

## 1. General Description

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The EM74LVC1G240 is a 1-bit inverting buffer/line driver with 3-state output. The device features an output enable  $\overline{OE}$ . A HIGH on  $\overline{OE}$  causes the output to assume a high-impedance OFF-state. Inputs can be driven from either 3.3 V or 5 V devices. This feature allows the use of these devices as translators in mixed 3.3 V and 5 V environments.

Schmitt-trigger action at all inputs makes the circuit tolerant of slower input rise and fall times. This device is fully specified for partial power down applications using  $I_{OFF}$ . The  $I_{OFF}$  circuitry disables the output, preventing the potentially damaging backflow current through the device when it is powered down.

## 2. Features and Benefits

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- Wide supply voltage range from 1.65 V to 5.5 V
- Inputs accept voltages up to 5 V
- High noise immunity
- CMOS low power dissipation
- $\pm 24$  mA output drive ( $V_{CC} = 3.0$  V)
- Latch-up performance exceeds 100 mA
- Direct interface with TTL levels
- Complies with JEDEC standard:
  - JESD8-7 (1.65 V to 1.95 V)
  - JESD8-5 (2.3 V to 2.7 V)
  - JESD8-B/JESD36 (2.7 V to 3.6 V)
- ESD protection:
  - HBM ANSI/ESDA/JEDEC JS-001 Class 3B exceeds 8000 V
  - MM JESD22-A115C Class C exceeds 550 V
  - CDM ANSI/ESDA/JEDEC JS-002 Class C3 exceeds 2000 V
- Multiple package options

## EM74LVC1G240

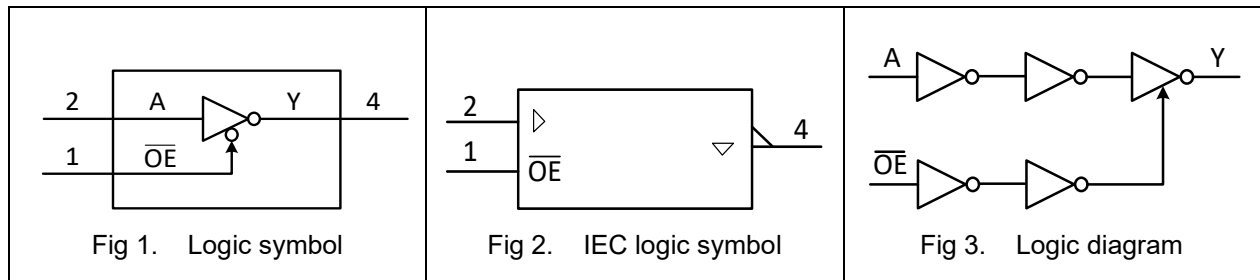
Single inverting buffer/line driver; 3-state

### 3. Ordering Information

Table 1. Ordering information

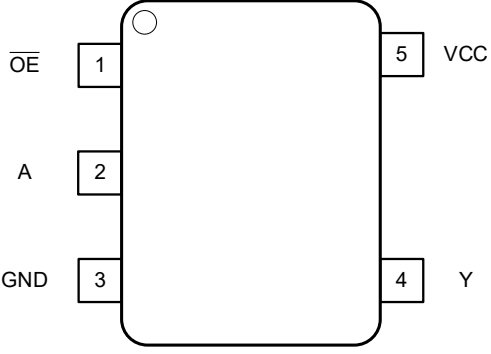
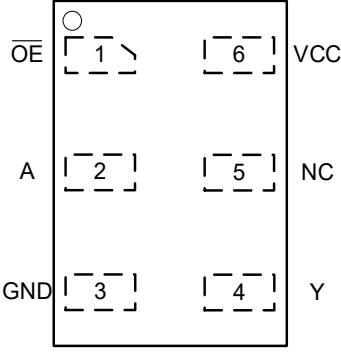
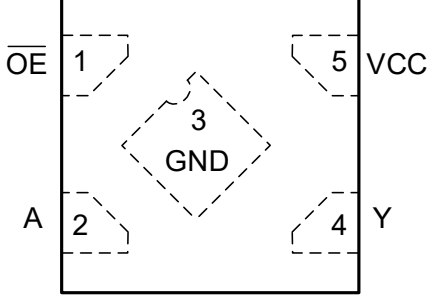
| Type number    | Topside marking | Package Name  | Description                                                        | Quantity |
|----------------|-----------------|---------------|--------------------------------------------------------------------|----------|
| EM74LVC1G240GV | VRYW            | SOT23-5L      | SOT23 package, 5 pins<br>2.92 mm × 1.6 mm; 1.25 mm (Max) height    | 3000     |
| EM74LVC1G240GW | VRYW            | SOT353        | SOT353 package, 5 pins<br>2.1 mm × 1.25 mm; 1.1 mm (Max) height    | 3000     |
| EM74LVC1G240GS | VR              | DFN1x1-6L     | DFN1×1 package, 6 pins<br>1 mm × 1 mm; 0.42 mm (Max) height        | 3000     |
| EM74LVC1G240GM | VRYW            | DFN1x1.45-6L  | DFN1.45×1 package, 6 pins<br>1.45 mm × 1 mm; 0.6 mm (Max) height   | 3000     |
| EM74LVC1G240GX | VR              | DFN0.8x0.8-4L | DFN0.8×0.8 package, 5 pins<br>0.8 mm × 0.8 mm; 0.4 mm (Max) height | 3000     |

