SK4556 28V 1A Single Li-ion Battery Linear Charger

GENERAL DESCRIPTION

The SK4556 is a complete constant-current/ constant voltage linear charger for single Lithium-Ion battery with high input voltage rating and large current. The largest input voltage is up to 28V and charge current is up to 1A. The input over voltage protection thread is 6.8V and the lowest input voltage is 3.75V, which can meet the requirement of voltage-adjustment to reduce charging power consumption and improve overall efficiency.

Thermal feedback regulates the charge current to limit the die temperature during high power operation or high ambient temperature. The charge voltage is fixed at 4.2V/4.35V/4.4V/4.45V, and the charge current can be programmed externally with a single resistor.

The SK4556 automatically terminates the charge cycle when the charge current drops to 1/10 the programmed value after the final float voltage is reached.

When the input voltage (supplied by AC adapter or USB power supply) is removed, the SK4556 automatically enters a low current state, decreasing the battery leakage current to less than 1μA.

Other features of SK4556 include over temperature protection, under voltage lockout, automatic recharge and charging state indication (two LED pins to show charge state and charge-ending state).

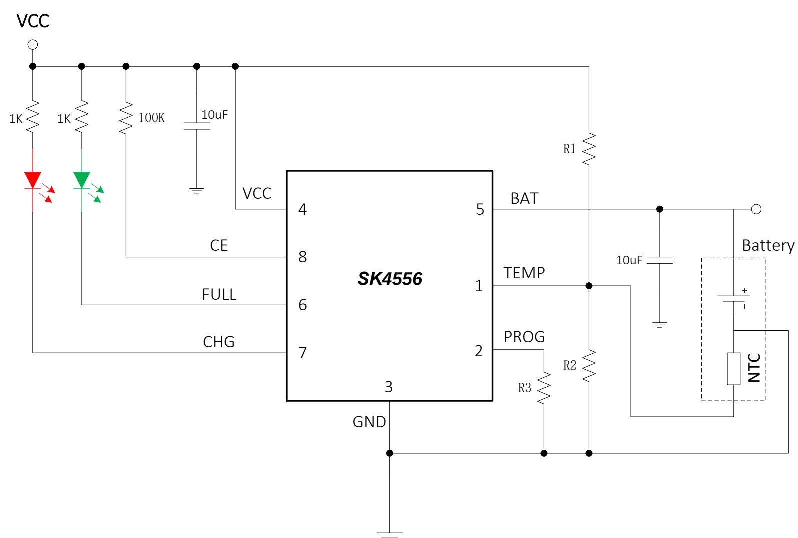
FEATURES

- Maximum Input Voltage Rating up to 28V
- Minimum Input Voltage: 3.75V (Typ.)
- Programmable Charge Current up to 1A
- Input Over Voltage Protection : 6.8V (Typ.)
- Float Charge Voltage : 4.2V / 4.35V/ 4.4V /4.45V
- Maximum BAT withstand voltage up to 20V
- 1% Charge Voltage Accuracy
- Battery reverse connection protection
- Thermal Regulation to Maximize Charge Rate Without Risk of Overheating
- 1/10C Termination Charge Current
- Charging status and fault status indication
- Battery Temperature Monitoring
- Chip Enable Input
- Trickle charge threshold: 2.9V (Float Voltage: 4.2V,Typ.)
- Soft-start and surge current limit
- Available ESOP8, DFN2x2-8L, DFN3x3-8L, DFN3x2-10L, DFN3x3-10L Packages

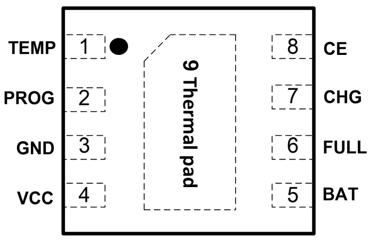
APPLICATIONS

- Standby power supply/ portable power source
- mobile phone, PDA, GPS
- MP3, MP4 player
- Digital camera, electronic dictionary
- Portable devices, Various charg

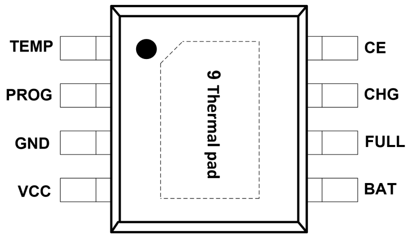
TYPICAL APPLICATION CIRCUIT



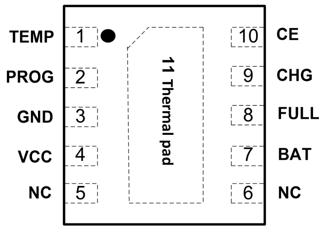
PIN ASSIGNMENT



DFN2x2-8L / DFN3x3-8L
(Top view)



ESOP8
(Top view)



DFN3x2-10L / DFN3x3-10L
(Top view)

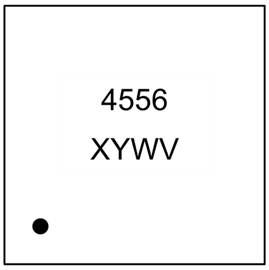
PIN DESCRIPTION

Pin No.		Name	Input/Output	Function
DFN2x2-8L DFN3x3-8L ESOP8	**DFN3x2-10L DFN3x3-10L**			
1	1	TEMP	I	Battery temperature detection and protection input pin. The higher threshold is 0.8*VCC and lower threshold is 0.45*VCC. If it is not used, please pull it low to ground.
2	2	PROG	I	Charge current setting, charge current monitor, and shut down pin. The charging current is given by I_{BAT}= 1000/R_{PROG}(A). Please choose 1% precision resistor for R_{PROG}.
3	3	GND	G	Ground
4	4	VCC	P	Power Supply
/	5, 6	NC	/	Not Connected
5	7	BAT	O	Charge Current Output. Provides charge current to the battery and regulates the final float voltage to 4.2V, 4.35V, 4.4V and 4.45V.
6	8	FULL	O	Open-Drain Charge termination indicated pin. When charge is terminated, it is pulled low, otherwise it is high impedance.
7	9	CHG	O	Open-Drain Charge Status Output. When the battery is charging, the CHG pin is pulled low. When the charge cycle is completed or VCC is removed, the CHG is forced high impedance.
8	10	CE	I	Charge enable pin. High or floating is enabled, low is disabled.
9	11	Thermal pad	/	Connected to GND plane for heat sink function.

