Features

- Up to 1A programmable charge current
- Vin(max): 30V (Typ)
- OVP(Vin): 6.5V (Typ)
- No external MOSFET, sense resistor, or blocking diode required
- Preset charge voltage with 4.35V±1% accuracy
- Automatic recharge
- 2.9V trickle charge voltage
- C/10 charge termination
- 50μA standby supply current
- Charge status indicator
- Soft-start to limit inrush current
- Thermal protection

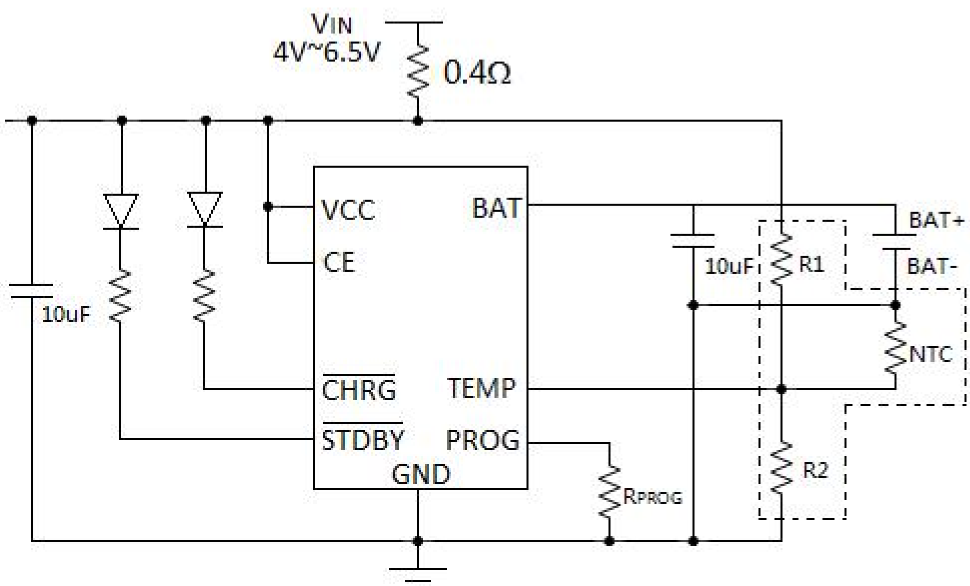
Description

The ITE4040H is a standalone linear Li-ion battery charger with ESOP-8 package. With few external components, the ITE4040H is well suited for a wide range of portable applications. Charging current can be programmed by an external resistor. The maximum withstand voltage of ITE4040H is 30V. In standby mode, supply current will be reduced to around 50μA. Other features include UVLO, automatic recharge, charge status indicators and thermal regulation.

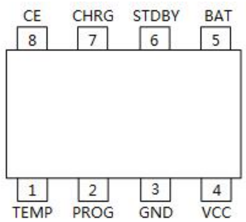
Applications

- Mobile Phone, PDA, MP3
- Bluetooth
- Charger

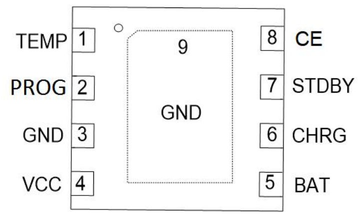
Typical Application



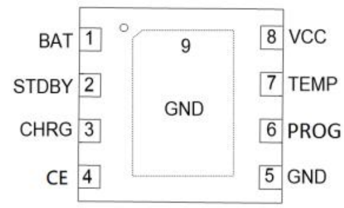
Pin Configuration



ESOP8



DFN2*2-8L



DFN3*3-8L

Pin Description

NAME	ESOP8L (ITE4040H)	DFN2*2-8L (ITE4040H8D)	DFN3*3-8L (ITE4040H8F)	DESCRIPTION
TEMP	1	1	7	Temperature detector.
PROG	2	2	6	CC charge current setting & monitor.
GND	3	3	5	Ground.
VCC	4	4	8	Supply voltage.
BAT	5	5	1	Battery voltage.
STDBY	6	7	2	Standby indicator.
CHRG	7	6	3	Charge indicator.
CE	8	8	4	Enable control.

