

## General Description

The TECH PUBLIC INCORPORATED LMV331/LMV393 series are low-voltage, (1.8V to 5.5V) single and dual comparators, which are designed to effectively reduce cost and space at low-voltage levels.

These devices offer specifications that meet or exceed the familiar LM331/LM393 devices operating with a lower supply voltage and consuming a far lower supply current.

## Features

- Guaranteed 1.8V and 5.5V performance
- Rail-to-Rail Input and Output
- Low supply current 40  $\mu$ A/comparator Typ
- Operating temperature range (-40°C to +85°C)
- Open-Drain Output for Maximum Flexibility
- SOT353, SOT23-5, SOP-8: Available in “Green” Molding

The LMV331 is available in 5-Pin SOT353/SOT23-5 packages that reduce space on PC boards and portable electronic devices. LMV393 is available in industry standard SOP-8 packages.

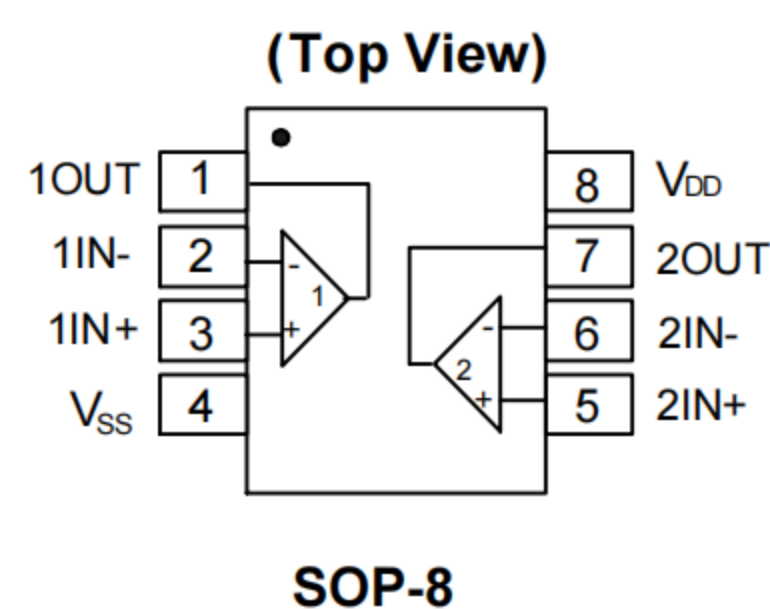
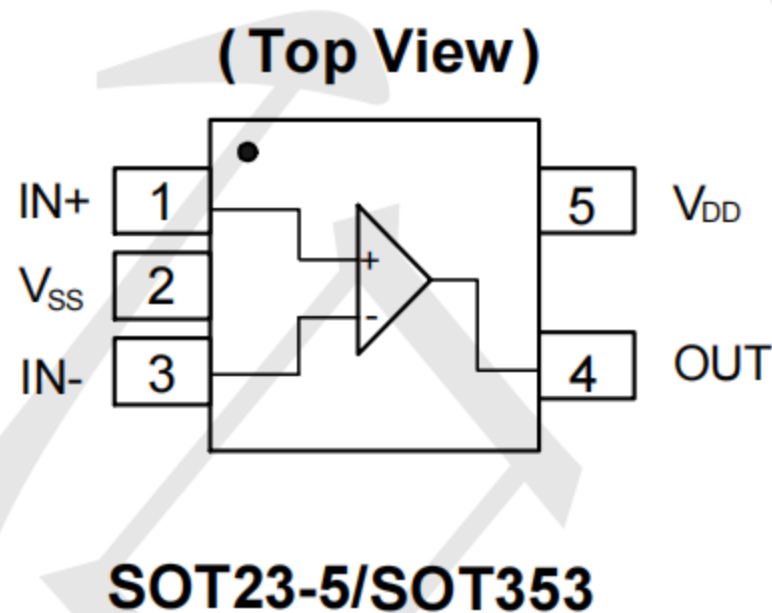
## Applications

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

## Ordering Information

| Part Number | Package | QTY Per Reel | Reel Size |
|-------------|---------|--------------|-----------|
| LMV331W5    | SOT23-5 | 3000         | 7"        |
| LMV331SE    | SOT353  | 3000         | 7"        |
| LMV393S     | SOP-8L  | 4000         | 12"       |

## Pin Assignments



### Absolute Maximum Ratings

| TECH PUBLIC Condition                        | Min      | Max      |
|--|----------|----------|
| Power Supply Voltage (VDD to Vss)            | -0.5V    | +7V      |
| Analog Input Voltage (IN+ or IN-)            | Vss-0.5V | VDD+0.5V |
| PDB Input Voltage                            | Vss-0.5V | +7V      |
| Operating Temperature Range                  | -40°C    | +125°C   |
| Junction Temperature                         | +160°C   |          |
| Storage Temperature Range                    | -65°C    | +150°C   |
| Lead Temperature (soldering, 10sec)          | +260°C   |          |
| <b>Package Thermal Resistance (TA=+25°C)</b> |          |          |
| SOP-8L, $\theta_{JA}$                        | 125°C/W  |          |
| SOT23-5, $\theta_{JA}$                       | 190°C/W  |          |
| SC70-5, $\theta_{JA}$                        | 333°C/W  |          |
| <b>ESD Susceptibility</b>                    |          |          |
| HBM  | 4KV      |          |
| MM   | 300V     |          |

## Electrical Characteristics

(At  $V_S = +5V$ ,  $V_{CM} = 0V$ ,  $C_L = 15pF$ , and  $T_A = +25^\circ C$ , unless otherwise noted.)

