

1A linear lithium battery charge management chip

1 Features

- Charge target voltage: 4.2V, support custom full voltage range: 4.05V~4.4V (step=50mV)
- Support customized lithium iron phosphate battery, charge target voltage range: 3.5V~3.8V (step=50mV)
- Maximum 1A charging current
- Optional external resistance setting charging current function or NTC function (choose one of two)
- Full stop charge detection current is 30mA
- Trickle charging current is 1/5 constant current charging current
- BAT Standby current 50nA
- Soft start to limit inrush current
- Support LED charging status indicator, support constant current function (can omit LED current limiting resistance)
- Support battery reverse protection
- Support a variety of protection functions: IC overtemperature protection, input undervoltage protection, input overvoltage protection, NTC protection (IP4054_NTC model support)
- Package SOT23-5

2 Typical Applications

- Low power handheld devices

3 Description

IP4054 is a 5V input IC that supports linear charge management of single lithium battery.

IP4054 integrates power MOS, only needs very few peripheral devices, effectively reduces the size of the overall scheme and BOM cost.

IP4054 features a complete triple charging process of Trickle Charge (TC), Constant Current (CC) and Constant Voltage (CV) charging; the Trickle Charge (TC) stage pre-charges the battery to restore a fully discharged battery; the Constant Current (CC) mode safely delivers a buck fast charge; and the final stage, Constant Voltage (CV) charging mode, ensures that the battery's full capacity is safely reached.

IP4054 has an input undervoltage protection function that intelligently adjusts the charging current and adapts to the load capacity of the adapter to prevent adapter failure.

IP4054 supports ISET pin external connection resistor to set charging current, or customized to NTC function

IP4054 is packaged in SOT23-5

4 Simplified Application Schematic

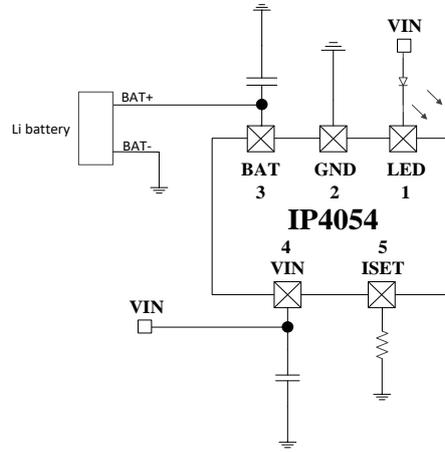


Figure 1 IP4054 Simplified Application Schematic

Directory

1	FEATURES	1
2	TYPICAL APPLICATIONS.....	1
3	DESCRIPTION	1
4	SIMPLIFIED APPLICATION SCHEMATIC	2
5	MODIFY RECORDS	4
6	COMMON MODEL.....	5
7	PIN DESCRIPTION.....	5
8	FUNCTIONAL BLOCK DIAGRAM	6
9	LIMIT PARAMETERS	6
10	RECOMMENDED OPERATING CONDITIONS.....	6
11	ELECTRICAL CHARACTERISTICS.....	7
12	FUNCTION DESCRIPTION	8
12.1	Charge Process.....	8
12.2	Charging protection	8
12.3	Charge current setting	9
12.4	NTC	9
12.5	Charging LED indication.....	10
12.6	Battery reverse protection.....	11
13	TYPICAL APPLICATION SCHEMATIC.....	11
14	BOM.....	11
15	SILKSCREEN	12
16	PACKAGE.....	13
17	IMPORTANT NOTICE.....	14

5 Modify records

NOTE: The page numbers of the previous version may differ from the page numbers of the current version.

Initial release version V1.00 (2023.12)

Change page numbers for version V1.00 to V1.01 (2024.3) Page

- Modify BAT pin withstand voltage range.....6
 - Add description of reverse battery connection.....11
-

Change page numbers for version V1.00 to V1.01 (2024.7) Page

- Updated Common Model.....5
 - Modify standby power consumption.....7
-

6 Common Model

Type name	Function
IP4054	The standard model .ISET pin is ISET function, without NTC function
IP4054_NTC	The ISET pin is NTC function,without ISET function
IP4054_CG320A	Based on the standard model, the full voltage is modified to 4.35V, the full stop charging current is modified to 3mA, and the charging function is turned off when the ISET pin is suspended.
IP4054_4V4	Based on the standard model, the full voltage is modified to 4.4V,
IP4054_CT	Based on the standard model,turn on the temperature ring.
IP4054_NTC_CT	Based on the IP4054_NTC,turn on the temperature ring.