Marking Information

ESOP8

DFN2*2-8L

DFN3*3-8L

PART NUMBER	PACKAGE	MARKING	DESCRIPTION
ITE4040H	ESOP8L	IHH6 XXXXXX	First row: Model code Second row: 8D/8F: Package code Third row: Year/Week/Version/Lot/Factory
ITE4040H8D	DFN2*2-8L	IHH6 8D YWVNNX	
ITE4040H8F	DFN3*3-8L	IHH6 8F YWVNNX	

Absolute Maximum Ratings (note 1)

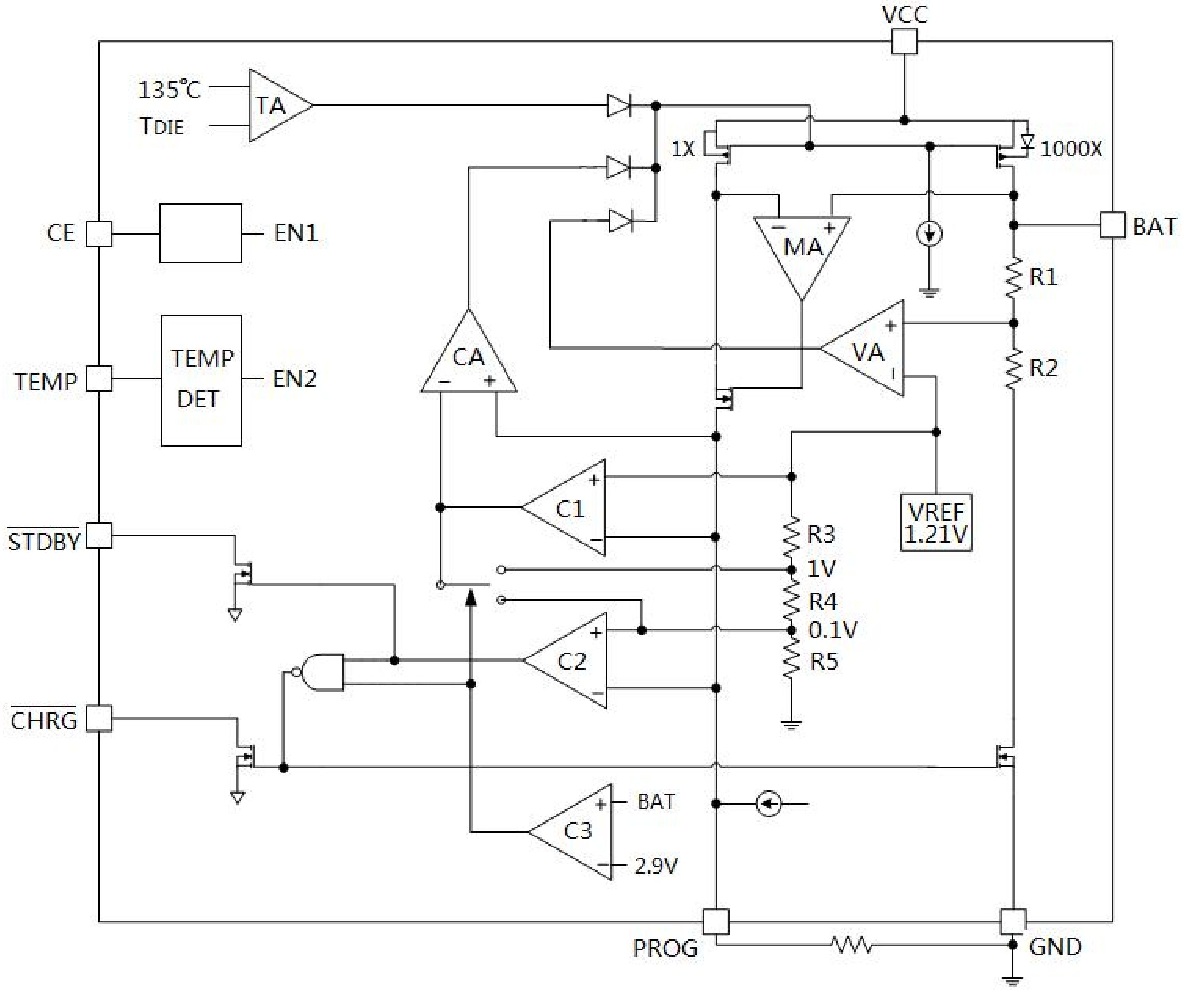
SYMBOL	PARAMETER	RANGE	UNIT
V_{CC}	Supply voltage	-0.3 to +36	V
V_{PROG}	PROG pin voltage	-0.3 to +6.5	V
V_{BAT}	BAT pin voltage	-0.3 to 18	V
$V_{CE/TEMP/STDBY/CHRG}$	CE, TEMP, STDBY, CHRG pin voltage	-0.3 to +30	V
P_{DMAX}	Power consumption	1500	mW
I_{BAT}	BAT pin current	1	A
I_{PROG}	PROG pin current	2	mA
Latch-Up		400	mA
T_{OPA}	Operating temperature	-40 to +85	℃
T_{STR}	Storage temperature	-65 to +125	℃