ORDERING INFORMATION

Part No.	Package	V_{FLOAT}	Temperature	Tape & Reel
SK4556E8-42	ESOP8	4.2V	-40 ~ +85℃	4000pcs/tape
SK4556E8-435		4.35V		
SK4556E8-44		4.4V		
SK4556E8-445		4.45V		
SK4556D8-42	DFN2x2-8L	4.2V	-40 ~ +85℃	4000pcs/tape
SK4556D8-435		4.35V		
SK4556D8-44		4.4V		
SK4556D8-445		4.45V		
SK4556DC8-42	DFN3x3-8L	4.2V	-40 ~ +85℃	5000pcs/tape
SK4556DC8-435		4.35V		
SK4556DC8-44		4.4V		
SK4556DC8-445		4.45V		
SK4556DB10-42	DFN3x2-10L	4.2V	-40 ~ +85℃	4000pcs/tape
SK4556DB10-435		4.35V		
SK4556DB10-44		4.4V		
SK4556DB10-445		4.45V		
SK4556DC10-42	DFN3x3-10L	4.2V	-40 ~ +85℃	5000pcs/tape
SK4556DC10-435		4.35V		
SK4556DC10-44		4.4V		
SK4556DC10-445		4.45V		

MARKING DESCRIPTION



(DFN2x2-8L / DFN3x2-10L)

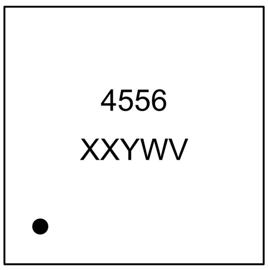
XY：Internal control code

W：Code of production week.

"A" means 1st week, "Z" means 26th week,

"a" means 27th week, "z" means 52nd week.

V：Voltage code



(DFN3x3-8L / DFN3x3-10L)

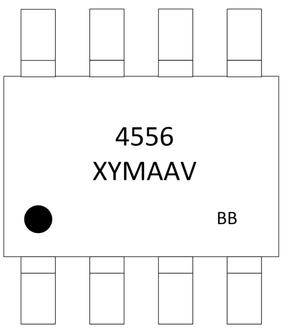
XXY：Internal control code

W：Code of production week. "A" means 1st week，

"Z" means 26th week, "a" means 27th week,

"z" means 52nd week.

V：Voltage code



(ESOP8)

X, BB: Internal control code

YM: Date code

AA: Series number

V: Voltage code

ABSOLUTE MAXIMUM RATINGS (Note1)

SYMBOL	ITEMS		VALUE	UNIT
V_{CC}	Supply voltage		-0.3～28	V
V_{BAT}	BAT voltage		-5.0～20	V
V_{PIN1}	CHG/FULL/CE voltage		-0.3～28	V
V_{PIN2}	TEMP/PROG voltage		-0.3～7	V
I_{BAT}	BAT Pin current		1200	mA
P_D	Maximum Power Dissipation	ESOP8	1.8	W
		DFN2x2-8L	1	W
		DFN3x3-8L	1.5	W
		DFN3x2-10L	1.25	W
		DFN3x3-10L	1.5	W
$R_{\theta JA}$	Junction to Ambient Thermal Resistance	ESOP8	55	℃/W
		DFN2x2-8L	100	℃/W
		DFN3x3-8L	67	℃/W
		DFN3x2-10L	80	℃/W
		DFN3x3-10L	67	℃/W
T_J	Junction Temperature		-40~150	℃
T_A	Ambient Temperature		-40~85	℃
T_{STG}	Storage Temperature		-55 to 150	℃
T_{SOLDER}	Package Lead Soldering Temperature		260℃, 10s	

Note 1: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING CONDITION

Symbol	Description	Min.	Typical	Max	Units
V_{CC}	Input Supply Voltage Range	3.75		25	V
I_{BAT}	Charge Current Range	100		1000	mA
R_{PROG}	CC mode charge current programming resistor	1		10	KΩ

ELECTRICAL CHARACTERISTICS

The following specifications apply for V_{CC}=5V T_A=25℃, unless specified otherwise.

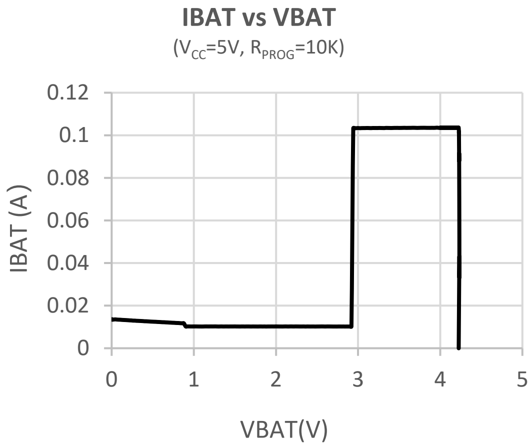
SYMBOL	PARAMETER	CONDITIONS	MIN	TYP.	MAX	UNITS
V_{IN_OP}	Input operating Voltage range		3.75	5	6.8	V
I_{CC}	Input Supply Current	Charge Mode, R_{PROG} = 10K		100		mA
		Standby Mode (Charge Termination) V_{BAT}=4.5V		155		μA
		OVP，V_{CC}=7V		75		μA
		ASD，V_{CC}=V_{BAT}=4V		110		μA
		OTP，V_{CC}=5V		200		μA
		UVLO，V_{CC}=3.3V		60		μA
		Shutdown Mode (CE=0)		4		μA
V_{FLOAT}	Float Voltage	I_{BAT} = 30mA，R_{PROG} = 10K	4.158	4.2	4.242	V
			4.306	4.35	4.394	V
			4.356	4.4	4.444	V
			4.405	4.45	4.495	V
I_{BAT}	BAT Pin Current	Charge Mode (R_{PROG}=2K)	450	500	550	mA
		Charge Mode (R_{PROG}=1K)	900	1000	1100	mA
		Standby Mode (Charge Termination) V_{BAT}=4.5V		4		μA
		OVP，V_{CC}=7V		0	1	μA
		ASD，V_{CC}=V_{BAT}=4V		2		μA
		OTP，V_{CC}=5V		10		μA
		UVLO，V_{CC}=3.3V		0	1	μA
		Shutdown Mode (CE=0)			1	μA
I_{TRIKL}	Trickle Charge Current	V_{BAT}<V_{TRIKL}，R_{PROG}=2K		50		mA
V_{TRIKL}	Trickle Charge Threshold Voltage	R_{PROG}=2K，V_{BAT} Rising; V_{FLOAT}=4.20V	2.7	2.9	3.1	V
		V_{FLOAT}=4.35V	2.7	2.94	3.1	V
		V_{FLOAT}=4.40V	2.7	2.97	3.1	V
		V_{FLOAT}=4.45V	2.7	3.08	3.15	V
V_{TRHYS}	Trickle Charge Hysteresis Voltage	R_{PROG}=2K		100		mV
V_{UV}	UVLO Threshold	V_{CC} from low to high		3.4	3.75	V
V_{UVHYS}	UVLO Hysteresis	V_{CC} from high to low		200		mV
V_{ASD}	Vcc-V_{BAT} Lockout Threshold Voltage	V_{CC} Rising		300		mV
		V_{CC} Falling		150		mV
I_{TERM}	C/10 Termination Current Threshold	R_{PROG}=2K		50		mA
		R_{PROG}=1K		100		mA
V_{PROG}	PROG Pin Voltage	R_{PROG}=2K，CC Charge Mode		1.5		V