### 4. Function Diagram



## 5. Pinning Information

### 5.1. Pin map

|                                                                                                                                               |                                                                                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
|  <p>Fig 4. Top view pin configuration SOT23-5 and SOT353</p> |  <p>Fig 5. Top view pin configuration DFN6L</p> |
|  <p>Fig 6. Top view pin configuration DFN4L</p>             |                                                                                                                                   |

### 5.2. Pin description

**Table 2. Pin description**

| Symbol          | Pin                       |       | Description         |
|-----------------|---------------------------|-------|---------------------|
|                 | SOT23-5, SOT353 and DFN4L | DFN6L |                     |
| $\overline{OE}$ | 1                         | 1     | Output enable input |
| A               | 2                         | 2     | Data input          |
| GND             | 3                         | 3     | Ground (0V)         |
| Y               | 4                         | 4     | Data output         |
| NC              | -                         | 5     | Not connected       |
| VCC             | 5                         | 6     | Supply voltage      |

## EM74LVC1G240

Single inverting buffer/line driver; 3-state

## 6. Functional Description

**Table 3. Function table**

H = HIGH voltage level; L = LOW voltage level; X = don't care; Z = high-impedance OFF-state.

| Input                  |   | Output |
|------------------------|---|--------|
| $\overline{\text{OE}}$ | A | Y      |
| L                      | L | H      |
| L                      | H | L      |
| H                      | X | Z      |

## 7. Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

**Table 4. Absolute Maximum Ratings**

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND.

| Symbol    | Parameter               | Conditions                          | Min  | Max            | Unit |
|-----------|-------------------------|-------------------------------------|------|----------------|------|
| $V_{CC}$  | supply voltage          |                                     | -0.5 | 6.5            | V    |
| $I_{IK}$  | input clamping current  | $V_I < 0$ V                         | -50  |                | mA   |
| $V_I$     | input voltage           | [1]                                 | -0.5 | 6.5            | V    |
| $I_{OK}$  | output clamping current | $V_O > V_{CC}$ or $V_O < 0$ V       |      | $\pm 50$       | mA   |
| $V_O$     | output voltage          | Active mode [1]                     | -0.5 | $V_{CC} + 0.5$ | V    |
|           |                         | Power-down mode; $V_{CC} = 0$ V [1] | -0.5 | 6.5            | V    |
| $I_O$     | output current          | $V_O = 0$ V to $V_{CC}$             |      | $\pm 50$       | mA   |
| $I_{CC}$  | supply current          |                                     |      | 100            | mA   |
| $I_{GND}$ | ground current          |                                     | -100 |                | mA   |
| $P_{tot}$ | total power dissipation | $T_{amb} = -40$ °C to $+125$ °C     |      | 250            | mW   |
| $T_{stg}$ | storage temperature     |                                     | -65  | 150            | °C   |

[1] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

## 8. Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. EnergyMath does not recommend exceeding them or designing to Absolute Maximum Ratings.

**Table 5. Recommended Operating Conditions**

| Symbol              | Parameter                           | Conditions                             | Min  | Typ | Max             | Unit |
|---------------------|-------------------------------------|----------------------------------------|------|-----|-----------------|------|
| V <sub>CC</sub>     | supply voltage                      |                                        | 1.65 |     | 5.5             | V    |
| V <sub>I</sub>      | input voltage                       |                                        | 0    |     | 5.5             | V    |
| V <sub>O</sub>      | output voltage                      | Active mode                            | 0    |     | V <sub>CC</sub> | V    |
|                     |                                     | Power-down mode; V <sub>CC</sub> = 0 V | 0    |     | 5.5             | V    |
| T <sub>amb</sub>    | ambient temperature                 |                                        | -40  |     | 125             | °C   |
| $\Delta t/\Delta V$ | Input transition rise and fall rate | V <sub>CC</sub> = 1.65 V to 2.7 V      |      |     | 20              | ns/V |
|                     |                                     | V <sub>CC</sub> = 2.7 V to 5.5 V       |      |     | 10              | ns/V |

## EM74LVC1G240

Single inverting buffer/line driver; 3-state

# 9.Static Characteristics

**Table 6. Static characteristics**

At recommended operating conditions. Voltages are referenced to GND (ground = 0 V).

