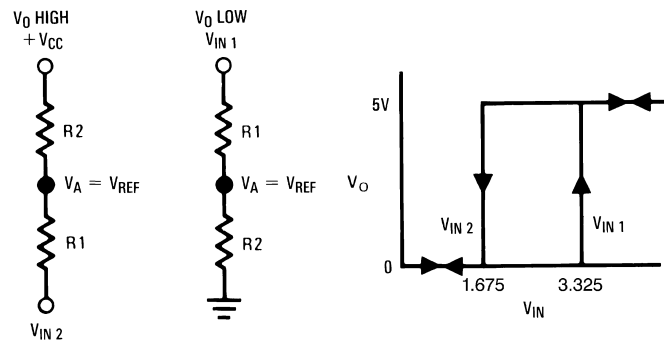


Figure 15.

### SQUAREWAVE OSCILLATOR

Comparators are ideal for oscillator applications. This square wave generator uses the minimum number of components. The output frequency is set by the RC time constant of the capacitor  $C_1$  and the resistor in the negative feedback  $R_4$ . The maximum frequency is limited only by the large signal propagation delay of the comparator in addition to any capacitive loading at the output, which would degrade the output slew rate.

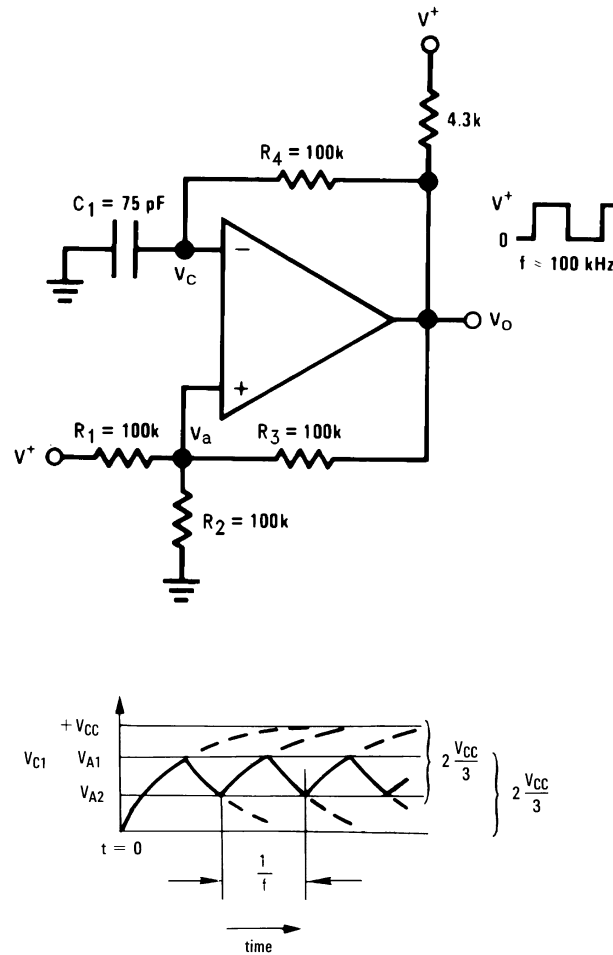


Figure 16. Squarewave Oscillator

To analyze the circuit, assume that the output is initially high. For this to be true, the voltage at the inverting input  $V_c$  has to be less than the voltage at the non-inverting input  $V_a$ . For  $V_c$  to be low, the capacitor  $C_1$  has to be discharged and will charge up through the negative feedback resistor  $R_4$ . When it has charged up to value equal to the voltage at the positive input  $V_{a1}$ , the comparator output will switch.

$V_{a1}$  will be given by:

$$V_{a1} = \frac{V_{CC} R_2}{R_2 + (R_1 // R_2)} \quad (9)$$

If:

$$R_1 = R_2 = R_3 \quad (10)$$

Then:

$$V_{a1} = 2V_{CC}/3 \quad (11)$$

When the output switches to ground, the value of  $V_a$  is reduced by the hysteresis network to a value given by:

$$V_{a2} = V_{CC}/3 \quad (12)$$

Capacitor  $C_1$  must now discharge through  $R_4$  towards ground. The output will return to its high state when the voltage across the capacitor has discharged to a value equal to  $V_{a2}$ .

