High-Current Over-Voltage Protectors with Adjustable OVLO and Input Moisture Detection

General Description

ET9545L1 can disconnect the systems from its output pin (OUT) in case wrong input operating conditions are detected. The system is positive over-voltage protected up to 28V. The internal over-voltage threshold (OVLO) is 5.95V.

ET9545L1 has internal Thermal-Shutdown Protection and Input Moisture detection.

The device is packaged in advanced full-Green compliant WLCSP12 package.

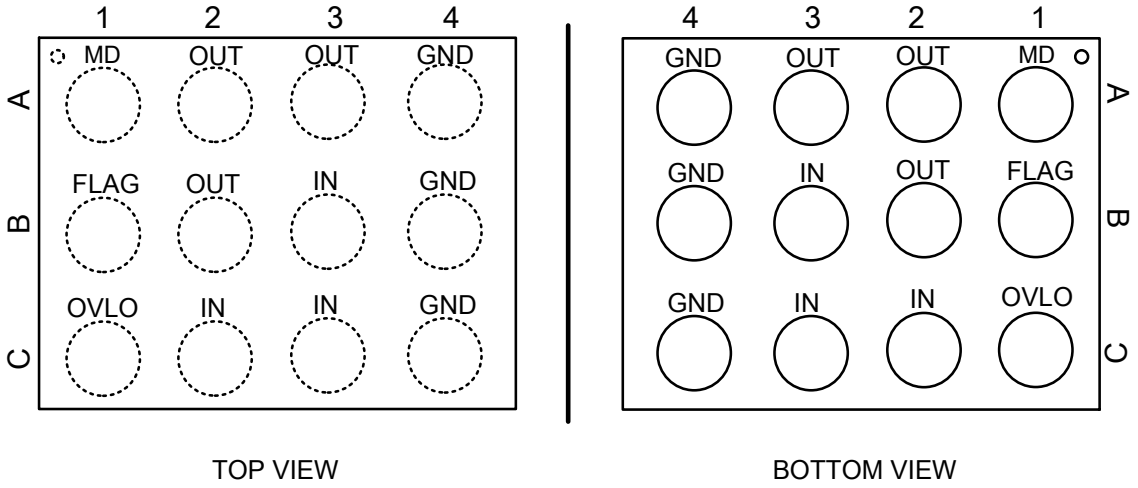
Features

- 5.5A Continuous Current Capability
- Typical R_{ON}: 20mΩ N-Channel MOSFET
- VIN Operating Range: 3.2V to 28V
- Internal Over-Voltage Lockout: 5.95V
- Over-Voltage-Protection Response Time: 50ns (TYP)
- Moisture Detection for VIN
- Startup Debounce Time: 15ms (TYP)
- Internal Thermal-Shutdown Protection
- Surge Immunity to ±80V
- ESD Protected: Human Body Model (JESD22-A114) All pins ±2KV Pass
- WLCSP12 (1.55mm×1.10mm 0.4mm pitch) Package

Application

- Smartphones, Tablet PC
- HDD, Storage and Solid State Memory Devices
- Portable Media Devices, Laptop & MID
- SLR Digital Cameras
- GPS and Navigation Equipment
- Industrial Handheld and Enterprise Equipment