| Symbol   | Parameter                 | Conditions                                                           | -40 °C to +85 °C |           |              | -40 °C to +125 °C |              | Unit          |
|----------|---------------------------|----------------------------------------------------------------------|------------------|-----------|--------------|-------------------|--------------|---------------|
|          |                           |                                                                      | Min              | Typ[1]    | Max          | Min               | Max          |               |
| $V_{IH}$ | HIGH-level input voltage  | $V_{CC} = 1.65 \text{ V to } 1.95 \text{ V}$                         | $0.65V_{CC}$     |           |              | $0.65V_{CC}$      |              | V             |
|          |                           | $V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$                           | 1.7              |           |              | 1.7               |              | V             |
|          |                           | $V_{CC} = 2.7 \text{ V to } 3.6 \text{ V}$                           | 2.0              |           |              | 2.0               |              | V             |
|          |                           | $V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$                           | $0.7V_{CC}$      |           |              | $0.7V_{CC}$       |              | V             |
| $V_{IL}$ | LOW-level input voltage   | $V_{CC} = 1.65 \text{ V to } 1.95 \text{ V}$                         |                  |           | $0.35V_{CC}$ |                   | $0.35V_{CC}$ | V             |
|          |                           | $V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$                           |                  |           | 0.7          |                   | 0.7          | V             |
|          |                           | $V_{CC} = 2.7 \text{ V to } 3.6 \text{ V}$                           |                  |           | 0.8          |                   | 0.8          | V             |
|          |                           | $V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$                           |                  |           | $0.3V_{CC}$  |                   | $0.3V_{CC}$  | V             |
| $V_{OH}$ | HIGH-level output voltage | $V_I = V_{IH} \text{ or } V_{IL}$                                    |                  |           |              |                   |              |               |
|          |                           | $I_O = -100\mu\text{A}; V_{CC} = 1.65 \text{ V to } 5.5 \text{ V}$   | $V_{CC} - 0.1$   |           |              | $V_{CC} - 0.1$    |              | V             |
|          |                           | $I_O = -4 \text{ mA}; V_{CC} = 1.65 \text{ V}$                       | 1.2              |           |              | 0.95              |              | V             |
|          |                           | $I_O = -8 \text{ mA}; V_{CC} = 2.3 \text{ V}$                        | 1.9              |           |              | 1.7               |              | V             |
|          |                           | $I_O = -12 \text{ mA}; V_{CC} = 2.7 \text{ V}$                       | 2.2              |           |              | 1.9               |              | V             |
|          |                           | $I_O = -24 \text{ mA}; V_{CC} = 3.0 \text{ V}$                       | 2.3              |           |              | 2.0               |              | V             |
|          |                           | $I_O = -32 \text{ mA}; V_{CC} = 4.5 \text{ V}$                       | 3.8              |           |              | 3.4               |              | V             |
| $V_{OL}$ | LOW-level output voltage  | $V_I = V_{IH} \text{ or } V_{IL}$                                    |                  |           |              |                   |              |               |
|          |                           | $I_O = 100\mu\text{A}; V_{CC} = 1.65 \text{ V to } 5.5 \text{ V}$    |                  |           | 0.10         |                   | 0.10         | V             |
|          |                           | $I_O = 4 \text{ mA}; V_{CC} = 1.65 \text{ V}$                        |                  |           | 0.45         |                   | 0.70         | V             |
|          |                           | $I_O = 8 \text{ mA}; V_{CC} = 2.3 \text{ V}$                         |                  |           | 0.30         |                   | 0.45         | V             |
|          |                           | $I_O = 12 \text{ mA}; V_{CC} = 2.7 \text{ V}$                        |                  |           | 0.40         |                   | 0.60         | V             |
|          |                           | $I_O = 24 \text{ mA}; V_{CC} = 3.0 \text{ V}$                        |                  |           | 0.55         |                   | 0.80         | V             |
|          |                           | $I_O = 32 \text{ mA}; V_{CC} = 4.5 \text{ V}$                        |                  |           | 0.55         |                   | 0.80         | V             |
| $I_I$    | Input leakage current     | $V_I = 5.5 \text{ V or GND}; V_{CC} = 0 \text{ V to } 5.5 \text{ V}$ |                  | $\pm 0.1$ | $\pm 1$      |                   | $\pm 1$      | $\mu\text{A}$ |
| $I_{OZ}$ | OFF-state output current  | $V_{CC} = 3.6 \text{ V}; V_I = V_{IH} \text{ or } V_{IL};$           |                  | $\pm 0.1$ | $\pm 2$      |                   | $\pm 2$      | $\mu\text{A}$ |

## EM74LVC1G240

Single inverting buffer/line driver; 3-state

|                 |                           |                                                                                                         |  |           |         |  |         |               |
|-----------------|---------------------------|---------------------------------------------------------------------------------------------------------|--|-----------|---------|--|---------|---------------|
|                 |                           | $V_O = 5.5 \text{ V or GND}$                                                                            |  |           |         |  |         |               |
| $I_{OFF}$       | power-off leakage current | $V_{CC} = 0 \text{ V} ; V_I \text{ or } V_O = 5.5 \text{ V}$                                            |  | $\pm 0.1$ | $\pm 2$ |  | $\pm 2$ | $\mu\text{A}$ |
| $I_{CC}$        | supply current            | $V_I = 5.5 \text{ V or GND} ; I_O = 0 \text{ A} ; V_{CC} = 1.65 \text{ V to } 5.5 \text{ V}$            |  | 0.1       | 4       |  | 4       | $\mu\text{A}$ |
| $\Delta I_{CC}$ | additional supply current | per pin ; $V_{CC} = 2.3 \text{ V to } 5.5 \text{ V} ; V_I = V_{CC} - 0.6 \text{ V} ; I_O = 0 \text{ A}$ |  | 5         | 500     |  | 500     | $\mu\text{A}$ |
| $C_I$           | input capacitance         | $V_{CC} = 3.3 \text{ V} ; V_I = \text{GND to } V_{CC}$                                                  |  | 5         |         |  |         | pF            |

[1] All typical values are measured at  $V_{CC} = 3.3 \text{ V}$  and  $T_{amb} = 25^\circ\text{C}$ .

## 10. Dynamic Characteristics

**Table 7. Dynamic characteristics**

Voltages are referenced to GND (ground = 0 V); for test circuit see Fig. 8.

