3.5V, 6A, Low Resistance Load Switch

General Description

The ET3161 is a small, ultra-low Resistance, signal channel load switch with controlled turn on. The device contains an N-channel MOSFET that can operate over an input voltage range of 0.8V to 3.5V and support a maximum continues current of 6A.

The combination of ultra-low RON and high current capability of the device makes it ideal for driving processor rails with very tight voltage dropout tolerances. Quick rise time of the device allows for power rails to come up quickly when the device is enabled, thereby reducing response time for power distribution. The switch can be independently controlled via the ON terminal, which is capable of interfacing directly with low-voltage control signals originating from micro-controllers or low voltage discrete logic. The device further reduces the total solution size by integrating a 240Ω pull-down transistor for quick output discharge (QOD) when the switch is turned off.

The ET3161 is available in a small, space-saving 3mm*3mm DFN8LQ package with integrated thermal pad allowing for high power dissipation. The device is characterized for operation over the free-air temperature range of -40°C to 85°C.

Features

- Integrated Single Channel Load Switch
- VBIAS Voltage Range: 3V to 5.5V
- Input Voltage Range: 0.8V to 3.5V
- Ultra low On Resistance:
  -- R_{ON}=4.8mΩ at V_{IN}=1.05V (V_{BIAS}=5V)
- 6A Maximum Continuous Switch Current
- Low<1uA Off Switch Current
- Low Control Input Threshold Enable use of 1.2V/1.8V/2.5V/3.3V Logic
- Quick Output Discharge (QOD)
- DFN8 (3mm ×3mm) Package with Thermal Pad
- Controlled Slew Rate:
  -- t_R=4.2us at V_{IN}=1.05V (V_{BIAS}=5V)
- ESD Protected: Above 4.0kV HBM, 2.0kV CDM Pass

Application

- Ultra-book TM/Notebooks
- Desktops
- Servers
- Set-top Boxes
- Telecom Systems
- Tablet PC

Pin Configuration

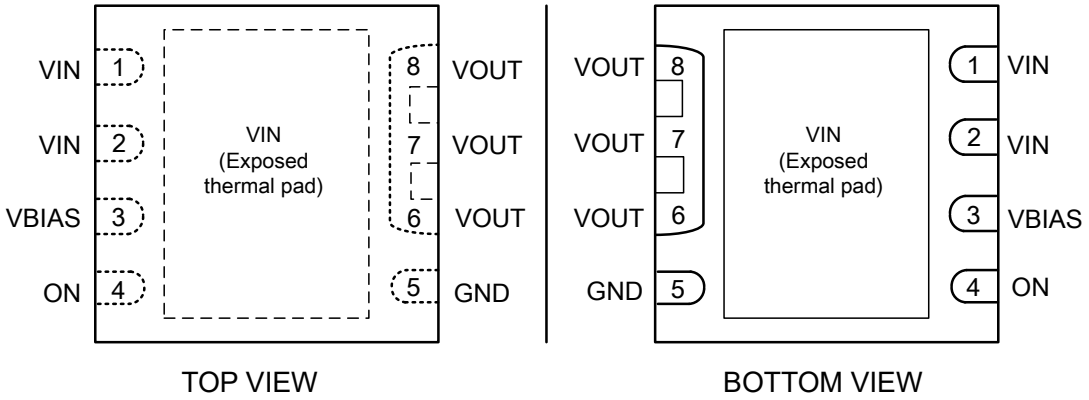


Figure 1. Pin Configuration

Pin Function

Pin No.	Pin Name	Description
1, 2	VIN	Switch input. Place ceramic bypass capacitor(s) between this terminal and GND.
3	VBIAS	Bias voltage. Power supply to the device.
4	ON	Active high switch control input. Do not leave floating.
5	GND	GND.
6,7,8	VOUT	Switch output. Place ceramic bypass capacitor(s) between this terminal and GND.