| Parameter                       | Symbol                   | Conditions                            | Min. | Typ.         | Max.        | Units            |
|---------------------------------|--------------------------|---------------------------------------|------|--------------|-------------|------------------|
| Operating Voltage Range         | $V_{DD}$                 |                                       | 1.8  | -            | 5.5         | V                |
| Quiescent Current / Comparator  | $I_Q$                    |                                       |      | 40           | 70          | $\mu A$          |
| Input Offset Voltage            | $V_{OS}$                 |                                       | -    | 0.5          | 3           | mV               |
| Input Offset Voltage Tempco     | $\Delta V_{OS}/\Delta T$ |                                       | -    | 2            | -           | $\mu V/^\circ C$ |
| Input Bias Current              | $I_B$                    | (Note 2)                              | -    | 6            | -           | pA               |
| Input Offset Current            | $I_{OS}$                 | (Note 2)                              | -    | 4            | -           | pA               |
| Common-Mode Voltage Range       | $V_{CM}$                 | $V_S = 5.5V$                          |      | -0.1 to +5.6 |             | V                |
| Common-Mode Rejection Ratio     | CMRR                     | $V_S = 5V, V_{CM} = 0V$ to $5V$       |      | 70           | -           | dB               |
| Input Hysteresis                | $V_{HYS}$                |                                       |      | 6            | -           | mV               |
| Power-Supply Rejection Ratio    | PSRR                     | $V_S = +1.6V$ to $+5.5V, V_{CM} = 0V$ |      | 75           | -           | dB               |
| Output Voltage Swing from Rail  | $V_{OH}$                 | $V_S = 5V, I_O = 1mA$                 |      | $V_S - 0.05$ | $V_S - 0.3$ | V                |
|                                 | $V_{OL}$                 |                                       |      | 57           | 300         | V                |
| Output Short-Circuit Current    | $I_{SOURCE}$             | $V_S = 5V, Out$ to $V_S/2$            |      | 35           |             | mA               |
|                                 | $I_{SINK}$               |                                       |      | 33           |             | mA               |
| Propagation Delay (Low to High) | $T_{DLH}$                | $V_S = 3V, Overdrive = 100mV$         | -    | 77.5         | -           | ns               |
| Propagation Delay (High to Low) | $T_{DHL}$                | $V_S = 3V, Overdrive = 100mV$         | -    | 59.4         | -           | ns               |
| Rise Time                       | $T_r$                    | $V_S = 3V, Overdrive = 100mV$         | -    | 5            | -           | ns               |
| Fall Time                       | $T_f$                    | $V_S = 3V, Overdrive = 100mV$         | -    | 5            | -           | ns               |

## Application Information

### Size

LMV331 comparator is low-power, high-speed and suitable for a wide range of general-purpose applications. The small footprints of the LMV331 package saves space on printed circuit boards and enable the design of smaller electronic products. The LMV331 interfaces directly to CMOS and TTL logics.

### Power Supply Bypassing and Board Layout

LMV331 operates from a single 1.8V to 5.5V supply or dual  $\pm 0.9V$  to  $\pm 2.75V$  supplies. For best performance, a  $0.1\mu F$  ceramic capacitor should be placed close to the  $V_{DD}$  pin in single supply operation. For dual supply operation, both  $V_{DD}$  and  $V_{SS}$  supplies should be bypassed to ground with separate  $0.1\mu F$  ceramic capacitors.

### Low Supply Current

The low supply current (typical  $40\mu A$  per channel) of LMV331 will help to maximize battery life. They are ideal for battery powered systems.

### Operating Voltage

LMV331 operates under wide input supply voltage (1.8V to 5.5V). In addition, all temperature specifications apply from  $-40^{\circ}C$  to  $+85^{\circ}C$ . Most behavior remains unchanged throughout the full operating voltage range. These guarantees ensure operation throughout the single Li-Ion battery lifetime

### Rail-to-Rail Input

The input common-mode range of LMV331 extends  $100mV$  beyond the supply rails ( $V_{SS}-0.1V$  to  $V_{DD}+0.1V$ ). This is achieved by using complementary input stage. For normal operation, inputs should be limited to this range.

### Internal Hysteresis

Because of noise or undesired parasitic feedback, high-speed comparators oscillate in the linear region. Oscillation tends to occur when the voltage on one input is at or equal to the voltage on the other input. The LMV98 family eliminates this undesired oscillation by integrating an internal hysteresis of  $6mV$ .

The hysteresis in a comparator creates two trip points: one for the rising input voltage and one for the falling input voltage (Figure 2). The difference between two trip points is the hysteresis, while the average of two trip points is the offset voltage. When the comparator's input voltages are equal, the hysteresis effectively causes one comparator input voltage to move quickly past the other, thus taking the input out of the region where oscillation occurs.

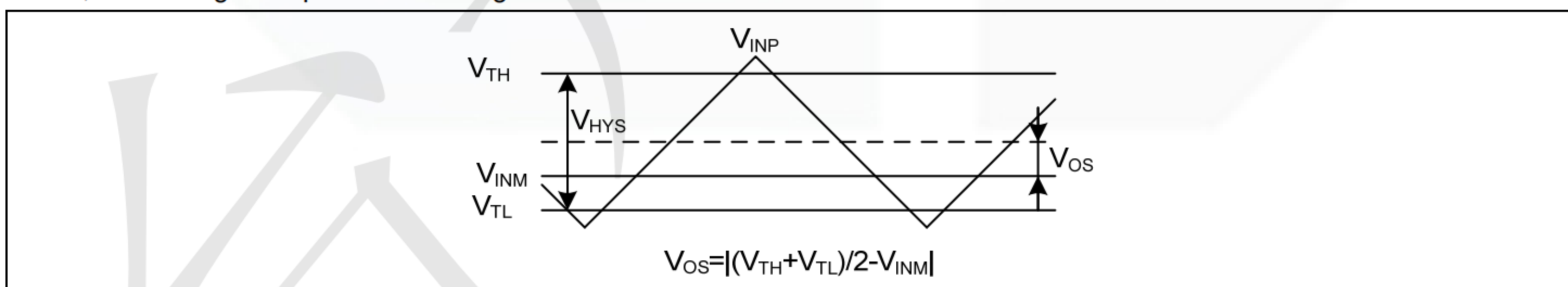


Figure 2. Comparator's hysteresis and offset

### External Hysteresis

Greater flexibility in selecting hysteresis is achieved by using external resistors. Hysteresis reduces output chattering when one input is slowly moving past the other.