| Symbol    | Parameter                     | Conditions                                               | -40 °C to +85 °C |        |      | -40 °C to +125 °C |      | Unit |
|-----------|-------------------------------|----------------------------------------------------------|------------------|--------|------|-------------------|------|------|
|           |                               |                                                          | Min              | Typ[1] | Max  | Min               | Max  |      |
| $t_{pd}$  | propagation delay             | A to Y; see Fig. 7 [2]                                   |                  |        |      |                   |      |      |
|           |                               | $V_{CC} = 1.65 \text{ V to } 1.95 \text{ V}$             | 2.8              | 8.1    | 14.1 | 2.8               | 14.5 | ns   |
|           |                               | $V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$               | 1.8              | 4.8    | 7.3  | 1.8               | 7.6  | ns   |
|           |                               | $V_{CC} = 3.0 \text{ V to } 3.6 \text{ V}$               | 1.4              | 3.6    | 5.3  | 1.4               | 5.6  | ns   |
|           |                               | $V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$               | 1.1              | 2.6    | 3.6  | 1.1               | 3.8  | ns   |
| $t_{en}$  | enable time                   | $\overline{OE}$ to Y; see Fig. 8 [3]                     |                  |        |      |                   |      |      |
|           |                               | $V_{CC} = 1.65 \text{ V to } 1.95 \text{ V}$             | 2.5              | 7.5    | 12.2 | 2.5               | 12.5 | ns   |
|           |                               | $V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$               | 1.6              | 4.4    | 6.6  | 1.6               | 6.9  | ns   |
|           |                               | $V_{CC} = 3.0 \text{ V to } 3.6 \text{ V}$               | 1.3              | 3.8    | 5.2  | 1.3               | 5.5  | ns   |
|           |                               | $V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$               | 1.1              | 2.4    | 3.4  | 1.1               | 3.7  | ns   |
| $t_{dis}$ | disable time                  | $\overline{OE}$ to Y; see Fig. 8 [4]                     |                  |        |      |                   |      |      |
|           |                               | $V_{CC} = 1.65 \text{ V to } 1.95 \text{ V}$             | 4.1              | 7.4    | 14.6 | 4.1               | 14.9 | ns   |
|           |                               | $V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$               | 2.9              | 5.6    | 10.3 | 2.9               | 10.5 | ns   |
|           |                               | $V_{CC} = 3.0 \text{ V to } 3.6 \text{ V}$               | 2.2              | 4.3    | 7.6  | 2.2               | 7.8  | ns   |
|           |                               | $V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$               | 1.7              | 4.0    | 5.0  | 1.7               | 5.2  | ns   |
| $C_{PD}$  | power dissipation capacitance | $V_I = \text{GND to } V_{CC} ; f_i = 10 \text{ MHz}$ [5] |                  |        |      |                   |      |      |

## EM74LVC1G240

Single inverting buffer/line driver; 3-state

|  |                 |  |     |  |  |  |    |
|--|-----------------|--|-----|--|--|--|----|
|  | output enabled  |  | 24  |  |  |  | pF |
|  | output disabled |  | 0.8 |  |  |  | pF |

[1] Typical values are measured at  $T_{amb} = 25^{\circ}\text{C}$  and  $V_{CC} = 1.8\text{ V}, 2.5\text{ V}, 3.3\text{ V}$  and  $5.0\text{ V}$  respectively.

[2]  $t_{pd}$  is the same as  $t_{PLH}$  and  $t_{PHL}$ .

[3]  $t_{en}$  is the same as  $t_{PZH}$  and  $t_{PZL}$ .

[4]  $t_{dis}$  is the same as  $t_{PLZ}$  and  $t_{PHZ}$ .

[5]  $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu\text{W}$ ).

$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(C_L \times V_{CC}^2 \times f_o)$  where:

$f_i$  = input frequency in MHz;

$f_o$  = output frequency in MHz;

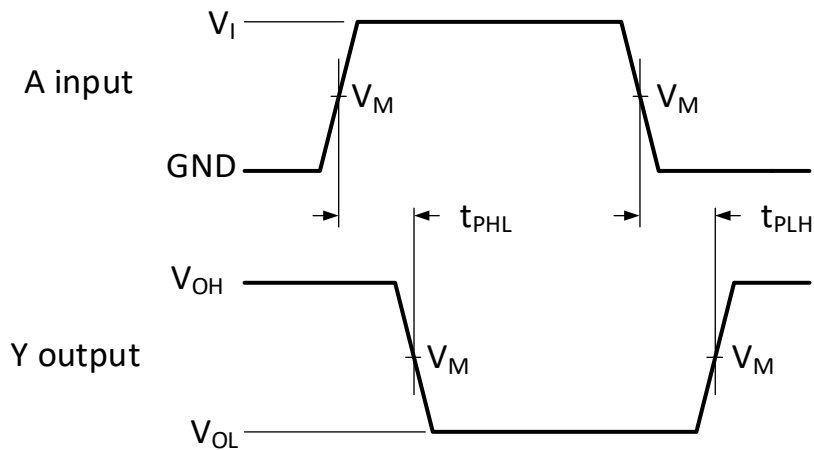
$C_L$  = output load capacitance in pF;

$V_{CC}$  = supply voltage in V;

$N$  = number of inputs switching;

$\Sigma(C_L \times V_{CC}^2 \times f_o)$  = sum of outputs.

### 10.1. Waveforms and test circuit



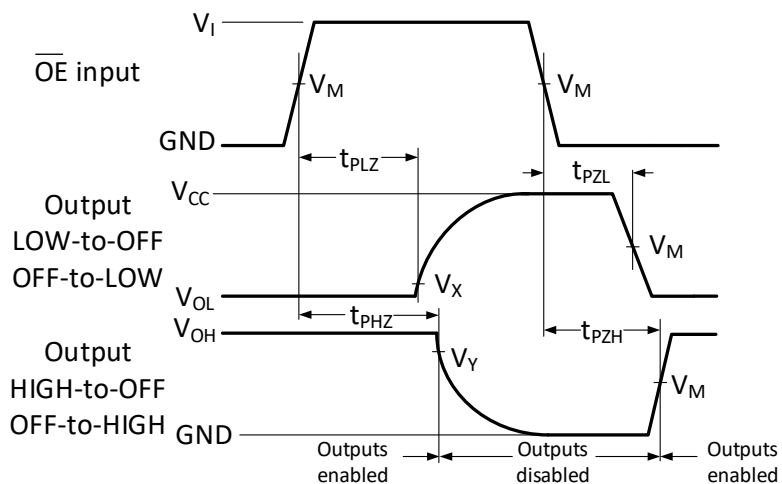
Measurement points are given in Table 8.