7 PIN Description

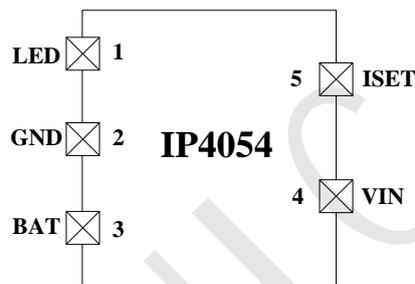


Figure 2 Pin of IP4054

Pin No.	Pin Name	Pin Description
1	LED	Charging indicator LED, support constant current function (can omit LED current limiting resistor)
2	GND	Power Ground
3	BAT	Battery connection pin, connected to the positive electrode of the battery
4	VIN	Input pin, connect 5V charging input
5	ISET	Constant current charging setting pin, can be customized to NTC pin

8 Functional Block Diagram

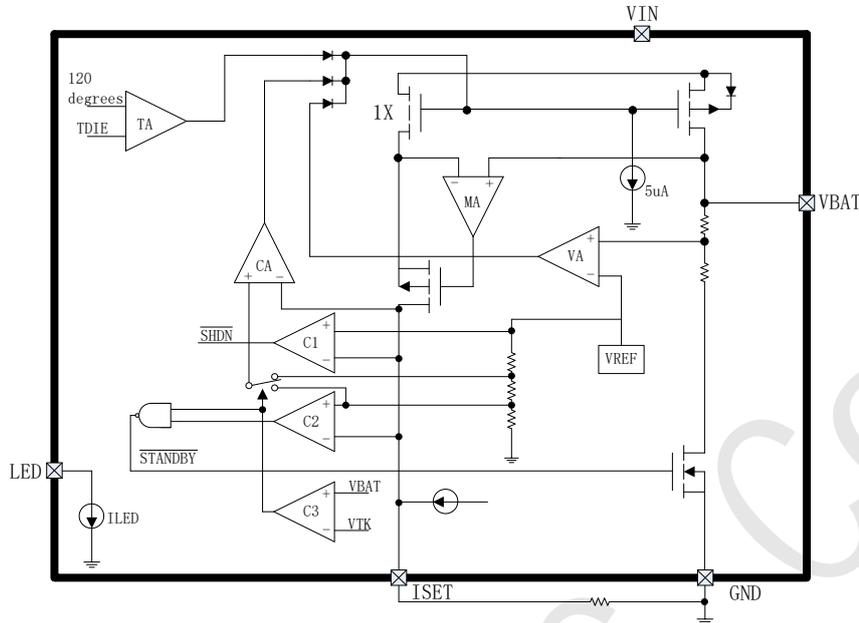


Figure 3 IP4054 Functional Block Diagram

9 Limit parameters

Parameters	Symbol	Value	Unit
Input port voltage range	V_{IN}	-0.3 ~ 7.5	V
Battery port voltage range	V_{bat}	-6 ~ 7.5	V
Junction temperature range	T_J	-40 ~ 150	°C
Storage temperature range	T_{stg}	-65 ~ 150	°C
Thermal resistance (junction temperature to environment)	θ_{JA}	220	°C/W
Human Body Model (HBM)	ESD	4	KV

*Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to Absolute Maximum Rated conditions for extended periods may affect device reliability.

10 Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input Voltage	V_{IN}	4.5	5	5.5	V
Charge Current	I_{OUT}			1	A

* Devices' performance cannot be guaranteed when working beyond those Recommended Operating Conditions.