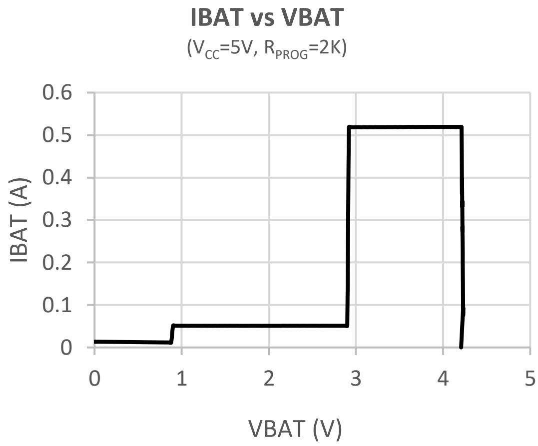
ELECTRICAL CHARACTERISTICS(Continued)

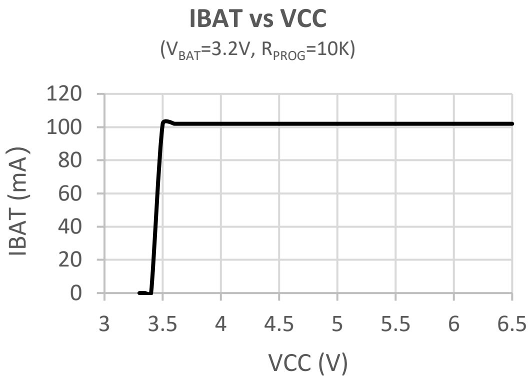
The following specifications apply for V_{CC}=5V T_A=25℃, unless specified otherwise.

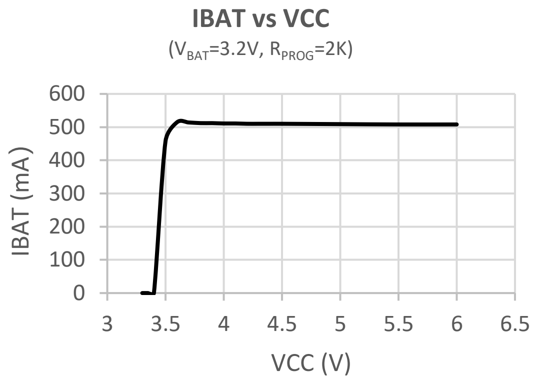
SYMBOL	PARAMETER	CONDITIONS	MIN	TYP.	MAX	UNITS
VCHG	CHG Pin Output Low Voltage	ICHG = 5mA			0.4	V
VFULL	FULL Pin Output Low Voltage	IFULL = 5mA			0.4	V
VCE-H	CE Pin Input High Voltage	CE rising	1.5			V
VCE-L	CE Pin Input Low Voltage	CE drop			0.4	V
VTEMP-H	TEMP Pin High Turn Over Voltage			80		%VCC
VTEMP-L	TEMP Pin Low Turn Over Voltage			45		%VCC
ΔVRECHRG	Auto Recharge Battery Voltage	VFLOAT - VRECHRG		130		mV
TLIM	Thermal regulation Mode			130		°C
OVP	OVP Threshold		6.7	6.8	7.1	V
	OVP Threshold Hysteresis			200		mV
OTP	Over Temperature Protection			150		°C
$t_{RECHARGE}$	Recharge Comparator Filter Time	VBAT High to Low		1		ms
tTERM	Charge Terminated Filter Time	IBAT drops below ICHG/10		1		ms
tSS	Soft-start Time			120		μs

