# 6A Load Switch with TRCB and Voltage Detector

## General Description

The ET3152 advanced load switches target applications requiring a highly integrated solution it disconnects loads powered from DC power rail (≤ 6.0V) with stringent off-state current targets and high load capacitances (up to 200uF). Each switch consists of slew-rate controlled low-impedance MOSFET Switch and other integrated analog features. The slew-rate controlled turn-on characteristic prevents inrush-current and the resulting excessive voltage droop on power rails.

The ET3152 has True Reverse Current Blocking(TRCB) function unwanted reverse current from OUT to IN during ON/OFF state. These devices have very low off-state current drain (<1uA max) which facilitate compliance in very low stand-by power applications. Switch control is managed by a logic input (Active HIGH) capable of interfacing directly with low voltage control signal with no external pull-down resistor required.

The ET3152 built in a high-precision voltage detectors. The detection voltage is typical 2.9V.

The device is in advanced full-Green compliant WLCSP12(0.4mm pitch) package.

## Features

**Load Switch**

- 2.2V to 6.0V Input Voltage Operating Range
- Ultra Low $R_{DS(on)}$:
  - -- 5mΩ (Typ) at $V_{IN}$=4.5V
  - -- 6mΩ (Typ) at $V_{IN}$=3.3V
  - -- 10mΩ (Typ) at $V_{IN}$=3.0V
- Maximum Continuous Switch Current up to 6A
- Slew Rate/Inrush Control with $t_R$ is 2.7ms Typical
- Low<1μA Off Switch Current
- True Reverse Current Blocking (TRCB)
- ESD Protected: Above 8kV (contact) IEC,4kV HBM, 1.5kV CDM

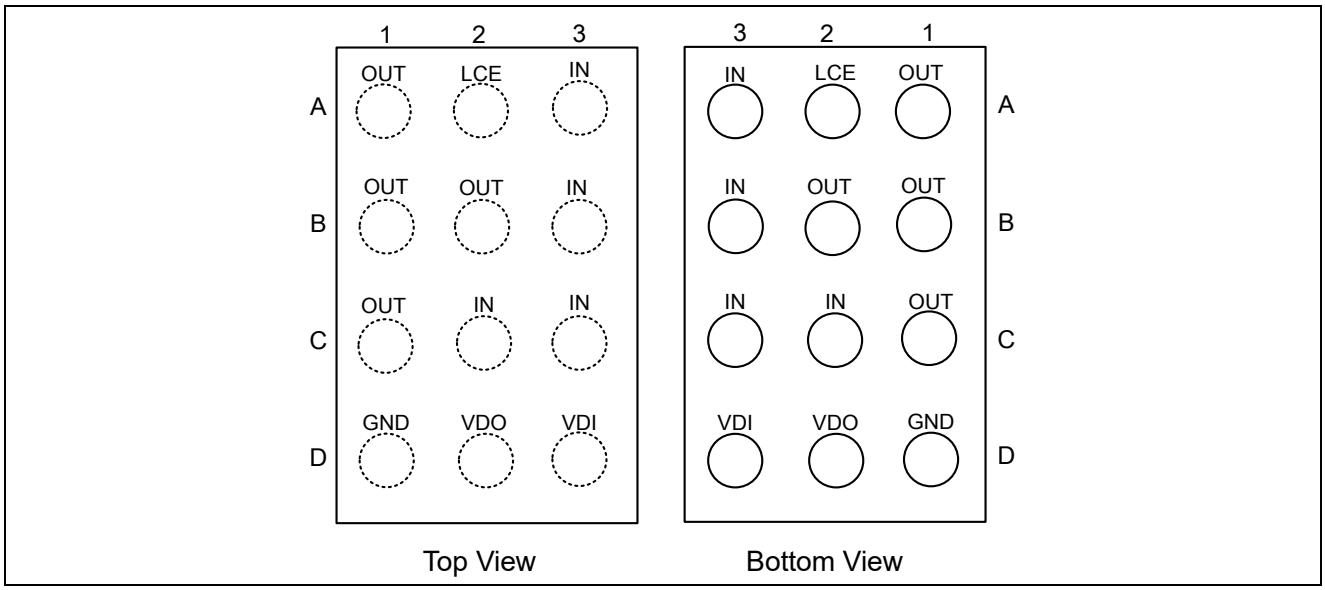
**Voltage Detector**

- Supply Current is Typical 1.0μA @$V_{DI}$=2.0V
- Operating Voltage Range from 1.2V to 5.5V (Ta=25°C)
- Detector Threshold Temperature Coefficient is ±100ppm/°C Typical