Non-Inverting Comparator with Hysteresis

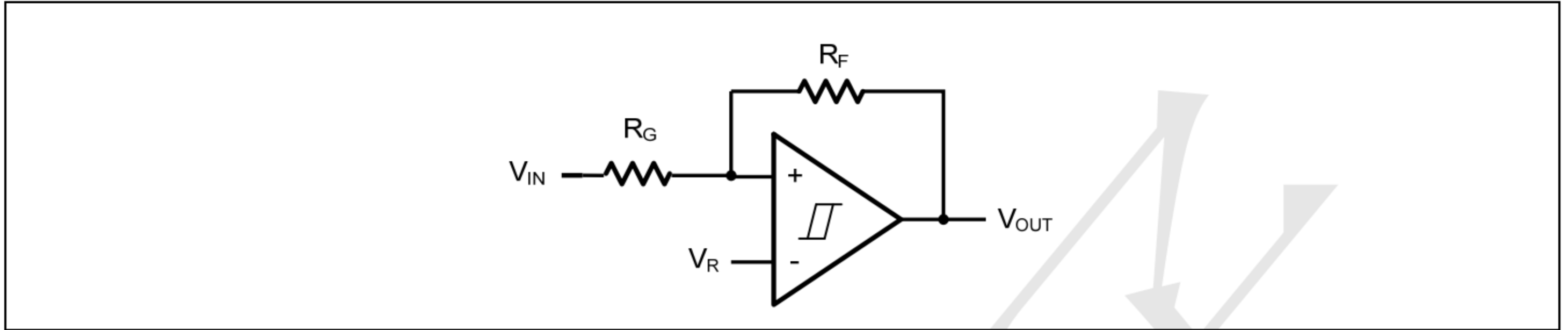


Figure 3. Non-Inverting Comparator with Hysteresis

A non-inverting comparator with hysteresis requires a two-resistor network, as shown in Figure 3 and a voltage reference ( $V_R$ ) at the inverting input.

$$V_{TH} = \frac{R_G + R_F}{R_F} \times V_R$$

$$V_{TL} = \frac{R_G + R_F}{R_F} \times V_R - \frac{R_G}{R_F} \times V_{DD}$$

$$V_{HYS} = \frac{R_G}{R_F} \times V_{DD}$$

Inverting Comparator with Hysteresis

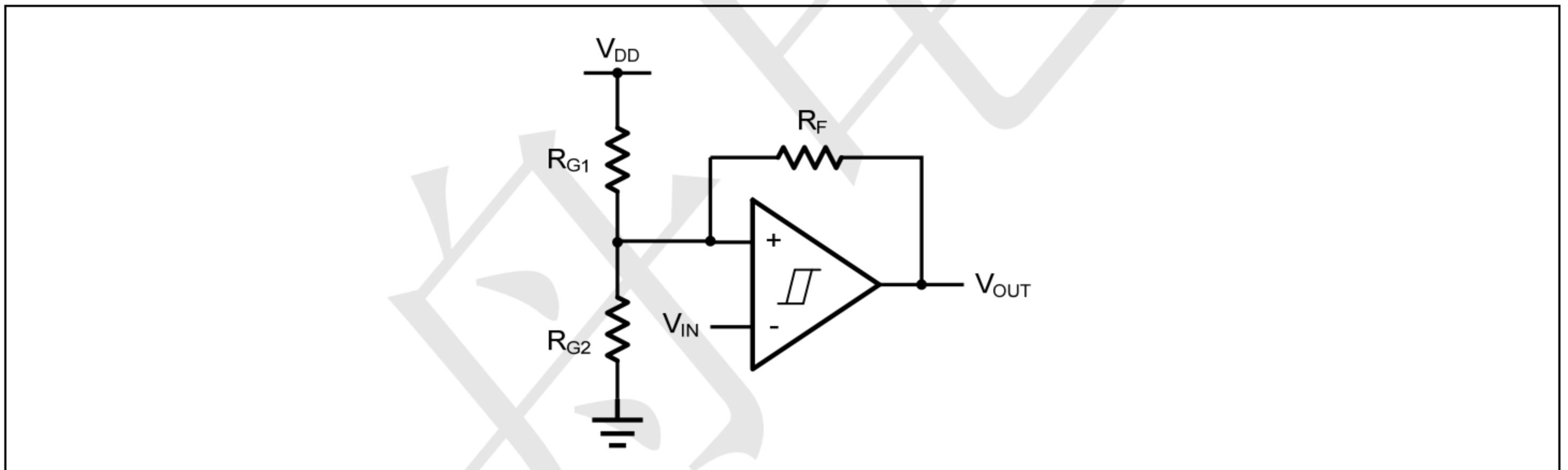


Figure 4. Inverting Comparator with Hysteresis

The inverting comparator with hysteresis requires a three-resistor network that is referenced to the comparator supply voltage ( $V_{DD}$ ), as shown in Figure 4.

$$V_{TH} = \frac{R_{G2}}{R_{G1} \parallel R_F + R_{G2}} \times V_{DD}$$

$$V_{TL} = \frac{R_{G2} \parallel R_F}{R_{G2} \parallel R_F + R_{G1}} \times V_{DD}$$

$$V_{HYS} = \frac{R_{G1} \parallel R_{G2}}{R_{G1} \parallel R_{G2} + R_F} \times V_{DD}$$

**Typical Application Circuits**

**Line Receiver**

A Line Receiver using LMV331 is shown in Figure 5. Resistors  $R_{G1}$  and  $R_{G2}$  set the bias point at the comparator's inverting input.  $R_{IN}$  should be same as  $R_{G1} || R_{G2}$  to get a better match. LMV331 detects the voltage of the Coax Line, and outputs logic high or logic low quickly with no glitch.