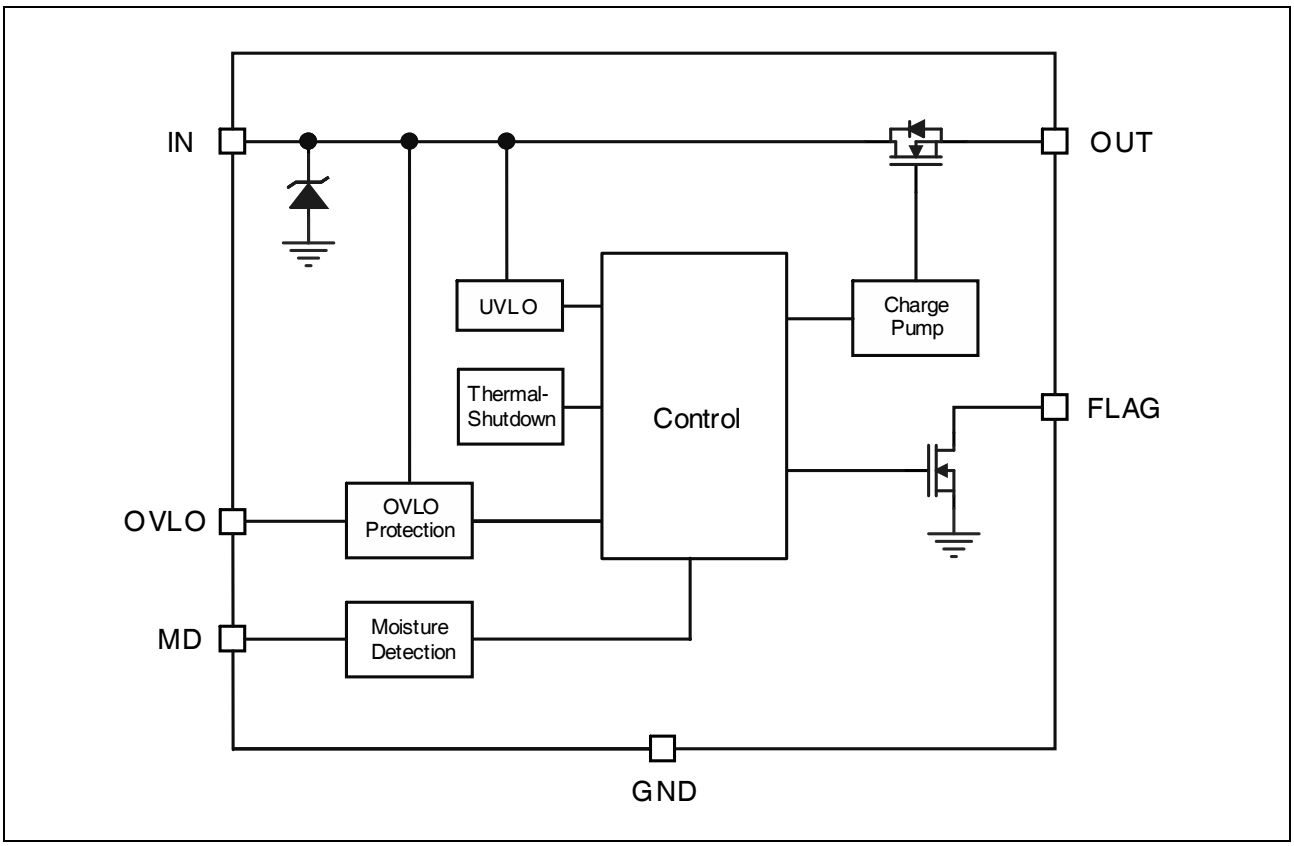
Pin Configuration



Pin Function

Pin	Name	Description		
A1	MD	Moisture Detection Input.		
A2,A3,B2	OUT	Output Voltage. Output of internal switch. Connect OUT pins together for proper operation.		
A4,B4,C4	GND	Ground. Connect GND pins together for proper operation.		
B1	FLAG	Power status indicator	1	V_{MD} shorted to IN or GND or VIN<V_{UVLO} or VIN>V_{OVLO}
			0	V_{IN} Stable
B3,C2,C3	IN	Voltage Input. Connect IN pins together for proper operation.		
C1	OVLO	External OVLO Adjustment. Connect OVLO to GND when using the internal threshold. Connect a resistor-divider to OVLO to set a different OVLO threshold; this external resistor-divider is completely independent of the internal threshold.		

Block Diagram



Functional Description

The OVP switch with over-voltage protection feature a low 20mΩ (TYP) on-resistance (R_{ON}) internal FET and protect low-voltage systems against voltage faults up to 28 VDC. When the input voltage(V_{IN}) exceeds 5.95V, the internal FET is quickly turned off to prevent damage to the protected downstream components and the flag pin will output logic high state. If there is no input voltage at IN pin, the flag pin output logic high state.

When input (OVLO) is set lower than 0.2V. The over-voltage protection threshold is 5.95V.