## Applications

- Smartphones, Tablet PC
- Portable Media Devices, Laptop & MID
- Industrial Handheld and Enterprise Equipment

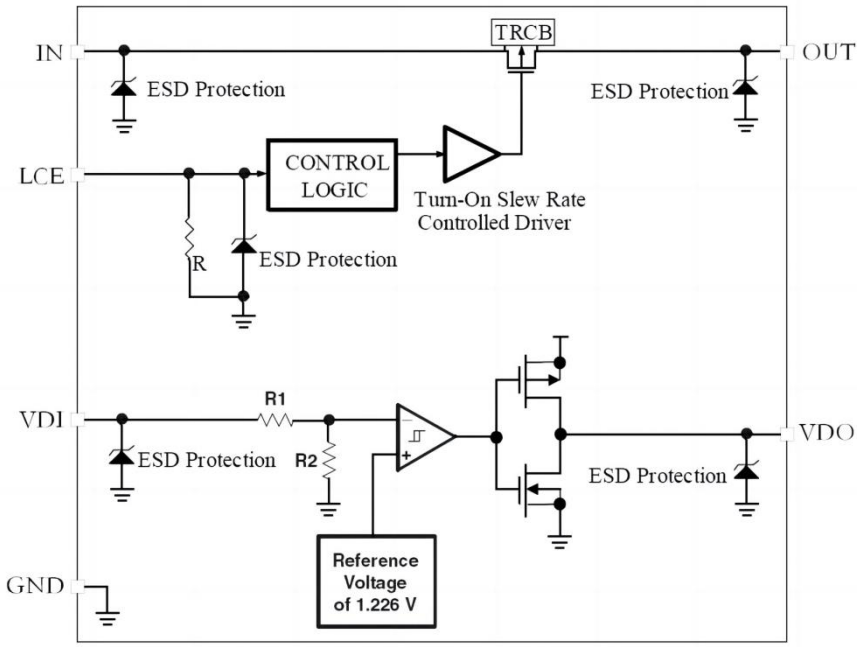
## Pin Configuration




## Pin Function

| Pin Number | Pin Name | Function |
|---|---|---|
| A1, B1, B2, C1 | OUT | Load Switch Output |
| A3, B3, C2, C3 | IN | Load Switch Input |
| A2 | LCE | Load Switch Control Enable |
| D1 | GND | Ground |
| D2 | VDO | Voltage Detector Output |
| D3 | VDI | Voltage Detector Input |

## Block Diagram




## Functional Description

The ET3152 is low-$R_{ON}$ load switches with controlled turn-on and TRCB (True Reverse Current Blocking). The core of each device is a 6mΩ P-channel MOSFET and controller capable of functioning over a wide input operating range of 2.2 to 6.0V. The LCE pin, an active HIGH input, controls the state of the switch. TRCB functionality blocks unwanted reverse current during ON and OFF when higher OUT than IN applied.

The ET3152 also built in a high-precision voltage detector. The detection voltage is 2.9V.

### Input Capacitor

To limit the voltage drop on the input supply caused by transient inrush current when the switch turns on into a discharged load capacitor or short-circuit, a capacitor must be placed between the IN and GND pins. A 10μF ceramic capacitor, $C_{IN}$ and a 2.2ohm resistor placed close to the pins is usually sufficient. Higher-value $C_{IN}$ can be used to reduce the voltage drop in higher-current applications.

