

General Description

The SM5206 is a single cell Li-ion battery linear charger using the complete CC/CV algorithm, which has the function of positive and negative electrode protection for battery at the same time.

No external sense resistor and blocking diode is required due to the internal P-MOSFET architecture. Besides, the thermal feedback can regulate the charge current to limit the die temperature during high power operation or high ambient temperature. The charge voltage is fixed at 4.2V, and the charge current can be programmed externally with a single resistor. Furthermore, the SM5206 automatically terminates the charge cycle when the charge current drops to 1/10 of the programmed value after the final float voltage is reached.

When the input supply (wall adapter or USB supply) is removed, the SM5206 automatically enters a low current CHRG_e dropping the battery drain current to less than 0.25 μ A. Also, it can enter standby mode, which the input supply current drops to 45 μ A.

The SM5206 has other features including charge current monitor, under-voltage lockout, automatic recharge and two CHRG_{us} pins to indicate charge and charge termination.

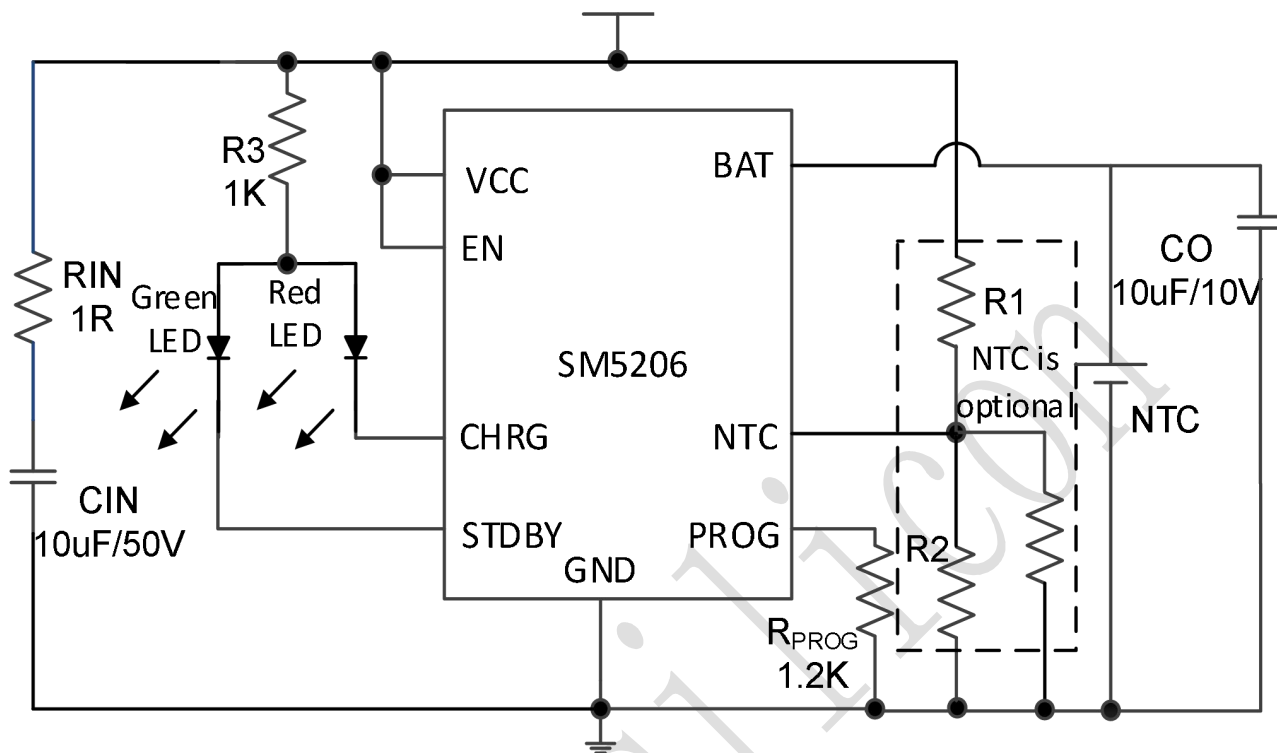
Features

- Programmable Charge Current Up to 1A
- No MOSFET, Sense Resistor or Blocking Diode Required
- Constant-Current/Constant-Voltage Operation with Thermal Regulation to Maximize Charge Rate without Overheating
- Charge Single Cell Li-ion Battery Directly from USB Port
- Accuracy up to $\pm 1\%$ of 4.2V preset charging voltage
- Charge Current Monitor Output for Battery Level Detection
- Support battery 0V charging
- Automatic Recharge
- Charging OVP
- 2.9 V Trickle Charge Threshold
- Soft-start limiting surge current
- C / 10 Charge Termination
- ESOP8/DFN2x2-8 Package
- 30V PIN withstand voltage