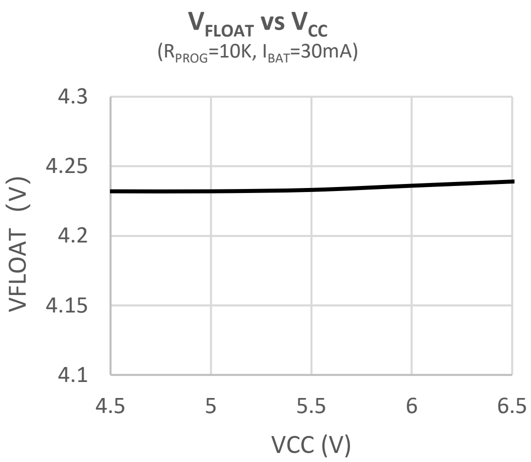
TYPICAL CHARACTERISTICS

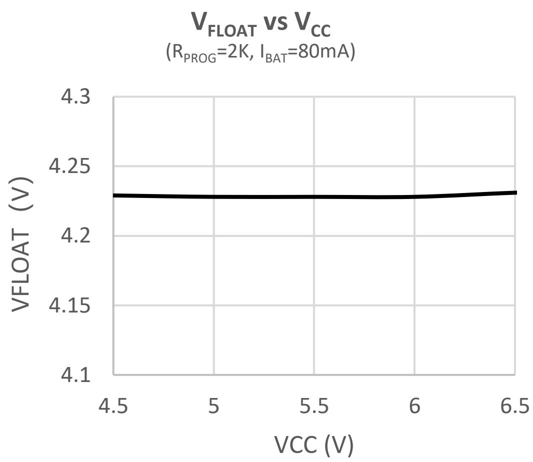




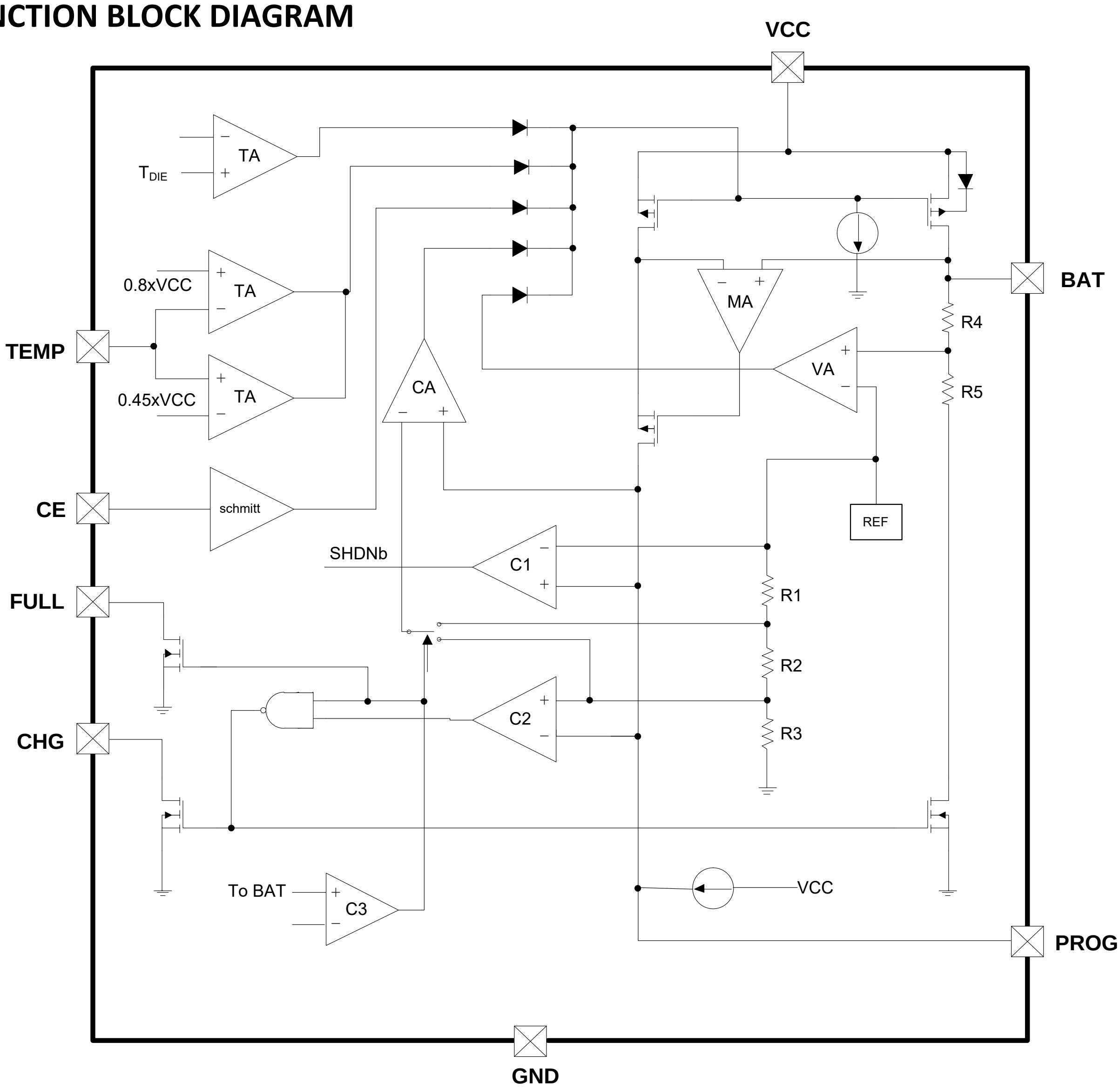




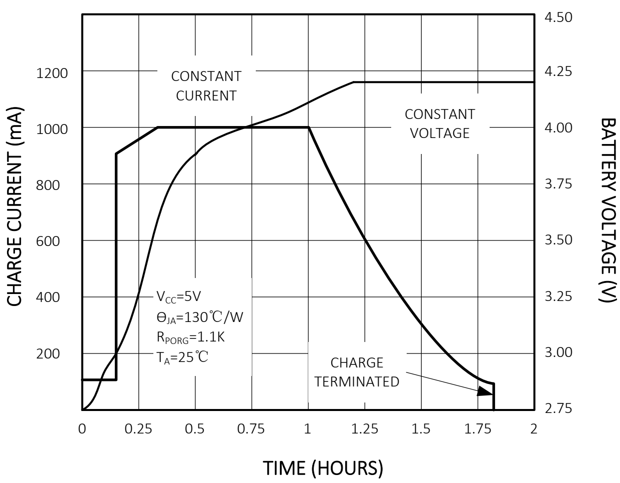




FUNCTION BLOCK DIAGRAM



TYPICAL COMPLETED CHARGING CURVE



APPLICATION INFORMATIONS

The SK4556 is a single cell Li-Ion battery liner charger using a constant-current /constant-voltage algorithm. Charging current can be programmed with external resistor and maximum continuous charging current is up to 1A. The SK4556 contains two open-drain indicators for the charge status indicate, one is CHG (charging status), and the other is FULL (full-charged status). FULL can be also used to indicate fault status. Inner temperature management circuit can automatically decrease charging current when Junction Temperature is over TLIM. This function can maximize the load capacity of the chip and prevent the damage to chip or external component caused by over-temperature.

The SK4556 begins a charge cycle when the voltage at the VCC pin rises above the UVLO threshold level. Thus, the CHG pin is pulled low, which means charging is in progress. If the BAT pin is less than the VTRIKL, the charger enters trickle charge mode. In this mode, the SK4556 supplies approximately 1/10 the programmed charge current to bring the battery voltage up to a safe level for full current charging. When the BAT pin voltage rises above the VTRIKL, the charger enters constant-current mode, where the programmed charge current is supplied to the battery. When the BAT pin approaches the final float voltage, the SK4556 enters constant-voltage mode and the charge current begins to decrease. The charging cycle terminates when the charging current drops to charging-over threshold. Under this condition, output of CHG is in high-impedance state while output of FULL is in low potential.

Charging-over threshold is 10% of constant charging current. A new charging cycle is started when battery voltage drops below recharging voltage threshold. High-accuracy inner reference voltage source makes sure a float voltage accuracy of 1%, which meets the requirements of Li-ion and Li-polymer battery.

The charger enters sleeping mode with low power consumption when input voltage drops or lower than battery voltage. In this mode, current consumed by battery is lower than 1uA, which helps to increase standby time. The charger stops charging when enable input CE is connected to low level.

Input Overvoltage Protection

The SK4556 has built-in input voltage surge protection as high as 28V. The charger cycle will be automatically closed when the input voltage is higher than 6.8V to avoid high-voltage damage and reworks when input voltage is below 6.8V.

Setting of Charging Current

The charge current is set by a resistor connecting between the PROG pin and GND. The relationship of the charging current and the programming resistance is established by the following equations:

$$R_{\text{PROG}} = \frac{1000}{I_{BAT}}$$

In applications, R_{PROG} could be selected according to requirements.

Relationship between R_{PROG} and charge current could be as follow：

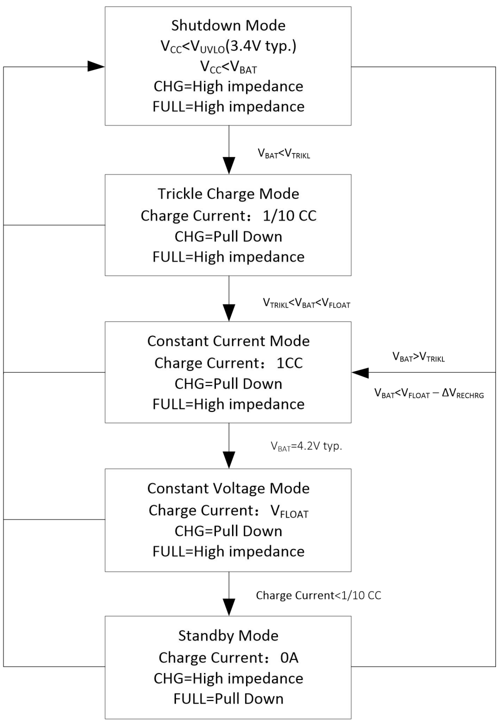
R_{PROG} (K)	I_{BAT} (mA)
25	40
16.6	60
8.3	120
4.2	240
3.33	300
2.5	400
1.66	600
1.43	700
1.25	800
1.11	900
1	1000

Charging Termination

A charge cycle is terminated when the charge current falls to 1/10th the programmed value after the final float voltage is reached. When the time that PROG pin voltage falls below 150mV (typ.) is longer than T_{TERM} and charging cycle is terminated. Then SK4556 enters standby mode, and input current drops to 155uA (typ.).

