5.5V 2A 38mΩ Load Switch with Reverse Current Protection and Controlled Turn On

General Description

The ET3561X is a single load switch with reverse current protection and controlled turn-on. The device can operate from 1V to 5.5V single supply and has the ability to drive up to 2A continuous current.

The device contains a 38mΩ low R_{ON} N-MOSFET controlled by the ON pin. When the power supply is turned on for the first time, a smart pull-down resistor is used to float the ON pin until the system is stable. Once the ON pin reaches a high voltage (> V_{IH}), the pull-down resistor is disconnected, then the standby current is very low and power loss can be reduced. The small package and low R_{ON} make the device very suitable for space limited, battery powered applications.

The device supports a wide input voltage range, which is suitable for many different voltage rails. The rise time is used to avoid inrush current. The ET3561X offers the quick output discharge function in disable status.

Features

- Input Voltage Range: 1.0V to 5.5V
- Maximum Continuous Current: 2A
- Ultra-Low On-Resistance
  -- R_{ON} = 38mΩ @ V_{IN} = 5V
  -- R_{ON} = 38mΩ @ V_{IN} = 3.3V
- Low Shutdown Current: 140nA (TYP)
- Low Threshold 1.8V GPIO Control Input
- Controlled Slew Rate to Avoid Inrush Current
- Quick Output Discharge
- Bi-directional Power Supplier for Power Zone Application
- Part No. and Package Information

Part No.	Package	Packaging Option	MSL
ET3561	WLCSP4 (0.762mm × 0.762mm)	Tape and Reel, 3K	Level 1
ET35611	WLCSP4 (0.762mm × 0.762mm)	Tape and Reel, 3K	Level 1
ET35612	WLCSP4 (0.762mm × 0.762mm)	Tape and Reel, 3K	Level 1
ET35613	WLCSP4 (0.762mm × 0.762mm)	Tape and Reel, 3K	Level 1

Applications

- Smartphone
- Notebook Computer and Ultrabook
- Tablet PC Computer
- Solid State Drive (SSD)
- DTV / IP Set Top Box
- POS Terminal and Media Gateway
- Wearable Technology

Functional Modes

Part No.	RCB State	Discharge (ON = L)	
		$V_{IN} > V_{OUT}$	$V_{IN} < V_{OUT}$
ET3561	OFF	Active	Active
ET35611	ON / OFF	Active	Disabled
ET35612	OFF	Active	Disabled
ET35613	ON / OFF	Disabled	Disabled

Pin Configuration

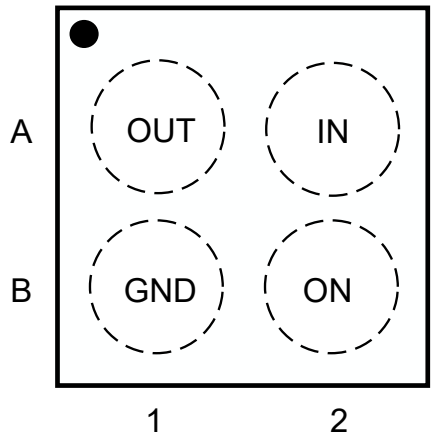


Fig 1. Top View

Pin Function

Pin Name	Symbol	Pin Description
A1	OUT	Switch Output.
A2	IN	Switch Input. Use a bypass capacitor (ceramic) to ground.
B1	GND	Ground.
B2	ON	Switch Control Input. Do not float this pin. Logic high turns on power switch