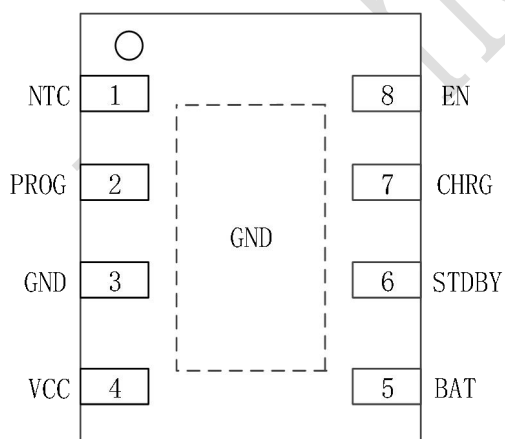
Applications

- Mobile phone, PDA, MP3 players
- Charging Docks and Cradles
- Bluetooth applications
- Other Portable Devices

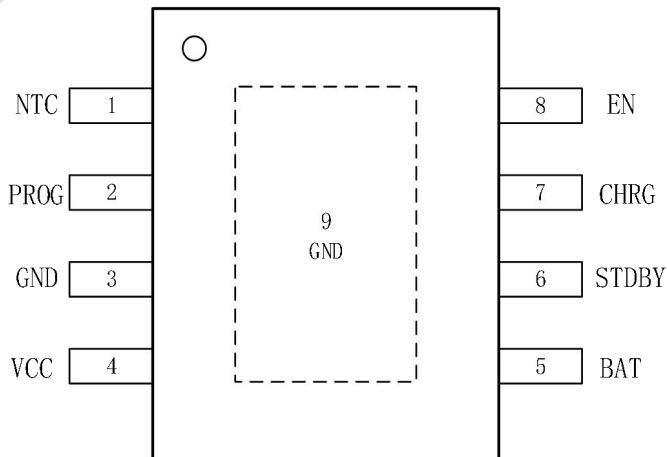
Typical Application Circui



Pin Assignment



DFN2x2-8



ESOP8

Functional Pin Description

ESOP8	DFN2x2-8	Pin Name	Pin function
1	1	NTC	Temperature thermal sensing input pin.
2	2	PROG	Charging Current Program Pin. The charging Current is Programmed by Connected PROG Resistor to GND.
3	3	GND	Ground Pin
4	4	VCC	Input Power Source. Connect to a wall adapter or USB Port.
5	5	BAT	Battery Connection Pin.
6	6	STDBY	Charging termination indicator pin. Open-Drain Charge CHRGus Output
7	7	CHRG	Charging CHRGus indicator pin. Open-Drain Charge CHRGus Output
8	8	EN	Chip enable pin. Charging when the pin is floating or connected to a high voltage.
9	9	Exposed pad	The exposed pad is needed to connect to GND.

Absolute maximum ratings⁽¹⁾

VCC -0.3V ~ 30V
 PROG -0.3V ~ 6.0V
 BAT -0.3V ~ 12V
 All other PIN -0.3V ~ 30V
 Operating temperature(TOP) -40℃ ~ +85℃
 Storage temperature(TSTG) -40℃ ~ +125℃

The scope of work

VCC 4.5V ~ 6.5V

(1) Stresses beyond this listed under “Absolute maximum ratings” may cause permanent damage to the device; All the above maximum ratings are for withstand pressure ratings only.