11 Electrical Characteristics

Unless otherwise specified, $T_A=25^{\circ}\text{C}$, $V_{\text{IN}}=5\text{V}$

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Charging System						
Input Voltage	V_{IN}		4.5	5	5.5	V
Input under-voltage threshold	$V_{\text{IN-UV}}$		4.4	4.5	4.6	V
Input under-voltage protection hysteresis				100		mV
Input over-voltage threshold	$V_{\text{IN-OV}}$			6		V
Input overvoltage protection hysteresis				300		mV
Input Current	I_{VIN}	$V_{\text{IN}}=5\text{V}$, $V_{\text{BAT}}=\text{NC}$, NO LED		0.6	1	mA
Standby Current	$I_{\text{standby-BAT}}$	$V_{\text{IN}}=0\text{V}$, $V_{\text{BAT}}=3.7\text{V}$, NO LED		50	2000	nA
		$V_{\text{IN}}=0\text{V}$, $V_{\text{BAT}}=-6\text{V}$, NO LED		1	2	mA
Charge Current	I_{CC}	$R_{\text{ISET}}=1\text{K}$	0.9	1	1.1	A
		$R_{\text{ISET}}=\text{NC}$ ($\geq 120\text{K}$)	0.45	0.5	0.55	A
Charge Target Voltage	V_{CV}	$V_{\text{IN}}=5\text{V}$	4.16	4.2	4.24	V
Full charge stop detection voltage	V_{SV}			4.15		V
Charging voltage after full charge	V_{RC}			$V_{\text{CV}}-0.1$		V
Trickle over constant current voltage	V_{TK}	$V_{\text{IN}}=5\text{V}$	2.8	2.9	3.0	V
Trickle Charge Current	I_{TK}	$V_{\text{IN}}=5\text{V}$, $V_{\text{BAT}}<2.9\text{V}$		$1/5 I_{\text{CC}}$		mA
Charge Cut-off Current	I_{STOP}			30	50	mA
Control System						
LED drive Current	I_{Led}	$V_{\text{IN}}=5\text{V}$			5	mA
Thermal shutdown temperature	T_{OTP}	Rising Threshold	100	110	120	$^{\circ}\text{C}$
Thermal shutdown recovery temperature	$T_{\text{OTP-H}}$	Falling Threshold	80	90	100	$^{\circ}\text{C}$

12 Function Description

12.1 Charge Process

The IP4054 uses a full trickle/constant/constant voltage charging mode.

When the battery voltage is less than the trickle to constant current voltage V_{TK} , it is charged with trickle charging current I_{TK} .

When the battery voltage is greater than V_{TK} , charge with constant current charging current I_{CC} .

When the battery voltage approaches the set constant voltage charging voltage V_{CV} , the charging voltage V_{CV} remains unchanged, the charging current slowly decreases, and the constant voltage charging mode is entered.

After entering the constant voltage charging mode, if the charging current is less than the full charge stop detection current I_{STOP} . The charging will be stopped first, and then detect whether the battery voltage is higher than the stop voltage V_{SV} . If it is higher than the charging stop voltage V_{SV} , stop charging. If the stop voltage is lower, charging continues.

After the battery is fully charged and stopped, and the input V_{IN} continues to be active, if the battery voltage is less than V_{RC} , it will enter the full charge stage and start the charging process again.

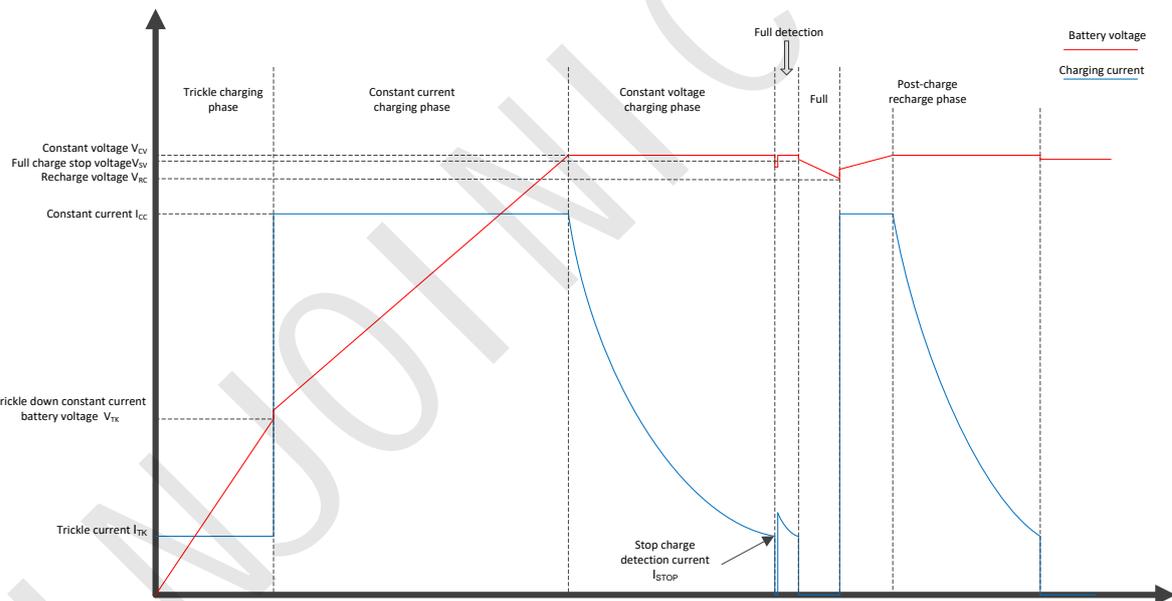


Figure 4 IP4054 Schematic diagram of the charging process

12.2 Charging protection

IP4054 has perfect protection function, integrated input under voltage, input over voltage, IC over temperature protection and other functions to ensure stable and reliable work of the system.