Block Diagram

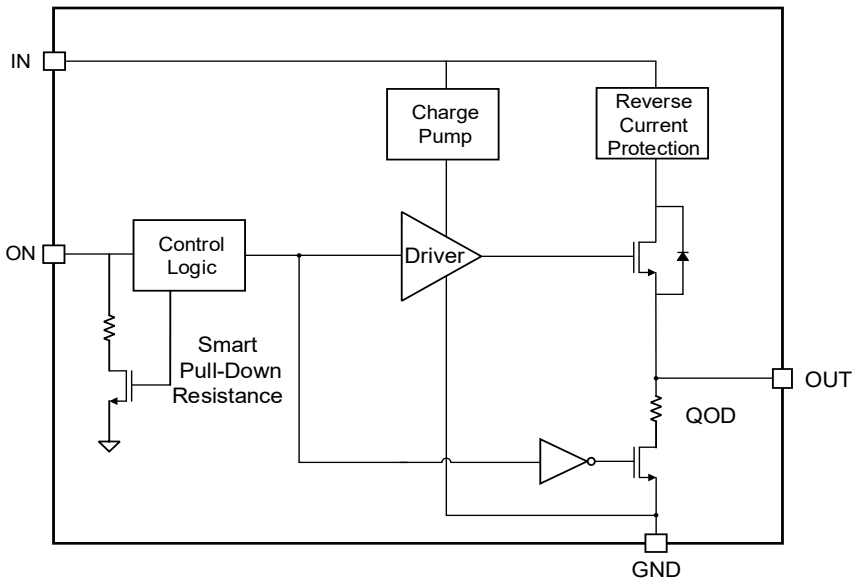


Fig 2. Functional Block Diagram

Functional Description

The ET3561X is a small, 4-ball, 2A load switch. A low on-resistance N-MOSFET is integrated, which makes a low voltage drop across the device. To choose suitable rise time is always used to avoid inrush current.

ON/OFF Control

The ON pin can control the device. Pulling the ON pin high enables the device. Logic high of V_{IH} on the ON pin will enable the device and V_{IL} will turn off it. It has the ability to interface with low-voltage GPIO. It can support with 1.8V, 2.5V, 3.3V GPIOs.

Table 1. Function Table

ON State	V_{IN} to V_{OUT}	Output Discharge
L	Off	Active
H	On	Disabled

Table 2. Smart-ON Functional Modes

ON	ON Pin
Below V_{IL}	Pull-Down Active
Above V_{IH}	No Pull-Down

Quick Output Discharge

The ET3561 includes the quick output discharge (QOD) feature while the switch is disabled; When ET35611 and ET35612 switch disabled(V_{IN} > V_{OUT}), a discharge resistance with a typical value of 250Ω is connected between the output and ground. This resistance pulls down the output and prevents it from floating when the device is disabled. ET35613 without the quick output discharge feature.

Reverse Current Protection

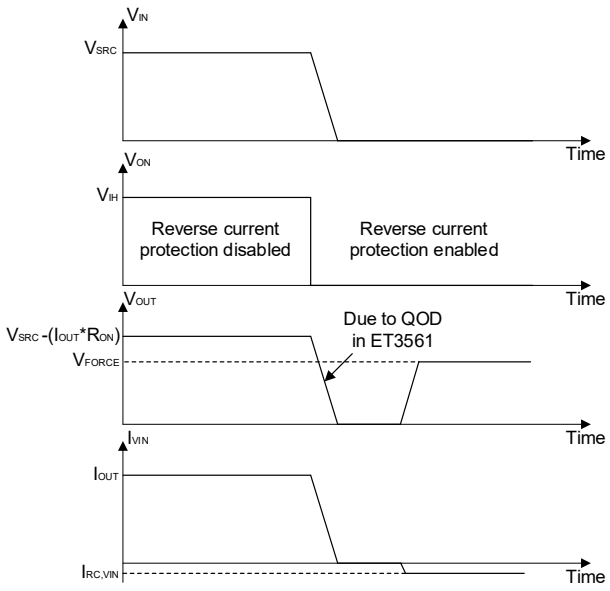
The device monitor VIN and VOUT voltage levels. When the reverse current voltage threshold (VRCP) is exceeded, the switch is disabled, so as to prevent any reverse current flow to VIN. This feature is particularly useful when the outputs of ET35611 and ET35613 need to be driven by another voltage source.

In order for this feature to work, ET3561 and ET35612 have to be disabled and either of the following conditions shall be met: V_{IN} > 1V or V_{OUT} > 1V.