The chip has designed the function of preventing the false turn off caused by the load transient jump. 1ms TTERM on Terminating Comparator prevents the early termination caused by load transient. Once the average charging current drops to 1/10 of the preset value and ends the charge cycle. No more current is outputted to BAT. Under this state, all load of BAT is powered by battery.

In standby mode, SK4556 keeps monitoring voltage of BAT pin. When BAT pin voltage drops below VRECHRG (recharge threshold Voltage), another charge cycle starts and supplies current to power again. Pic 1 shows a typical charging cycle.



PIC 1： A Typical Charging Cycle

Charge Status Indicator (CHG and FULL)

SK4556 has two different open-drain status outputs of charge status, one is CHR, and the otheris FULL. If those two outputs are connected to LED light, light goes on when the pin to pull low and light goes off when high impedance.

Battery temperature monitor works when typical connection of TEMP pin is used. No-battery pulse signal is outputted by CHG pin if battery is not connected to charger. CHG and FULL pin will be in high-impedance state if battery temperature is out of normal range.

Battery temperature monitor doesn’t work if TEMP is connected to GND. No-battery pulse signal is outputted by CHG pin if battery is not connected to charger.

When the external capacitance of BAT pin connected to battery is 10uF, flash frequency of CHG is 1-4s. The output of status indicator should be connected to GND, when status indicator function is not used.

Refer to the following table for the function of status indication:

PIN	STATUS	FULL	CHG	Description
VCC	$V_{CC}<V_{UVLO}$	OFF	OFF	Fault
	$V_{CC}<V_{ASD}$	OFF	OFF	Fault
	$V_{ASD}<=V_{CC}<OVP$	OFF	ON	Charging
	VCC>=OVP	OFF	OFF	Fault
	VCC Floating	OFF	OFF	No-charging
VBAT	$V_{BAT} < V_{TRIKL}$	OFF	ON	Charging
	$V_{BAT}>= V_{TRIKL}$	OFF	ON	Charging
	$V_{BAT} > V_{ASD}$	OFF	OFF	Fault
	BAT short-circuit	OFF	ON	Charging
	BAT Floating	Flash	Flash	No battery
IBAT	$I_{BAT}=0$	ON	OFF	Charging End
	$0< I_{BAT} <1/10C$	Flash	Flash	No battery
	$I_{BAT} >1/10C$	OFF	ON	Charging
PROG	PROG floating，then VCC powers on	OFF	OFF	Fault
	PROG floating when charging	OFF	OFF	Fault

	PROG short circuit, then VCC powers on	OFF	OFF	Fault
	PROG short circuit during charging	Slightly light	ON	Fault
CE	CE=0	OFF	OFF	No-charging

Thermal Limit

If the chip temperature is above preset T_{LIM} , an inner thermal reflective circuit will decrease charging current. This function can prevent SK4556 from overheating and damage caused by increase load capacity. Charging current can be set according to typical (not the worst) ambient temperature on the premise that the charger will automatically reduce the current under the worst conditions.

Battery Temperature Monitoring

To prevent damage to battery caused by too high or too low temperature, the SK4556 integrates batter temperature monitoring circuit. It monitors temperature by measuring the voltage of TEMP PIN. The voltage is developed by a NTC thermistor and an external voltage divider, which is showed by typical application circuit.

SK4556 Compares this voltage against its internal V_{LOW} and V_{HIGH} to make sure if the battery temperature exceeds normal range. Inner SK4556, V_{LOW} is fixed at 45%$\times V_{CC}$ (K_1) and V_{HIGH} is fixed at 80% $\times$ V_{CC} (K_2). The charging cycle will be suspended when $V_{TEMP} < V_{LOW}$ or $V_{TEMP} > V_{HIGH}$, which means battery temperature is too high or too low. The charging cycle will continue if V_{TEMP} is in the range of V_{LOW} and V_{HIGH}.

The battery temperature monitoring function will be forbidden if the TEMP pin is connected to ground.

Determining the Value of R_1 and R_2

The values of R_1 and R_2 shall be determined according to the temperature monitoring range of the battery and the resistance value of the thermistor. Examples are as follows: If the preset battery temperature is from T_L to T_H, ($T_L < T_H$) and the negative temperature coefficient (NTC) thermistor is used, R_{TL} means the resistance of T_L and R_{TH} means the resistance of T_H. Then $R_{TL} > R_{TH}$. Therefore, in T_L, the voltage of TEMP is

$$V_{\text{TEMPL}} = \frac{R_2||R_{TL}}{R_1 + R_2||R_{TL}} \times VIN$$

In T_H , the voltage of TEMP is：

$$V_{\text{TEMPH}} = \frac{R_2||R_{TH}}{R_1 + R_2||R_{TH}} \times VIN$$

Then, according to

$V_{TEMPL} = V_{HIGH} = K2 \times V_{CC}$ (K2=0.8)

$V_{TEMPH} = V_{LOW} = K1 \times V_{CC}$ (K1=0.45)

We get equals below:

$$R_1 = \frac{R_{TL}R_{TH}(K_2 - K_1)}{(R_{TL} - R_{TH})K_1K_2}$$

$$R_2 = \frac{R_{TL}R_{TH}(K_2 - K_1)}{R_{TL}(K_1 - K_1K_2) - R_{TH}(K_2 - K_1K_2)}$$

Similarly, if there is a positive temperature coefficient (PTC) thermistor, according to $R_{TL} < R_{TH}$, we get the equals below：

$$R_1 = \frac{R_{TL}R_{TH}(K_2 - K_1)}{(R_{TH} - R_{TL})K_1K_2}$$

$$R_2 = \frac{R_{TL}R_{TH}(K_2 - K_1)}{R_{TH}(K_1 - K_1K_2) - R_{TL}(K_2 - K_1K_2)}$$

It can be seen from the above derivation that the temperature range to be set is independent of the power voltage V_{CC}. and only related to R_1、R_2、R_{TH}、R_{TL}. R_{TH}、 R_{TL} can be obtained from relevant battery manual or through experimental tests. In application, R_2 can be ignored if we only focus on temperature characteristics at one end, like over-heating protection. Then we will only focus on R_1 and the derivation of R_1 will be easier, which won't be given details.