For the circuit shown, the period for one cycle of oscillation will be twice the time it takes for a single RC circuit to charge up to one half of its final value. The time to charge the capacitor can be calculated from

$$V_C = V_{max} e^{-\frac{t}{RC}} \tag{13}$$

Where  $V_{max}$  is the max applied potential across the capacitor =  $(2V_{CC}/3)$

and  $V_C = V_{max}/2 = V_{CC}/3$

One period will be given by:

$$1/freq = 2t \tag{14}$$

or calculating the exponential gives:

$$1/freq = 2(0.694) R_4 C_1 \tag{15}$$

Resistors  $R_3$  and  $R_4$  must be at least two times larger than  $R_5$  to insure that  $V_O$  will go all the way up to  $V_{CC}$  in the high state. The frequency stability of this circuit should strictly be a function of the external components.

### FREE RUNNING MULTIVIBRATOR

A simple yet very stable oscillator that generates a clock for slower digital systems can be obtained by using a resonator as the feedback element. It is similar to the free running multivibrator, except that the positive feedback is obtained through a quartz crystal. The circuit oscillates when the transmission through the crystal is at a maximum, so the crystal in its series-resonant mode.

The value of  $R_1$  and  $R_2$  are equal so that the comparator will switch symmetrically about  $+V_{CC}/2$ . The RC constant of  $R_3$  and  $C_1$  is set to be several times greater than the period of the oscillating frequency, insuring a 50% duty cycle by maintaining a DC voltage at the inverting input equal to the absolute average of the output waveform.

When specifying the crystal, be sure to order series resonant with the desired temperature coefficient.

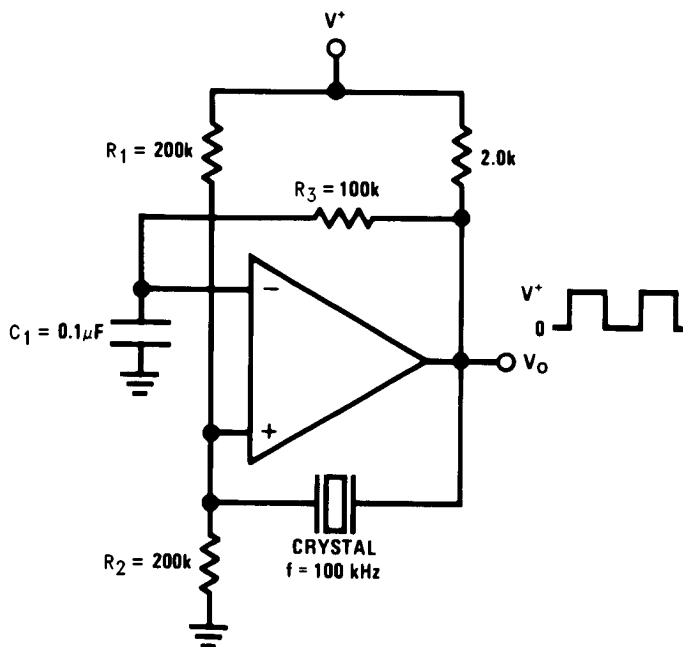
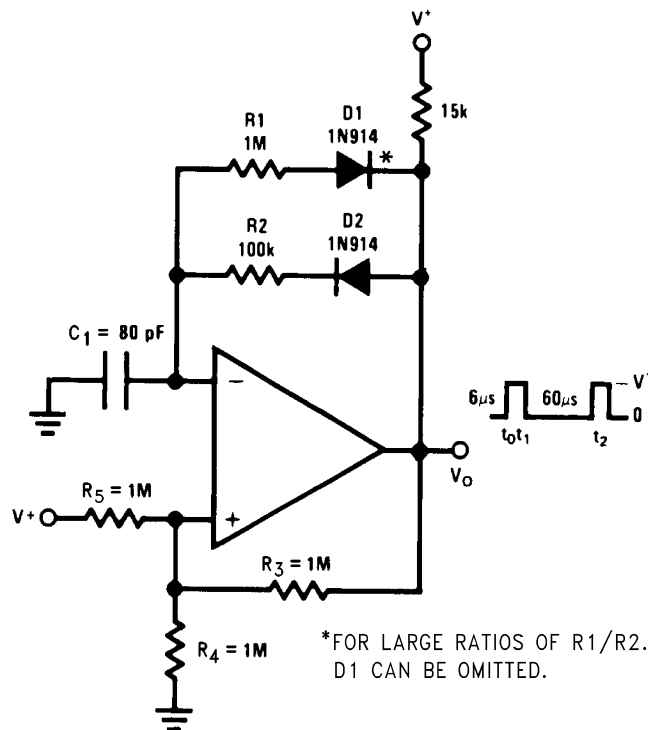