Note 1. The device may be damaged if the maximum range is exceeded. The device may operate within the recommended operating range, but its characteristics are not guaranteed. The DC and AC characteristics shown in the electrical characteristics are measured under specific conditions and their characteristics are guaranteed. This characterization assumes that the device is operating within the recommended operating range. Characteristics not shown do not guarantee performance. Typical values are best performance points.

ESD/Latch-up

HBM ESD	2000V
MM ESD	200V
Latch-up	200mA

Functional Block Diagram



DC Electrical Characteristics

$T_A = 25℃$

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{CC}	Supply voltage		4.2		6	V
I_{CC}	Input current	Charge mode（R_{PROG} = 12KΩ）(1)		240	500	μA
		Stand-by mode		60	120	μA
		Shut down（R_{PROG} not connect, $V_{CC} < V_{BAT}$ or $V_{CC} < V_{UV}$）		50	100	μA
V_{FLOAT}	CV output (float) voltage	0℃< Ta <85℃	4.3	4.35	4.393	V
Vovp	Input voltage protection		6.1	6.5		V
VOVP_H	OVP hysteresis			200		mV
I_{BAT}	BAT pin current	R_{PROG} = 2.4K, current mode	465	500	535	mA
		R_{PROG} = 1.5K, current mode	744	800	856	mA
		V_{BAT} = 4.24V, stand-by mode	0	-2.5	-6	μA
		Shut down		1	2	μA
		V_{BAT} = - 4V, battery reverse		0.7		mA
		V_{CC} = 0V, sleep mode		0	1	μA
I_{TRIKL}	Trickle charge current	V_{BAT}<V_{TRIKL}, R_{PROG} = 2.4K	40	50	60	mA
V_{TRIKL}	Trickle charge threshold Voltage	R_{PROG} = 12K, V_{BAT} rising	2.7	2.9	3.1	V
V_{TRHYS}	Trickle charge hysteresis voltage	R_{PROG} = 12K	60	80	110	mV
V_{UV}	V_{cc} under voltage lockout threshold	V_{cc} rising	3.6	3.8	4	V
V_{UVHYS}	V_{cc} under voltage lockout threshold hysteresis		150	200	300	mV
V_{MSD}	Manual shutdown threshold voltage	PROG rising	1.15	1.21	1.30	V
		PROG falling	0.9	1	1.1	V
V_{ASD}	V_{cc}-V_{BAT} lockout threshold	V_{cc} rising	70	100	140	mV
		V_{cc} falling	5	30	50	mV
I_{TERM}	C/10 termination current threshold (2)	R_{PROG} = 1.5K	0.08	0.1	0.12	mA/mA
		R_{PROG} = 2.4K	0.08	0.1	0.12	
V_{PROG}	PROG pin voltage	R_{PROG} = 12K, current mode	0.93	1	1.07	V
V_{CHRG}	CHRG pin output low voltage	I_{CHRG} = 5mA		0.35	0.6	V
V_{STDBY}	STDBY pin output low voltage	I_{STDBY} = 5mA		0.35	0.6	V
ΔV_{RECG}	Battery recharge threshold voltage	V_{FLOAT}-V_{RECHRG}		50	100	mV
t_{RECHG}	Recharge comparator filter time	V_{BAT} high to low	0.8	1.8	4	mS
t_{TERM}	C/10 termination comparator filter time	I_{BAT} falling below I_{TERM}	0.63	1.4	3	mS
I_{PROG}	PROG pin pull-up current			2		μA

Notes

（1）: In charging state, ICC=IVCC-IBAT.

（2）: C/10 termination current threshold refers to the ratio of the termination current to the constant current charging current.