The over-voltage protection threshold can also be adjusted by external resistors when input (OVLO) is set higher than 0.3V.

$$V_{IN_OVLO} = V_{OVLO_TH} \times (1+R1/R2)$$

Note: V_{OVLO_TH} = 1.2V (TYP)

The internal FET turns off when the junction temperature exceeds +155ºC (TYP). The device exits thermal shutdown after the junction temperature cools by 20ºC (TYP).

Moisture Detection

The moisture detection module is built into the ET9545L1, and its principle is shown in the following Figure 1.

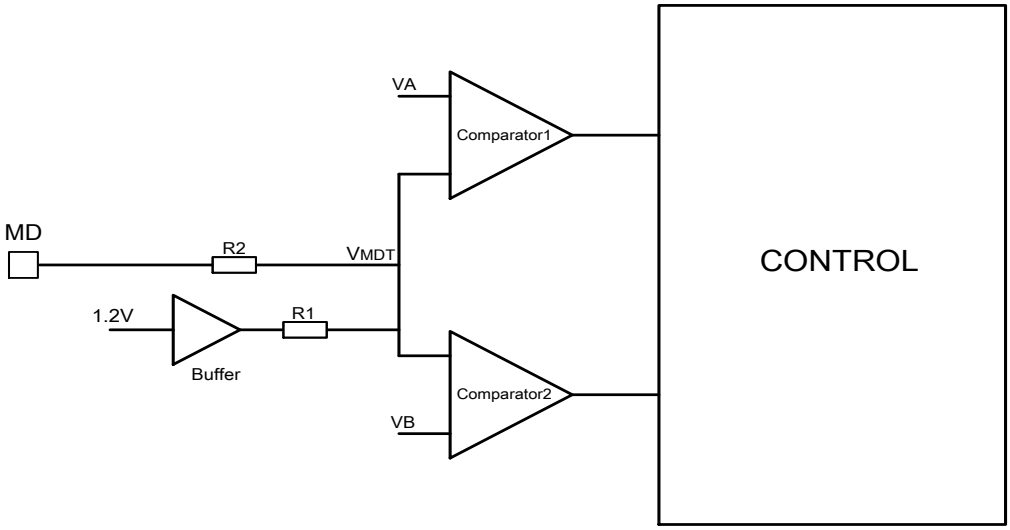


Figure 1. Moisture Detection Principle

When using, place the MD pin on the PCB close to the IN pin. Under normal circumstances, the MD pin is in a floating state, and at this time, V_B=0.9V<V_{MDT}=1.2V<V_A=2.2V, no moisture is detected. If there is water vapor on the USB interface at this time, causing the MD pin to connect to the IN, the IN voltage will be transmitted to the V_{MDT} through the MD pin. At this time, V_{MDT}>V_A, the output of comparator 1 is inverted, and the FLAG is set high through control logic. If the water vapor from the USB interface causes the MD pin to connect to the GND, then V_{MDT}<V_B, the comparator 2 output flips, and the FLAG is set high through control logic.

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 0.1μF or lager must be placed between the VIN and GND pins.

Output Capacitor

A 1μF or lager capacitor should be placed between the OUT and GND pins.

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}	V_{IN} to GND			-0.3	29	V
V_{OUT}	V_{OUT} to GND			-0.3	V_{IN}+0.3	V
V_{OVLO}	OVLO to GND			-0.3	7	V
V_{MD}	MD to GND			-0.3	29	V
V_{FLAG}	FLAG to GND			-0.3	7	V
I_{SW1}	Maximum Continuous Current of switch IN-OUT				5.5	A
I_{SW2}	Maximum Peak Current of switch IN-OUT(10ms)				8	A
P_D	Power Dissipation at T_A= +25°C				1.4	W
T_{STG}	Storage Junction Temperature			-65	+150	°C
T_A	Operating Temperature Range			-40	+85	°C
T_{SOLD}	Soldering Temperature (reflow).				+260	°C
T_J	Junction Temperature				+150	°C
ESD	Electrostatic Discharge Capability	IEC 61000-4-2 System Level ESD	Air Discharge	15.0		KV
			Contact Discharge	8.0		
		Human Body, ANSI/ESDA/JEDEC JS-001-2012	All Pins	>2.0		
		Charged Device Model, JESD22-C101	All Pins	>1.5		
Surge		IEC 61000-4-5, Surge Protection	VIN(NO DC)	-80	80	V

Electrical Characteristics

T_A=-40°C to 85°C unless otherwise noted, typical values are at V_{IN}=5V, I_{IN}≤2A, C_{IN}=0.1uF and T_A=25°C.

