DESCRIPTION

The A4059 is charging management circuit that can be programmed through an external resistor constant current / constant voltage charging. The device includes an internal power transistor, does not need external current sense resistor and blocking diode in applications. A4059 requires minimal external components, and meet the USB bus specification, is very suitable for portable applications in the field.

Thermal modulation circuit can control the internal chip temperature in a safe range when the device power dissipation be relatively large or the ambient temperature be higher. The output voltage can be programmed by an external resistor. Charging current is set by an external resistor. When the input voltage (AC adapter or USB power supply) power is lost, A4059 automatically enters a low power sleep mode, then the battery current consumption is less than 0.1μA. Built-in protection circuits against irrigation, when the battery voltage is higher than the input voltage, automatically turn off built-in power MOSFET. Other features include low input voltage latch, automatic recharge, the battery temperature monitoring, Built - in OVP protection and charge status / charge status indication functions.

The internal use of the patented technology is to realize protecting reverse battery. When the battery is reversed, stop charging, indicator

The A4059 is available in PSOP8 package.

ORDERING INFORMATION

Package Type	Part Number	
PSOP8	MP8	A4059MP8R
		A4059MP8VR
Note	V: Halogen free Package R: Tape & Reel SPQ: 3,000pcs / Reel	
AiT provides all RoHS products Suffix “ V “ means Halogen free Package		

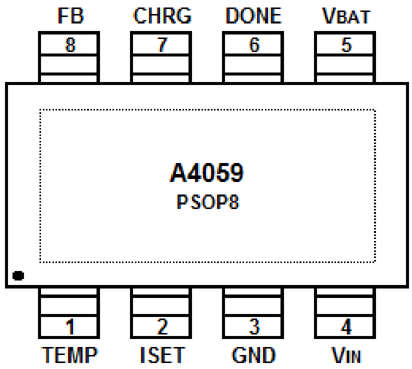
FEATURES

- In the package allows the range of programmable charge current up to 1.2A above
- No MOSFET, sense resistor or blocking diode required
- Complete linear charger in small package for single cell lithium-ion batteries
- Constant-current/constant-voltage operation with thermal regulation to maximize charge rate without risk of overheating
- Charging voltage can be adjusted by the FB
- Monitor output charge current
- Charging status indicator and full status flag
- 3/10 charge current termination
- Automatic recharge
- 40μA supply current in shutdown
- 0.7 times the programming voltage trickle charge threshold voltage
- Soft-Start limits inrush current
- OVP protection function , the input is higher than 6.8V, stop charging
- Output with protection against anti-irrigation
- When you unplug V_{IN} , the IC does not consume battery power
- Available in PSOP8 Package

APPLICATION

- Mobile phones
- Digital Cameras
- MP4 Player
- Bluetooth applications
- Electronic Dictionary
- portable devices
- all kinds of charger
- Mobile power

PIN DESCRIPTION



Top View

Pin #	Symbol	Function
1	TEMP	The TEMP pin to the battery of the NTC sensor output. If the TEMP pin voltage is less than the input voltage of 30% or greater than 60% of the input voltage means the battery temperature is too low or too high, then the charge will be suspended. If the TEMP input voltage between 30% and 60%, then the battery fault condition will be cleared, the charge will continue. If you want to shield this feature ,you can connect the PIN to GND.
2	ISET	Charge current programming, charge current monitoring and close pin. Charge current is controlled by a resistor of precision of 1% to the ground. In the constant charge current state, this port provides 1V voltage. In all conditions, this port charge current can be calculated using the following formula: $I_{BAT} = (V_{ISET}/R_{ISET}) \times 1000$ ISET port can also be used to turn off the charger. Resistance to side with the separation of programming can pull the 3μA current source to increase ISET port voltage. When the suspension reached the limit voltage 1.21V, the device enters stop state, after charging the input current drop to 25μA. This port pinch-off voltage is about 2.4V. If supply this port voltage more than pinch-off voltage, the current will be 1.5mA. Through combination ISET pin to the ground, the charger will back to normal.
3	GND	Ground terminal .The EXPOSED pin is also connected with pin 3.
4	V_{IN}	Supply positive input voltage. Power supply for the charger. V_{CC} can be 4.25V to 6.5V and must have at least 1F bypass capacitor. If the BAT pin voltage of V_{CC} down to within 30mV, A4052 into the suspension state, and make BAT Current less than 2A.