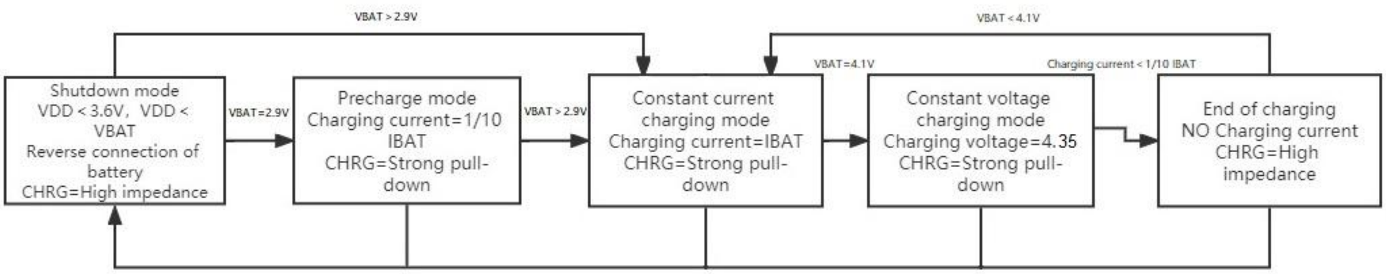
Function Description

The ITE4040H is a single-cell Li-ion battery charger with a constant current/constant voltage algorithm. It can provide a maximum charge current of around 1A (with a thermally well-designed PCB layout) and an internal P-channel power MOSFET and thermal regulation circuit. No blocking diodes or external current sense resistors are required.

Normal Charge Cycle

A charge cycle begins when the Vcc pin voltage rises above the UVLO threshold level and a 1% programmed resistor is connected between the PROG pin and ground or when a battery is connected to the charger output. If the BAT pin level is lower than 2.9V, the charger enters trickle charge mode. In this mode, the ITE4040H provides approximately 1/10 of the set charging current to boost the current to a safe level for full current charging.

When the BAT pin voltage rises above 2.9V, the charger enters constant current mode, which provides a constant charging current to the battery. When the BAT pin voltage reaches the final float voltage (4.35V), it enters the constant voltage mode and the charging current starts to decrease. The charging cycle ends when the charging current drops to 1/10 of the set value.



Setting of Charging Current

Charge current is programmed with a resistor connected from the PROG pin to ground. The current charging current is 1200 times the output current of the PROG pin. The setting resistor and charging current are calculated using the following formula.

The charging current output from the BAT pin can be determined at any time by monitoring the voltage of the PROG pin, the formula is as follows:

$$R_{PROG} = \frac{1200}{I_{BAT}}$$

The reference table for the relationship between RPROG and charging current is as follows:

RPROG(K)	IBAT(mA)
1.2	1000
2.4	500
3.0	400
4.0	300
6.0	200
12.0	100

Battery Reverse Polarity Protection

The ITE4040H has lithium battery reverse connection protection function. The positive and negative poles of the high-grade lithium battery are reversely connected to the current output pin of ITE4040H. ITE4040H will stop and display a fault state without charging current. In the case of reverse connection, the power supply voltage should be around the standard voltage of 5V and should not exceed 8V. If the power supply voltage is too high, the chip voltage difference will exceed 10V when the battery voltage is reversed, so the power supply voltage should not be too high in the case of reverse connection.

Charge Status Indicator (CHRG)

The ITE4040H has an open-drain status indication output "CHRG". When the charger is in the charging state, CHRG is pulled to a low level, and in other states, CHRG is in a high-impedance state. When the battery is not connected to the charger, CHRG outputs a pulse signal to indicate that the battery is not installed. When the external capacitance of the BAT pin of the battery connection terminal is 10μF, the CHRG flashing period is about 0.5 to 2seconds. When the status indication function is not used, connect the unused status indication output terminal to ground.

With battery charging indicator status	CHRG
Normal state of charge	Constant on
Battery full state	Off
The battery is reversed, the power supply is undervoltage	Off
Power on without battery	Flashing

Thermal

An internal thermal feedback loop reduces the programmed charge current if the die temperature attempts to rise above a preset value of approximately 135℃. This feature prevents the ITE4040H from overheating and allows the user to increase the upper limit of a given board's power handling capability without risking damage to the ITE4040H. Under the premise of guaranteeing that the charger will automatically reduce the current under worst-case conditions, the charging current can be set according to the typical (not worst-case) ambient temperature.

