4.5 ~ 18V, 0.75 ~ 5A, Current Limit Power Switch with Reverse Block

General Description

The ET20170H is a current limit N-Channel MOSFET power switch. It is designed to protect circuitry on the output from transients on the input. It also protects the input from undesired shorts and transients coming from the output.

The current limit magnitude is controlled by an external resistor from ILIMIT to GND. It is fixed 0.73A when ILIMIT is floating. Programmable soft-start time controls the slew rate of the output voltage during the start-up time. It can be controlled by the DV/DT pin setting.

The ET20170H offer a GATE drive signal connected to an external N-Channel MOSFET gate to block current flowing from the output to the input when the IC is disable, power off or thermal shutdown.

In the event device temperature (T_J) exceeds T_{SD}(155°C), The ET20170H device remains off for 100ms until the temperature drops to T_{SD} -T_{SD_HYS} (30°C), after which it attempts to restart. This ON and OFF cycle continues until fault is cleared.

Features

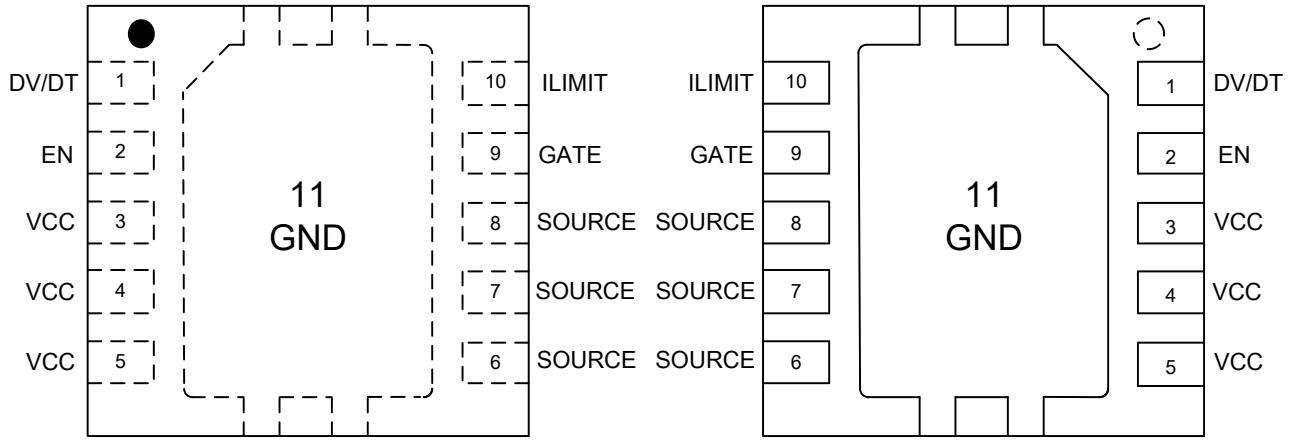
- V_{IN} Operating Range: 4.5V to 18V
- Programmable Current Limit and Soft-Start Time
- Short-Circuit Protection
- Typical R_{ON}: 31mΩ From Input to Output Power Path
- Very Low Quiescent Current: 110μA (Typ)
- Reverse-Blocking MOSFET Driver
- Over-Current Protection
- Internal Thermal Shutdown Protection
- ESD Human Body Model Protected：All pins ± 2KV Pass
- Package Information

Part No.	Package	MSL
ET20170H	DFN10 (3.0mm × 3.0mm)	Level 1

Application

- SSD Hard Disk
- PC Cards
- Wireless Modem Data Cards
- USB Power Distribution/USB Protection
- USB 3.1 Power Delivery
- Server PC