Electrical Characteristics

(VCC=5V, T_A=25℃, unless otherwise noted.)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
The input voltage range	V _{CC}		4.5	5	6.5	V
The input voltage over-voltage protectorate	VOVP			6.5		V
The input voltage current	I _Q	Charging mode, R _{PROG} =1.2k		300		μA
		Standby mode (charging termination)		100		μA
		Stop mode(R _{PROG} Not connected, V _{CC} < V _{BAT} , or V _{CC} < V _{UV})		75		μA
Float Voltage	V _{FLOAT}	0℃≤T _A ≤85℃, I _{BAT} = 40mA	4.16	4.2	4.24	V
BAT Pin Current	I _{BAT}	R _{PROG} = 2.4k, Charging mode		500		mA
		R _{PROG} = 1.2k, Charging mode		1000		mA
		Standby mode, V _{BAT} = 4.2V	0	2	3	μA
		Shutdown mode(R _{PROG} NC)		0.25	0.35	μA
		Sleep mode, V _{CC} = 0V		0.25	0.35	μA
Trickle Charge Current	I _{TRIKL}	V _{BAT} < V _{TRIKL} , R _{PROG} = 1.2k	180	200	220	mA
Trickle Charge Threshold Voltage	V _{TRIKL}	R _{PROG} = 1.2k, V _{BAT} Rising	2.75	2.93	3.1	V
Trickle Charge Hysteresis Voltage	V _{TRHYS}	R _{PROG} = 1.2k	120	150	180	mV
VCC Under voltage Lockout Threshold	V _{UV}	V _{CC} from low to high		3.8		V
VCC Under voltage Lockout Hysteresis	V _{UVHYS}			280		mV
VCC-VBAT Lockout Threshold Voltage	V _{ASD}	V _{CC} from low to high		140		mV
		V _{CC} from high to low	50	100		mV
Battery Reverse Connect Protection Voltage	V _{REV}	V _{BAT} from high to low, V _{BAT} -V _{GND}		-230		mV
Battery Reverse Connect Protection Hysteresis Voltage	V _{REHYS}	V _{BAT} from low to high, V _{BAT} -V _{GND}		-200		mV
Termination Current Threshold	I _{TERM}	R _{PROG} = 2.4k		50		mA
		R _{PROG} = 1.2k		100		mA
PROG Pin Voltage	V _{PROG}	BAT=4.0V, Charging mode	0.9	1.0	1.1	V
CHRG Pin Output Low Voltage	V _{CHRG}	I _{CHRG} = 5mA		0.35	0.6	V
STDBY Pin Output Low Voltage	V _{STDBY}	I _{STDBY} = 5mA		0.35	0.6	V
Auto Recharge Battery Voltage	ΔV _{RECHRG}	V _{FLOAT} - V _{RECHRG}		100		mV
Junction Temperature in Constant Temperature Mode	T _{LIM}	(Only internal temperature of chip)		120		℃
Power FET On Resistance	R _{ON}			0.6		mΩ
Soft-Start Time	T _{SS}	I _{BAT} = 0 to I _{BAT} = 1000V/R _{PROG}		100		μs
Recharge Comparator Filter Time	T _{RECHARGE}	V _{BAT} From high to low	0.4	1.0	2.5	ms

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Charge Terminated Filter Time	T _{TERM}	I _{BAT} Down to I _{CHG} /10	0.4	1.0	2.5	ms
PROG Pin Pull Current	I _{PROG}			1.0		μA
NTC Pin High Turn Over Voltage	V _{NTC-H}	(Only internal temperature of chip)		80	82	%VC C
NTC Pin Low Turn Over Voltage	V _{NTC-L}	(Only internal temperature of chip)	43	45		%VC C
EN Pin Pull Current			0.5	1		μA
EN Pin Input High Voltage	V _{ENH}		1.6			V
EN Pin Input Low Voltage	V _{ENL}				0.6	V

Function Description

The SM5206 is a single cell Li-ion battery charger using a constant-current/constant-voltage algorithm. It can deliver up to 1A of charge current (using a good thermal PCB layout) and accuracy up to ±1% of preset charging voltage .

The SM5206 includes an internal P-channel power MOSFET and thermal regulation circuitry. No blocking diode or external current sense resistor is required; thus, the basic charger circuit requires only two external components.

Normal Charge Cycle

A charge cycle begins when the voltage at the VCC pin rising above the UVLO threshold level, and a 1% PROG resistor is connected from the PROG pin to ground or when a battery is connected to the charger output. If the BAT pin is less than 2.9V, the charger enters trickle charge mode. In this mode, the SM5206 supplies approximately 2/10 of the programmed value current to bring the battery voltage up to a safe level for full current charging.