### Output Capacitor

A 4.7μF capacitor, $C_{OUT}$, should be placed between the OUT and GND pins. This capacitor prevents parasitic board inductance from forcing OUT below GND when the switch is on. CIN greater than $C_{OUT}$ is highly recommended. $C_{OUT}$ greater than $C_{IN}$ can cause $V_{OUT}$ to exceed $V_{IN}$ when the system supply is removed. This could result in current flow through the body diode from OUT to IN.

## 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.

| Symbol | Parameters | | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{IN}$ (*) | IN to GND | | -2.0 | 7.0 | V |
| $V_{LCE}$ | LCE to GND | | -0.3 | 7.0 | V |
| $V_{OUT}$ | OUT to GND | | -0.3 | 7.0 | V |
| $V_{VDI}$ | VDI to GND | | -2.0 | 7.0 | V |
| $V_{VDO}$ | VDO to GND | | -0.3 | $V_{VDI}$ +0.3 | V |
| $I_{SW1}$ | Maximum Continuous Switch Current | | | 6 | A |
| $I_{SW2}$ | Maximum Repetitive Pulsed Current (1ms,20% Duty Cycle) | | | 12 | A |
| $I_{SW3}$ | Maximum Non-Repetitive Pulsed Current (100μs) | | | 15 | A |
| $P_D$ | Power Dissipation at $T_A$=25°C | | | 1.6 | W |
| $T_{STG}$ | Storage Junction Temperature | | -65 | +150 | °C |
| $T_J$ | Operating Junction Temperature Range | | -40 | +150 | °C |
| $\theta_{JA}$ | Thermal Resistance, Junction-to-Ambient | | | 75 | °C/W |
| ESD | Electrostatic Discharge Capability | Human Body Model, JESD22-A114 | ± 4.0 | | KV |
| | | Charged Device Model, JESD22-C101 | ± 1.5 | | |

***Note* :*** ET3152 can pass the 10V test (Instant Contact): can support up to 100mS 10V pulse.

## 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. ETEK does not recommend exceeding them or designing to Absolute Maximum Ratings.

| Symbol | Parameters | Min | Max | Unit |
|---|---|---|---|---|
| $V_{IN}$ | Input Voltage | 2.2 | 6.0 | V |
| $V_{VDI}$ | Voltage detector input voltage | 1.2 | 5.5 | V |
| $T_A$ | Ambient Operating Temperature | -40 | +85 | °C |

## Electrical Characteristics

### Load switch

Unless otherwise noted, typical values are at $V_{IN}$=4.5V and $T_A$=25°C.

| Symbol | Parameters | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Basic Operation** | | | | | | |
| $V_{IN}$ | Input Voltage | | 2.2 | | 6.0 | V |
| $I_{Q(OFF)}$ | Off Supply Current | $V_{LCE}$=GND, $V_{OUT}$=Open | | | 1 | μA |
| $I_{SD}$ | Shutdown Current | $V_{LCE}$=GND, $V_{OUT}$=GND | | 0.2 | 1.2 | μA |
| $I_Q$ | Quiescent Current | $I_{OUT}$=0mA | | | 11 | μA |
| $R_{ON}$ | On-Resistance | $V_{IN}$=5.5V, $I_{OUT}$=1A | | 4 | | mΩ |
| | | $V_{IN}$=4.5V, $I_{OUT}$=1A | | 5 | | |
| | | $V_{IN}$=3.3V, $I_{OUT}$=1A, $T_A$=25°C | | 6 | 10 | |
| | | $V_{IN}$=3.0V, $I_{OUT}$=1A, | | 10 | | |
| $V_{IH}$ | LCE Input Logic High Voltage | $V_{IN}$=5.0V | 2.3 | | | V |
| $V_{IL}$ | LCE Input Logic Low Voltage | $V_{IN}$=5.0V | | | 2.0 | V |
| $I_{LCE}$ | LCE Input Leakage | $V_{LCE}$= $V_{IN}$ or GND | | | 1.0 | μA |
| $R_{LCE\_PD}$ | Pull-Down Resistance at LCE pin | $V_{IN}$=2.2V to 6.0V, $T_A$= -40 to+ 85°C | 6.38 | 7.65 | 8.86 | MΩ |
| **True Reverse Current Blocking** | | | | | | |
| $V_{T\_RCB}$ | RCB Protection Trip Point | $V_{OUT}$ - $V_{IN}$ | | 15 | | mV |
| $V_{R\_RCB}$ | RCB Protection Release Trip Point | $V_{IN}$ - $V_{OUT}$ | | 45 | | mV |
| | RCB Hysteresis | | | 60 | | mV |
| $I_{SD\_OUT}$ | $V_{OUT}$ Shutdown Current | $V_{LCE}$=0V, $V_{OUT}$=5.0V, $V_{IN}$ =Short to GND | | | 2 | μA |
| $T_{RCB\_LCE}$ | RCB Response Time when Device ON | $V_{OUT}$ - $V_{IN}$ =100mV $V_{LCE}$=High | | 4.0 | | μs |
| $T_{RCB\_OFF}$ | RCB Response Time Device OFF | $V_{OUT}$ - $V_{IN}$ =100mV $V_{LCE}$=Low | | 2.5 | | μs |