Pin Configuration



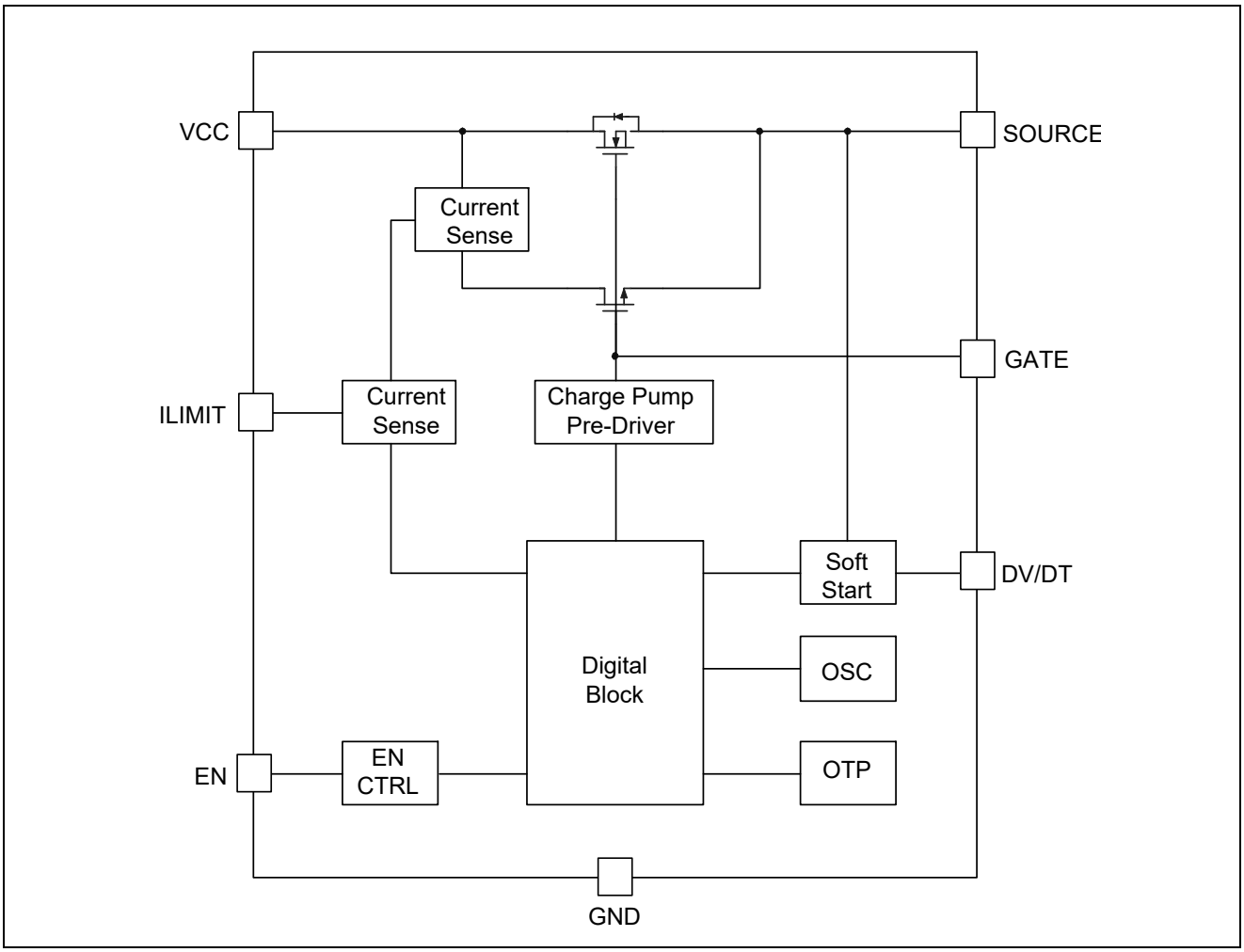
Top View

Bottom View

Pin Function

Pin	Name	Description
1	DV/DT	Soft start programming pin. Connect a capacity from DV/DT to GND to set the DV/DT slew rate.
2	EN	This is a dual function control pin. When used as an ENABLE pin and pulled down, it shuts off the internal pass MOSFET and pulls BFET to GND. When pulled high, it enables the device and BFET. As an UVLO pin, it can be used to program different UVLO trip point via external resistor divider.
3,4,5	VCC	Power supply input. Must be closely decoupled to GND pins with a 1uF or greater ceramic capacitor. Connect VCC using a wide PCB trace.
6,7,8	SOURCE	Source of internal power n-channel MOSFET and the output terminal.
9	GATE	Gate pin for external reverse-current block MOSFET.
10	ILIMIT	Current limit programming pin. Program the current limit by connecting a resistor to GND. Floating ILIMIT pin to achieve a 0.73A fixed current limit.
11	GND	Ground pin.

Block Diagram



Operation

ET20170H is an an integrated power switch with a low R_{DSON} N-Channel MOSFET.When the ET20170H turns on, it can deliver up to 5A continuous current to load. When the device is active, the device only consumes 110uA supply current if no load.

Power Supply Considerations

At least 1μF MLCC capacitor between VCC and GND, close to the device, is recommended. Placing a high-value electrolytic capacitor on the output pin is recommended when the output load is heavy. This precaution reduces power-supply transients that may cause ringing on the input and minimize the input voltage droops. Additionally, bypassing the output with a 10μF MLCC capacitor improves the immunity of the device to short-circuit transients.

Current Limit(ILIMIT)

A sense FET is employed to check for over current conditions. When an over current condition is detected, the device maintains a constant output current and reduces the output voltage accordingly. ET20170H will limit the current until the overload condition is removed or the device begins to thermal cycle.

The current limit can be programmed by an external resistor. It can be approximated with equation below.