Fig 3 demonstrates the ideal behavior of reverse current protection circuit in ET3561. After the device is disabled via the ON pin and VOUT pin is forced to an external voltage V_{FORCE}, a very small amount of current given by I_{RC_VIN}, V_{IN} will flow from V_{OUT} to V_{IN}. This will prevent any extra current loading on the voltage source supplying the V_{FORCE} voltage.

Table 3. The Truth Table of RCB

Part No.	ON State	V_{IN} > V_{OUT}		V_{IN} < V_{OUT}	
		ON Pin	Discharge	ON Pin	Discharge
ET3561 (OFF RCB)	L	Pull-Down Active	Active	Pull-Down Active	Active
	H	No Pull-Down	Disabled	No Pull-Down	Disabled
ET35611 (ON / OFF RCB)	L	Pull-Down Active	Active	Pull-Down Active	Disabled
	H	No Pull-Down	Disabled	Pull-Down Active	Disabled
ET35612 (OFF RCB)	L	Pull-Down Active	Active	Pull-Down Active	Disabled
	H	No Pull-Down	Disabled	No Pull-Down	Disabled
ET35613 (ON / OFF RCB)	L	Pull-Down Active	Disabled	Pull-Down Active	Disabled
	H	No Pull-Down	Disabled	Pull-Down Active	Disabled



I_{VIN} = Current through V_{IN} pin

V_{SRC} = Input voltage applied to the device

V_{FORCE} = External voltage source forced at VOUT pin of the device

I_{OUT} = Output load current

Fig 3. The Ideal Behavior of Reverse Current Protection Circuit in ET3561X

Application Information

Input Capacitor

It is recommended to place a capacitor (C_{IN}) between IN and GND pins of ET3561X. This capacitor helps to limit the voltage drop on the input voltage supply when the switch turns ON into a discharged load capacitor. A 1μF ceramic capacitor that is placed close to the IC pins is usually sufficient. Higher values of C_{IN} can be used to further reduce the voltage drop in high current applications.

Output Capacitor

It is recommended to place a capacitor (C_{OUT}) between OUT and GND pins of ET3561X. This capacitor acts as a low pass filter along with the switch ON-resistance to remove any voltage glitches coming from the input voltage source. It is generally recommended to have C_{IN} greater than C_{OUT} so that once the switch is turned ON, C_{OUT} can charge up to V_{IN} without V_{IN} dropping significantly. A 0.1μF ceramic capacitor that is placed close to the IC pins is usually sufficient.