Symbol	Parameters	Conditions	Min	Typ	Max	Unit
Basic Operation						
V_{IN}	Input Voltage		3.2		28	V
V_{IN_CLAMP}	Input Clamping Voltage	I_{IN}=10mA		33		V
I_{IN}	V_{IN} Quiescent Current	V_{IN}=5V, OUT Floating		100		μA
R_{ON}	On-Resistance of Switch IN-OUT	V_{IN}=5.0V, I_{OUT}=1A, T_A=25°C		20		mΩ
V_{OVLO}	Over-voltage protect of V_{IN}	V_{IN} Rising, OVLO=GND	5.68	5.95	6.18	V
	Over-voltage protect hysteresis of V_{IN}			0.15		V
	Adjustable OVLO Threshold Range	V_{IN}=3.2V to V_{OVLO}	4		20	V
V_{OVLO_TH}	OVLO Set Threshold	V_{IN}=3.2V to V_{OVLO}	1.18	1.2	1.22	V
V_{OVLO_SELCET}	External OVLO Select Threshold		0.2		0.3	V
V_{UVLO_R}	Under Voltage Lockout Threshold	V_{IN} Rising		3.0		V
V_{UVLO_F}		V_{IN} Falling		2.8		V
V_{OL_FLAG}	FLAG Output Logic Low Voltage	V_{PU}=1.8V, I_{SINK}=1mA		0.1	0.2	V
I_{FLAG_LEAK}	FLAG Output HIGH Leakage Current	V_{FLAG}=5V,			0.5	uA
I_{OVLO}	OVLO Input Leakage Current	V_{OVLO}=V_{OVLO_TH}	-100		100	nA
V_A	Moisture to IN Detect Threshold		2.15	2.2	2.25	V
V_B	Moisture to GND Detect Threshold		0.85	0.9	0.95	V
I_{MOI}	Moisture Detect Source/Sink Current			3		uA
T_{SHDN}	Thermal Shutdown(1)			155		°C
T_{SHDN_HYS}	Thermal-shutdown Hysteresis(1)			20		°C
Dynamic Characteristics						
t_{DEB_OVP}	Debounce Time For OVP	Time from V_{UVLO_R}<V_{IN}< V_{OVLO} to V_{OUT}=10% of V_{IN}		15		ms
t_{ON}	Switch Turn-On Time	R_L=100Ω, C_L=22uF, V_{OUT} from 0.1×V_{IN} to 0.9×V_{IN}		2		ms
t_{DEB_MD}	Debounce Time For Moisture Detection	Time from V_{UVLO_R}<V_{IN}< V_{OVLO} to V_{FLAG} become to 0		100		ms

Electrical Characteristics (Continued)

Symbol	Parameters	Conditions	Min	Typ	Max	Unit
t_{DEG_MD}		Time from moisture detected to V_{FLAG} become to “H”		1		ms
t_{REC_MD}		Time from moisture disarmed to V_{FLAG} become to “L”		50		ms
t_{OFF_RES}(1)	Switch turn-off response time	V_{IN} > V_{OVLO} to V_{OUT} stop rising		50		ns

Note1: Guaranteed by characterization and design.