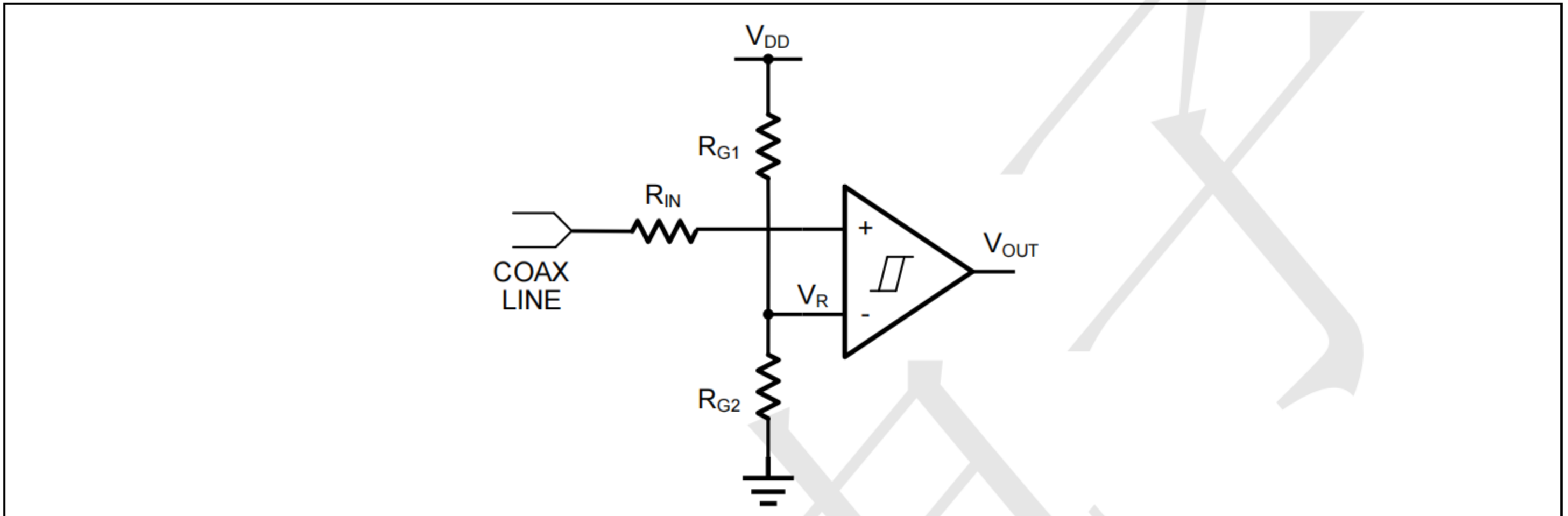


Figure 5. Line Receiver

**IR Receiver**

LMV331 is an ideal candidate to be used as an infrared receiver shown in Figure 6. The infrared photo diode creates a current relative to the amount of infrared light present. The current creates a voltage across  $R_{IN}$ . When this voltage level cross the voltage applied by the voltage divider to the inverting input, the output transitions. Optional  $R_F$  provides additional hysteresis for noise immunity.