Block Diagram

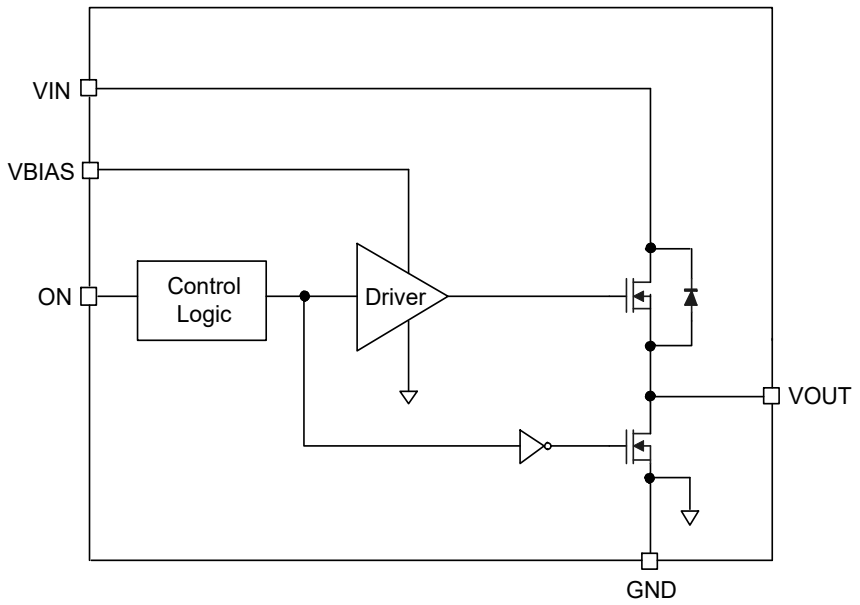


Figure 2. Functional Block Diagram

Functional Description

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 V_{IN} and GND pins. A 1uF ceramic capacitor, C_{IN}, placed close to the pins is usually sufficient.

Higher-value C_{IN} can be used to reduce the voltage drop in higher-current applications. When switching heavy loads, it is recommended to have an input capacitor 10 times higher than the output capacitor to avoid excessive voltage drop.

Output Capacitor

Due to the integrated body diode in the NMOS switch, a C_{IN} greater than C_L is highly recommended. A C_L 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 V_{OUT} to V_{IN}. A C_{IN} to C_{OUT} ratio of 10 to 1 is recommended for minimizing V_{IN} dip caused by inrush currents during startup, however a 10 to 1 ratio for capacitance is not required for proper functionality of the device. A ratio smaller than 10 to 1 (such as 1 to 1) could cause a V_{IN} dip upon turn-on due to inrush currents.

ON/OFF Control

The ON terminal controls the state of the load switch, and asserting the terminal high (active high) enables the switch. The ON terminal is compatible with standard GPIO logic threshold and can be used with any micro-controller or discrete logic with 1.2V or higher GPIO voltage. This terminal cannot be left floating and must be tied either high or low for proper functionality.

V_{IN} and V_{BIAS} Voltage Range

For optimal R_{ON} performance, make sure $V_{IN} \leq (V_{BIAS}-1.95V)$. For example, in order to have $V_{IN}=3.5V$, V_{BIAS} must be 5.5V. The device will still be functional if $V_{IN} > (V_{BIAS}-1.95V)$ but it will exhibit R_{ON} greater than what is listed in the Electrical Characteristics, $V_{BIAS}=5.0V$ table. See Figure 3 for an example of a typical device. Notice the increasing R_{ON} as V_{IN} increase. Be sure to never exceed the maximum voltage rating for V_{IN} and inrush currents.

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	4.0	V
V_{BIAS}	V_{BIAS} to GND		-0.3	6.0	V
V_{OUT}	V_{OUT} to GND		-0.3	4.0	V
V_{ON}	ON to GND		-0.3	6.0	V
I_{MAX}	Maximum Continuous Switch Current			6.0	A
I_{PLS}	Maximum Pulsed Switch Current, pulse <300us, 2% Duty Cycle			8.0	A
P_D	Power Dissipation at T_A=25°C			1.0	W
T_{STG}	Storage Junction Temperature		-65	+150	°C
θ_{JA}	Junction-to-ambient thermal resistance			44.6	°C/W
T_J	Maximum junction temperature			150	°C
T_L	Maximum lead temperature (10s soldering time)			300	°C
V_{ESD}	Electrostatic Discharge Capability	Human Body Model, JESD22-A114	±4.0		kV
		Charged Device Model, JESD22-C101	±2.0		

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		0.8	V_{BIAS}-1.95	V
V_{BIAS}	Bias voltage range		3	5.5	V
V_{ON}	ON voltage range		0	5.5	V
V_{OUT}	Output voltage range			V_{IN}	V
V_{IH_ON}	High-level voltage ON	V_{BIAS}=3V to 5.5V	1.2	5.5	V
V_{IL_ON}	Low-level voltage ON	V_{BIAS}=3V to 5.5V	0	0.5	V
T_A	Ambient Operating Temperature		-40	+85	°C

Electrical Characteristics, V_{BIAS}=5.0V

Unless otherwise noted, the specification in the following table applies over the operating ambient temperature T_A=-40 to +85°C and V_{BIAS}=5.0V; typical values are for T_A=25°C.