$$I_{ILIMIT} = 0.7 + 3 \times 10^{-5} \times R_{LIMIT}$$

The ET20170H allows ILIMIT to be floated during operation. The internal fixed current limit threshold is set at 0.73A. The current limit response time is about 20us(1).

Short-Circuit Protection(SCP)

During a transient short circuit event, the current through the device increases very rapidly. The current-limit amplifier cannot respond very quickly to this event due to its limited bandwidth. Therefore, the ET20170H incorporates a fast-trip comparator, which shuts down the pass device very quickly when $I_{OUT} > I_{FASTRIP}$, and terminates the rapid short-circuit peak current. The trip threshold is set to 50% higher than the programmed overload current limit ($I_{FASTRIP} = 1.5 \times I_{LIMIT}$). After the transient short-circuit peak current has been terminated by the fast-trip comparator, the current limit amplifier smoothly regulates the output current to Ilimit.

To prevent safe operating area(SOA) damage during a high input voltage short-circuit protection(SCP) condition, the IC current limit folds back when the power MOSFET VDS voltage is above the typical 11V and the junction temperature is over 100°C.

Soft Start

The soft start time can be set by an external capacity connecting from DV/DT to GND. The soft start time can be calculated with Equation:

$$t_{DVDT} = \frac{VCC}{GAIN} \times (C_{DVDT} + 70pF) / I_{DVDT} = 10^6 \times VCC \times (C_{DVDT} + 70pF)$$

where:

- GAIN=8V
- I_{DVDT}=125nA

The dV/dt slew rate is determined by external DVDT capacitor.

Reverse-Blocking MOSFET Driver

The ET20170H has a GATE pin to provide an external N-channel MOSFET gate drive signal for reverse-current protection (RCP).

If GATE pin float, there is no RCP function.

Thermal Protection - Auto-Retry

Thermal protection prevents damage to the IC when heavy-overload or short-circuit faults are present for extended periods of time. The ET20170H implements a thermal sensing to monitor the operating junction temperature of the power MOSFET. In an over-current or short-circuit condition, the junction temperature rises due to excessive power dissipation.