Pin #	Symbol	Function
5	BAT	Make the battery's positive terminal connected to this pin. When the power supply voltage lower than the threshold latch voltage or sleep mode voltage, BAT pin current is less than 2μA. BAT pin provide the battery charge current and constant voltage charging voltage.
6	DONE	When charging end, DONE pin is pulled low by internal switch represents that charge has ended; otherwise DONE pin is high impedance state.
7	CHRG	When the charger to the battery charging, CHRG pin is pulled low by the internal switch, represents charging being; otherwise CHRG pin is in high impedance state.
8	FB	This pin can test Kelvin battery voltage, and thus precisely modulated constant voltage battery charging voltage, avoiding the positive from the battery to the BAT pin A4059 or contact resistance between the resistance wire and other parasitic resistance of the charge. If the FB pin and the BAT pin is an indirect one resistor, users can adjust the constant charging voltage.

ABSOLUTE MAXIMUM RATINGS

V_{CC}, Input Supply Voltage	V_{SS}-0.3V ~ V_{SS}+7V
V_{PROG}, ISET pin Voltage	V_{SS}-0.3V ~ Vcc+0.3V
V_{BAT}, BAT pin Voltage	Vss-0.3V ~ 6V
V_{DONE}, DONE pin Voltage	V_{SS}-0.3V ~ V_{SS}+7V
V_{CHRG}, CHAG pin Voltage	V_{SS}-0.3V ~ V_{SS}+7V
I_{BAT}, BAT pin Current	1500mA
I_{PROG}, ISET pin Current	1500μA
T_{OPA}, Operating Ambient Temperature	-40°C ~ +85°C
T_{STR}, Storage Temperature	-65°C ~ +125°C

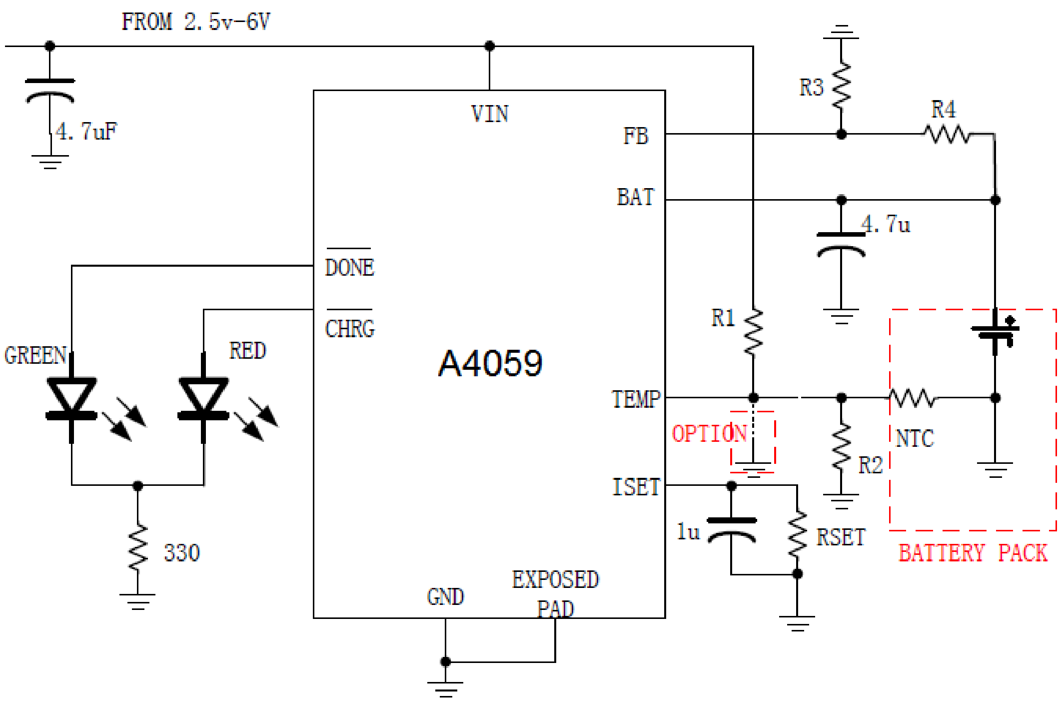
Stress beyond above listed “Absolute Maximum Ratings” may lead permanent damage to the device. These are stress ratings only and operations of the device at these or any other conditions beyond those indicated in the operational sections of the specifications are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