Standby Power Reduction

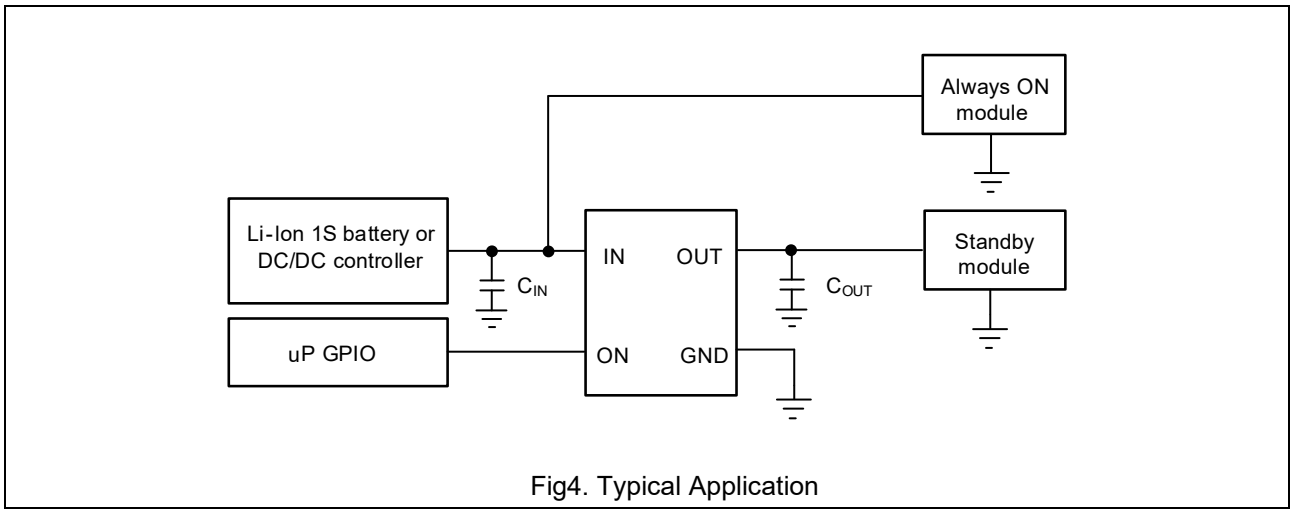


Fig4. Typical Application

Any end equipment that is being powered from the battery has a need to reduce current consumption in order to keep the battery charged for a longer time. ET3561 helps to accomplish this by turning off the supply to the modules that are in standby state and hence significantly reduces the leakage current overhead of the standby modules.

Power Supply Sequencing Without a GPIO Input

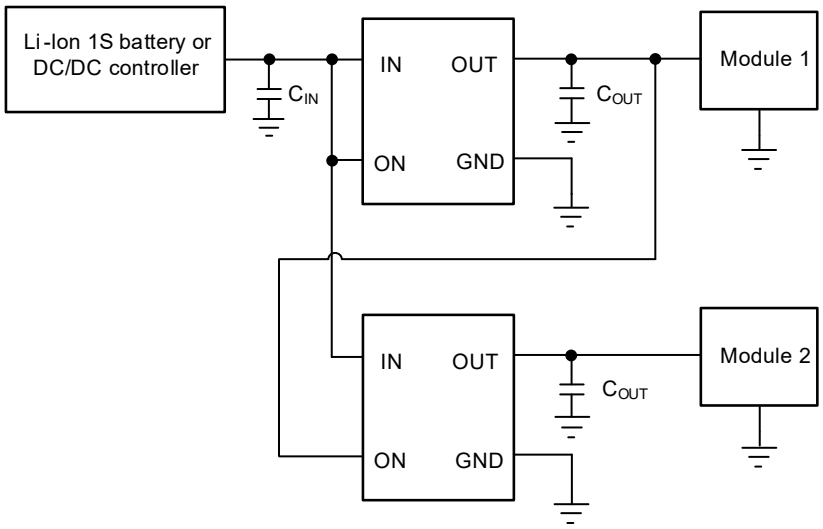


Fig 5. Power Supply Sequencing Without a GPIO Input

In many end equipment, there is a need to power up various modules in a predetermined manner. ET3561X can solve the problem of power sequencing without adding any complexity to the overall system. Fig5 shows the configuration required for powering up two modules in a fixed sequence. The output of the first load switch is tied to the enable of the second load switch, so when Module 1 is powered the second load switch is enabled and Module 2 is powered.

Typical Application

ET3561X is an ultra-low ON-resistance, 2A integrated load switch that is capable of interfacing directly with 1S battery in portable consumer devices such as smartphones, tablets etc. Its wide input voltage range (1V to 5.5V) makes it suitable to be used for lower voltage rails as well inside different end equipment to accomplish power sequencing, inrush current control and reducing leakage current in subsystems that are in standby mode.

Fig 6 shows the typical application circuit of ET3561X.

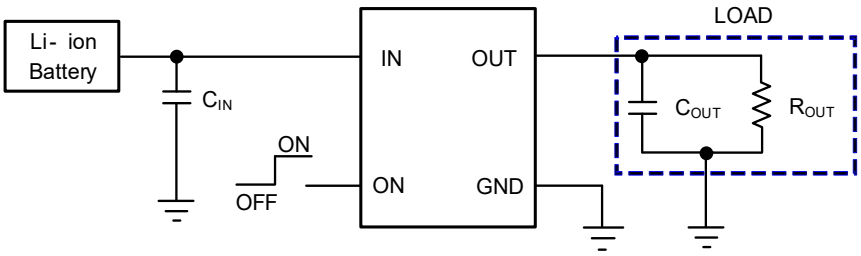


Fig 6. Typical Application Circuit

Power Supply Recommendations

The device is designed to operate with a V_{IN} range of 1V to 5.5V. This supply must be well regulated and placed as close to the device terminal as possible with the recommended 1μF bypass capacitor.
If the supply is located more than a few inches from the device terminals, additional bulk capacitance may be required in addition to the ceramic bypass capacitors. If additional bulk capacitance is required, an electrolytic, tantalum, or ceramic capacitor of 10μF may be sufficient.

Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted)

Symbol	Parameter	Rating	Unit
V_{IN}	Input Voltage Range	-0.3 to 6.0	V
V_{OUT}	Output Voltage Range	-0.3 to 6.0	V
V_{ON}	ON Pin Voltage Range	-0.3 to 6.0	V
I_{MAX}	Maximum Continuous Switch Current	2.0	A
I_{PLS}	Maximum Pulsed Switch Current, Pulse < 300us, 2% Duty Cycle	2.5	A
T_{JMAX}	Maximum Junction Temperature	150	°C
T_{STG}	Storage Temperature Range	-65 to 150	°C
V_{ESD}	Human-Body Model (HBM)	±4000	V
	Charged-Device Model (CDM)	±1000	V

Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Unit
V_{IN}	Input Voltage Range	1		5.5	V
V_{OUT}	Output Voltage Range	0		5.5	V
C_{IN}	Input Capacitor		1[(1)]		μF
T_A	Operating Free Air Temperature Range	-40		85	°C

Note1: Refer to the application information.

Electrical Characteristics

(Typical values are at T_A = 25°C, V_{IN} = 1V to 5.5V. unless otherwise noted.)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{IN}	Input Voltage Range		1		5.5	V
I_Q	Quiescent Current	V_{IN} = V_{ON} = 5.0V, I_{OUT} = 0mA		280	650	nA
		V_{IN} = V_{ON} = 3.3V, I_{OUT} = 0mA		220	500	
		V_{IN} = V_{ON} = 1.0V, I_{OUT} = 0mA		140	350	
I_{SD}	Shutdown Current	V_{ON} = 0V, V_{IN} = 5.5V, T_A = 25°C		140	500	nA
$I_{LEAKAGE}$	Supply Leakage Current in Shutdown Mode	V_{ON} = 0V, V_{IN} = 5.5V, V_{OUT} = 0V, T_A = 25°C			500	nA
R_{ON}	On-Resistance	V_{IN} = 5V, V_{ON} = 1.2V, I_{OUT} = -200mA		38	60	mΩ
		V_{IN} = 3.3V, V_{ON} = 1.2V, I_{OUT} = -200mA		38	60	
I_{ON}	ON Pin Leakage Current	V_{ON} = V_{IN} = 5.5V		10	420	nA
V_{RCP}	Reverse Current Voltage Threshold	V_{IN} = 1.0V to 5.5V		120		mV
I_{RC}	Reverse Current When Disabled	V_{IN} = V_{ON} = 0V, V_{OUT} = 5V, Measure Input leakage		0.02	1.5	μA
R_{PD}[(2)]	Output Pull-Down Resistance	V_{IN} = 2.5V, V_{ON} =0V, I_{OUT} = 2mA		250	370	Ω
		V_{IN} = 5V, V_{ON} = 0V, I_{OUT} = 2mA		250	360	
R_{PD_ON}	Smart Pull-Down Resistance	Disabled		1.2	3.0	MΩ
V_{IL}	ON Pin Input Low Voltage				0.4	V
V_{IH}	ON Pin Input High Voltage		0.9			V

Note2: Except ET35613.

Switching Characteristics

T_A = 25°C, unless otherwise noted.