Examples of TEMP Resistance Calculation:

TEMPL=-7℃, TEMPH=50℃, As known:

TS1（K_1）	0.45	Inner Set
TS2（K_2）	0.8	Inner Set

Entry the values of NTC resistance:

(Check the manual of MuRata NCP15XH103F03RC)

R_{TL}	37, 073.00	-7℃
R_{TH}	4, 161.00	50℃
R25℃	10, 000.00	

Calculation Results:

R_1	4, 556.87
R_2	35, 857.20

Under-voltage Lockout

Build-in under voltage lockout circuit monitors the input voltage and keeps the charger in shutdown mode until VCC rises above the under-voltage lockout threshold. If the UVLO comparator is tripped, the charger will not come out of shutdown mode until VCC rises 100mV above the battery voltage.

Automatic Recharge

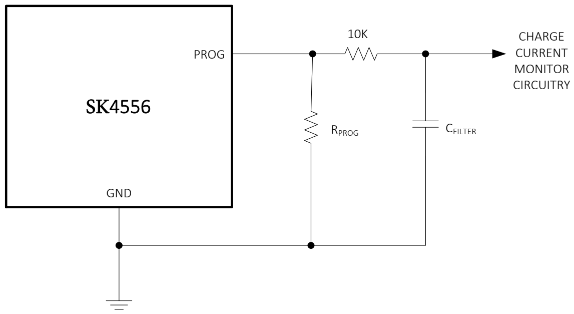
Once the charging cycle is terminated, the SK4556 uses a filtering time Comparator ($t_{RECHARGE}$) to monitor the voltage on the BAT pin. Once battery voltage drops below ΔV_{RECHRG} (Almost 80% to 90%of Battery capacity), charging cycle reworks, which makes sure the battery is kept in full-charged (or almost full-charged) state and avoids starting a periodic charging cycle. In recharging cycle, the output of CHG pin enters a strong pull-down state.

Consideration of Stability

Under constant current mode, it is the PROG pin not the battery that in the feedback loop. The stability of constant-current mode is affected by impedance of PROG pin. When there is no additional capacitance on the PROG pin, the maximum allowable resistance value of the preset resistance will be reduced. The maximum resistance value can be calculated by the equals below:

$$R_{PROG} \le \frac{1}{2\pi \times 10^5 \times C_{PROG}}$$

For user, they are more interested in charging current instead of transient current. For example, if a switch power supply working in low current mode is parallel connected to battery, the average current flowing from the BAT pin is usually more important than the transient current. In this condition, a simple RC filter on prog PIN can be used to measure the average current. (Showed by PIC 2). An additional 10k resistance is added between PROG pin and filter capacitor to ensure stability.



PIC 2：Charge current monitor circuit

Thermal Design

Due to the small package dimension of ESOP8, an elaborate thermal design of PCB layout, which is used for increasing usable charging current to maximum extent, is very important. The heat radiation circuit, used to dissipate the heat generated by IC, runs from chip to lead frame, and arrives PCB copper foil (which is an auxiliary radiator) through radiator below. The measure of copper foil, connected to radiator, should be as large as possible and stretch out to external larger copper foil to spread the heat to surrounding environment. The holes placed on the middle layer or back copper foil layer are also useful in improving the overall thermal performance of the charger. When designing PCB layout, other heat sources n the circuit board not related to the charger must also be considered. Because they will also have an impact on the overall temperature rise and the maximum charging current.

Soft start for charging current

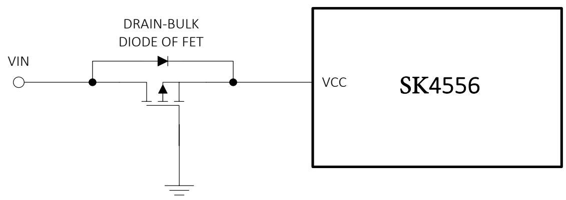
A soft-start circuit is designed to decrease inrush current to maximum extent at the beginning of charging cycle. When a charging cycled starts, the charging current will rise from 0 to the max in around 20μs, which can decrease the load of transient current to the maximum.

Protection of Reverse Connection of Battery

In SK4556, a reversed-connection protection circuit is designed to avoid the damage to chips caused by reverse connection of battery during production and assembly.

Reverse Polarity Input Voltage Protection

In some applications, reverse polarity voltage protection of VCC is necessary. A series isolating diode can be used if power voltage is high enough. Under other conditions that need to keep low voltage, a P channel MOSFET can be chose.

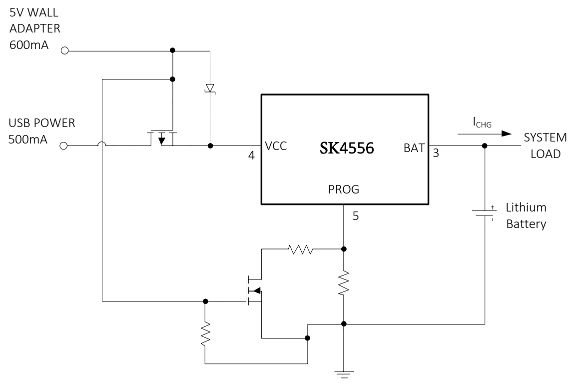


PIC 3：VCC Reverse Protection

USB and AC adapter Power Supply

SK4556 allows charging from an AC adapter or an USB port. Pic 4 shows a real example of how to combine AC adapter with USB. A P channel MOSFET (MP1) is used to prevent signal enters USB port when AC adapter is connected. A Schottky diode is used to prevent USB power consumption when it passes 1K pull-down resistor.

Generally, current supplied by AC adapter is larger than that supplied by USB, which limiting value is 500mA. Therefore, when AC adapter is connected, a N channel MOSFET (MN1) and an additional 10K pre-set resistance are used to increase charging current to 600mA.