Symbol	Parameter	Test Conditions			Min	Typ	Max	Unit
Power Supply and Current								
I_Q,V_{BIAS}	V_{BIAS} Quiescent Current	I_{OUT}=0, V_{IN}=3V V==V_{BIAS}=5.0V				0.4	1.0	uA
I_{SD},V_{BIAS}	V_{BIAS} Shutdown Current	V_{ON}=0V, V_{OUT}=0V				0.4	1.0	uA
I_{SD},V_{IN}	V_{IN} Shutdown Current	V_{ON}=0V V_{OUT}=0V		V_{IN}=3.0V			0.4	uA
				V_{IN}=2.5V			0.4	
				V_{IN}=2.0V			0.4	
				V_{IN}=1.05V			0.4	
				V_{IN}=0.8V			0.4	
I_{ON}	ON Terminal Input Leakage Current	V_{ON}=5.5V					0.1	uA
Resistance Characteristics								
R_{ON}	On-Resistance	I_{OUT}=-1A V_{BIAS}=5.0V	V_{IN}=3.0V	T_A=25°C		6.2	11.0	mΩ
				T_A=-40 to +85°C			12.0	
			V_{IN}=2.5V	T_A=25°C		5.4	7.0	
				T_A=-40 to +85°C			8.0	
			V_{IN}=2.0V	T_A=25°C		5.1	5.8	
				T_A=-40 to +85V			6.7	
			V_{IN}=1.05V	T_A=25°C		4.8	5.3	
				T_A=-40 to +85°C			6.2	
			V_{IN}=0.8V	T_A=25°C		4.7	5.3	
				T_A=-40 to +85°C			6.1	
R_{PD}	Output Pull-down Resistance	V_{IN}=5.0V, V_{ON}=0V, V_{OUT}=1V				240	300	Ω

Electrical Characteristics, V_{BIAS}=3.0V

Unless otherwise noted, the specification in the following table applies over the operating ambient temperature T_A=-40 to +85°C and VBIAS=3.0V; typical values are for T_A=25°C .

Symbol	Parameters	Conditions			Min	Typ	Max	Unit
Power Supply and Current								
I_Q,V_{BIAS}	V_{BIAS} Quiescent Current	I_{OUT}=0, V_{IN}=1.0V V_{ON}=V_{BIAS}=3.0V				0.2	1.0	uA
I_{SD},V_{BIAS}	V_{BIAS} Shutdown Current	V_{ON}=0V, V_{OUT}=0V				0.2	1.0	uA
I_{SD},V_{IN}	V_{IN} Shutdown Current	V_{ON}=0V V_{OUT}=0V	V_{IN}=1.05V				0.4	uA
			V_{IN}=0.8V				0.4	
I_{ON}	ON Terminal Input Leakage Current	V_{ON}=5.5V					0.1	uA
Resistance Characteristics								
R_{ON}	On-Resistance	I_{OUT}=-1A V_{BIAS}=3.0V	V_{IN}=1.05V	T_A=25°C		6.2	12.0	mΩ
				T_A=-40 to +85°C			13.0	
			V_{IN}=0.8V	T_A=25°C		5.8	8.0	
				T_A=-40 to +85°C			9.0	
R_{PD}	Output Pull-down Resistance	V_{IN}=3.0V, V_{ON}=0V, V_{OUT}=1V				240	300	Ω

Switching Characteristics[(1)(2)]

Refer to the timing test circuit in the Figure 3 (unless otherwise noted) for references to external components used for the test condition in the switching characteristics table.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{IN}=2.5V, V_{ON}=V_{BIAS}=5.0V,T_A=-40°C to 85°C						
t_{ON}	Turn-on time	R_L=10Ω, C_L=0.1uF		7.5	45.0	us
t_{OFF}	Turn-off time			6.0	30.0	
t_R	V_{OUT} rise time			7.5	36.0	
t_F	V_{OUT} fall time			3.0	25.0	
t_D	Delay time			5.5	30.0	
V_{IN}=1.05V, V_{ON}=V_{BIAS}=5.0V,T_A=-40°C to 85°C						
t_{ON}	Turn-on time	L=2.2uH (DCR=0.33Ω)	7.0	20.5	55.0	us
t_{OFF}	Turn-off time	C_L=2×22uF	4600			
t_R	V_{OUT} rise time	Refer to Typical Application Powering Rails	4.0	27.0	40.0	
t_F	V_{OUT} fall time	Sensitive to Ringing and Over-voltage due to	25000			
t_D	Delay time	Fast Rise Time and Figure 5	6.0	10.0	45.0	