Parameter		Conditions	Min	Typ	Max	Unit
V_{IN} = 5.0V						
t_{ON}	Turn-On Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF		165	450	μs
t_{OFF}	Turn-Off Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF		3		
t_R	V_{OUT} Rise Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF		110		
t_F	V_{OUT} Fall Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF		2		
t_D	Delay Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF		145		
V_{IN} = 3.3V						
t_{ON}	Turn-On Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF		110	350	μs
t_{OFF}	Turn-Off Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF		4		
t_R	V_{OUT} Rise Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF		130		
t_F	V_{OUT} Fall Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF		2		
t_D	Delay Time	R_{OUT} = 10Ω, C_{IN} = 1μF, C_{OUT} = 0.1μF		70		

Switching Waveform

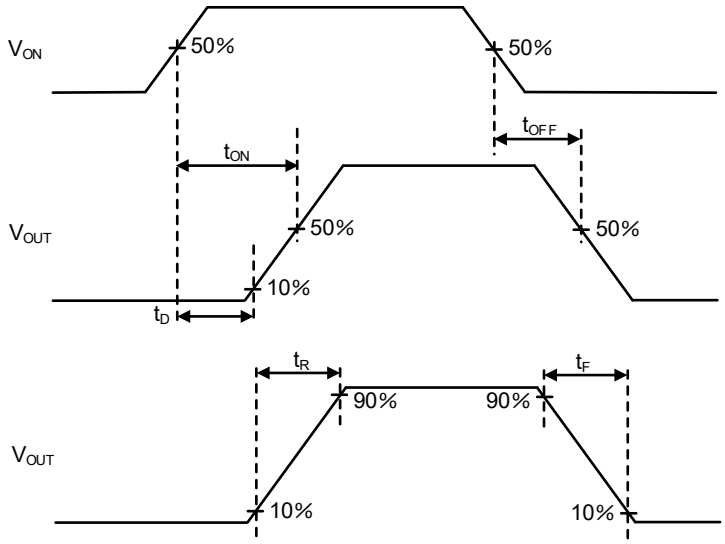
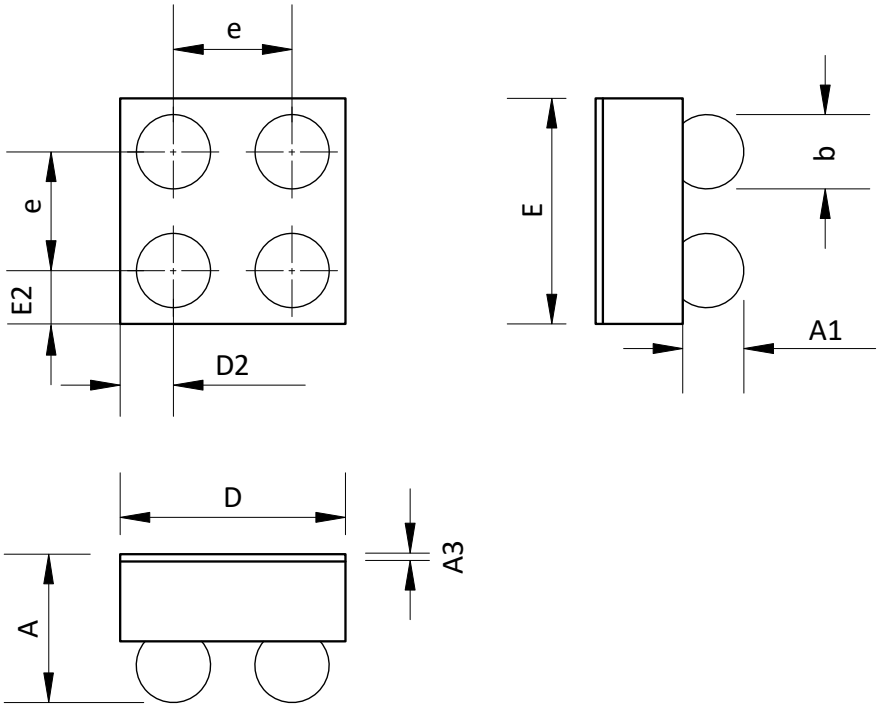


Fig 7. Timing Diagram

Package Dimension

WLCSP4 (0.762mm × 0.762mm)