## Electrical Characteristics(Continued)

### Load switch

| Symbol | Parameters | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Dynamic Characteristics: See Definitions Below** | | | | | | |
| $t_{DON}$ | Turn-On Delay[1,2] | $V_{IN}$ =4.5V, $R_L$=50Ω, $C_L$=10μF, $T_A$=25°C | | 1.1 | | ms |
| $t_R$ | $V_{OUT}$ Rise Time[1,2] | | | 2.0 | | ms |
| $t_{LCE}$ | Turn-On Time[1,3] | | | 3.1 | | ms |
| $t_{DON}$ | Turn-On Delay[1,2] | $V_{IN}$ =3V, $R_L$=50Ω, $C_L$=10μF, $T_A$=25°C | | 1.3 | | ms |
| $t_R$ | $V_{OUT}$ Rise Time[1,2] | | | 1.7 | | ms |
| $t_{LCE}$ | Turn-On Time[1,3] | | | 3.0 | | ms |
| $t_{DOFF}$ | Turn-Off Delay[1,2] | $V_{IN}$ =4.5V, $R_L$=50Ω, $C_L$=10μF, $T_A$=25°C | | 0.1 | | ms |
| $t_F$ | $V_{OUT}$ Fall Time[1,2] | | | 1.4 | | ms |
| $t_{OFF}$ | Turn-Off Time[1,4] | | | 1.5 | | ms |
| $t_{DOFF}$ | Turn-Off Delay[1,2] | $V_{IN}$ =3V, $R_L$=50Ω, $C_L$=10μF, $T_A$=25°C | | 0.1 | | ms |
| $t_F$ | $V_{OUT}$ Fall Time[1,2] | | | 1.4 | | ms |
| $t_{OFF}$ | Turn-Off Time[1,4] | | | 1.5 | | ms |

### Voltage Detector

Unless otherwise noted, $V_{VDI}$=3.6V and $T_A$=25°C.

| Symbol | Parameters | Test Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{DET}$[5] | Detector Threshold | | | 2.8 | 2.9 | 3 | V |
| $V_{HYS}$[1][5] | Detector Threshold Hysteresis | | | 100 | 150 | 200 | mV |
| $I_{VDI}$ | Supply Current | $V_{VDI}$ = 2.0V | | | 1.0 | | uA |
| | | $V_{VDI}$ = 2.60V | | | | 3.3 | |
| | | $V_{VDI}$ = 3.50V | | | | 3.4 | |
| $V_{VDI}$ | Operating Voltage | | | 1.2 | | 5.5 | V |
| $I_{VDO}$ | Output Current | Nch | $V_{DS}$ = 0.5V, $V_{VDI}$ = 1.5V | 1.0 | 2.0 | | mA |
| | | Pch | $V_{DS}$ = -2.1V, $V_{VDI}$ = 5.5V | 1.0 | 2.5 | | |
| $T_{PLH}$ | Output Delay Time[6] | | | | | 100 | uS |
| $\Delta V_{DET}$ /$\Delta T_A$ | Detector Threshold Temperature Coefficient | −40°C < $T_A$ < 85°C | | | ±100 | | ppm/°C |