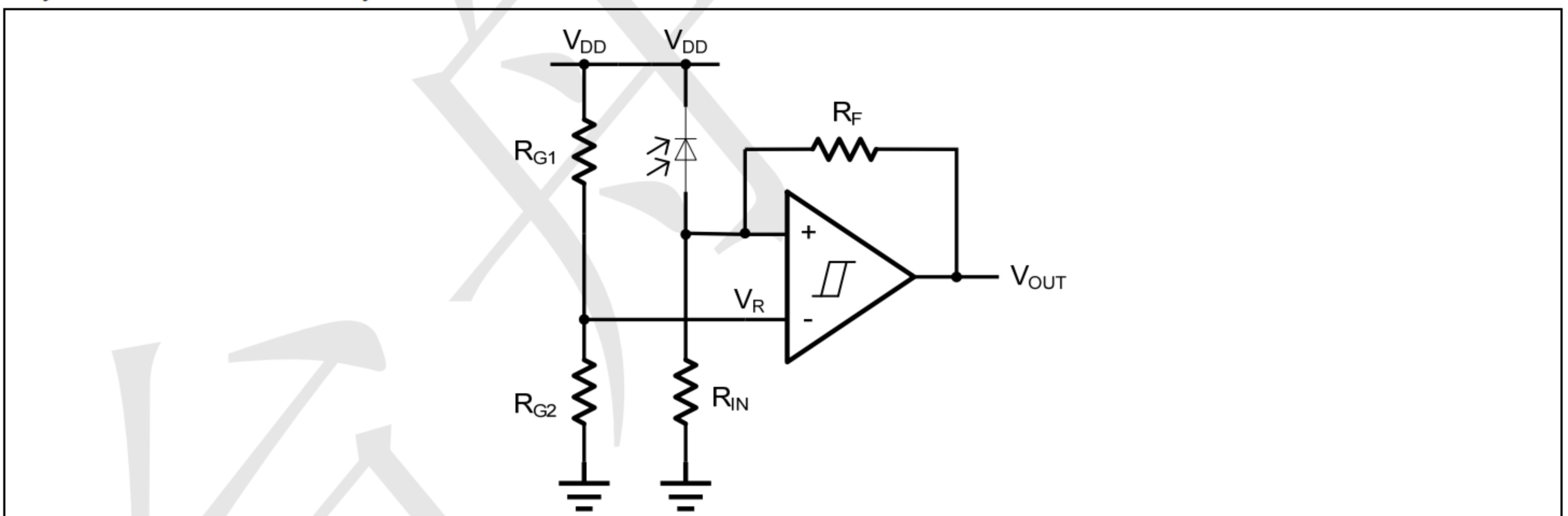


Figure 6. IR Receiver

**Oscillator**

A oscillator using LMV331 is shown in Figure 7. Resistors  $R_{G1}$  and  $R_{G2}$  set the bias point at the comparator's inverting input. The period of oscillator is set by the time constant of  $R_C$  and  $C_{IN}$ . The maximum frequency is limited by the large signal propagation delay of the comparator. LMV331 is low propagation delay guarantees the high frequency oscillation.

If  $R_{G1}=R_{G2}= R_F$ , then the frequency of the oscillator is:

$$f_{osc} = \frac{1}{2 \times \ln 2 \times R_C \times C_{IN}}$$

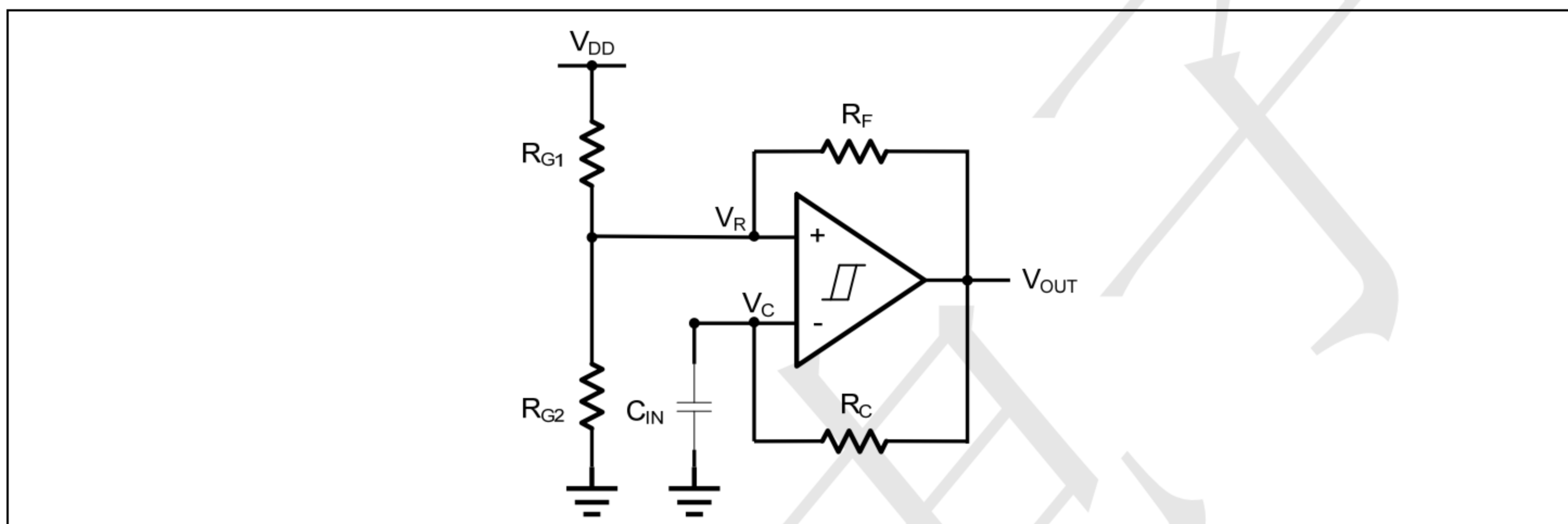
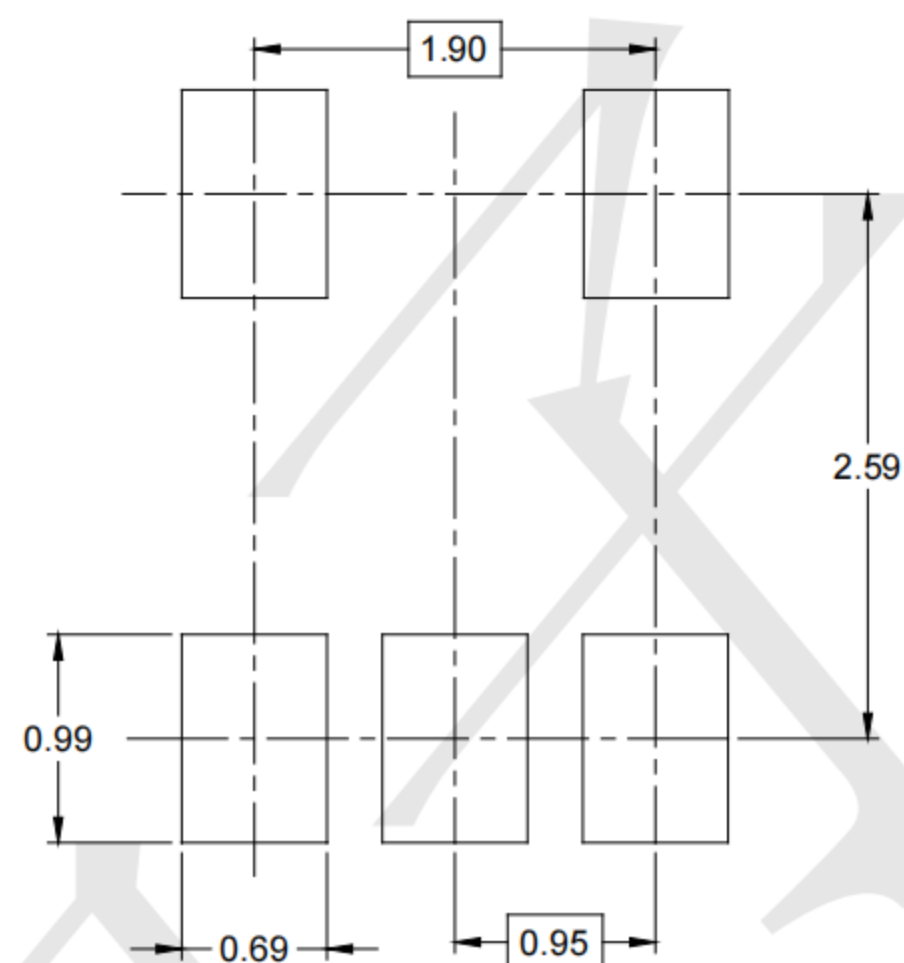
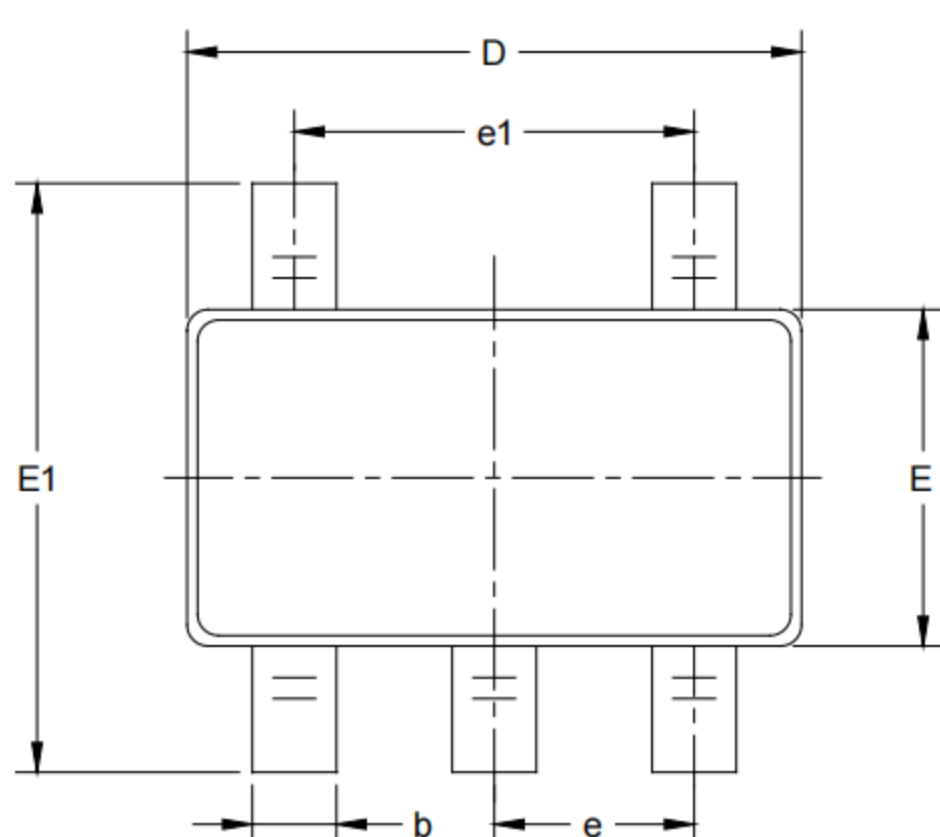