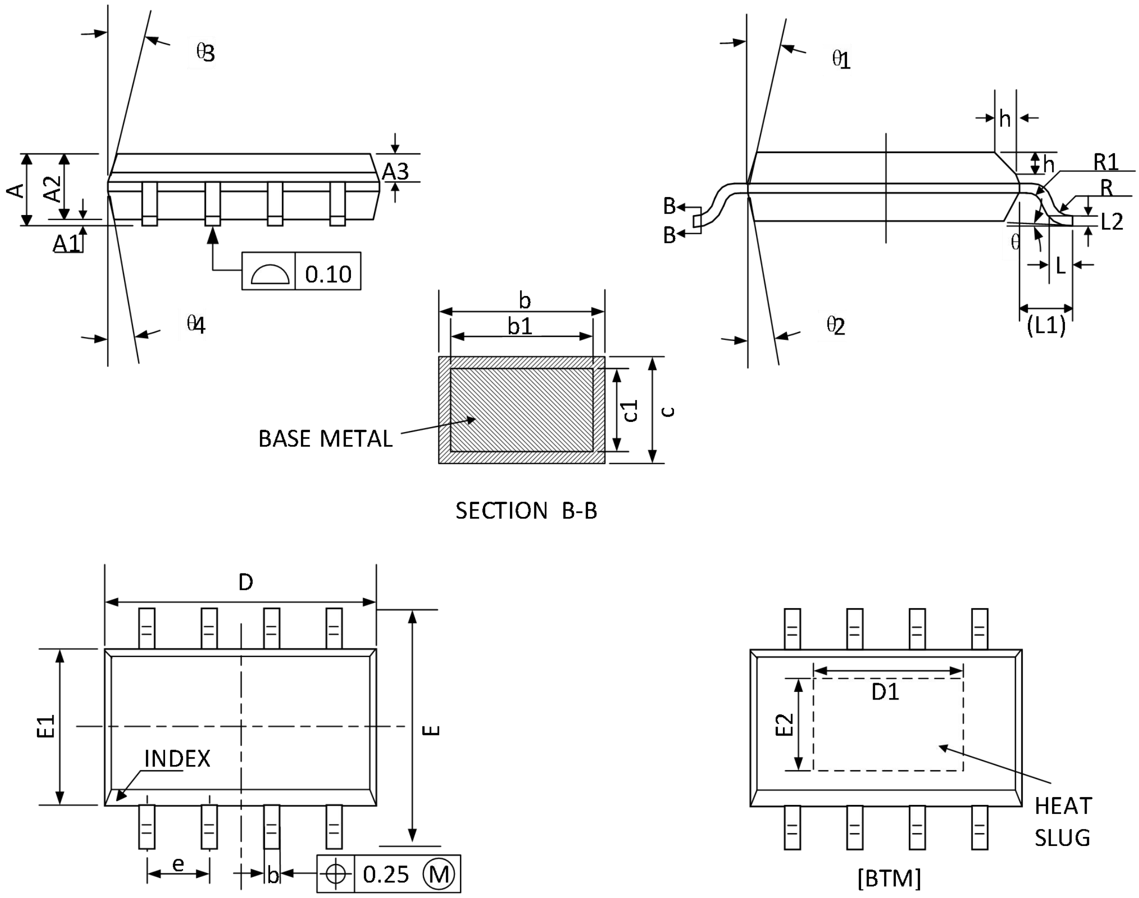


PIC 4：Combination of AC adapter and USB power supply

PACKAGE OUTLINE

Package	**ESOP-8**	**Devices per reel**	**4000PCS**	**Unit**	**mm**

Package Dimension:



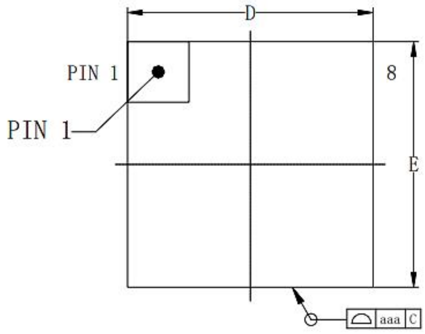
NOTES:
ALL DMENSIONS REFER TO JEDEC STANDARD MS-012 AA
DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

SYMBOL	MILLIMETER			SYMBOL	MILLIMETER		
	MIN	NOM	MAX		MIN	NOM	MAX
A	/	/	1.77	D	4.7	4.9	5.1
A1	0.08	0.18	0.28	E	5.8	6	6.2
A2	1.2	1.4	1.6	E1	3.7	3.9	4.1
A3	0.55	0.65	0.75	e	1.27BSC		
b	0.37	0.4	0.44	L	0.5	0.65	0.8
b1	0.36	0.39	0.43	L1	1.05BSC		
c	0.21	-	0.26	θ	0	-	8°
D1	3.1	3.3	3.5	E2	2.2	2.4	2.6

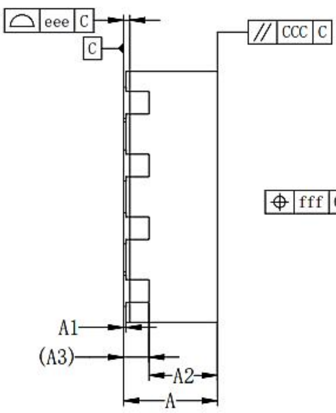
PACKAGE OUTLINE

Package	DFN2x2-8L	Devices per reel	4000PCS	Unit	mm

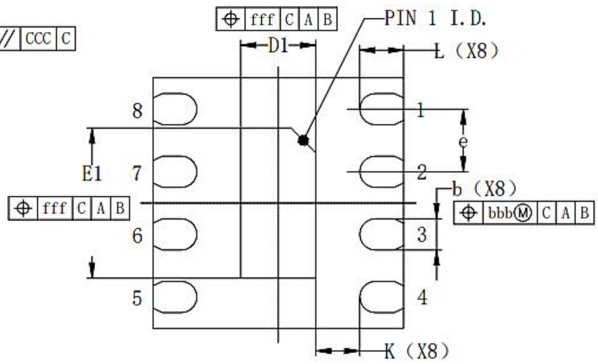
Package Dimension:



TOP VIEW



SIDE VIEW



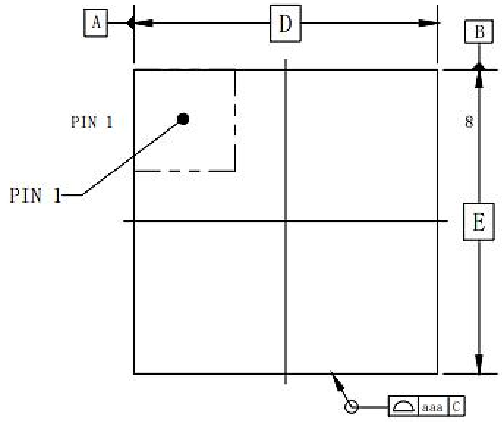
BOTTOM VIEW

SYMBOL	MILLIMETER			SYMBOL	MILLIMETER		
	MIN	NOM	MAX		MIN	NOM	MAX
D	2.0 BSC			b	0.20	0.25	0.30
E	2.0 BSC			L	0.30	0.35	0.40
D1	0.50	0.60	0.70	e	0.50 BSC		
E1	1.10	1.20	1.30	K	0.35 REF		
A	0.70	0.75	0.80	aaa	0.10		
A1	0	0.02	0.05	bbb	0.10		
A2	/	0.55	/	ccc	0.10		
A3	0.203 REF			eee	0.05		
				fff	0.10		