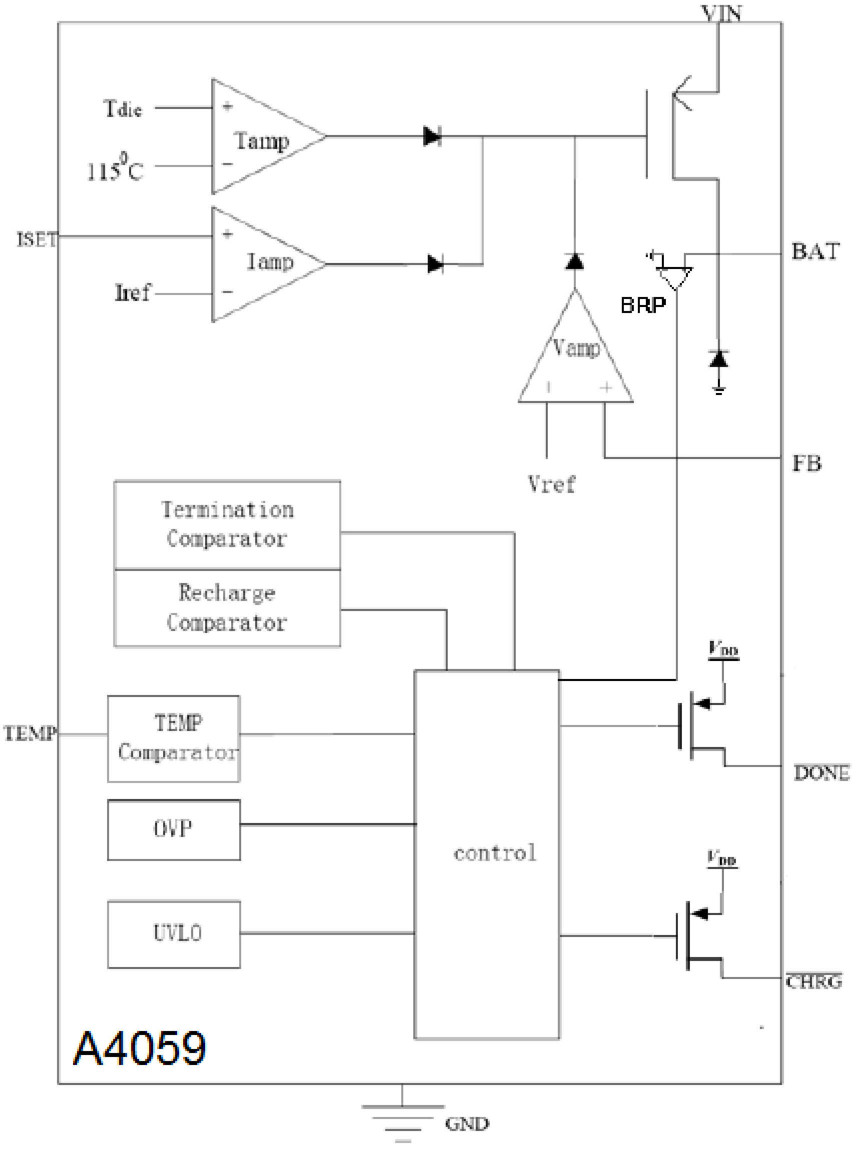
T_A=25℃, 4.2V Lithium battery, Unless specifically designated