When the BAT pin voltage rises above 2.9V, the charger enters constant-current mode, where the programmed charge current is supplied to the battery. Finally, when the BAT pin approaches the final float voltage(4.2V), the SM5206 enters constant-voltage mode and the charge current begins to decrease. When the charge current drops to 1/10 of the programmed value, the charge cycle ends.

Programming Charge Current

The charge current is programmed, using a single resistor from the PROG pin to ground. The battery charge current is 1200 times the current out of the PROG pin. The charge current out of the BAT pin can be determined at any time by monitoring the PROG pin voltage using the following equation:

$$R_{PROG} = \frac{1200V}{I_{CHG}} \text{ or } I_{CHG} = \frac{1200V}{R_{PROG}}$$

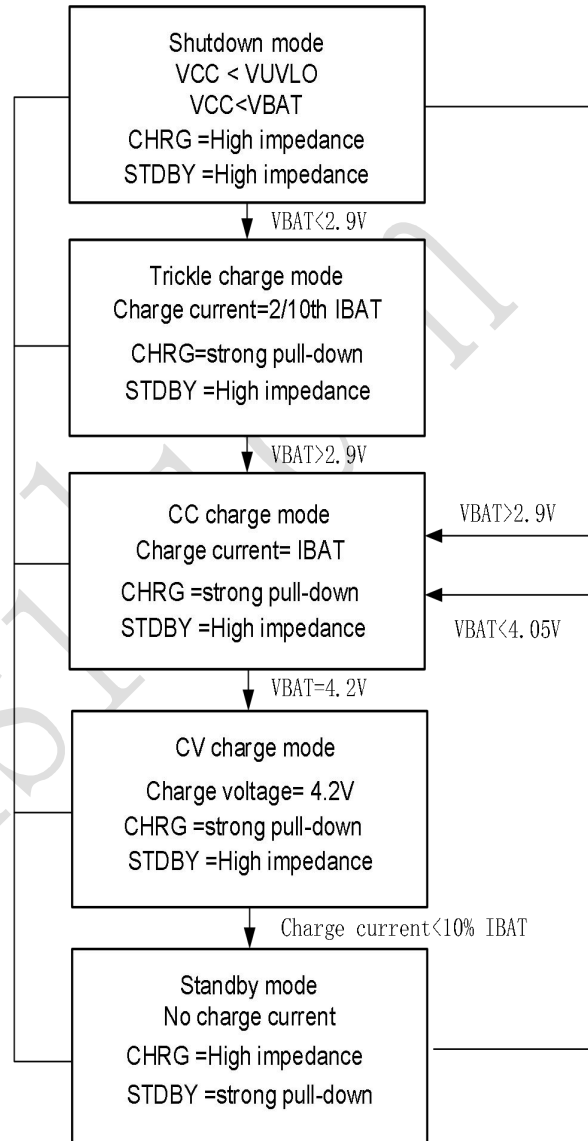
Charge termination

A charge cycle is terminated when the charge current falls to 1/10 of the programmed value after the final float voltage is reached. This condition is detected by using an internal, filtered comparator to monitor the PROG pin. When the PROG pin voltage falls below 100mV for longer than TTERM (typically 1.8ms), charging is terminated. Therefore, the charge current is latched off and the SM5206 enters standby mode, where the input supply current drops to 200uA. (Note: 1/10 CC termination is disabled in trickle charge mode and thermal limiting mode).

When charging, transient loads on the BAT pin can cause the PROG pin to fall below 100mV transitorily before the DC charge current has dropped to 1/10 of the programmed value. The 1ms filter time (TTERM) of the termination comparator ensures that the transient loads will not result in premature charge cycle termination. Once the average charge current drops below 1/10 of the programmed value, the SM5206 terminates the charge cycle and stop providing any current through the BAT pin. The chip will be put into standby mode. In this CHRG, all loads on the BAT pin must be supplied by the battery.

The SM5206 constantly monitors the BAT pin voltage in standby mode. If this voltage drops below the recharge threshold (VRECHRG), another charge cycle begins and then current is supplied to the battery once again. To manually restart a charge cycle in standby mode, the input voltage must be removed and reapplied or the charger must be shut

down and restarted using the PROG pin. The CHRG diagram of a typical charge cycle is as below:



Charge CHRGus Indicator

The SM5206 has two open-drain CHRGus indicator output: CHRG and STDBY. CHRG is pull-down

when the SM5206 in a charge cycle. In other CHRGus CHRG is in high impedance. And STDBY is

pull-down when the charging cycle is complete.