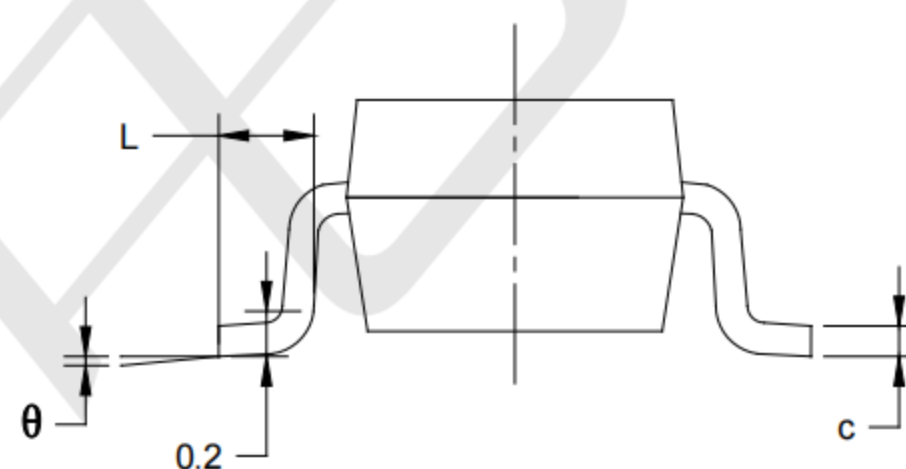
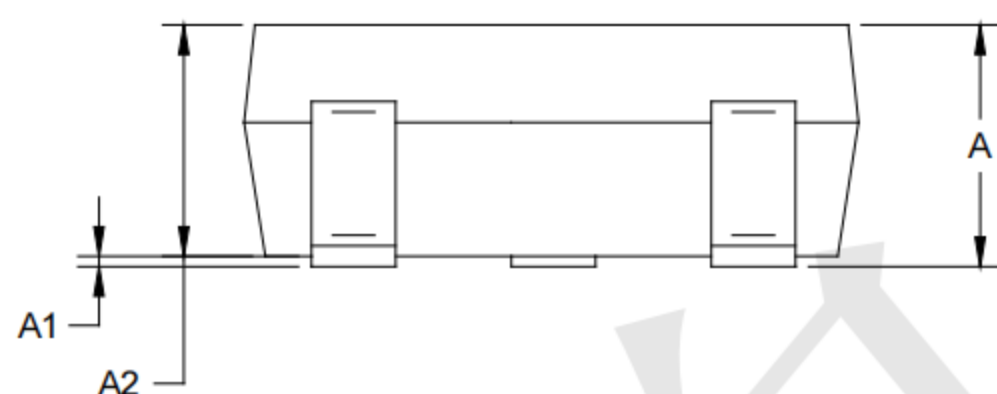
Figure 7. Oscillator