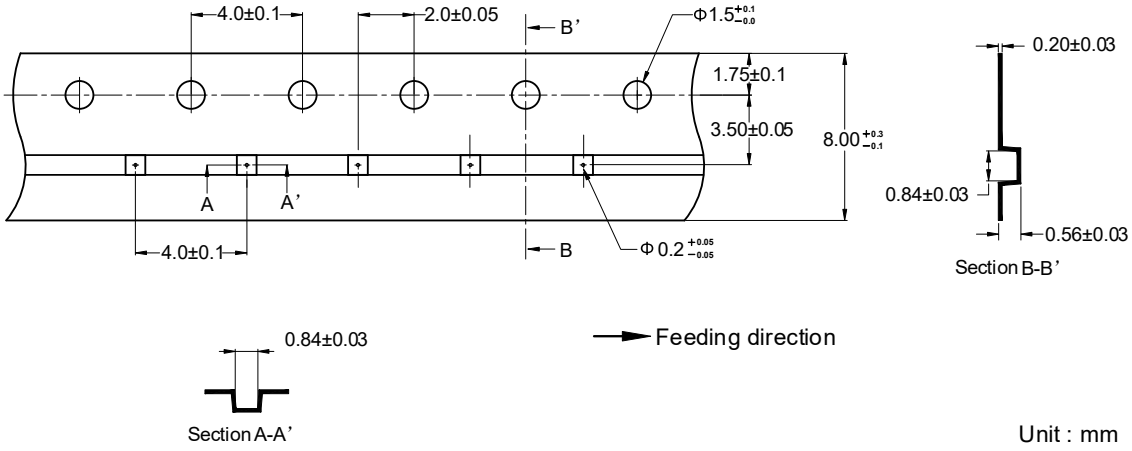


COMMON DIMENSIONS

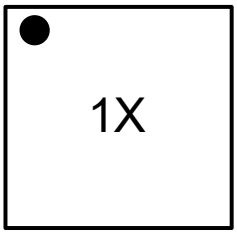
(Unit: mm)

SYMBOL	MIN	NOM	MAX
A	0.4205	0.450	0.4795
A1	0.068	0.080	0.092
A3	0.020	0.025	0.030
b	0.216	0.240	0.264
D	0.737	0.762	0.787
E	0.737	0.762	0.787
D2	0.181 REF		
E2	0.181 REF		
e	0.400 BSC		

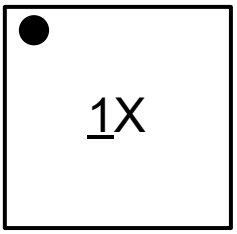
Tape Information



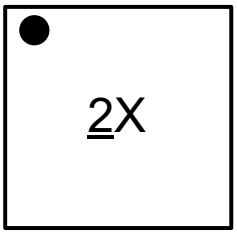
Marking



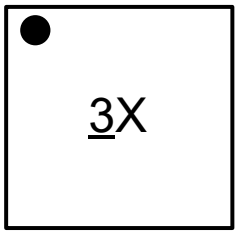
ET3561
1 = Part Number
X = Tracking Number



ET35611
1 = Part Number
X = Tracking Number



ET35612
2 = Part Number
X = Tracking Number



ET35613
3 = Part Number
X = Tracking Number

Revision History and Checking Table

Version	Date	Revision Item	Modifier	Function & Spec Checking	Package & Tape Checking
0.0	2025-07-02	Preliminary Version	Wangar	Yangxx	Liujy
0.1	2025-12-10	Update POD	Shib	Yangxx	Liujy
1.0	2026-02-11	Official Version	Yuyf	Yangxx	Liujy
1.1	2026-03-30	Add Derivative Products Information	Yuyf	Yangxx	Liujy
1.2	2026-05-27	Update Functional Modes	Yuyf	Wangar	Liujy
1.2.a	2026-07-01	Update Marking	Yangxx	Yangxx	Liujy
1.3	2026-09-10	Update EC Table	Wangar	Yangxx	Liujy