Timing Waveform

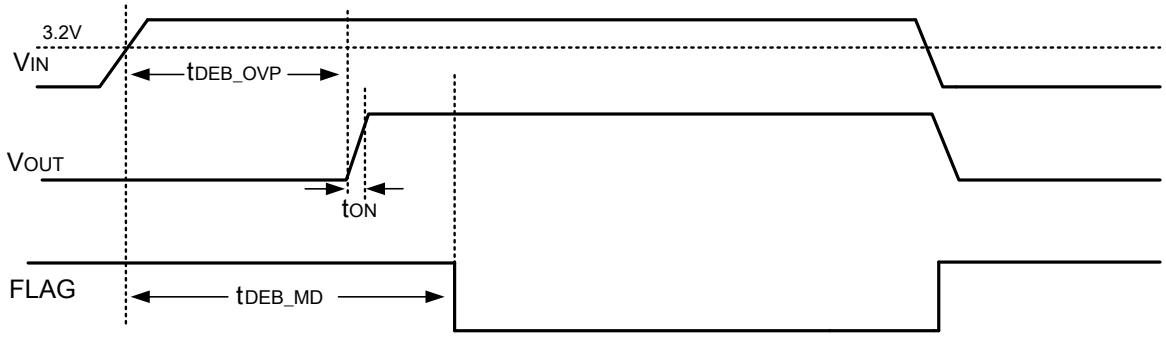


Figure 2. Timing for Power Up and Normal Operation

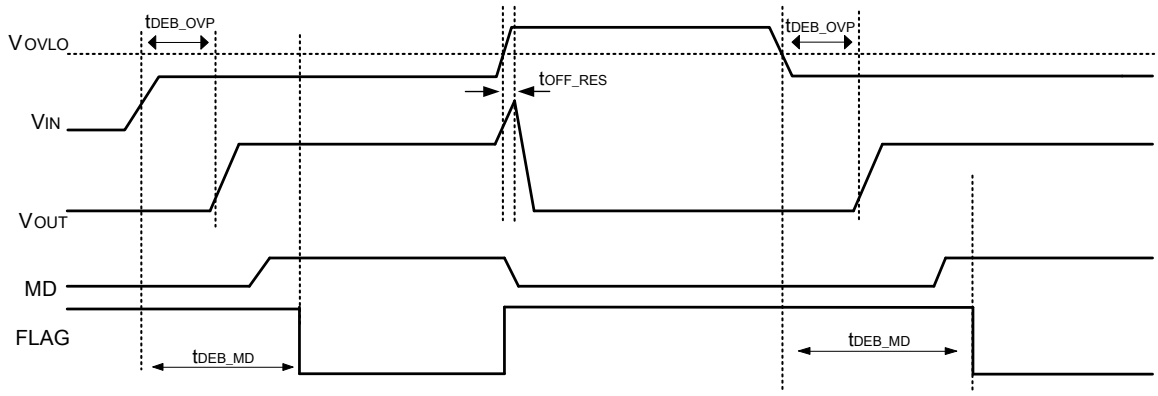


Figure 3. Timing for OVLO Trip

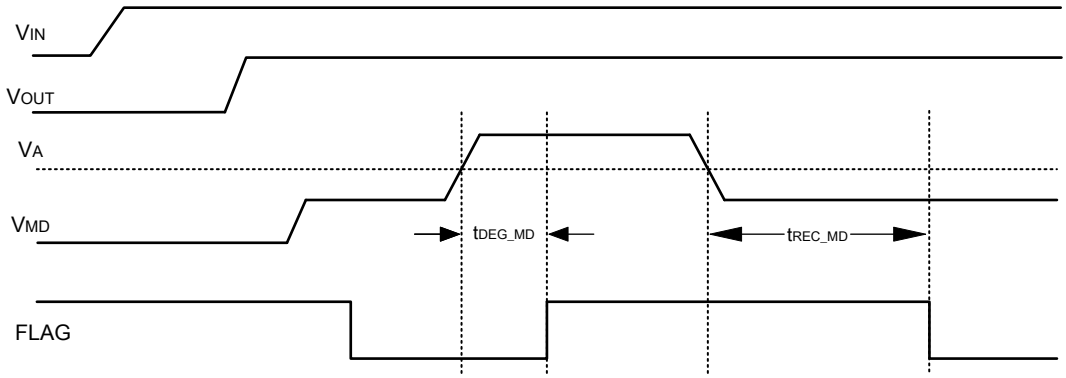