$V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

Fig 7. The input A to output Y propagation delays

# EM74LVC1G240

Single inverting buffer/line driver; 3-state



Measurement points are given in Table 8.

$V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

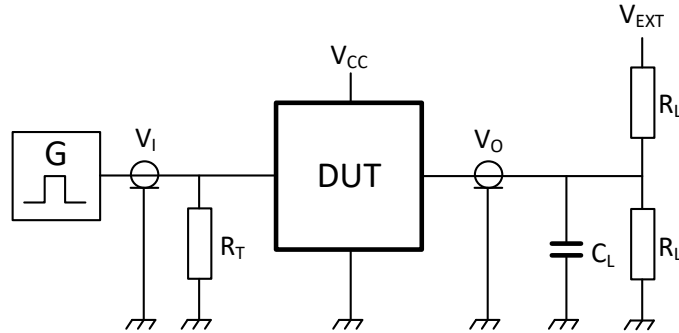
Fig 8. 3-state enable and disable times

Table 8. Measurement points

| Supply voltage   | Input       | Output      |                  |                  |
|------------------|-------------|-------------|------------------|------------------|
| $V_{CC}$         | $V_M$       | $V_M$       | $V_X$            | $V_Y$            |
| 1.65 V to 1.95 V | $0.5V_{CC}$ | $0.5V_{CC}$ | $V_{OL} + 0.15V$ | $V_{OH} - 0.15V$ |
| 2.3 V to 2.7 V   | $0.5V_{CC}$ | $0.5V_{CC}$ | $V_{OL} + 0.15V$ | $V_{OH} - 0.15V$ |
| 3.0 V to 3.6 V   | 1.5 V       | 1.5 V       | $V_{OL} + 0.3V$  | $V_{OH} - 0.3V$  |
| 4.5 V to 5.5 V   | $0.5V_{CC}$ | $0.5V_{CC}$ | $V_{OL} + 0.3V$  | $V_{OH} - 0.3V$  |

## EM74LVC1G240

### Single inverting buffer/line driver; 3-state



Test data is given in Table 9.

Definitions for test circuit:

$R_L$  = Load resistance.

$C_L$  = Load capacitance including jig and probe capacitance.

$R_T$  = Termination resistance should be equal to the output impedance  $Z_o$  of the pulse generator.

$V_{EXT}$  = External voltage for measuring switching times.

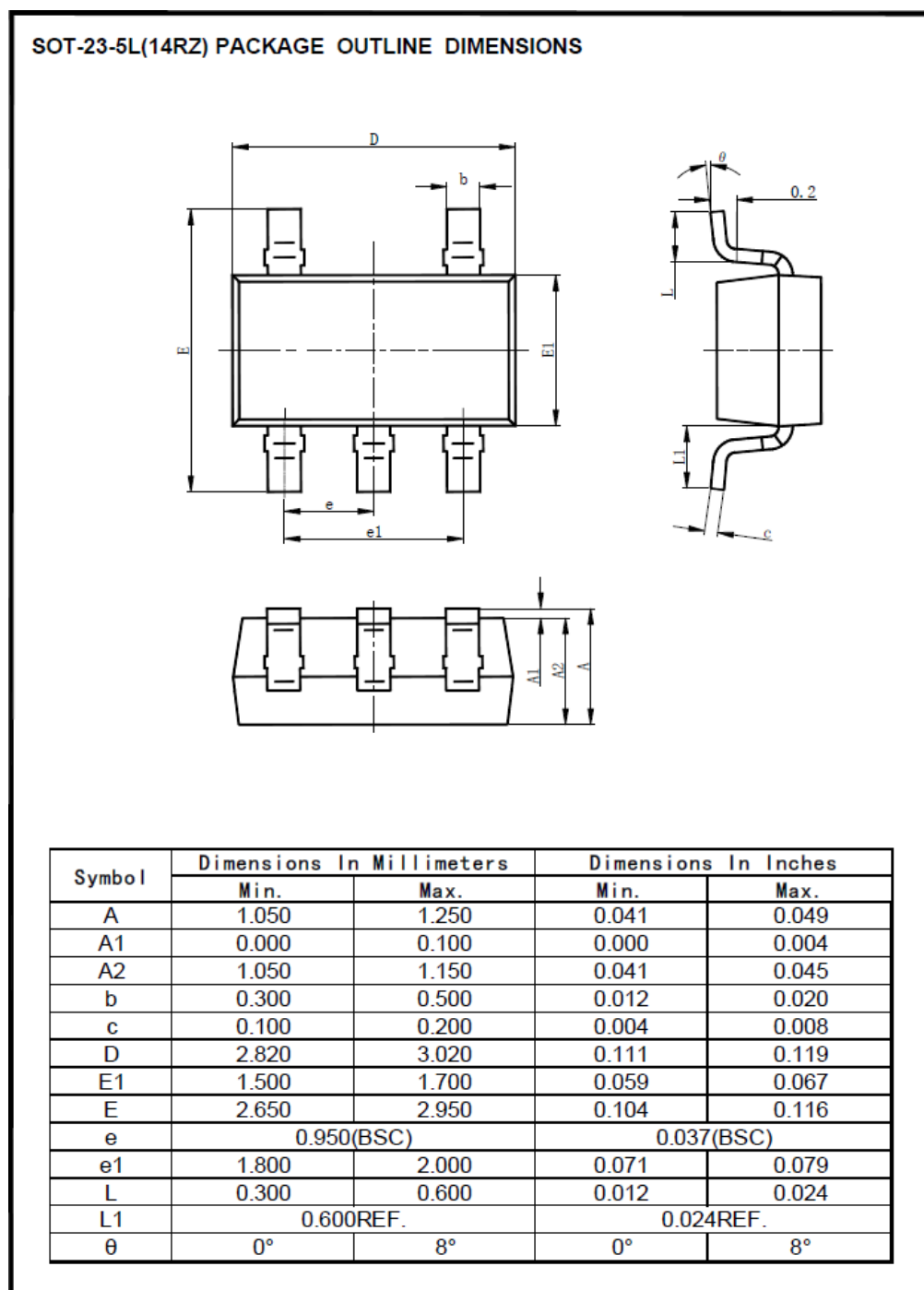
Fig 9. Test circuit for measuring switching times