**Package Information**

**SOT-23-5**



**RECOMMENDED LAND PATTERN (Unit: mm)**



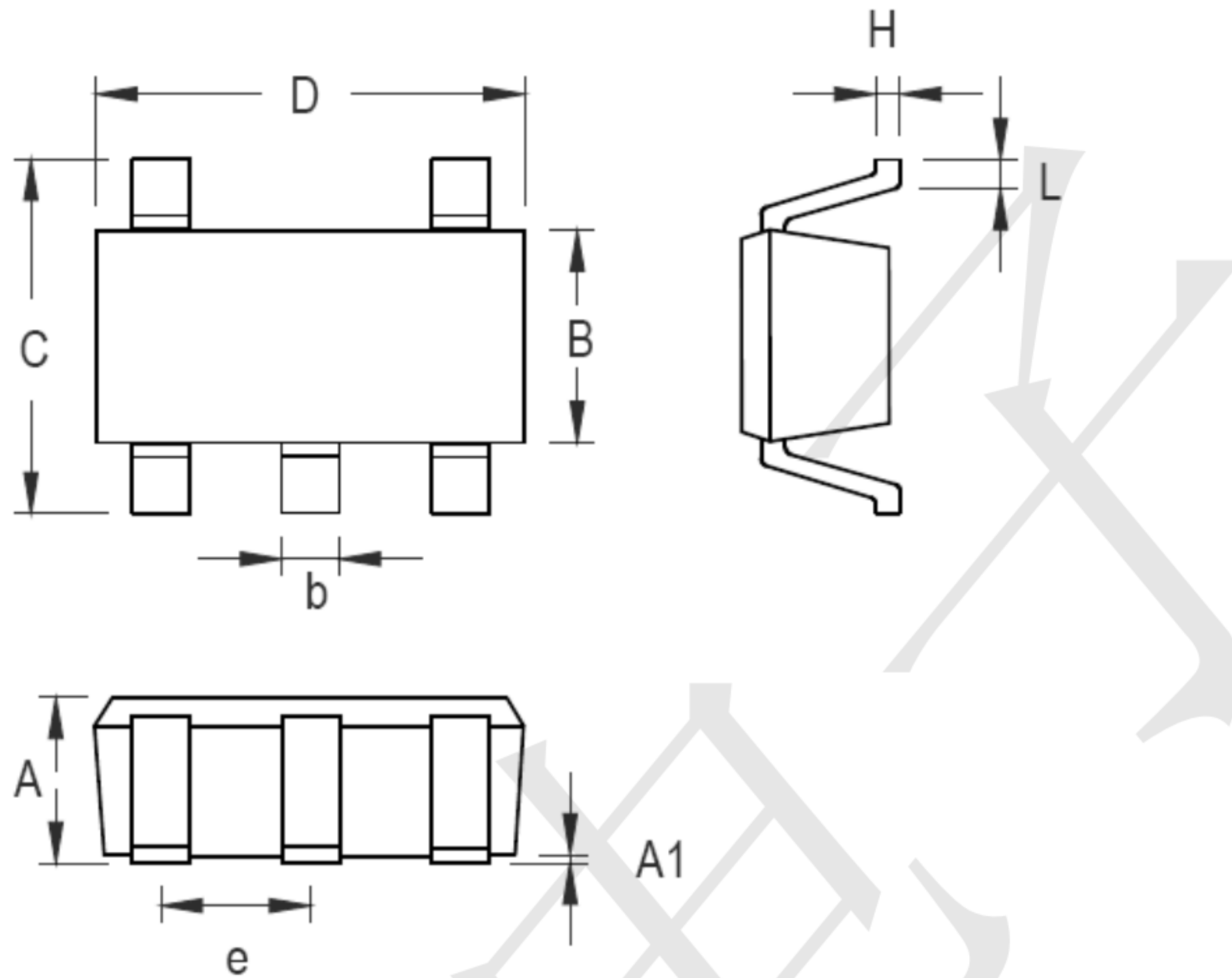
| Symbol   | Dimensions<br>In Millimeters |       | Dimensions<br>In Inches |       |
|----------|------------------------------|-------|-------------------------|-------|
|          | MIN                          | MAX   | MIN                     | MAX   |
| A        | 1.050                        | 1.250 | 0.041                   | 0.049 |
| A1       | 0.000                        | 0.100 | 0.000                   | 0.004 |
| A2       | 1.050                        | 1.150 | 0.041                   | 0.045 |
| b        | 0.300                        | 0.500 | 0.012                   | 0.020 |
| c        | 0.100                        | 0.200 | 0.004                   | 0.008 |
| D        | 2.820                        | 3.020 | 0.111                   | 0.119 |
| E        | 1.500                        | 1.700 | 0.059                   | 0.067 |
| E1       | 2.650                        | 2.950 | 0.104                   | 0.116 |
| e        | 0.950 BSC                    |       | 0.037 BSC               |       |
| e1       | 1.900 BSC                    |       | 0.075 BSC               |       |
| L        | 0.300                        | 0.600 | 0.012                   | 0.024 |
| $\theta$ | 0°                           | 8°    | 0°                      | 8°    |