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Input supply voltage	V_{CC}		2.3		6.5	V
Input supply current	I_{CC}	Charge mode, R_{ISET}=10K		200	2000	μA
		Standby mode		200	500	
		Shutdown mode (R_{ISET} not connected, V_{CC}<V_{BAT} or V_{CC}<V_{UV})		25	70	
Feedback Voltage	V_{FB}	0℃≤T_A≤85℃,I_{BAT}=40mA	1.212	1.255	1.238	V
BAT pin Current	I_{BAT}	R_{ISET}=10k,Current mode	90	100	110	mA
		R_{ISET}=1k,Current mode	900	1000	1100	
		Standby mode, V_{BAT}=4.2V	0	-2.5	-6	μA
		Shutdown mode			±0.1	
		Sleep mode, V_{CC}=0V			±0.1	
Trickle charge current	I_{TRIKL}	V_{BAT}<V_{TRIKL}, R_{PROG}=2k	90	100	110	mA
Trickle charge Threshold Voltage	V_{TRIKL}	R_{ISET}=10K，V_{BAT} Rising	2.8	2.9	3.0	V
Trickle voltage hysteresis voltage	V_{TRHYS}	R_{ISET}=10k	60	80	110	mV
V_{CC} undervoltage lockout Threshold	V_{UV}	From V_{CC} low to high	3.7	3.8	3.93	V
V_{CC} undervoltage lockout hysteresis	V_{UVHYS}		150	200	300	mV
Manual shutdown threshold voltage	Vmsd	Iset pin rising	1.15	1.21	1.30	V
		Iset pin falling	0.9	1.0	1.1	
V_{CC}-V_{BAT} Lockout Threshold voltage	Vasd	V_{CC} from low to high	70	100	140	mV
		V_{CC} from high to low	5	30	50	
3C/10 Termination Current Threshold	Iterm	R_{ISET}=10k	20	30	40	mA
		R_{ISET}=2k	120	150	190	
PROG pin Voltage	V_{PROG}	R_{ISET}=10k, Current mode	0.93	1.0	1.07	V
Battery reversed current	I_{FBAT}	V_{DD}=5V,V_{BAT}=-4.2V	-0.5	-0.7	-1	mA
CHRG pin Output low voltage	V_{DONE}	I_{DONE}=5mA	V_{CC}-0.3		V_{CC}+0.3	V
CHRG pin Output low voltage	V_{CHRG}	I_{CHRG}=5mA	V_{CC}-0.3		V_{CC}+0.3	V
Recharge Battery threshold Voltage	ΔV_{RECG}	VFLOAT - VRECHRG		80	120	mV

TYPICAL APPLICATION CIRCUIT



BLOCK DIAGRAM



DETAILED INFORMATION

Application Information

Set constant voltage charging voltage

Through an external resistor, the output voltage can be set , taking into account the accuracy requirements , it is recommended that the resistor with an accuracy of 1% . Constant voltage charging voltage (V_{BAT}) can be calculated:

$$V_{BAT}=V_{FB}\times(1+R4 / R3)$$

Set the charge current

In constant-current mode, formula for calculating charge current: I_{CH} = 1000V / R_{ISET}

ICH represents the charge current, units is ampere, RISET represents ISET pin to ground resistance in ohms. For example, if you need 500mA charge current, according to the following formula:

$$R_{ISET}=1000V/0.5A = 2K\Omega$$

In order to ensure good stability and temperature characteristics, RISET recommend the use of 1% precision metal film resistors. By measuring the ISET pin voltage can be detected charge current. Charge current can be calculated using the following formula: $I_{CH} = (V_{ISET} / R_{ISET}) \times 1000$

Battery temperature monitoring

In order to prevent the battery temperature is too high or too low on the battery damage, A4059 internal battery temperature monitoring of integrated circuits. Battery temperature monitoring is by measuring the TEMP pin voltage to achieve, TEMP pin voltage is within the battery NTC thermistor and a resistor divider network.

A4059 the TEMP pin voltage with the chip and the two thresholds V_{LOW} V_{HIGH} compared to confirm whether the battery temperature exceeds the normal range. In the A4059, V_{LOW} were fixed in 30% × V_{IN}, V_{HIGH} were fixed in 60% × V_{IN}. If the TEMP pin voltage V_{TEMP} <V_{LOW} or V_{TEMP}> V_{HIGH}, the battery temperature is too high or too low, charging will be suspended; If the TEMP pin voltage V_{TEMP} V_{LOW} and V_{HIGH} in between, the charge cycle will continue.

Enable design

By controlling whether the ISET pin resistor connected, users can reach close A4059 function. Figure 1a . Can also be achieved simultaneously through the TEMP port Close A4059 the function. When the external battery is not in NTC resistor can be set through the microcontroller TEMP port Wade is 0 to achieve open A4059, to configure external resistors R1 and R2 to achieve closure A4059.Figure 1b.