Switching Characteristics (Continued)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{IN}=1.05V, V_{ON}=V_{BIAS}=5.0V,T_A=-40°C to 85°C						
t_{ON}	Turn-on time	R_L=2.0Ω, C_L=0.1uF		8.5	60.0	us
t_{OFF}	Turn-off time			9.0	70.0	
t_R	V_{OUT} rise time			6.0	30.0	
t_F	V_{OUT} fall time			2.0	25.0	
t_D	Delay time			6.0	35.0	
V_{IN}=0.8V, V_{ON}=V_{BIAS}=5.0V,T_A=-40°C to 85°C						
t_{ON}	Turn-on time	R_L=10Ω, C_L=0.1uF		8.0	40.0	us
t_{OFF}	Turn-off time			10.0	45.0	
t_R	V_{OUT} rise time			4.0	25.0	
t_F	V_{OUT} fall time			3.0	30.0	
t_D	Delay time			6.0	35.0	
V_{IN}=1.05V, V_{ON}=5.0V, V_{BIAS}=3.0V, T_A=-40°C to 85°C						
t_{ON}	Turn-on time	R_L=10Ω, C_L=0.1uF		16.0	65.0	us
t_{OFF}	Turn-off time			8.0	35.0	
t_R	V_{OUT} rise time			10.0	40.0	
t_F	V_{OUT} fall time			3.0	25.0	
t_D	Delay time			11.0	45.0	
V_{IN}=0.8V, V_{ON}=5V, V_{BIAS}=3.0V,T_A=-40°C to 85°C						
t_{ON}	Turn-on time	R_L=10Ω, C_L=0.1uF		15.0	65.0	us
t_{OFF}	Turn-off time			9.0	35.0	
t_R	V_{OUT} rise time			8.0	35.0	
t_F	V_{OUT} fall time			3.0	30.0	
t_D	Delay time			11.0	45.0	

Note(1) This parameter is guaranteed by design and characterization; not production tested.

Note(2) t_{ON} / t_{OFF} / t_R / t_F / t_D are defined in Figure 4.