***Notes:***

1. This parameter is guaranteed by design and characterization.
2. $t_{DON}$ / $t_{DOFF}$ / $t_R$ / $t_F$ are defined in Figure 1.
3. $t_{ON}$ = $t_R$ + $t_{DON}$
4. $t_{OFF}$ = $t_F$ + $t_{DOFF}$
5. $V_{DET}$ is defined as an actual detector threshold in Figure 2.
6. The time interval between the rising edge of $V_{VDI}$ input pulse from 1.3V to 3.9V and output voltage level becoming to 2.4V.
7. $T_{PLH}$ is defined in Figure 3.

## Timing Diagram (Load Switch)

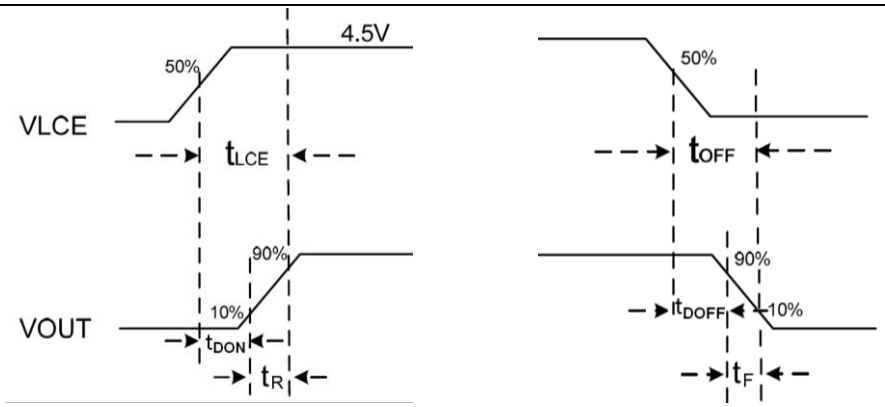
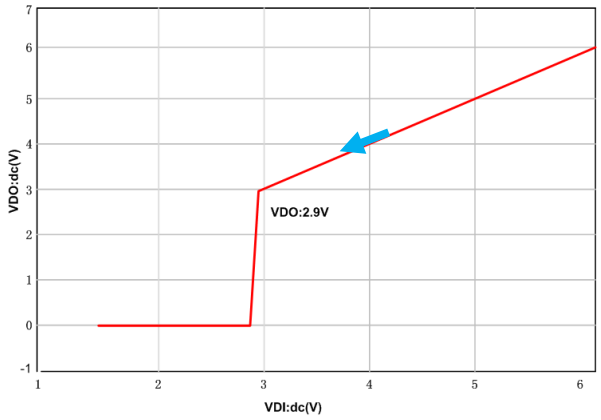
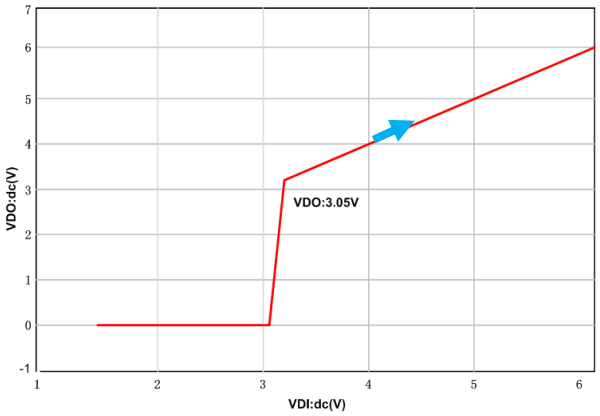