Figure 17. Crystal controlled Oscillator

### PULSE GENERATOR WITH VARIABLE DUTY CYCLE

The pulse generator with variable duty cycle is just a minor modification of the basic square wave generator. Providing a separate charge and discharge path for capacitor  $C_1$  generates a variable duty cycle. One path, through  $R_2$  and  $D_2$  will charge the capacitor and set the pulse width ( $t_1$ ). The other path,  $R_1$  and  $D_1$  will discharge the capacitor and set the time between pulses ( $t_2$ ).

By varying resistor  $R_1$ , the time between pulses of the generator can be changed without changing the pulse width. Similarly, by varying  $R_2$ , the pulse width will be altered without affecting the time between pulses. Both controls will change the frequency of the generator. The pulse width and time between pulses can be found from:



**Figure 18. Pulse Generator**

$$V_1 = V_{\max} \left( 1 - e^{-t_1/R_4 C_1} \right) \quad \text{rise time}$$

$$V_1 = V_{\max} e^{-t_2/R_5 C_1} \quad \text{fall time}$$

Where

$$V_{\max} = \frac{2 V_{CC}}{3}$$

and

$$V_1 = \frac{V_{\max}}{3} = \frac{V_{CC}}{3}$$

Which gives

$$\frac{1}{2} = e^{-t_1/R_4 C_1}$$

$t_2$  is then given by:

$$\frac{1}{2} = e^{-t_2/R_5 C_1} \tag{16}$$

Solving these equations for  $t_1$  and  $t_2$

$$t_1 = R_4 C_1 \ln 2 \tag{17}$$

$$t_2 = R_5 C_1 \ln 2 \tag{18}$$

These terms will have a slight error due to the fact that  $V_{\max}$  is not exactly equal to  $2/3 V_{CC}$  but is actually reduced by the diode drop to:

$$V_{\max} = \frac{2}{3} (V_{CC} - V_{BE}) \tag{19}$$

$$\frac{1}{2(1 - V_{BE})} = e^{-t_1/R_4C_1} \tag{20}$$

$$\frac{1}{2(1 - V_{BE})} = e^{-t_2/R_5C_1} \tag{21}$$

**POSITIVE PEAK DETECTOR**

Positive peak detector is basically the comparator operated as a unit gain follower with a large holding capacitor from the output to ground. Additional transistor is added to the output to provide a low impedance current source. When the output of the comparator goes high, current is passed through the transistor to charge up the capacitor. The only discharge path will be the 1 MΩ resistor shunting C1 and any load that is connected to the output. The decay time can be altered simply by changing the 1 MΩ resistor. The output should be used through a high impedance follower to avoid loading the output of the peak detector.