Timing Diagram

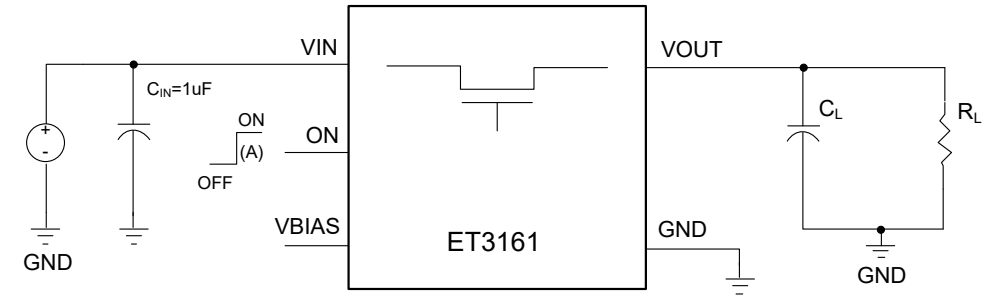


Figure 3. Timing Test Circuit

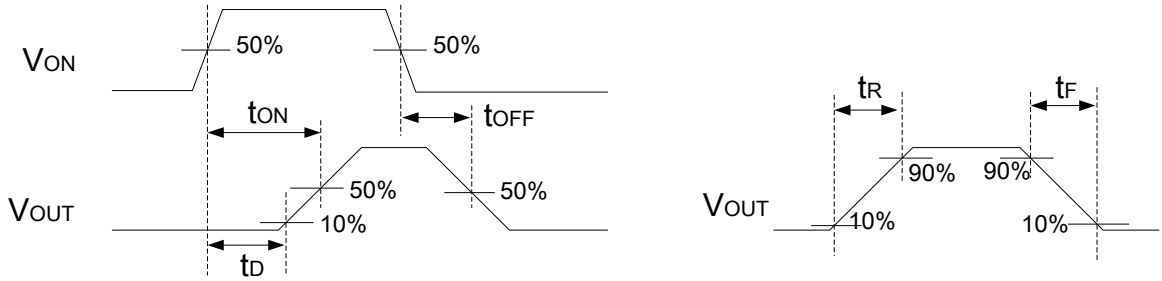


Figure 4. Switching Characteristics Measurement Setup and Definitions

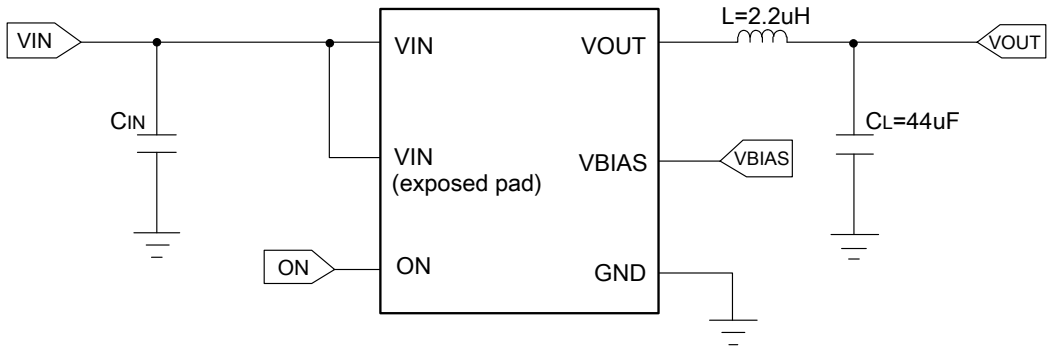


Figure 5. Typical Application Schematic for Powering Rails Sensitive to Ringing

Application Circuit

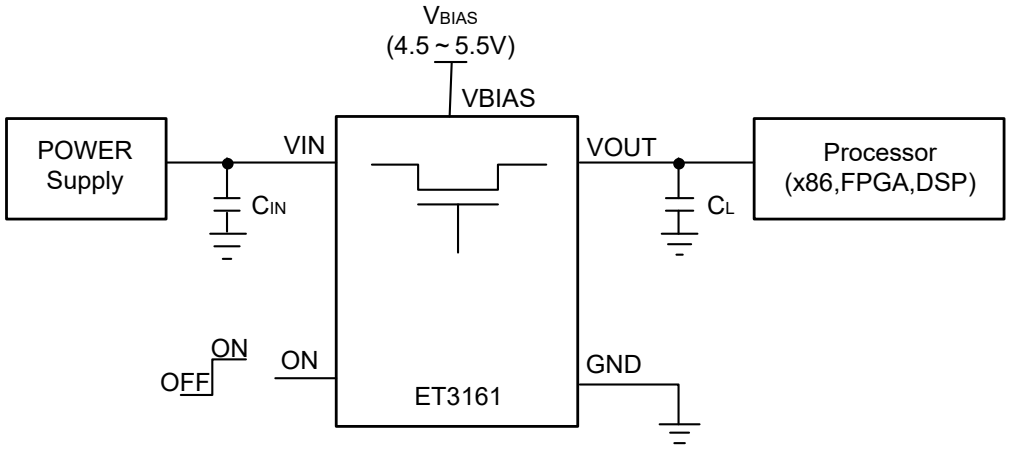
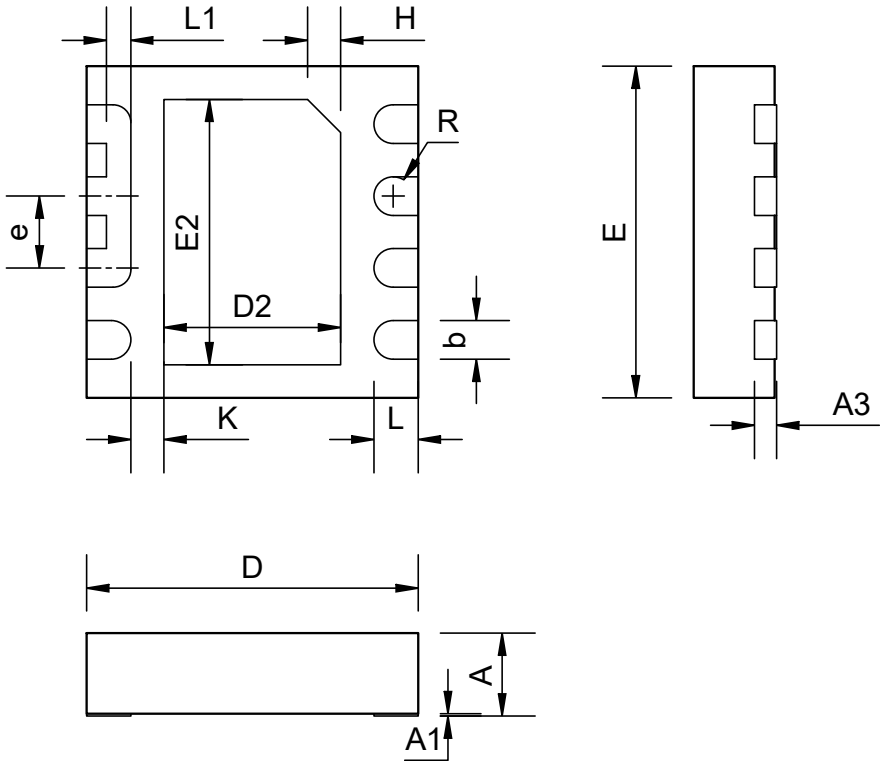