IP4054 features an input voltage regulator loop that automatically adjusts to reduce the charging current when

it detects that the input voltage is approaching the 4.5V undervoltage threshold, ensuring that the input voltage stabilizes near the input undervoltage threshold and preventing adapter failure.

IP4054 integrated over-temperature protection function, when the internal temperature of the chip is detected to exceed 110 degrees, it will be forced to stop charging.

12.3 Charge current setting

The IP4054 standard product supports this function

IP4054 supports ISET pin to set the charging current, external resistor RISET to set the constant charging current;

The relationship between constant current and RISET : $I_{CC}=1000/RISET$.

RISET resistance (Ω)	constant charging current
1K	1A
2K	0.5A
10K	0.1A
NC ($\geq 120K$)	0.5A

12.4 NTC

This feature is supported by IP4054_NTC

IP4054_NTC supports NTC protection function which can cooperate with NTC resistance to detect battery temperature;

By default, 100uA current is discharged, and when the pin voltage is detected to be greater than 1.5V (NTC resistance is greater than 15K), the output current is reduced to 30uA; at the output of 30uA, when the pin voltage is detected to be less than 0.3V (NTC resistance is less than 10K), the output current changes to 100uA.

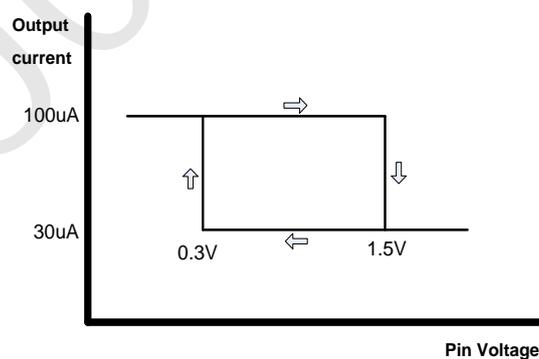


Figure 5 Pin output current vs. pin voltage

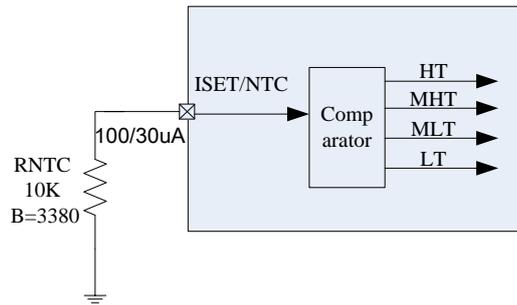


Figure 6 NTC Diagram

When IP4054 detects that the NTC pin voltage rises to greater than $0.82V@30\mu A$ (below $0^{\circ}C$), it triggers low-temperature protection and stops charging;

When IP4054 detects that the NTC pin voltage is between $0.54V@30\mu A \sim 0.82V@30\mu A$ ($0^{\circ}C \sim 10^{\circ}C$), it triggers the medium-low temperature protection and the charging current is reduced to half;

When IP4054 detects NTC pin voltage between $0.49V@100\mu A \sim 0.54V@30\mu A$ ($10^{\circ}C \sim 45^{\circ}C$), it indicates that the battery temperature is normal and normal charging;

When IP4054 detects NTC pin voltage between $0.417V@100\mu A \sim 0.49V@100\mu A$ ($45^{\circ}C \sim 50^{\circ}C$), it triggers medium-high temperature protection with full voltage $CV-50mV$;

When IP4054 detects that the NTC pin voltage drops to less than $0.417V@100\mu A$ (above $50^{\circ}C$), it triggers high temperature protection and stops charging.

If NTC function is not required, connect the NTC pin to ground with a 10K resistor.