Figure 1. $V_{LCE}$ to $V_{OUT}$ Timing




VDI: 6.0V to 1.5V




VDI: 1.5V to 6.0V

Figure 2. VDI vs VDO

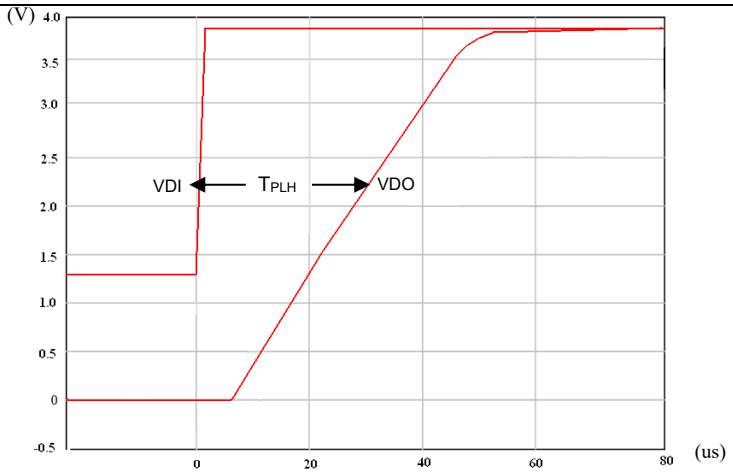
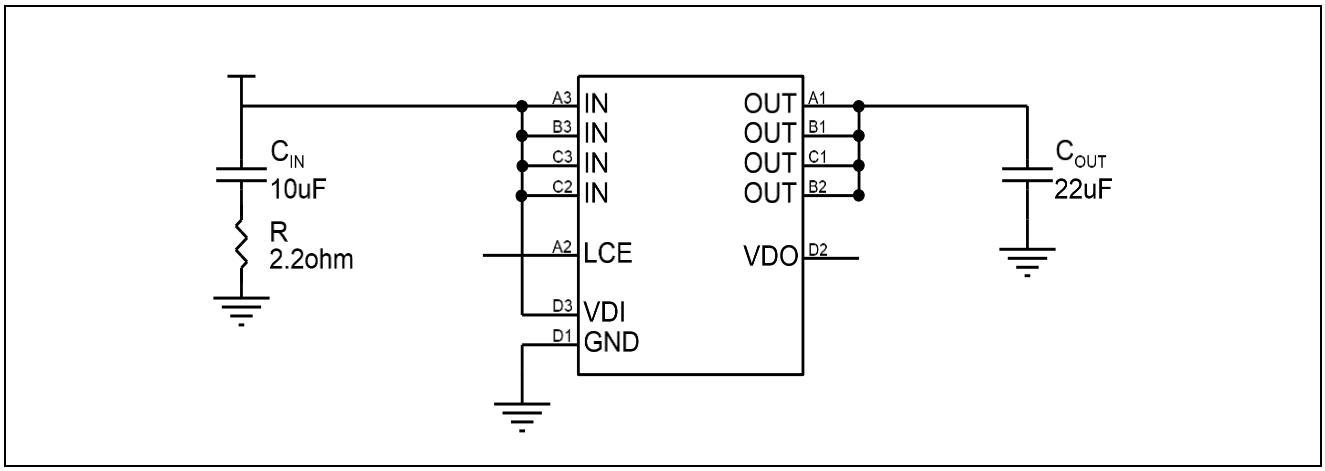