Figure 6. Typical Application(*)

*：This electric circuit only supplies for reference.

Package Dimension

DFN8

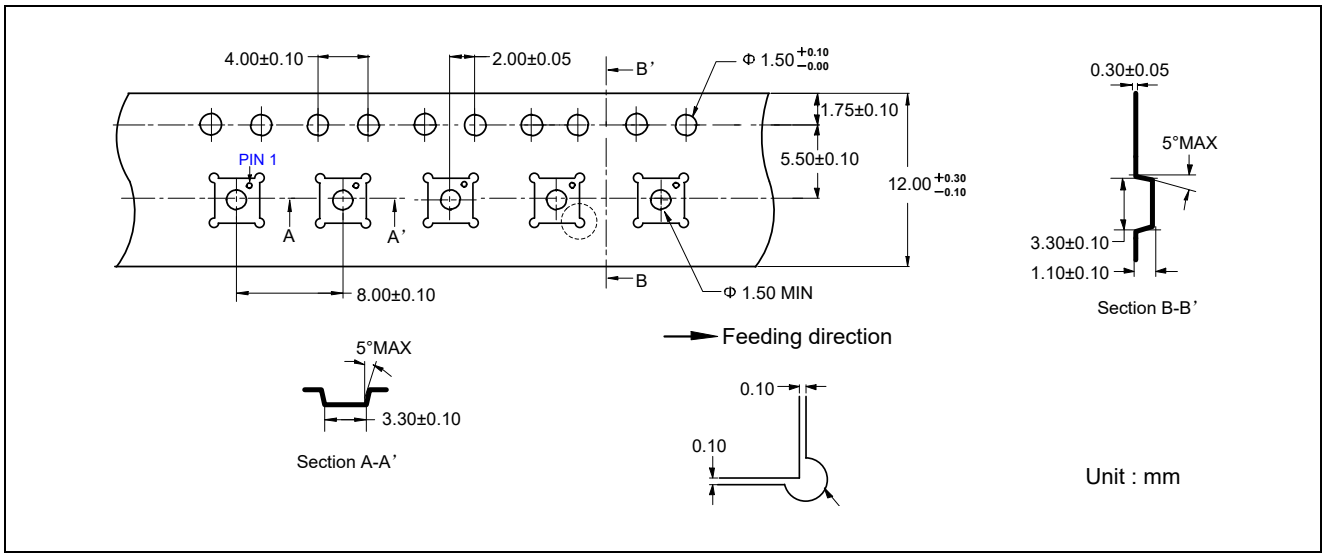


COMMON DIMENSIONS

(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A3		0.20REF	
b	0.30	0.35	0.40
D	2.90	3.00	3.10
E	2.90	3.00	3.10
D2	1.50	1.60	1.70
E2	2.30	2.40	2.50
e	0.55	0.65	0.75
H		0.30REF	
K	0.20	0.30	0.40
L	0.30	0.40	0.50
L1	0.12	0.22	0.32
R	0.16	--	--

Reel



Revision History and Checking Table

Version	Date	Revision Item	Modifier	Function & Spec Checking	Package & Tape Checking
0.0	2020-03-06	Preliminary Version	Zhujl	Luh	Zhujl
1.0	2020-06-09	Initial Version	Liujy	Luh	Liujy
1.1	2021-8-6	Update RON	Liujy	Luh	Liujy
1.2	2022-07-05	Update typeset	Shib	Luh	Liujy