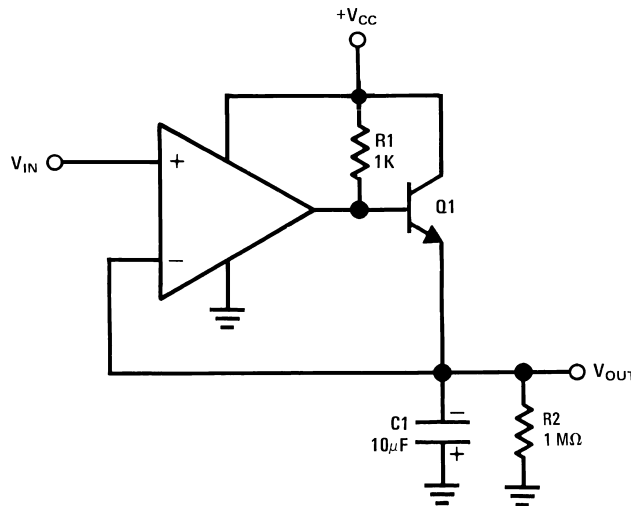


Figure 19. Positive Peak Detector

**NEGATIVE PEAK DETECTOR**

For the negative detector, the output transistor of the comparator acts as a low impedance current sink. The only discharge path will be the 1 MΩ resistor and any load impedance used. Decay time is changed by varying the 1 MΩ resistor.

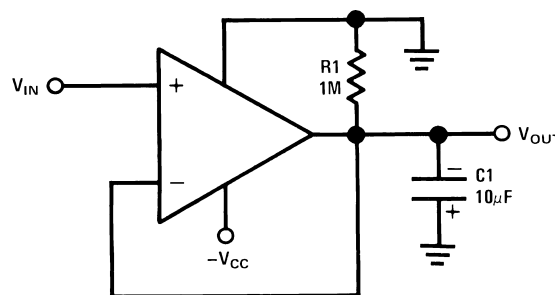


Figure 20. Negative Peak Detector

**DRIVING CMOS AND TTL**

The comparator's output is capable of driving CMOS and TTL Logic circuits.

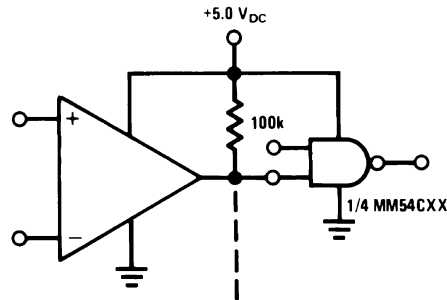


Figure 21. Driving CMOS

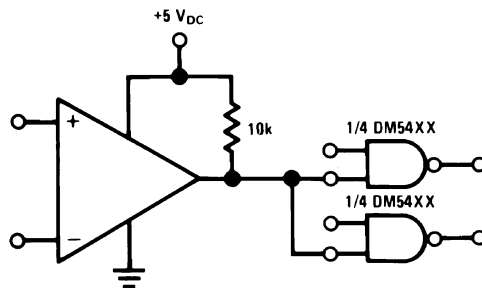


Figure 22. Driving TTL

## AND GATES

The comparator can be used as three input AND gate. The operation of the gate is as follows:

The resistor divider at the inverting input establishes a reference voltage at that node. The non-inverting input is the sum of the voltages at the inputs divided by the voltage dividers. The output will go high only when all three inputs are high, causing the voltage at the non-inverting input to go above that at inverting input. The circuit values shown work for a "0" equal to ground and a "1" equal to 5V.

The resistor values can be altered if different logic levels are desired. If more inputs are required, diodes are recommended to improve the voltage margin when all but one of the inputs are high.