When the battery is out of the normal temperature, CHRGe and STDBY are both in high impedance.

The function of battery temperature sense is disabled by connecting NTC pin to GND. If battery is not connected to charger and BAT pin connects a 10μF capacitor, the Red and Green LED will both flicker at the frequency of about 1-4s.

charger's CHRGe	Red led CHRGe	Green led STDBY
Charging	light	dark
Battery in full CHRGe	dark	light
Under-voltage, battery's temperature is too high or too low, or not connect to battery(use NTC)	dark	dark
BAT pin is connected to 10uF capacitor, No battery mode (NTC=GND)	Green LED and red LED flicker F=1-4 S	

Thermal Limiting (Only internal temperature of chip)

The internal thermal feedback loop will help to reduce the charging current, if the chip temperature is raised to a preset 120℃. This function protects the SM5206 from excessive temperature and allows the user to improve the limits of the power handling capability of a given circuit board without the risk of damaging. What's more, the charge current can be set according to typical but not the worst ambient temperature with the assurance that the charger will automatically reduce the current in worst-case conditions.

Under Voltage lockout (UVLO)

An internal 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 is 100mV higher than the battery voltage.

Automatic Recharge

Once the charge cycle is terminated, the SM5206 continuously monitors the voltage on the BAT pin by using a comparator with a 1ms filter time. A charge cycle restarts when the battery voltage falls below 4.05V, which corresponds to approximately 80% to 90% battery capacity. It ensures that the battery is kept at or near a fully charged condition and eliminates the need for periodic charge cycle initiations. CHRGe output enters a strong pull-down CHRGe during recharge cycles.

Power dissipation (Only internal temperature of chip)

Chip junction temperature depends on the ambient temperature, PCB layout, load and encapsulation types and other factors. Power consumption and chip junction temperature can be calculated according to the following formula:

$$PD = RDS(ON) \times IOUT2$$

And according to the PD junction temperature,

it can be obtained by the following formula:

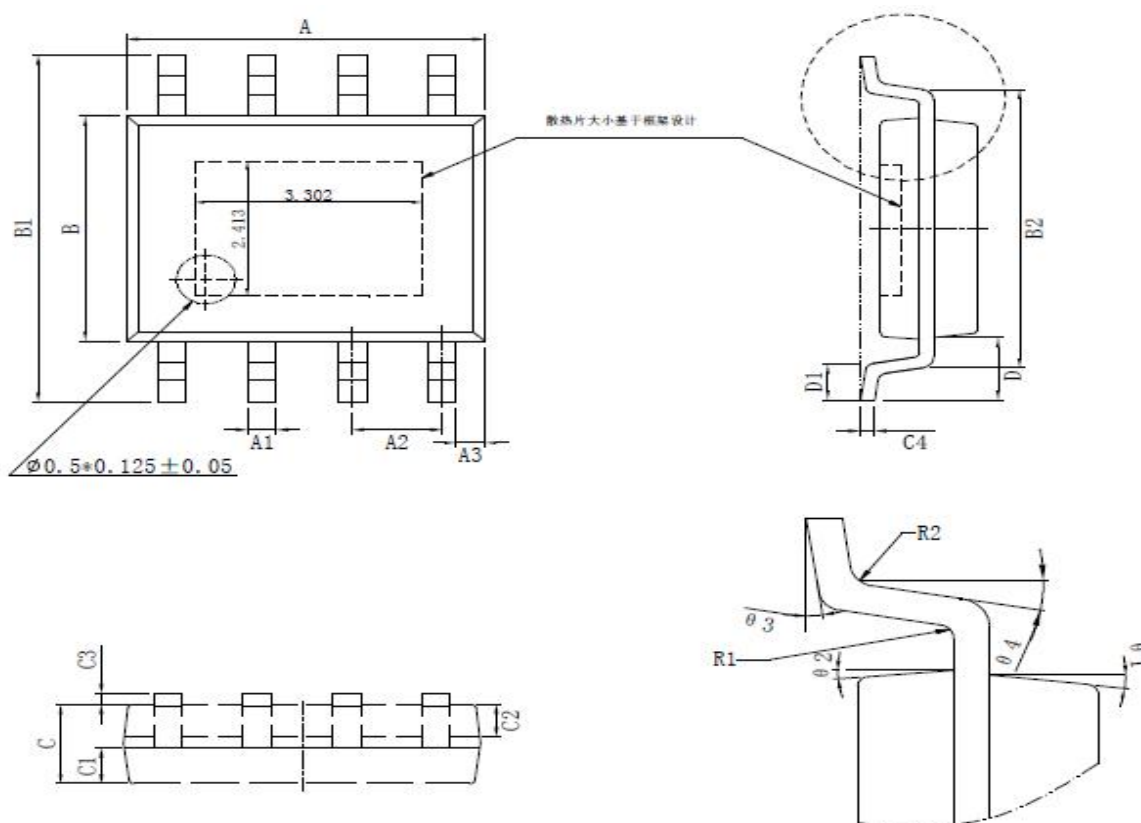
$$T_J = P_D \times \theta_{JA} + T_A$$

Note: T_J is chip junction temperature, T_A is the ambient temperature, θ_{JA} is encapsulated

Battery Temperature Detection(NTC) (Only internal temperature of chip)

The NTC pin from the output of the NTC sensor of the battery. If the NTC pin voltage is less than the input voltage of 45% or greater than the input voltage of 80%, means that the battery temperature too low or too high, the charge is suspended. If the NTC directly to GND, battery temperature detection cancelled, other normal charging function.

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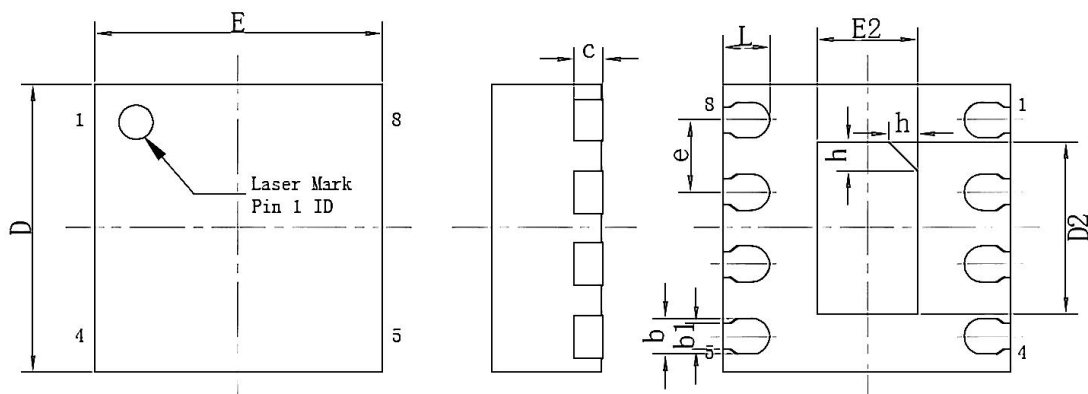


symbol I	dimensions		symbol	dimensions	
	millimeters			millimeters	
	min	max		min	max
A	4.80	0.05	C3	1.95	2.05
A1	0.356	0.30	C4	0.65	0.75
A2	1.27TYP		D	1.05TYP	
A3	0.345TYP		D1	0.40	0.80
B	3.80	4.00	R1	0.20TYP	
B1	5.80	6.20	R2	0.20TYP	
B2	5.00TYP		Θ1	1.7° TYP	
C	1.30	1.60	Θ2	13° TYP	
C1	0.55	0.65	Θ3	0° ~8°	
C2	0.55	0.65	Θ4	4° ~12°	

* The Die pad exposure size is based on the lead frame design.

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bottom view



Symbol	Dimensions In		Symbol	Dimensions In	
	Min	Max		Min	Max
A	0.70	0.80	e	0.50BSC	
A1	0.00	0.05	E	1.95	2.05
b	0.18	0.30	E2	0.65	0.75
b1	0.18REF		L	0.25	0.35
c	0.20REF		h	0.15	0.25
D	1.95	2.05	L/F 载体尺寸: 1.10*1.80		
D2	1.15	1.25			

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