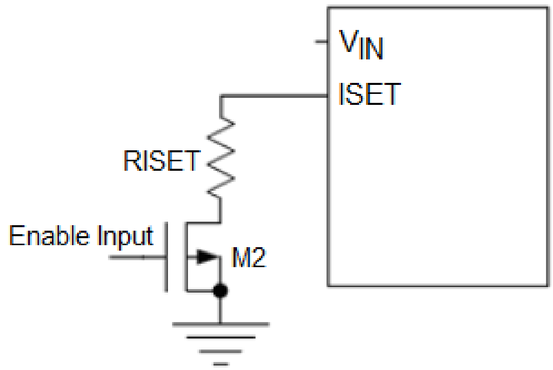


Figure 1a

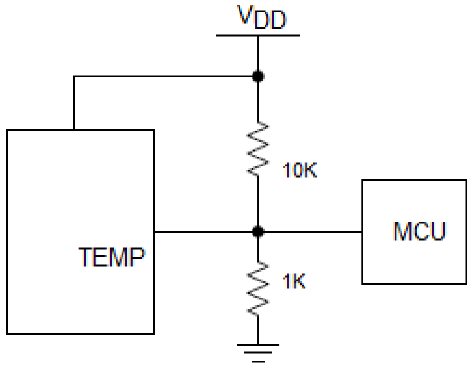


Figure 1b

Figure 1. A4059 Enable Design

Determine the value of R1, R2

The value of R1 and R2 according to battery temperature monitoring range and the thermistor resistance values to determine, are described as follows: assume that the temperature range of the battery set TL ~ TH, (TL <TH); batteries used in negative temperature coefficient thermistor (NTC), RTL TL when its temperature resistance, RTH its resistance when the temperature TH, then the R_{TL}> R_{TH}, then the temperature TL, the first pin TEMP-side voltage is:

$$V_{TEMPL} = \frac{R_2 // R_{TL}}{R_1 + R_2 // R_{TL}} \times V_{IN}$$

When the temperature reaches TH, the first side of the TEMP pin voltage is:

$$V_{TEMPH} = \frac{R_2 // R_{TH}}{R_1 + R_2 // R_{TH}} \times V_{IN}$$

then , according to: $V_{TEMPL} = V_{HIGH} = K2 \times V_{IN}$ (K2 = 0.6)

$V_{TEMPH}=V_{LOW}=K1 \times V_{IN}$ (K1=0.3)

Can solve for: $$R1 = \frac{R_{TL}R_{TH}(K2-K1)}{(R_{TL}-R_{TH})K1K2}$$

$$R2 = \frac{R_{TL}R_{TH}(K2-K1)}{R_{TL}(K1-K1K2)-R_{TH}(K2-K1K2)}$$

Similarly, if the battery is the positive temperature coefficient of internal (PTC) thermistor the R_{TH}> R_{TL}, we can calculate:

$$R1 = \frac{R_{TL}R_{TH}(K2 - K1)}{(R_{TH} - R_{TL})K1K2}$$

$$R2 = \frac{R_{TL}R_{TH}(K2 - K1)}{R_{TH}(K1 - K1K2) - R_{TL}(K2 - K1K2)}$$

From the above derivation can be seen to be setting the temperature range and supply voltage V_{IN} is irrelevant, only with R1, R2, R_{TH}, R_{TL}; one, R_{TH}, R_{TL} can access the relevant manuals or through experimental test battery be.

In practice, if only one side of the temperature characteristics of concern, such as over-temperature protection, then R2 can't and can only R1. R1 derivation becomes very simple, not discussed here

Open-drain output status indication

A4059 has two open-drain status indication sides, CHAG and DONE, the two status indicator LEDs client can drive or microcontroller port. CHAG used to indicate charging status, charging time, CHAG is low; DONE to indicate the charging end of the state, when the charging end, DONE is low. When the battery temperature is outside the normal temperature range more than 0.15 seconds, CHAG and the DONE pin is high impedance output state.

When the battery charger not received, the charger will quickly charge the output capacitor to the constant voltage value, as the battery voltage detection the BAT pin input leakage current, the BAT pin voltage will slowly down to recharge threshold, so the BAT pin voltage is 150mV to form a ripple waveform, while CHAG output pulse signal that there is no battery installed. When the battery BAT pin external connectors for the 4.7uF capacitor, the pulse period of about 2Hz

The following table lists CHAG and DONE pin status in each case:

State	Charge	Full	Without Battery	Error
CHAG	Always bright	Always off	Flashing	Always off
DONE	Always off	Always bright	Always bright	Always off

NOTE1: CHAG flicker frequency with external capacitor when not connect battery, generally recommended 4.7uF.The greater the capacitance, the smaller frequency flicker.