Table 9. Test data

| Supply voltage   | Input    |               | Load  |              | $V_{EXT}$          |                    |                    |
|------------------|----------|---------------|-------|--------------|--------------------|--------------------|--------------------|
| $V_{CC}$         | $V_I$    | $t_r = t_f$   | $C_L$ | $R_L$        | $t_{PLH}, t_{PHL}$ | $t_{PZH}, t_{PHZ}$ | $t_{PZL}, t_{PLZ}$ |
| 1.65 V to 1.95 V | $V_{CC}$ | $\leq 2.0$ ns | 30 pF | 1 k $\Omega$ | open               | GND                | $2 \times V_{CC}$  |
| 2.3 V to 2.7 V   | $V_{CC}$ | $\leq 2.0$ ns | 30 pF | 500 $\Omega$ | open               | GND                | $2 \times V_{CC}$  |
| 3.0 V to 3.6 V   | 3 V      | $\leq 2.5$ ns | 50 pF | 500 $\Omega$ | open               | GND                | 6V                 |
| 4.5 V to 5.5 V   | $V_{CC}$ | $\leq 2.5$ ns | 50 pF | 500 $\Omega$ | open               | GND                | $2 \times V_{CC}$  |

## 11. Package Outline

### SOT23-5L

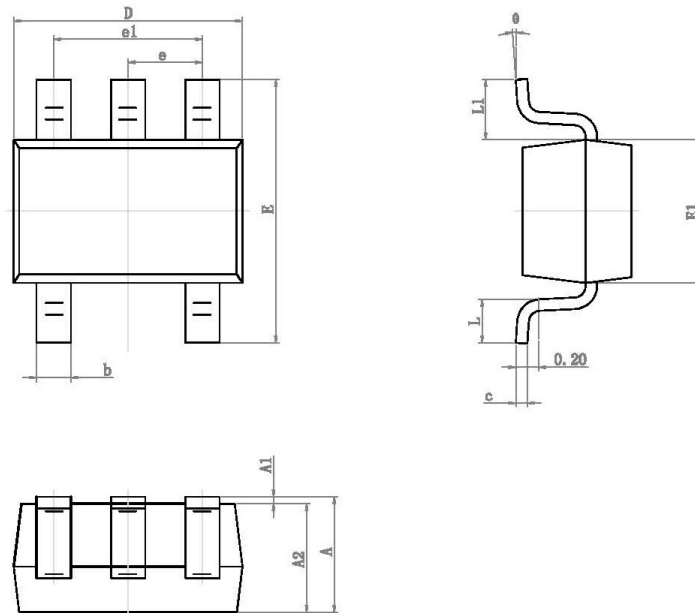


# EM74LVC1G240

Single inverting buffer/line driver; 3-state

SOT353

## SOT-353 (16R) PACKAGE OUTLINE DIMENSIONS

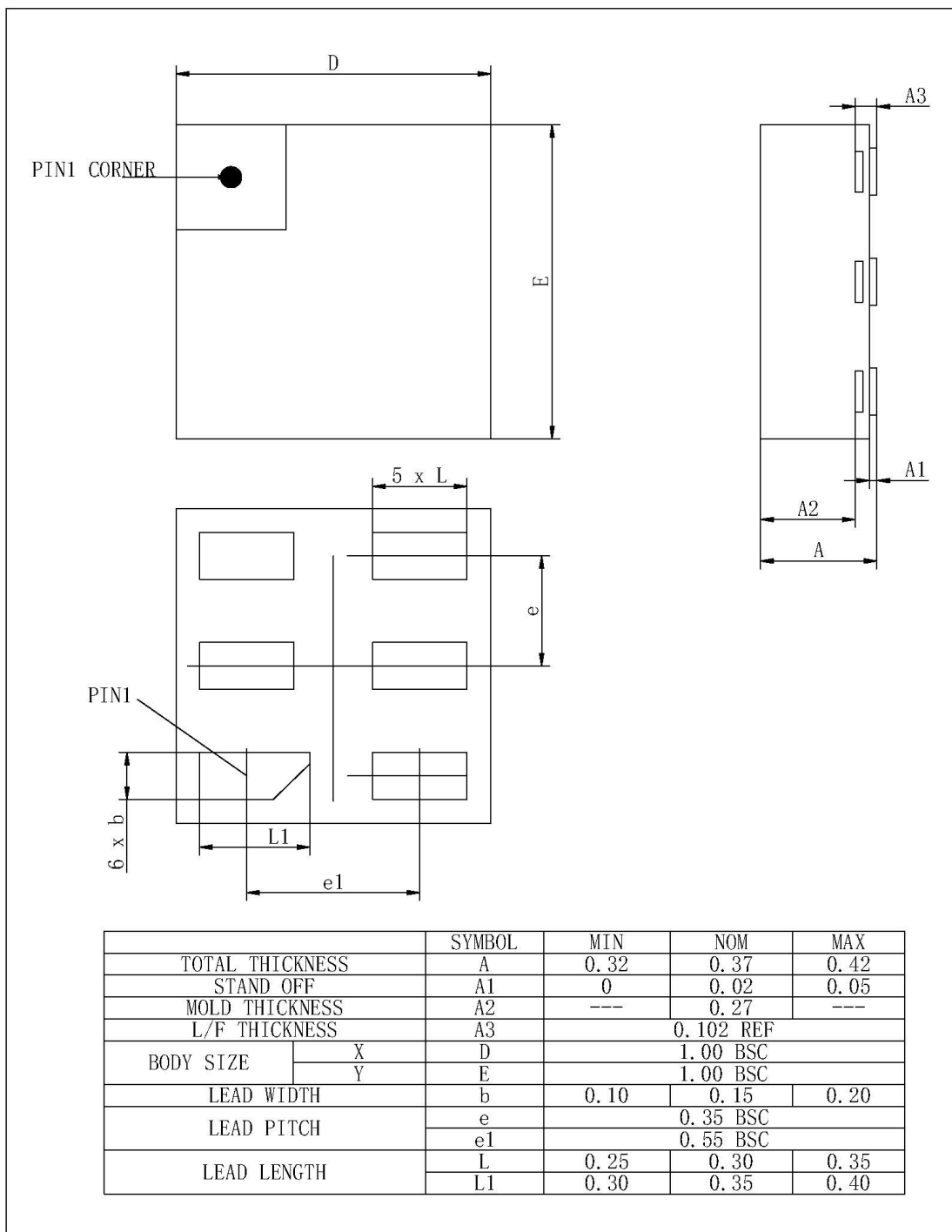


| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | Min.                      | Max.  | Min.                 | Max.  |
| A      | 0.900                     | 1.100 | 0.035                | 0.043 |
| A1     | 0.000                     | 0.100 | 0.000                | 0.004 |
| A2     | 0.900                     | 1.000 | 0.035                | 0.039 |
| b      | 0.150                     | 0.350 | 0.006                | 0.014 |
| c      | 0.110                     | 0.175 | 0.004                | 0.007 |
| D      | 2.000                     | 2.200 | 0.079                | 0.087 |
| E      | 2.150                     | 2.450 | 0.085                | 0.096 |
| E1     | 1.150                     | 1.350 | 0.045                | 0.053 |
| e      | 0.650 TYP.                |       | 0.026 TYP.           |       |
| e1     | 1.200                     | 1.400 | 0.047                | 0.055 |
| L      | 0.260                     | 0.460 | 0.010                | 0.018 |
| L1     | 0.525 REF.                |       | 0.021 REF.           |       |
| θ      | 0°                        | 8°    | 0°                   | 8°    |

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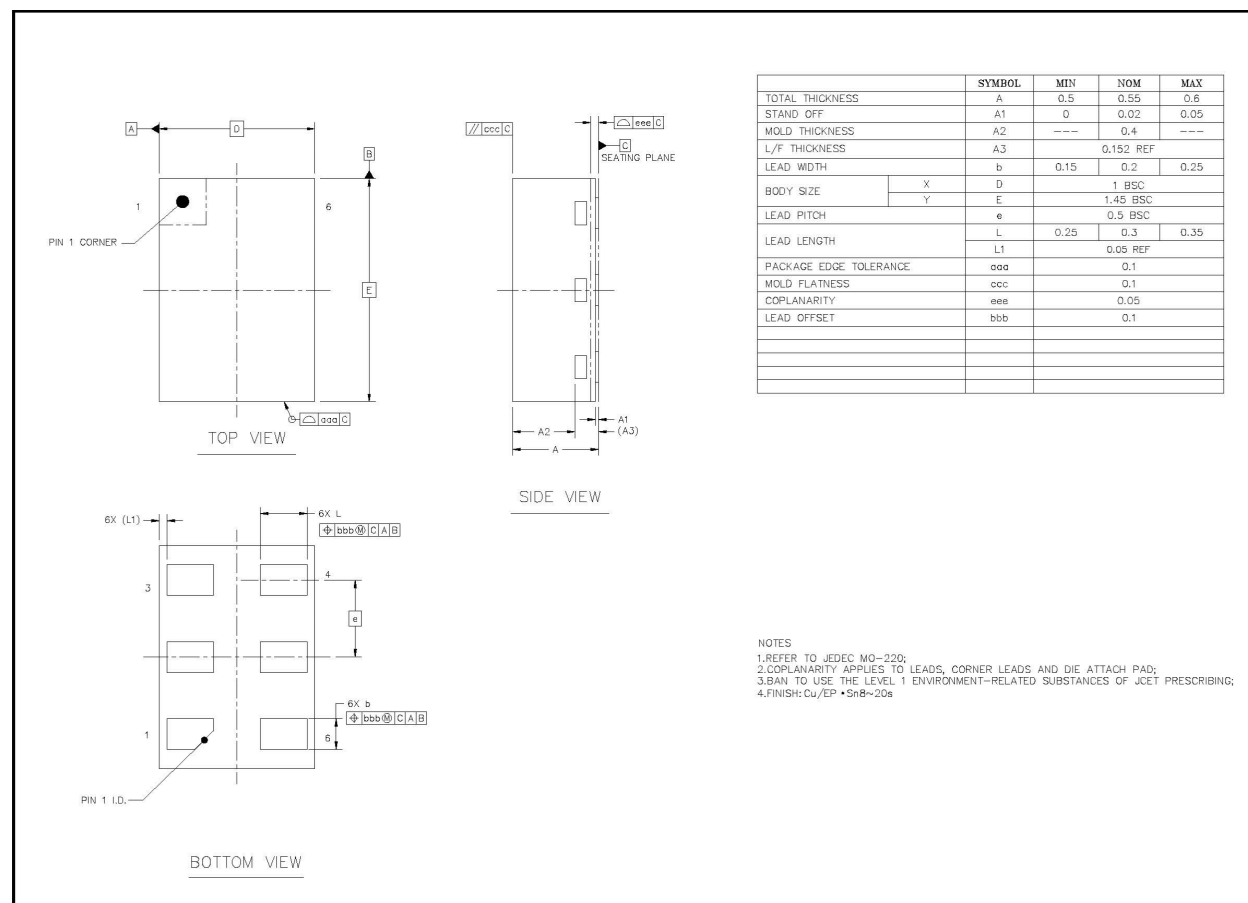
## DFN1x1-6L