Once the die temperature rises to approximately 155°C due to over-current conditions, the internal thermal sense circuitry turns the power switch off, thus preventing the power switch from damage. When the temperature drops below its lower threshold (typically 125°C), the chip is enable again after a 100ms delay.

Three events can pull down the GATE voltage: VIN below the under-voltage lockout (UVLO), the enable (EN) voltage below the low level threshold, or thermal shutdown. If any of these conditions occur, GATE sinks the current from the gate of the external MOSFET to initiate a fast turn-off.

Note1： Test condition is as V_{IN}=12V, I_{LIMIT}=3.7A, T_A=25°C, C_{OUT}=0uF. Current Limit Response Time is the time difference between I_{OUT} first exceeding ILIM and falling back to I_{LIM}. and falling back to I_{LIMIT}. Short-circuit Response Time is the time difference between I_{OUT} exceeding $I_{FASTRIP}$ and falling back to 0A.

Absolute Maximum Ratings

Symbol	Parameters		Min	Max	Unit
V_{CC},V_{SOURCE}	VCC,SOURCE to GND		-0.3	20	V
V_{GATE}	GATE to GND		-0.3	V_{SOURCE}+5.5	V
V_{ILIMIT} ,V_{EN} ,V_{DVDT}	ILIMIT, EN, DV/DT to GND		-0.3	7	V
P_D	Power Dissipation at T_A= +85°C[(2)]			1.05	W
T_J	Junction Temperature		-40	+150	°C
T_{STG}	Storage Junction Temperature		-65	+150	°C
T_{SOLD}	Soldering Temperature (reflow)			+260	°C
V_{ESD}	Electrostatic Discharge Capability	Human Body Mode, ESDA/JEDEC JS-001-2023	-2.0	+2.0	KV
		Charged Device Mode, ESDA/JEDEC JS-002-2022	-1.5	+1.5	KV

Note2: The maximum allowable Power Dissipation is recording to maximum allowable Junction Temperature.

$P_{D(MAX)}$@T_A=($T_{J(MAX)}$-T_A)/ θ_{JA}.

Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
V_{IN}	DC Input Voltage	4.5	18	V
I_{OUT}	DC Output Current Limit	0.73	5.0	A
T_A	Operating Temperature Range	-40	+85	°C

Electrical Characteristics

Unless otherwise noted, V_{CC}=12V, R_{LIMIT}=NS, C_{DVDT}=FLOAT, C_{OUT}=10uF, T_A=-40°C to 85°C, typical value is tested at T_A=25°C.

Symbol	Parameters	Conditions	Min	Typ	Max	Unit
Basic Operation						
V_{IN}	Input Voltage		4.5		18	V
I_Q	V_{IN} Quiescent Current	EN = High		110	150	uA
I_S	V_{IN} Shutdown Current	EN = GND		11	25	uA
Power MOSFET						
R_{ON}	On-Resistance of Switch IN-OUT	R_{LIMIT}=100KΩ, I_{OUT}=1A		31	60	mΩ
t_{DELAY}	Turn-on Delay Time	EN/UVLO→H, I_{VCC} = 100mA, 1-A resistive load at SOURCE		280		us
I_{OFF}	Off-state Leakage Current	V_{CC} = 12V, V_{EN} = GND		0.1	3	uA
V_{UVLO_R}	Under Voltage Lockout Threshold	V_{IN} Rising	4.15	4.3	4.5	V
$V_{UNLOHYS}$	UVLO Hysteresis			190		mV
DV/DT						
t_{DVDT}	Output Ramp Time	EN → H to V_{SOURCE} = 11.7V, V_{CC}=12V, C_{DVDT} = 0	0.7	1	1.3	ms
		EN → H to V_{SOURCE} = 11.7V, V_{CC}=12V, C_{DVDT}= 1nF		15		ms
V_{DVDT_MAX}	DV/DT Max Capacitor Voltage			5		V
$I_{DV/DT}$	DV/DT Current	$V_{DV/DT}$ = 0.5V		125		nA
$GAIN_{DVDT}$[(3)]	DV/DT to OUT Gain			8		V/V
Current Limit						
I_{LIMIT_NO}	Current Limit at Normal Operation	ILIMIT float, V_{CC}=12V		0.73		A
		R_{LIMIT} = 0, V_{CC}=12V		0.84		A
		R_{LIMIT} = 10KΩ, V_{CC}=12V		1.1		A
		R_{LIMIT} = 45.3KΩ, V_{CC}=12V	1.79	2.07	2.42	A
		R_{LIMIT} = 100kΩ, V_{CC}=12V	3.46	3.7	4.03	A
		R_{LIMIT} = 150kΩ, V_{CC}=12V	4.5	5.0	5.7	A
I_{ILIM_B}	ILIM Bias Current	R_{LIMT}=0		10		uA
Enable (EN)						
V_{EN_RISING}	EN Rising Threshold		1.37	1.45	1.54	V
V_{EN_HYS}	EN Hysteresis			250		mV