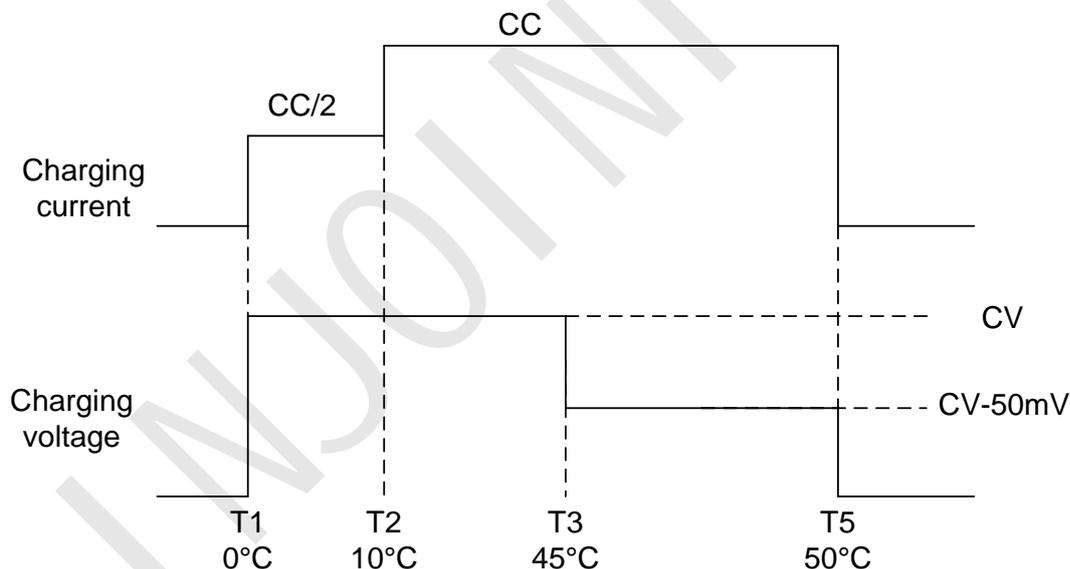


Figure 7 Schematic diagram of 5-segment battery temperature charge protection (JEITA compliant)

12.5 Charging LED indication

Standard product light display for: charging process LED on, charging full LED off, abnormal state (over-temperature protection, NTC protection) LED flashes (0.5S on, 0.5S off).

12.6 Battery reverse protection

IP4054 supports reverse battery protection, which can effectively prevent the chip from being damaged when the battery is reversed.

When $V_{IN}=0V$, the maximum negative withstand voltage at the BAT terminal is $-6V$.

When $V_{IN}=5V$, the maximum negative withstand voltage of BAT is $-5V$.

13 Typical Application Schematic

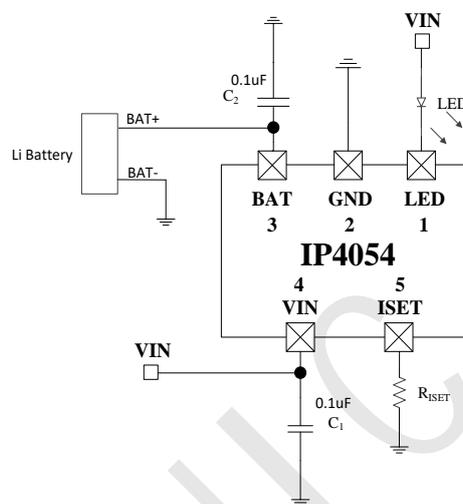


Figure 8 Typical Application Schematic

14 BOM

No.	Part Name	Type & Specification	Units	Quantity	Location	Note
1	IC	IP4054	PCS	1	U1	
2	SMD capacitors	0603 0.1uF 25V 10%	PCS	2	C ₁ 、C ₂	
3	SMD resistors	0603	PCS	1	R _{ISET}	
4	LED	0603	PCS	1	LED	