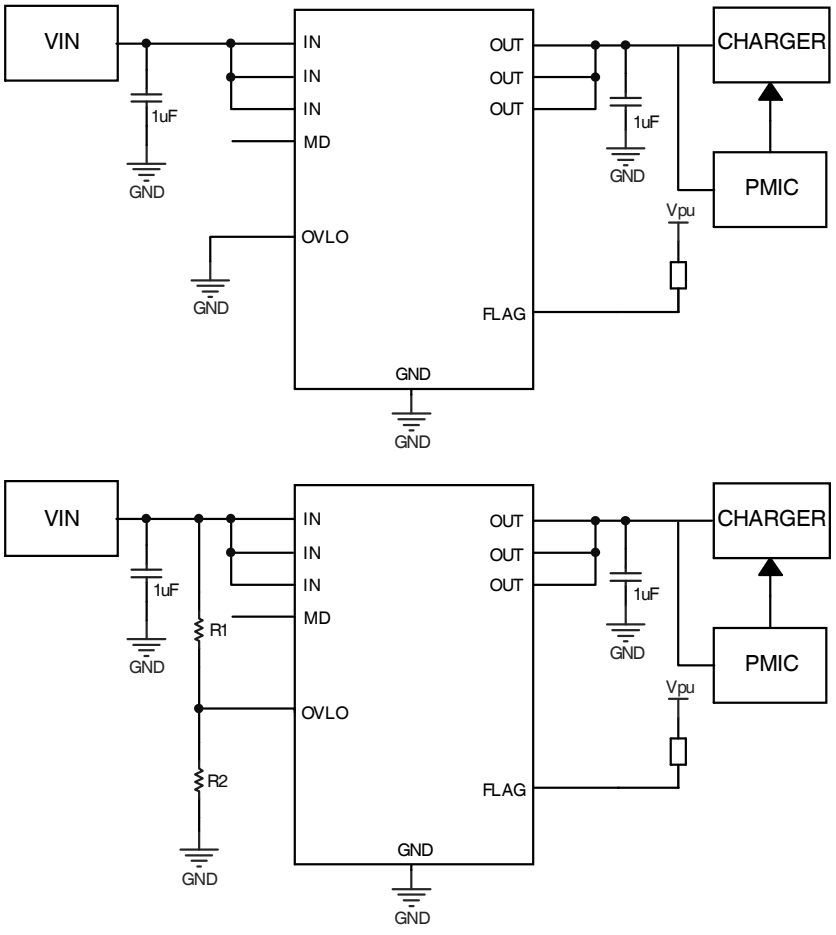


Figure 4. Timing for moisture detection

Application Circuits



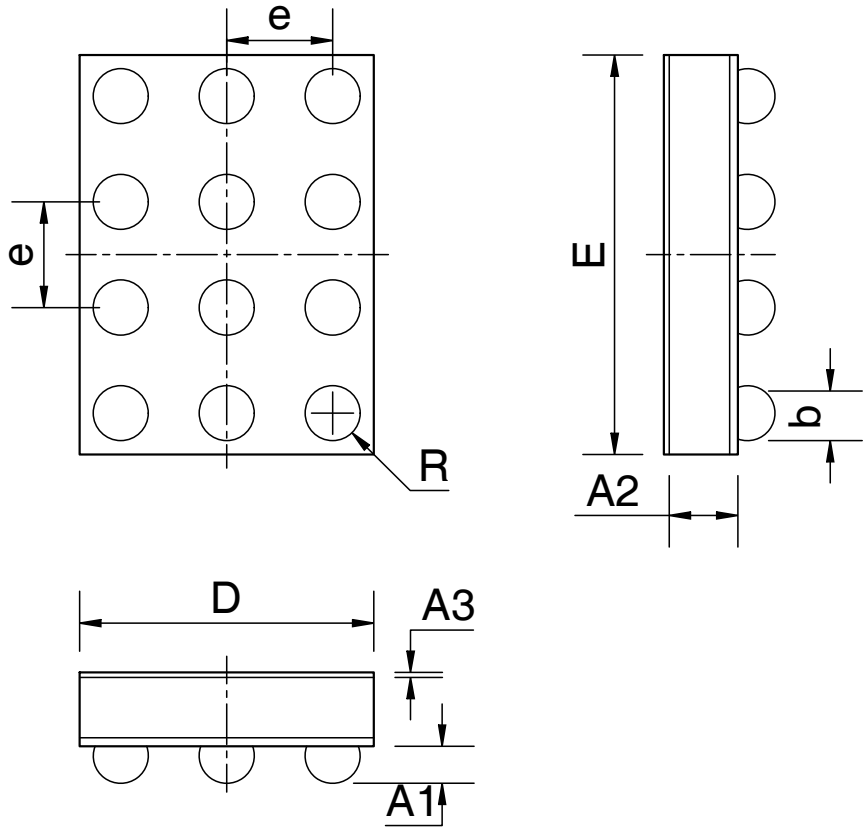
R1 and R2 are only required for adjustable OVLO; otherwise connect OVLO to GND.