Battery Temperature Detection

In order to prevent damage to the battery caused by high or low temperature, ITE4040H integrates a battery temperature monitoring circuit inside. Battery temperature monitoring is realized by measuring the voltage of the TEMP pin, which is realized by an NTC thermistor inside the battery and a resistor divider network, as shown in the typical application diagram. If the voltage of the TEMP pin is less than 45% of the input voltage or greater than 80% of the input voltage, it means that the battery temperature is too low or too high, and the charging is suspended.

If the TEMP pin is directly connected to GND, the battery temperature detection function is canceled, and other charging functions are normal.

The values of R1 and R2 should be determined according to the temperature monitoring range of the battery and the resistance value of the thermistor. The examples are as follows:

Assume that the set battery temperature range is TL ～ TH, (where TL<TH); the battery uses a negative temperature coefficient thermistor (NTC), RTL is its resistance at the temperature TL, and RTH is its resistance at the temperature TL. The resistance value at the temperature TH, then RTL>RTH, then, at the temperature TL, the voltage at the first pin TEMP is:

$$V_{TEMPL} = \frac{R2 \| R_{TL}}{R1 + R2 \| R_{TL}} \times VIN$$

At the temperature TH, the voltage at the first pin TEMP is:

$$V_{TEMPH} = \frac{R2 \| R_{TH}}{R1 + R2 \| R_{TH}} \times VIN$$

$$V_{TEMPL} = V_{HIGH} = K_2 \times V_{CC} (K_2 = 0.8)$$

$$V_{TEMPH} = V_{LOW} = K_1 \times V_{CC} (K_1 = 0.45)$$

$$R1 = \frac{R_{TL} R_{TH} (K_2 - K_1)}{(R_{TL} - R_{TH}) K_1 K_2}$$

$$R2 = \frac{R_{TL} R_{TH} (K_2 - K_1)}{R_{TL}(K_1 - K_1 K_2) - R_{TH}(K_2 - K_1 K_2)}$$

Similarly, if the inside of the battery is a thermistor with a positive temperature coefficient (PTC), then >, we can calculate:

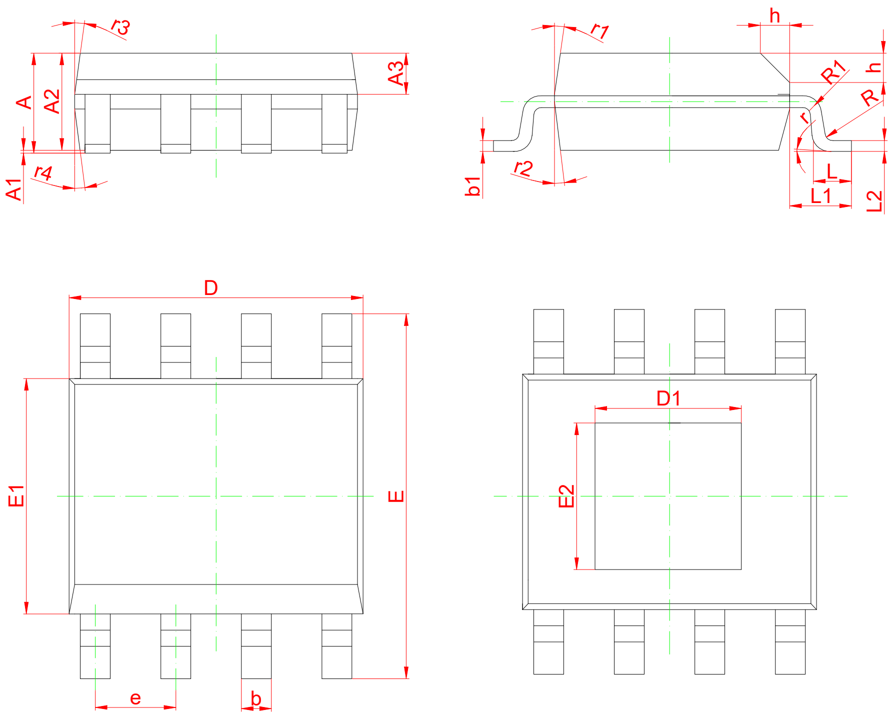
$$R1 = \frac{R_{TL} R_{TH} (K_2 - K_1)}{(R_{TH} - R_{TL}) K_1 K_2}$$

$$R2 = \frac{R_{TL} R_{TH} (K_2 - K_1)}{R_{TH}(K_1 - K_1 K_2) - R_{TL}(K_2 - K_1 K_2)}$$

It can be seen from the above derivation that the temperature range to be set has nothing to do with the power supply voltage VCC, and is only related to R1, R2, RTH, and RTL; among them, RTH and RTL can be checked by referring to the relevant battery manual or through experiments get.