Package Information

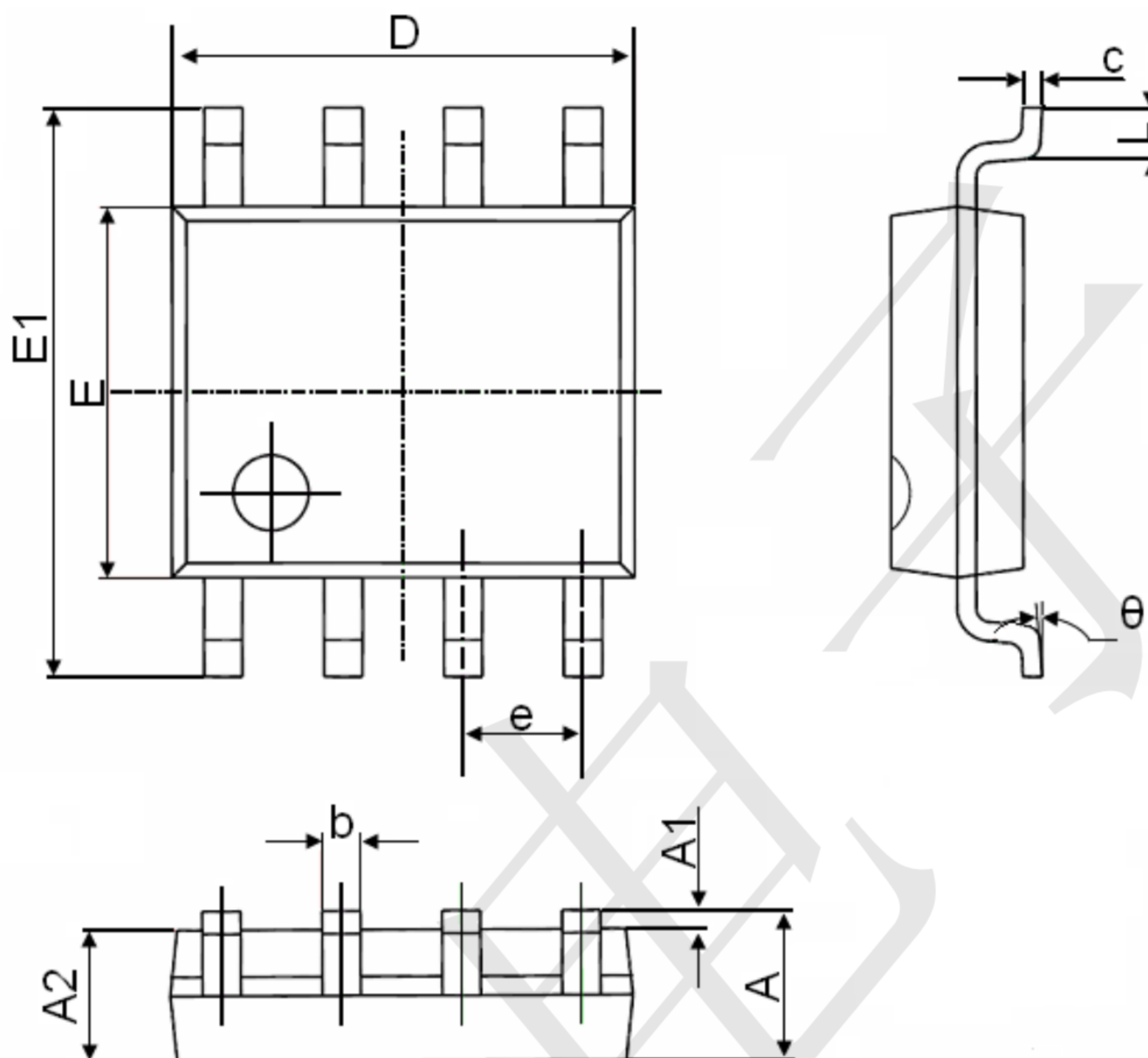
SOT353



| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | Min                       | Max   | Min                  | Max   |
| A      | 0.800                     | 1.100 | 0.031                | 0.044 |
| A1     | 0.000                     | 0.100 | 0.000                | 0.004 |
| B      | 1.150                     | 1.350 | 0.045                | 0.054 |
| b      | 0.150                     | 0.400 | 0.006                | 0.016 |
| C      | 1.800                     | 2.450 | 0.071                | 0.096 |
| D      | 1.800                     | 2.250 | 0.071                | 0.089 |
| e      | 0.650                     |       | 0.026                |       |
| H      | 0.080                     | 0.260 | 0.003                | 0.010 |
| L      | 0.210                     | 0.460 | 0.008                | 0.018 |

**Package Information**

**SOP-8**



| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | Min.                      | Max.  | Min.                 | Max.  |
| A      | 1.350                     | 1.750 | 0.053                | 0.069 |
| A1     | 0.100                     | 0.250 | 0.004                | 0.010 |
| A2     | 1.350                     | 1.550 | 0.053                | 0.061 |
| b      | 0.330                     | 0.510 | 0.013                | 0.020 |
| c      | 0.170                     | 0.250 | 0.006                | 0.010 |
| D      | 4.700                     | 5.100 | 0.185                | 0.200 |
| E      | 3.800                     | 4.000 | 0.150                | 0.157 |
| E1     | 5.800                     | 6.200 | 0.228                | 0.244 |
| e      | 1.270(BSC)                |       | 0.050(BSC)           |       |
| L      | 0.400                     | 1.270 | 0.016                | 0.050 |
| θ      | 0°                        | 8°    | 0°                   | 8°    |

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