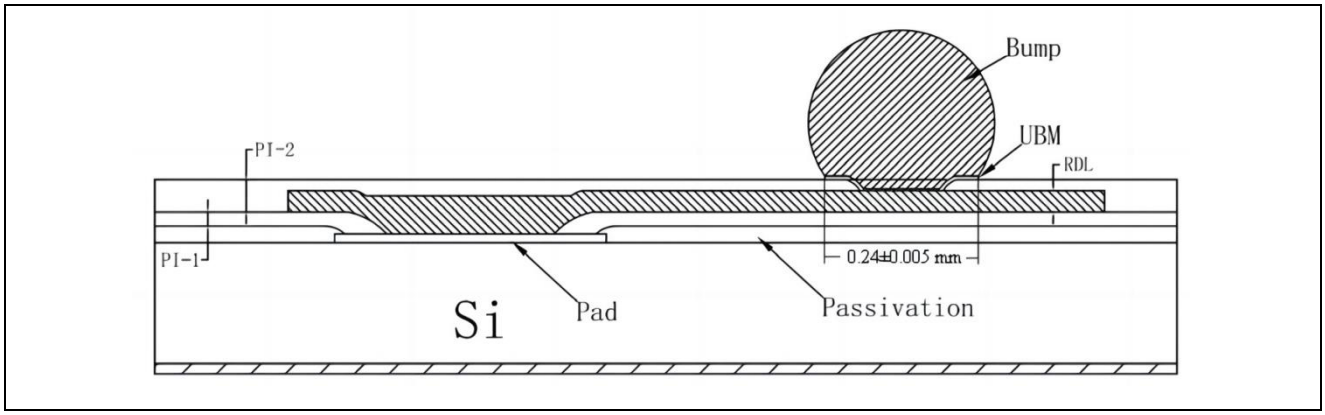

Figure 3. Output Delay Time

## Application Circuit



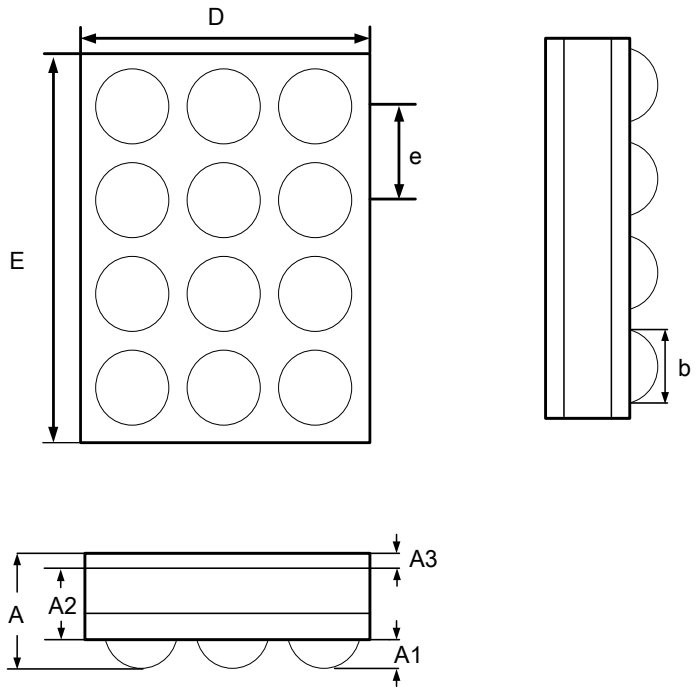

*：This electric circuit only supplies for reference.

## UBM Structure



## Package Dimension

WLCSP12




**Dimensions Table (Units: mm)**

| Symbol | Min | Nom | Max |
|---|---|---|---|
| A | 0.59 | 0.65 | 0.71 |
| A1 | 0.17 | 0.20 | 0.23 |
| A2 | 0.385 | 0.415 | 0.445 |
| A3 | | 0.035BSC | |
| b | 0.22 | 0.25 | 0.28 |
| D | 1.26 | 1.28 | 1.30 |
| E | 1.66 | 1.68 | 1.70 |
| e | | 0.40BSC | |

## Revision History and Checking Table

| Version | Date | Revision Item | Modifier | Function & Spec Checking | Package & Tape Checking |
|---|---|---|---|---|---|
| 1.0 | 2014-3-27 | Original version | Wu Xiang Jun | Wu Xiang Jun | Zhu Jun Li |
| 1.1 | 2018-1-5 | 1.Change the AMR value from 6.5V to 7V 2. Add “ET3152 can pass the 10V test (Instant Contact) : can support up to 100ms 10V pulse” | Wu Xiang Jun | Wu Xiang Jun | Jenna Liu |
| 1.2 | 2020-03-12 | Document check and formalize | Shib | Shib | Liujy |
| 1.3 | 2022-11-12 | Update Typesetting | Shib | Shib | Liujy |