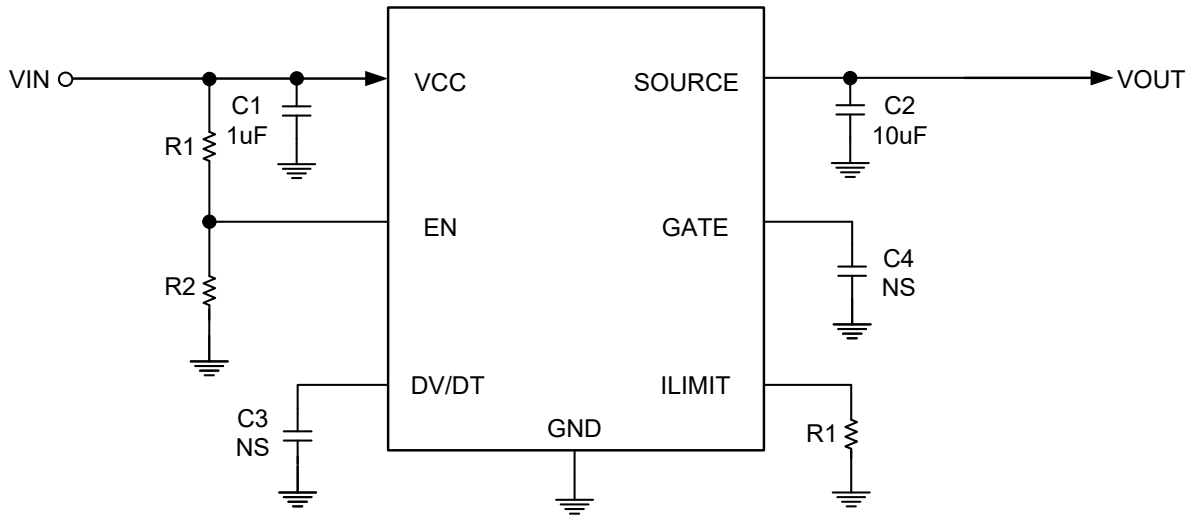
Electrical Characteristics (Continued)

Unless otherwise noted, V_{CC}=12V, R_{LIMIT}=NS, C_{DVDT}=FLOAT, C_{OUT}=10uF, T_A=-40°C to 85°C, typical value is tested at T_A=25°C.