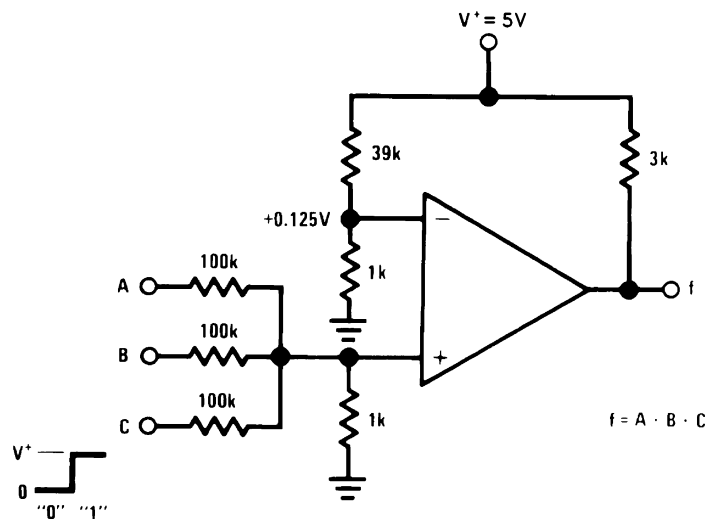


Figure 23. AND Gate

## OR GATES

A three input OR gate is achieved from the basic AND gate simply by increasing the resistor value connected from the inverting input to  $V_{CC}$ , thereby reducing the reference voltage.

A logic "1" at any of the inputs will produce a logic "1" at the output.

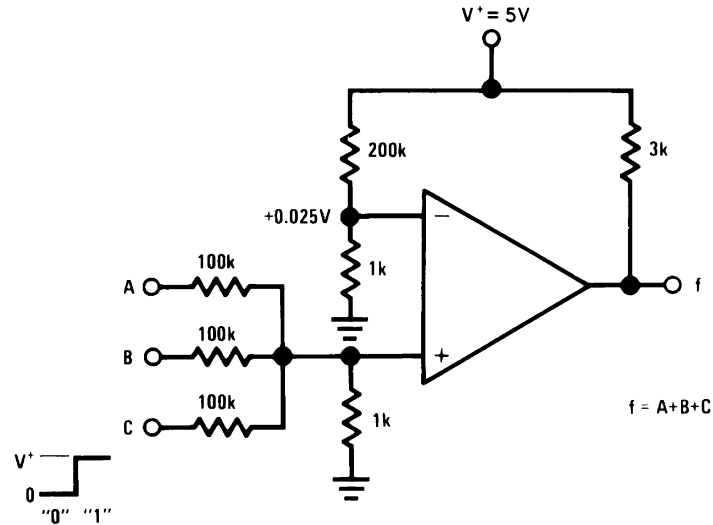


Figure 24. OR Gate

## ORing THE OUTPUT

By the inherent nature of an open collector comparator, the outputs of several comparators can be tied together with a pull up resistor to  $V_{CC}$ . If one or more of the comparators outputs goes low, the output  $V_O$  will go low.