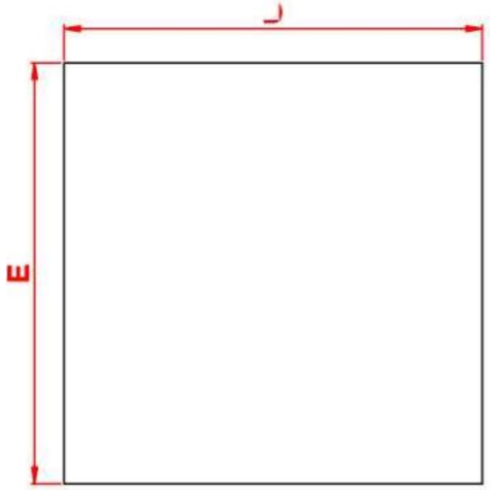
In practical applications, if you only care about the temperature characteristics of a certain end, such as overheating protection, then R2 can be used instead of R1. The derivation of R1 also becomes simple, and will not be repeated here.

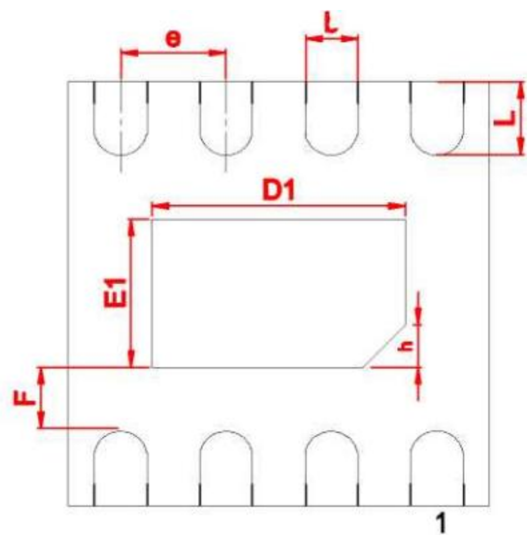
Package Outline: ESOP-8

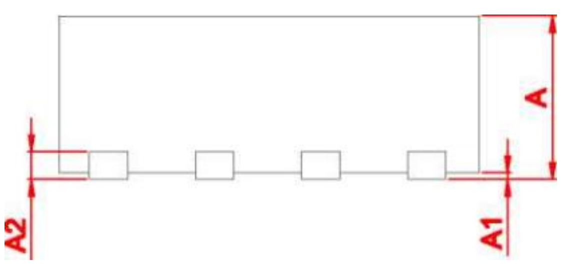


SYMBOL	MIN	NOM	MAX
A	1.35	1.55	1.70
A1	0	0.10	0.15
A2	1.25	1.40	1.65
A3	0.50	0.60	0.70
b	0.38	-	0.51
b1	0.37	0.42	0.47
D	4.80	4.90	5.00
D1	3.10	3.30	3.50
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
E2	2.20	2.40	2.60
e	1.17	1.27	1.37
L	0.45	0.60	0.80
L1		1.04REF	
L2		0.25BSC	
R	0.07	-	-
R1	0.07	-	-
h	0.30	0.40	0.50
r	0°	-	8°
r1	15°	17°	19°
r2	11°	13°	15°
r3	15°	17°	19°
r4	11°	13°	15°