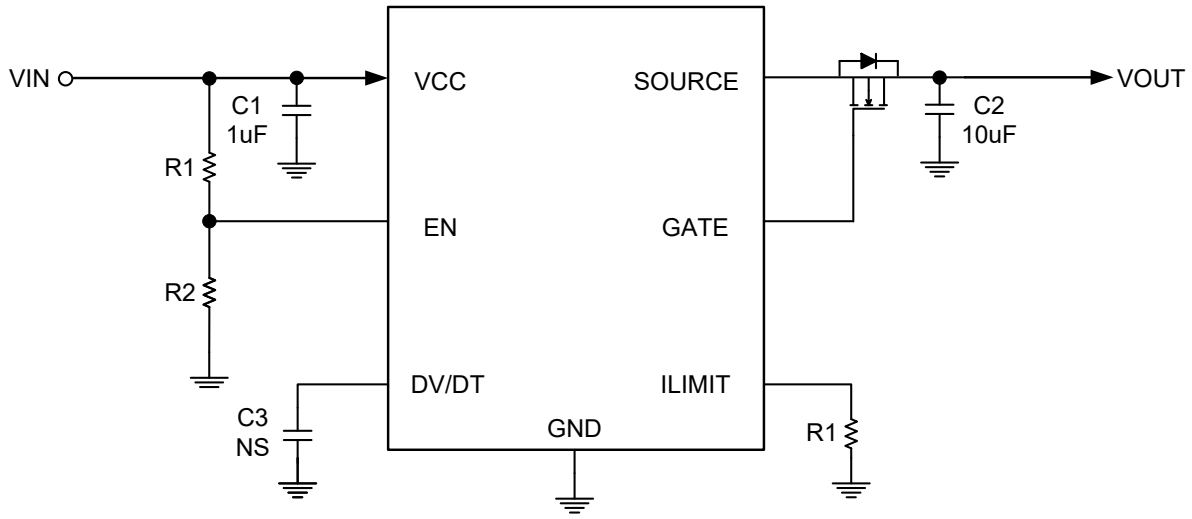
Symbol	Parameters	Conditions	Min	Typ	Max	Unit
GATE						
I_{G_SOURCE}	GATE Maximum Source Current	V_{CC}=12V, EN=5V, V_{GATE}=V_{CC}	8	11	13	uA
I_{G_SINK}	GATE Maximum Sink Current	V_{CC} = V_{SOURCE} = 5.5V, V_{GATE} = 10.5V, EN=0		57		uA
V_{GATE}	GATE Voltage	R_{LIMIT}=100KΩ, I_{OUT} = 1A		V_{CC}+4.6		V
OTP						
T_{SD}	Thermal Shutdown			155		°C
T_{SD_HYS}	Thermal-shutdown Hysteresis			30		°C