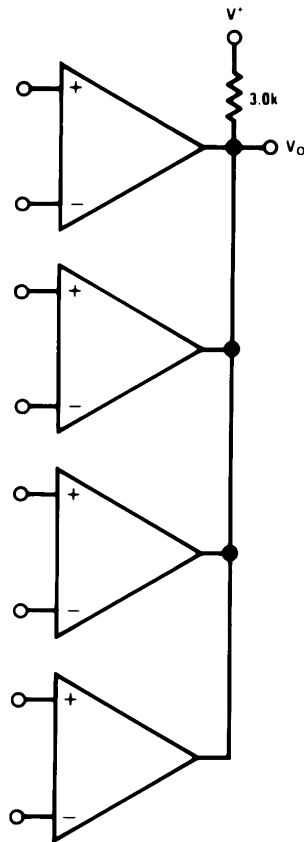


Figure 25. ORing the Outputs

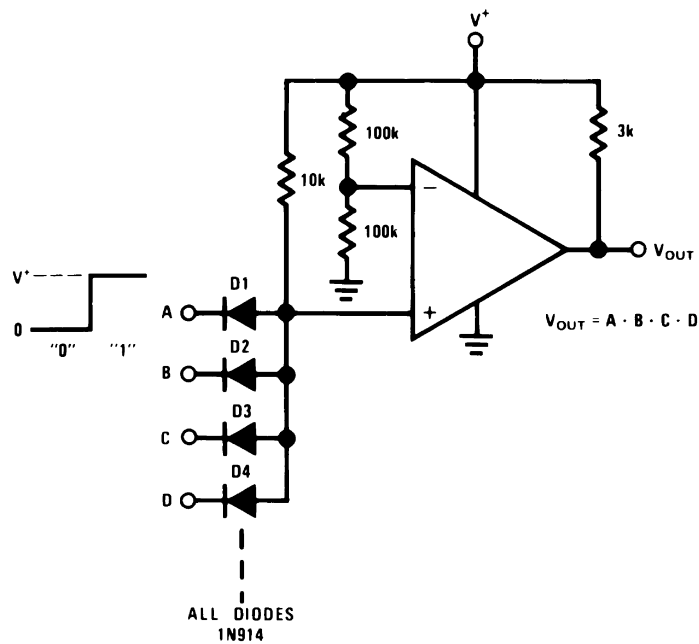


Figure 26. Large Fan-In AND Gate

Connection Diagram

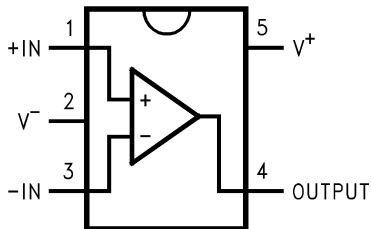


Figure 27. 5-Pin SC70/SOT23 Top View

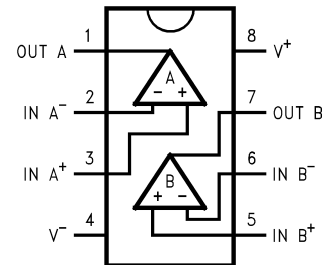


Figure 28. 8-Pin SOIC/VSSOP Top View

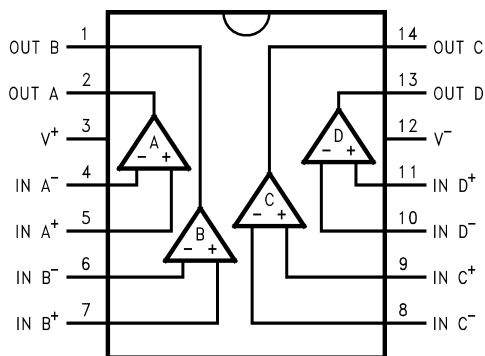


Figure 29. 14-Pin SOIC/TSSOP Top View

---

**REVISION HISTROY**

<b>Changes from Revision F (February 2013) to Revision G</b>	<b>Page</b>
<ul style="list-style-type: none"><li>• Changed layout of National Data Sheet to TI format .....</li></ul>	<a href="#">18</a>

---

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
LMV331M5	ACTIVE	SOT-23	DBV	5	1000	TBD	Call TI	Call TI	-40 to 85	C12	<a href="#">Samples</a>
LMV331M5/NOPB	ACTIVE	SOT-23	DBV	5	1000	Green (RoHS & no Sb/Br)	SN	Level-1-260C-UNLIM	-40 to 85	C12	<a href="#">Samples</a>
LMV331M5X	ACTIVE	SOT-23	DBV	5	3000	TBD	Call TI	Call TI	-40 to 85	C12	<a href="#">Samples</a>
LMV331M5X/NOPB	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	SN	Level-1-260C-UNLIM	-40 to 85	C12	<a href="#">Samples</a>
LMV331M7	ACTIVE	SC70	DCK	5	1000	TBD	Call TI	Call TI	-40 to 85	C13	<a href="#">Samples</a>
LMV331M7/NOPB	ACTIVE	SC70	DCK	5	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	C13	<a href="#">Samples</a>
LMV331M7X	ACTIVE	SC70	DCK	5	3000	TBD	Call TI	Call TI	-40 to 85	C13	<a href="#">Samples</a>
LMV331M7X/NOPB	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	C13	<a href="#">Samples</a>
LMV339M	ACTIVE	SOIC	D	14	55	TBD	Call TI	Call TI	-40 to 85	LMV339M	<a href="#">Samples</a>
LMV339M/NOPB	ACTIVE	SOIC	D	14	55	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	LMV339M	<a href="#">Samples</a>
LMV339MT	ACTIVE	TSSOP	PW	14	94	TBD	Call TI	Call TI	-40 to 85	LMV339 MT	<a href="#">Samples</a>
LMV339MT/NOPB	ACTIVE	TSSOP	PW	14	94	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	LMV339 MT	<a href="#">Samples</a>
LMV339MTX	ACTIVE	TSSOP	PW	14	2500	TBD	Call TI	Call TI	-40 to 85	LMV339 MT	<a href="#">Samples</a>
LMV339MTX/NOPB	ACTIVE	TSSOP	PW	14	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	LMV339 MT	<a href="#">Samples</a>
LMV339MX	ACTIVE	SOIC	D	14	2500	TBD	Call TI	Call TI	-40 to 85	LMV339M	<a href="#">Samples</a>
LMV339MX/NOPB	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	LMV339M	<a href="#">Samples</a>
LMV393M	ACTIVE	SOIC	D	8	95	TBD	Call TI	Call TI	-40 to 85	LMV 393M	<a href="#">Samples</a>
LMV393M/NOPB	ACTIVE	SOIC	D	8	95	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	LMV 393M	<a href="#">Samples</a>