NOTE2: The error situation: Beyond the operating temperature range (temperature too high or too low), I set side vacant, $V_{IN} < V_{BAT}$, V_{IN} <3.8V and so on.

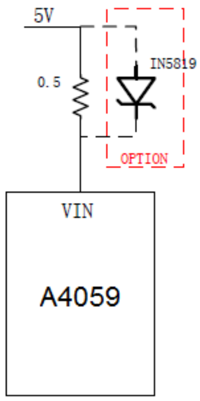
The large current output design

Since the A4059 using the internal constant power technology, therefore , when the input V_{IN} and BAT pressure is too large, will lead to smaller the BAT voltage range of the maximum current , so that the charging time becomes longer , in order to make the maximum current charging interval larger by an external resistor or Schottky methods to achieve.

The assumption the A4059 of PSOP8 inside the package the maximum allowable power 1.2W, maximum charge current is set to 1.2A. If uses a resistive, We assume that the use of the resistance of 0.5Ω (1W), High current charging, the voltage drop across the resistor is 0.5*1.2=0.6V. The A4059 real operating voltage is 4.4V. Thus, in this state, $(V_{IN}-V_{BAT})$ *1.2<1.2W, therefore V_{BAT}>3.6V, the battery voltage is above 3.6V 1.2A charging support. Below 3.6V, the A4059 will automatically reduce the charge current to maintain the chip internal power balance.

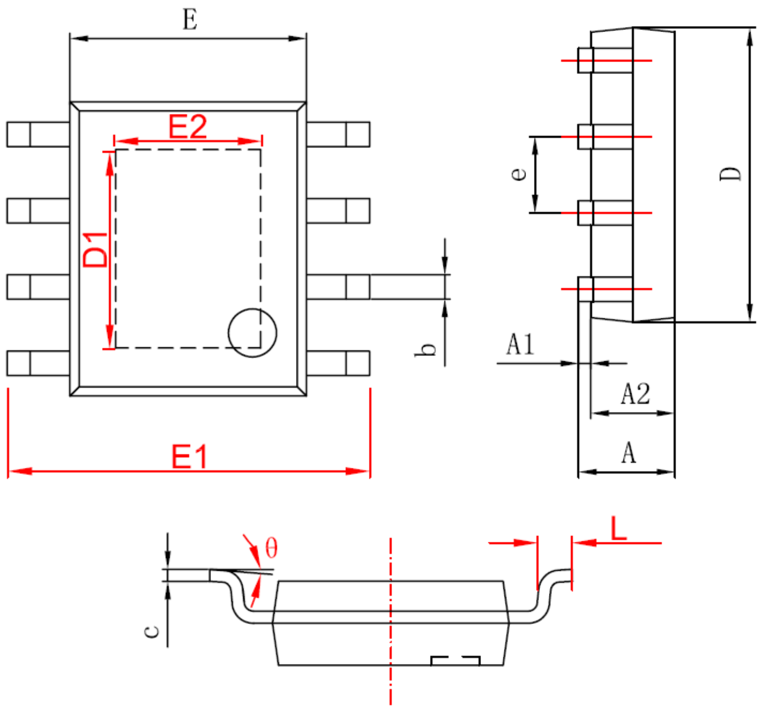
If Schottky similar calculation can be made , according to the Schottky voltage drop at different current .

In addition , in the high-current applications need to pay attention A4059 PCB layout design must consider increasing EXPOSED PAD area , and will be connected to the EXPOSED PAD to GND in order to improve the thermal performance , and ensure the stable operation of the chip .



PACKAGE INFORMATION

Dimension in PSOP8 Package (Unit: mm)



Symbol	Min	Max
A	1.350	1.750
A1	0.050	0.150
A2	1.350	1.550
b	0.330	0.510
c	0.170	0.250
D	4.700	5.100
D1	3.202	3.402
E	3.800	4.000
E1	5.800	6.200
E2	2.313	2.513
e	1.270(BSC)	
L	0.400	1.270
θ	0°	8°

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