Package Outline: DFN2*2-8

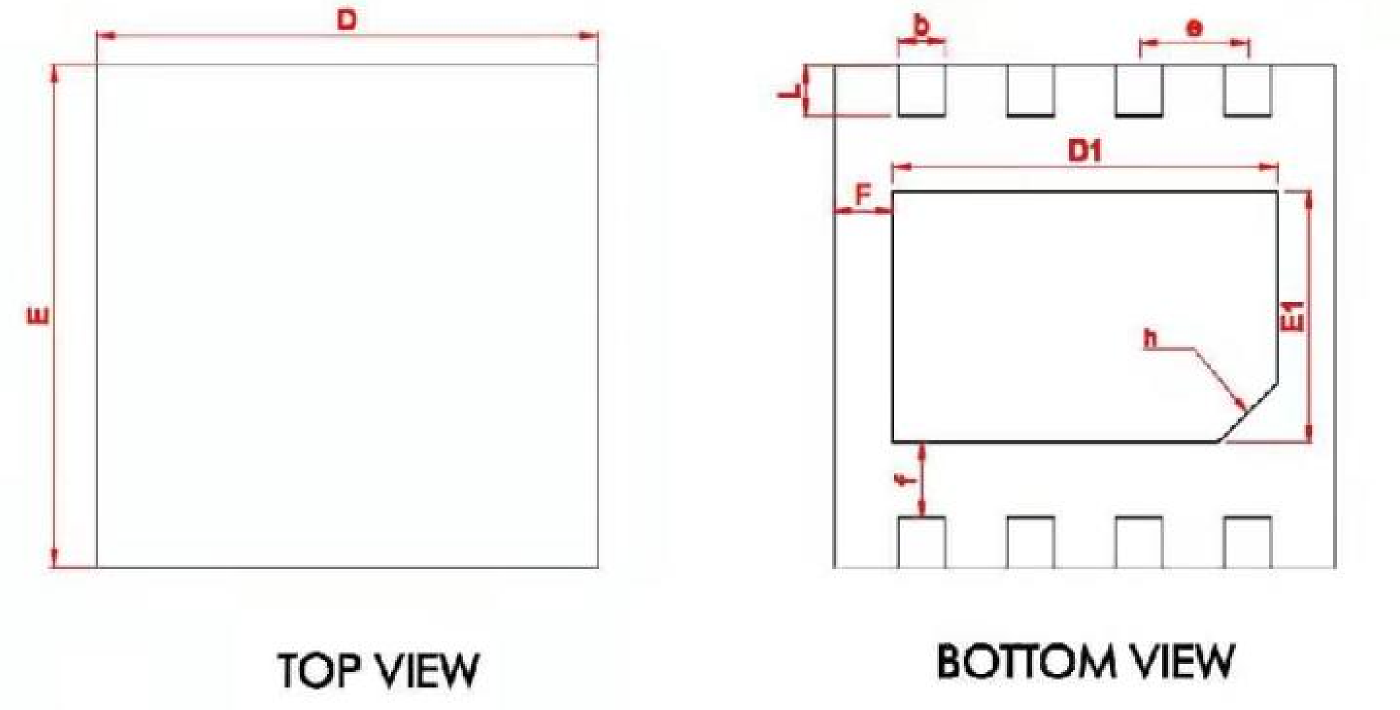


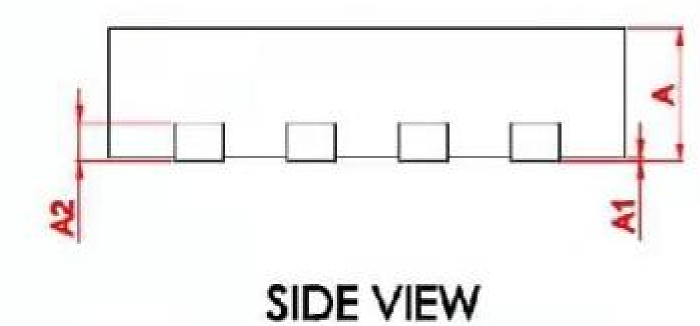




SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.700	0.750	0.800
*A1	0.000	0.020	0.050
* b	0.200	0.250	0.300
*A2	0.180	0.200	0.220
* D	1.900	2.000	2.100
* E	1.900	2.000	2.100
*D1	1.100	1.200	1.300
*E1	0.600	0.700	0.800
* e	0.450	0.500	0.550
* L	0.300	0.350	0.400
* F	0.250	0.300	0.350
h	R	IEF	0

Package Outline: DFN 3X3-8L





SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.700	0.750	0.800
* A1	0.000	0.020	0.050
* b	0.255	0.280	0.305
* A2	0.190	0.210	0.230
* D	2.900	3.000	3.100
* E	2.900	3.000	3.100
* E1	1.450	1.500	1.550
* D1	2.250	2.300	2.350
* e	0.600	0.650	0.700
* L	0.250	0.300	0.350
h	0.490 REF		
* F	0.300	0.350	0.400
* f	0.400	0.450	0.500

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