15 Silkscreen

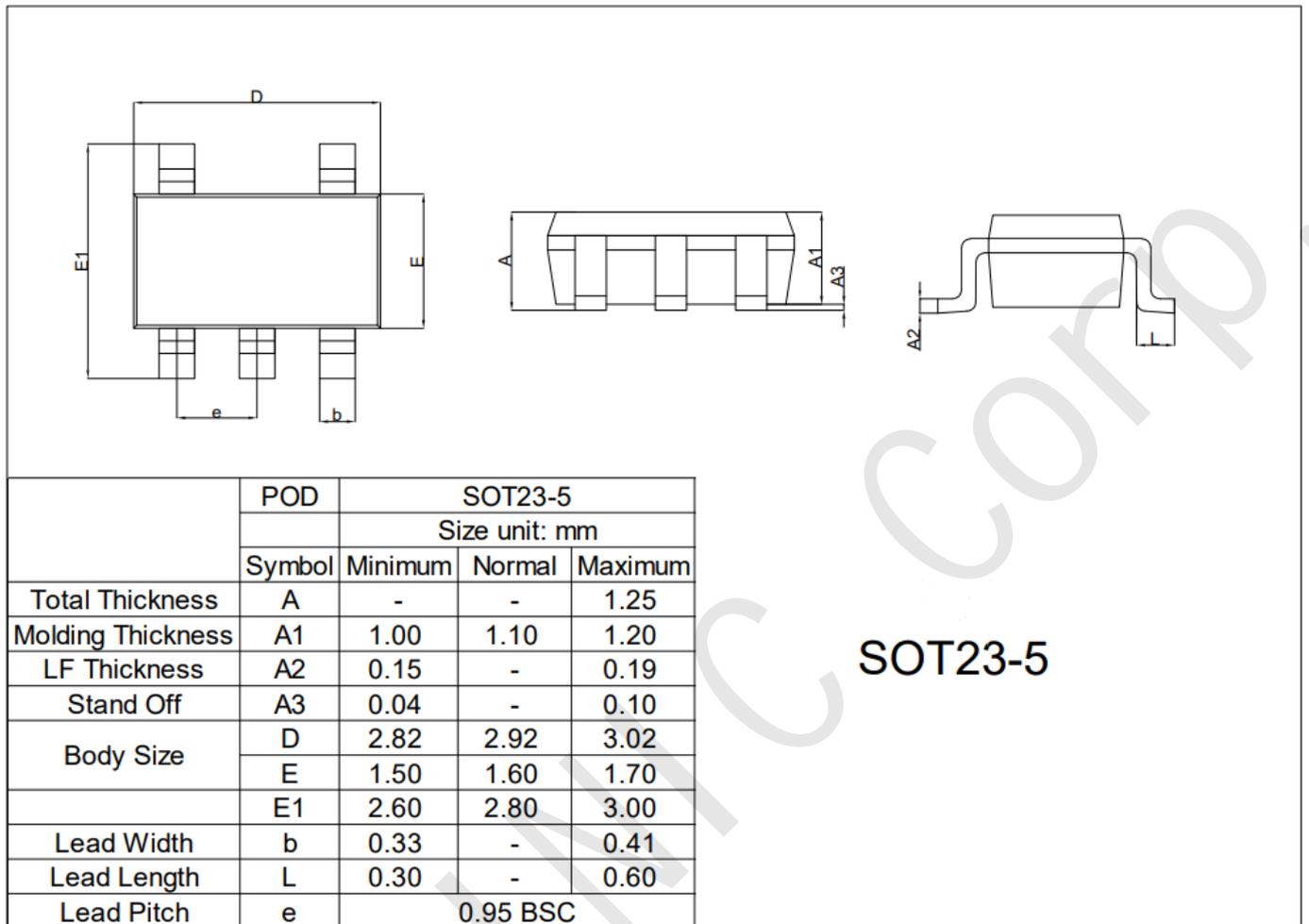


Instruction:

- 1、4054 --Product name
- 2、XXXX --Product number
- 3、○ --PIN1 Position

Figure 9 IP4054 Silkscreen

16 Package



17 IMPORTANT NOTICE

INJOINIC TECHNOLOGY and its subsidiaries reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to INJOINIC TECHNOLOGY's terms and conditions of sale supplied at the time of order acknowledgment.

INJOINIC TECHNOLOGY assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using INJOINIC TECHNOLOGY's components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of INJOINIC TECHNOLOGY's components in its applications, notwithstanding any applications-related information or support that may be provided by INJOINIC TECHNOLOGY. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify INJOINIC TECHNOLOGY and its representatives against any damages arising out of the use of any INJOINIC TECHNOLOGY's components in safety-critical applications.

Reproduction of significant portions of INJOINIC TECHNOLOGY's information in INJOINIC TECHNOLOGY's data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. INJOINIC TECHNOLOGY is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

INJOINIC TECHNOLOGY will update this document from time to time. The actual parameters of the product may vary due to different models or other items. This document voids all express and any implied warranties.

Resale of INJOINIC TECHNOLOGY's components or services with statements different from or beyond the parameters stated by INJOINIC TECHNOLOGY for that component or service voids all express and any implied warranties for the associated INJOINIC TECHNOLOGY's component or service and is an unfair and deceptive business practice. INJOINIC TECHNOLOGY is not responsible or liable for any such statements.