# EM74LVC1G240

Single inverting buffer/line driver; 3-state

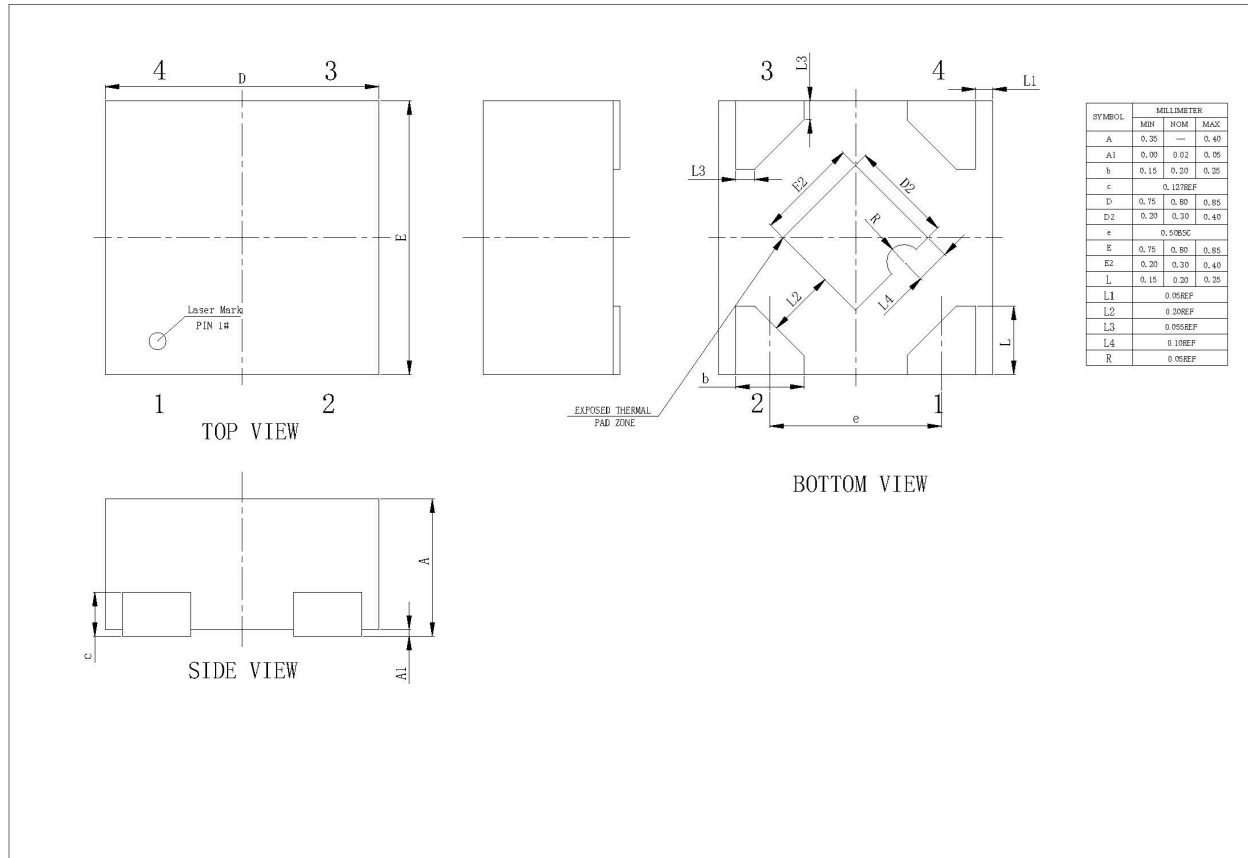
## DFN1x1.45-6L



# EM74LVC1G240

**Single inverting buffer/line driver; 3-state**

**DFN0.8x0.8-4L**



## 12. Abbreviations

Table 10. Abbreviations

| Acronym | Description                             |
|---------|-----------------------------------------|
| CMOS    | Complementary Metal-Oxide Semiconductor |
| DUT     | Device Under Test                       |
| ESD     | ElectroStatic Discharge                 |
| HBM     | Human Body Model                        |
| MM      | Machine Model                           |
| TTL     | Transistor-Transistor Logic             |

## 13. Revision History

Table 11. Revision history

| Document ID            | Release Date | Data sheet status | Change notice | Supersedes |
|------------------------|--------------|-------------------|---------------|------------|
| EM74LVC1G240<br>Rev1.0 | Oct 30, 2023 | Product datasheet |               |            |