Recommend 30K ≤ R2 ≤ 51K

Note*：This electric circuit only supplies for reference.

Package Dimension

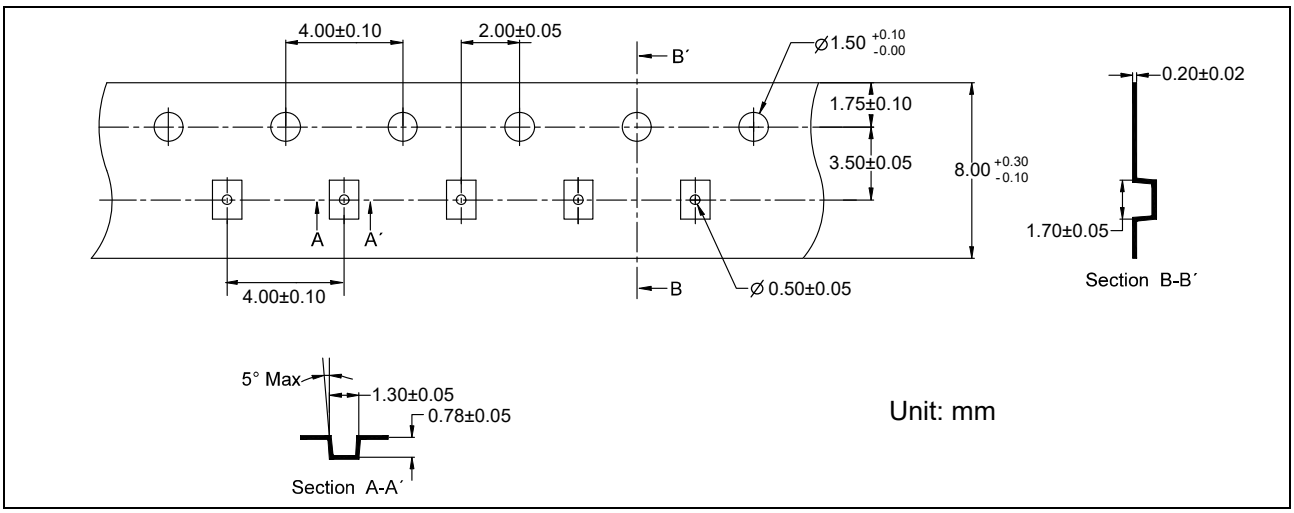
WLCSP12



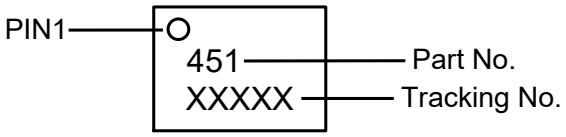
COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A1	0.12	0.14	0.16
A2	0.39	0.40	0.41
A3	0.028	0.035	0.042
b	0.15	0.18	0.21
D	1.05	1.10	1.15
E	1.50	1.55	1.60
e	0.40BSC		
R	0.15	0.18	0.21

Tape Information



Marking



Revision History and Checking Table

Version	Date	Revision Item	Modifier	Function & Spec Checking	Package & Tape Checking
0.0	2023.03	Preliminary Version	Wumin	Wuxj	liujy
0.1	2025.05	Preliminary Version	Caojc	Wumin	liujy
0.2	2025.05	Preliminary Version	Caojc	Wumin	liujy
1.0	2025.07	Initial Version	Caojc	Wumin	liujy
1.1	2026.09	Update Timing Waveform	Caojc	Wumin	liujy