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
LMV393MM	ACTIVE	VSSOP	DGK	8	1000	TBD	Call TI	Call TI	-40 to 85	V393	<a href="#">Samples</a>
LMV393MM/NOPB	ACTIVE	VSSOP	DGK	8	1000	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	V393	<a href="#">Samples</a>
LMV393MMX	ACTIVE	VSSOP	DGK	8	3500	TBD	Call TI	Call TI	-40 to 85	V393	<a href="#">Samples</a>
LMV393MMX/NOPB	ACTIVE	VSSOP	DGK	8	3500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	V393	<a href="#">Samples</a>
LMV393MX	ACTIVE	SOIC	D	8	2500	TBD	Call TI	Call TI	-40 to 85	LMV 393M	<a href="#">Samples</a>
LMV393MX/NOPB	ACTIVE	SOIC	D	8	2500	Green (RoHS & no Sb/Br)	CU SN	Level-1-260C-UNLIM	-40 to 85	LMV 393M	<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.

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

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side 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 Top-Side Marking for that device.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

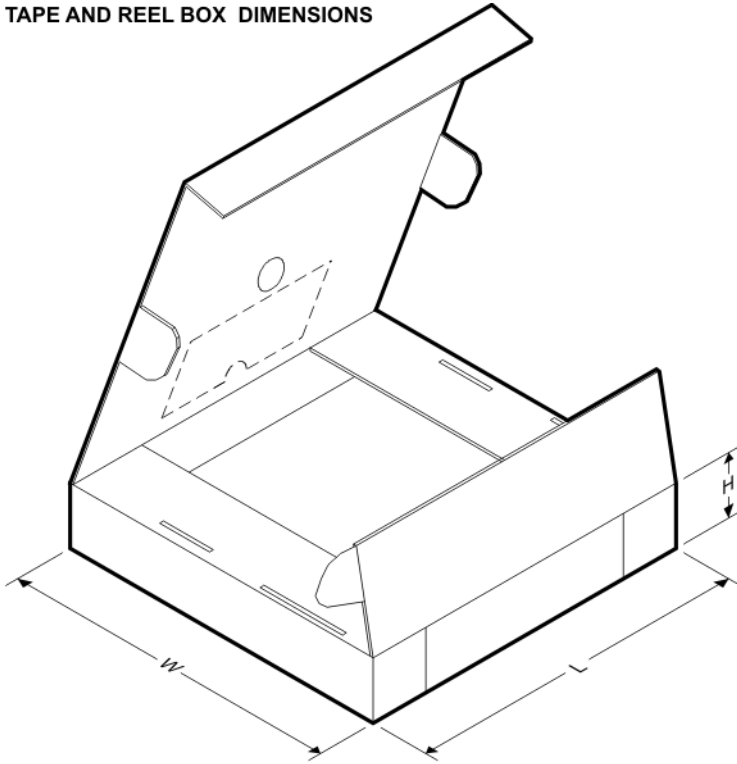
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**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
LMV331M5	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV331M5/NOPB	SOT-23	DBV	5	1000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV331M5X	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV331M5X/NOPB	SOT-23	DBV	5	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
LMV331M7	SC70	DCK	5	1000	178.0	8.4	2.25	2.45	1.2	4.0	8.0	Q3
LMV331M7/NOPB	SC70	DCK	5	1000	178.0	8.4	2.25	2.45	1.2	4.0	8.0	Q3
LMV331M7X	SC70	DCK	5	3000	178.0	8.4	2.25	2.45	1.2	4.0	8.0	Q3
LMV331M7X/NOPB	SC70	DCK	5	3000	178.0	8.4	2.25	2.45	1.2	4.0	8.0	Q3
LMV339MTX	TSSOP	PW	14	2500	330.0	12.4	6.95	8.3	1.6	8.0	12.0	Q1
LMV339MTX/NOPB	TSSOP	PW	14	2500	330.0	12.4	6.95	8.3	1.6	8.0	12.0	Q1
LMV339MX	SOIC	D	14	2500	330.0	16.4	6.5	9.35	2.3	8.0	16.0	Q1
LMV339MX/NOPB	SOIC	D	14	2500	330.0	16.4	6.5	9.35	2.3	8.0	16.0	Q1
LMV393MM	VSSOP	DGK	8	1000	178.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
LMV393MM/NOPB	VSSOP	DGK	8	1000	178.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
LMV393MMX	VSSOP	DGK	8	3500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
LMV393MMX/NOPB	VSSOP	DGK	8	3500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
LMV393MX	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1
LMV393MX/NOPB	SOIC	D	8	2500	330.0	12.4	6.5	5.4	2.0	8.0	12.0	Q1