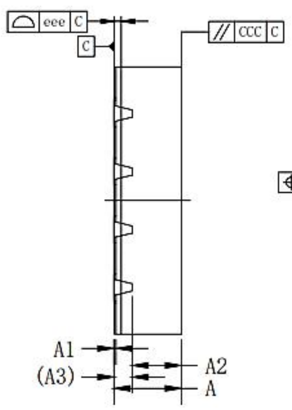
PACKAGE OUTLINE

Package	DFN3x3-8L	Devices per reel	5000PCS	Unit	mm

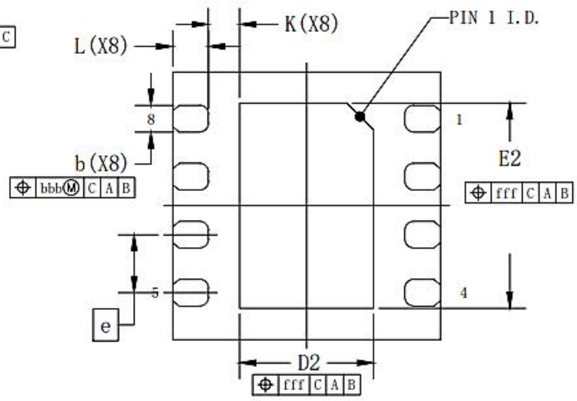
Package Dimension:



TOP VIEW



SIDE VIEW



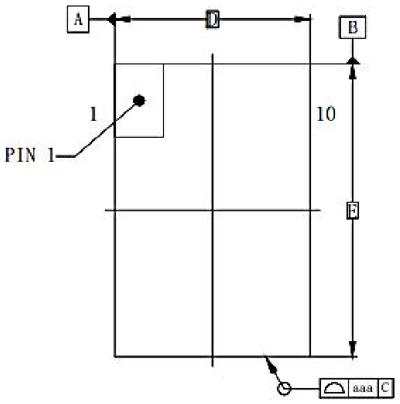
BOTTOM VIEW

SYMBOL	MILLIMETER			SYMBOL	MILLIMETER		
	MIN	NOM	MAX		MIN	NOM	MAX
D	3.0 BSC			b	0.25	0.30	0.35
E	3.0 BSC			L	0.30	0.40	0.50
D2	1.40	1.50	1.60	e	0.65 BSC		
E2	2.20	2.30	2.40	K	0.35 REF		
A	0.70	0.75	0.80	aaa	0.10		
A1	0	0.02	0.05	bbb	0.10		
A2	/	0.55	/	ccc	0.10		
A3	0.203 REF			eee	0.08		
				fff	0.10		

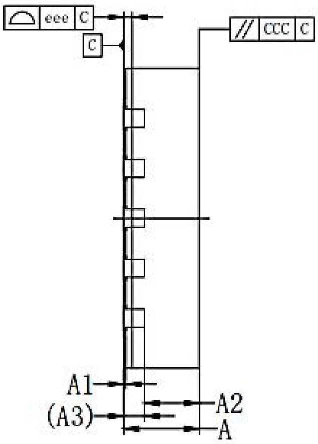
PACKAGE OUTLINE

Package	DFN3x2-10L	Devices per reel	4000PCS	Unit	mm

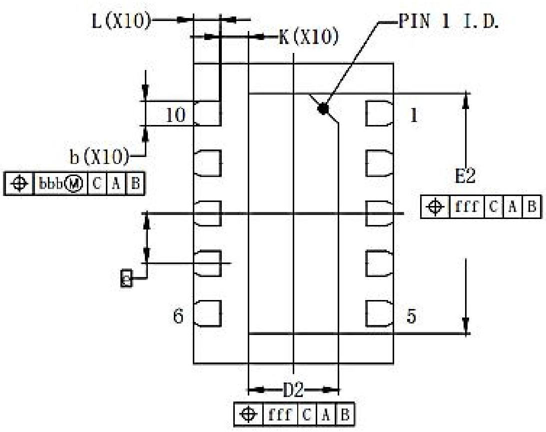
Package Dimension:



TOP VIEW



SIDE VIEW



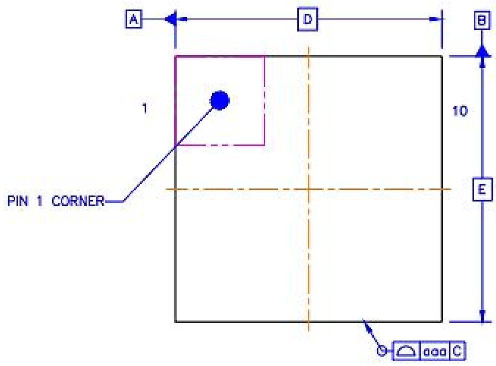
BOTTOM VIEW

SYMBOL	MILLIMETER			SYMBOL	MILLIMETER		
	MIN	NOM	MAX		MIN	NOM	MAX
D	2.0 BSC			b	0.20	0.25	0.30
E	3.0 BSC			L	0.22	0.27	0.32
D2	0.80	0.90	1.00	e	0.50 BSC		
E2	2.30	2.40	2.50	K	0.28 REF		
A	0.70	0.75	0.80	aaa	0.10		
A1	0	0.02	0.05	bbb	0.10		
A2	/	0.55	/	ccc	0.10		
A3	0.203 REF			eee	0.05		
				fff	0.10		

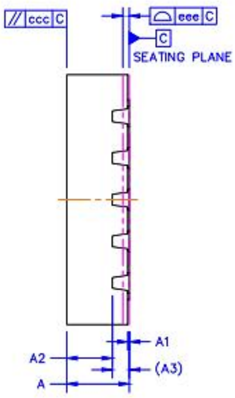
PACKAGE OUTLINE

Package	DFN3x3-10L	Devices per reel	5000PCS	Unit	mm

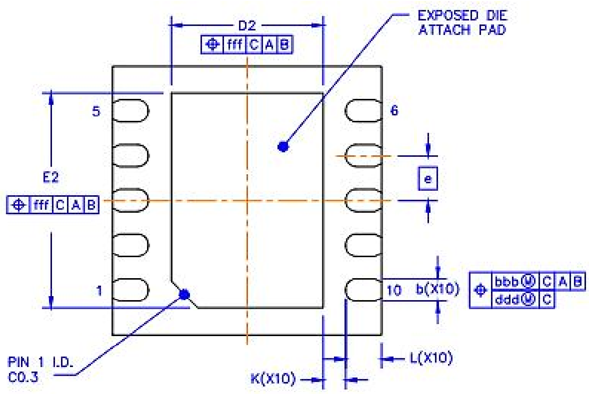
Package Dimension:



TOP VIEW



SIDE VIEW



BOTTOM VIEW

SYMBOL	MILLIMETER			SYMBOL	MILLIMETER		
	MIN	NOM	MAX		MIN	NOM	MAX
D	3.0 BSC			b	0.20	0.25	0.30
E	3.0 BSC			L	0.30	0.40	0.50
D2	1.60	1.70	1.80	e	0.50 BSC		
E2	2.30	2.40	2.50	K	0.25 REF		
A	0.70	0.75	0.80	aaa	0.10		
A1	0	0.02	0.05	bbb	0.10		
A2	/	0.55	/	ccc	0.10		
A3	0.203 REF			ddd	0.05		
				eee	0.08		
				fff	0.10		