Note3: Guaranteed by design

Application Circuits



Typical Application Circuit without RCB MOSFET

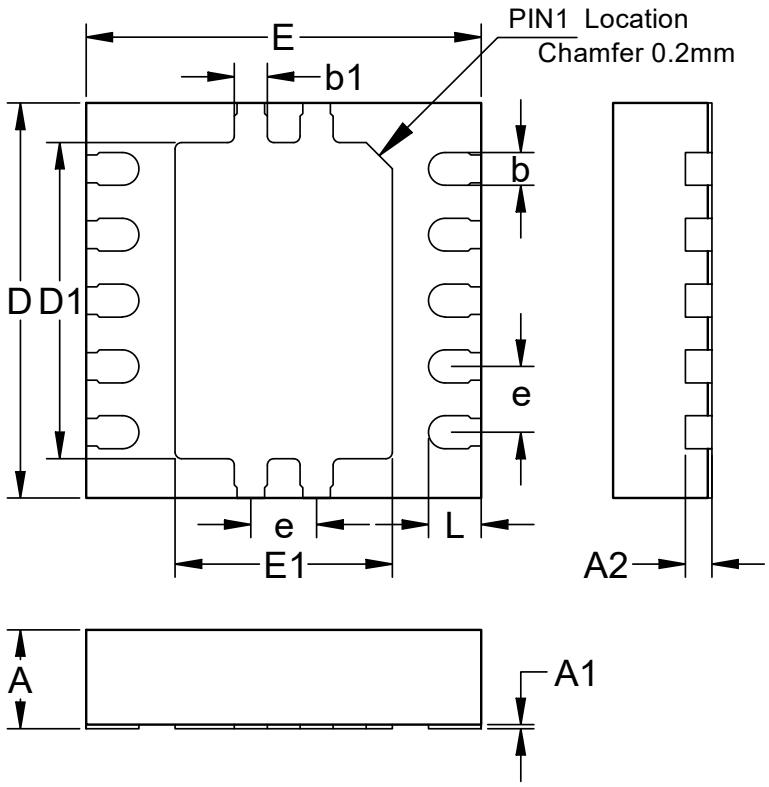


Typical Application Circuit with RCB MOSFET

*：This electric circuit only supplies for reference.

Package Dimension

DFN10-3x3

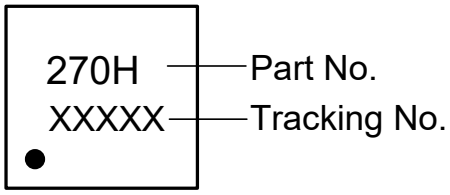


COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

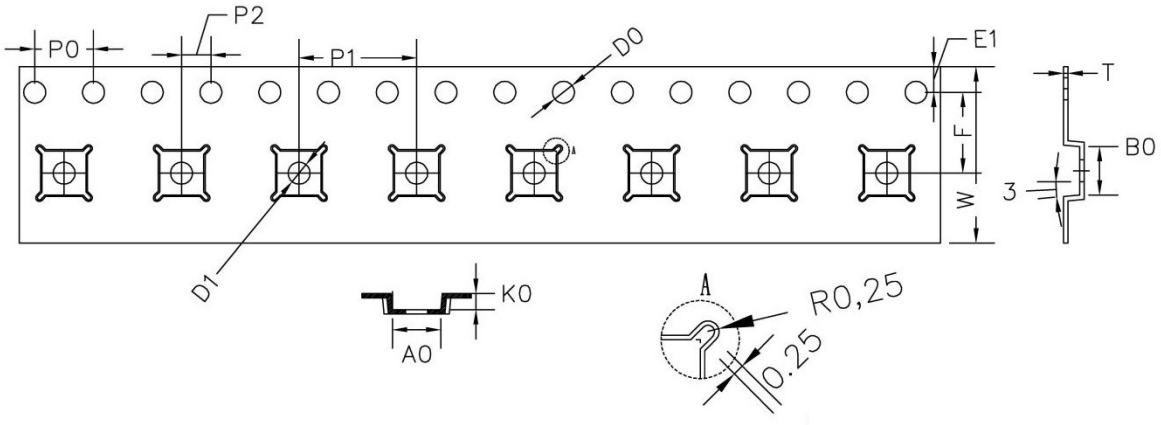
SYMBOL	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0.00	-	0.05
A2		0.20 REF	
b	0.20	0.25	0.35
b1	0.20	0.25	0.30
D	2.95	3.00	3.05
E	2.95	3.00	3.05
D1	2.25	2.40	2.50
E1	1.50	1.65	1.75
e		0.50 BSC	
L	0.30	0.40	0.50

Unit: mm

Marking



Tape Information



SYMBOL	A0	B0	K0	P0	P1	P2
Size	3.30±0.10	3.30±0.10	1.10±0.10	4.00±0.10	8.00±0.10	2.00±0.10
SYMBOL	E1	F	D0	D1	T	W
Size	1.75±0.10	5.50±0.10	1.55±0.05	1.55±0.05	0.30±0.05	12.00±0.30

Revision History and Checking Table

Version	Date	Revision Item	Modifier	Function & Spec Checking	Package & Tape Checking
1.0	2023-12-1	Initial Version	Zoucm	Xuw	Shib
1.1	2023-12-13	Content and Package Dimension Upset	Zoucm	Xuw	Shib
1.2	2024-5-13	Update EC table	Zoucm	Xuw	Shib
1.3	2024-9-10	Update Application Circuits	Zoucm	Xuw	Shib