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LMV331M5	SOT-23	DBV	5	1000	210.0	185.0	35.0
LMV331M5/NOPB	SOT-23	DBV	5	1000	210.0	185.0	35.0
LMV331M5X	SOT-23	DBV	5	3000	210.0	185.0	35.0
LMV331M5X/NOPB	SOT-23	DBV	5	3000	210.0	185.0	35.0
LMV331M7	SC70	DCK	5	1000	210.0	185.0	35.0
LMV331M7/NOPB	SC70	DCK	5	1000	210.0	185.0	35.0
LMV331M7X	SC70	DCK	5	3000	210.0	185.0	35.0
LMV331M7X/NOPB	SC70	DCK	5	3000	210.0	185.0	35.0
LMV339MTX	TSSOP	PW	14	2500	367.0	367.0	35.0
LMV339MTX/NOPB	TSSOP	PW	14	2500	367.0	367.0	35.0
LMV339MX	SOIC	D	14	2500	367.0	367.0	35.0
LMV339MX/NOPB	SOIC	D	14	2500	367.0	367.0	35.0
LMV393MM	VSSOP	DGK	8	1000	210.0	185.0	35.0
LMV393MM/NOPB	VSSOP	DGK	8	1000	210.0	185.0	35.0
LMV393MMX	VSSOP	DGK	8	3500	367.0	367.0	35.0
LMV393MMX/NOPB	VSSOP	DGK	8	3500	367.0	367.0	35.0
LMV393MX	SOIC	D	8	2500	367.0	367.0	35.0
LMV393MX/NOPB	SOIC	D	8	2500	367.0	367.0	35.0





DBV (R-PDSO-G5)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
  - D. Publication IPC-7351 is recommended for alternate designs.
  - E. 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. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.

DCK (R-PDSO-G5)

PLASTIC SMALL-OUTLINE PACKAGE



- 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. Mold flash and protrusion shall not exceed 0.15 per side.
  - D. Falls within JEDEC MO-203 variation AA.



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.

PW (R-PDSO-G14)

PLASTIC SMALL OUTLINE



- 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

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



NOTES: A. All linear dimensions are in inches (millimeters).  
 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 0.006 (0,15) each side.  
 D. Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.  
 E. Reference JEDEC MS-012 variation AA.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

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 relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)