DESCRIPTION

The A4054H is a high-performance linear charger for single-cell lithium-ion batteries with constant- current / constant-voltage (CC/CV) charging. It is available in a compact SOT-23-5L package and requires only a few external components, making it ideal for portable applications powered by USB ports or AC adapters.

The A4054H integrates internal power MOSFET and reverse current protection, eliminating the need for an external current-sense resistor or blocking diode. The charging voltage is fixed at 4.2V, while the charging current is programmable with a single external resistor. An internal thermal feedback loop regulates the charging current during high-power or high-temperature operation.

The A4054H automatically terminates charging when the charge current decreases to 3/10 of the programmed value after the battery reaches the float voltage. It also features Sleep Mode, reducing battery leakage current to less than 1μA, and supporting the Shutdown Mode, UVLO, automatic recharge, and charge status indication. Compared with conventional 6V versions, the A4054H supports input voltages up to 8.5V and withstands 16V surge voltages, providing improved input voltage tolerance.

The A4054H is available in SOT-25 and DFN6 (2x2) packages.

ORDERING INFORMATION

Package Type	Part Number	
SOT25 SPQ: 3,000/Reel	E5	A4054HE5R
		A4054HE5VR
DFN6 (2x2) SPQ: 3,000/Reel	J6	A4054HJ6R
		A4054HJ6VR
Note	V: Halogen free Package R: Tape & Reel	
AiT provides all RoHS products Suffix " V "means Halogen free Package		

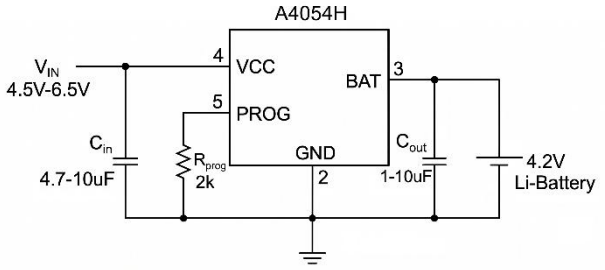
FEATURES

- Surge voltage withstand capability: 16V
- Programmable charging current: Up to 400mA
- No external MOSFET, current-sense resistor, or blocking diode required.
- Constant-current/constant-voltage (CC/CV) charging with thermal regulation to maximize charging rate without risk of overheating
- Accurate Pre-charge Voltage:
  4.2V -1% to 4.2V +2%
- Charge current monitor output for battery charge level indication
- Charge termination at 3/10 of the programmed charging current with automatic recharge
- Charge status indication output
- Low standby current: 35μA
- Trickle charging at 2.9V
- Soft-start function to limit inrush current
- Available in SOT-25 and DFN6 (2x2) packages

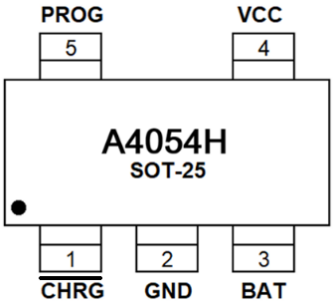
APPLICATION

- Mobile phones
- Digital Cameras
- MP4 Player
- Bluetooth applications
- Electronic Dictionary
- Portable devices
- All kinds of chargers
- Mobile power

TYPICAL APPLICATION

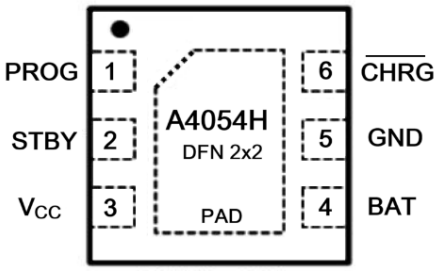


PIN DESCRIPTION



SOT-25, E5

Top View



DFN6 2x2, J6

Top View

Pin #		Symbol	Function
SOT-25	DFN2x2		
1	6	$\overline{\text{CHRG}}$	Charge status indication output
2	5	GND	Ground terminal,
3	4	BAT	Battery connection pin
4	3	V_{CC}	Positive power supply input
5	1	PROG	Programmable constant-current charge current setting pin
	2	STBY	Charge Complete Indicator Output
		PAD	Expose pad, connect to GND

ABSOLUTE MAXIMUM RATINGS

V_{CC}, Input Supply Voltage		-0.3V~16V
V_{PROG}, PROG pin Voltage		-0.3V~6.5V
I_{PROG}, PROG pin Current		500μA
V_{BAT}, BAT pin Voltage		-0.3V~6.5V
I_{BAT}, BAT pin Current		600mA
V_{CHRG}, CHRG pin Voltage		-0.3V~14V
Max power Dissipation		400mW
	Increase PCB heat dissipation (1)	800mW
T_{OPA}, Operating Ambient Temperature		-40°C ~ +85°C
T_{STR}, Storage Temperature		-65°C ~ +125°C
ESD	Human Body Model (HBM) ESD Rating	> 5KV
	Machine Model (MM) ESD Rating:	> 300V
Latch-up Immunity		> 500mA

Stress beyond the above-listed “Absolute Maximum Ratings” may lead to 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.

Note : :

The PCB thermal performance parameters are for reference only. Actual performance may vary depending on the PCB design and application conditions.

ELECTRICAL CHARACTERISTICS

T_A=25℃, Unless specifically designated

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Input supply voltage	V_{CC}		4.0		8.5	V
Input supply current	I_{CC}	Charge mode, R_{PROG}=10K		240	500	μA
		Standby mode		50	100	
		Shutdown mode (R_{PROG} not connected, V_{CC}<V_{BAT} or V_{CC}<V_{UV})		35	70	
Regulated Output Voltage	V_{FLOAT}	0℃≤T_A≤85℃, I_{BAT}=40mA	4.158	4.2	4.282	V
BAT pin Current	I_{BAT}	R_{PROG} =10k, Current mode	93	100	107	mA
		R_{PROG} =5k, Current mode	186	200	214	
		Standby mode, V_{BAT}=4.2V	0	-2.5	-6	μA
		Shutdown mode		1	2	
		Sleep mode, V_{CC}=0V		0	1	
		Battery Reverse Connection Protection. V_{BAT}=-4.0V		0.7		mA
Trickle charge current	I_{TRIKL}	V_{BAT}<V_{TRIKL},	20	25	30	mA
Trickle charge Threshold Voltage	V_{TRIKL}	V_{BAT} Rising	2.7	2.9	3.1	V
Trickle voltage hysteresis Voltage	V_{TRHYS}	V_{BAT} Falling	60	80	100	mV
V_{CC} Undervoltage lockout Threshold	V_{UV}	From V_{CC} low to high	3.6	3.8	4.0	V
V_{CC} undervoltage lockout hysteresis	V_{UVHYS}	From V_{CC} high to low	150	200	300	mV
V_{CC} Over voltage protection	V_{OVP}	V_{BAT} Rising	9.1	9.5	9.9	V
V_{CC} Over voltage release hysteresis	V_{OVHYS}	From V_{CC} high to low	160	240	360	mV
Manual shutdown threshold voltage	V_{MSD}	V_{PROG} Rising	1.15	1.21	1.30	V
		V_{PROG} Falling	0.9	1.0	1.1	V
V_{CC}-V_{BAT} Lockout Threshold voltage	V_{ASD}	V_{CC} from low to high	100	145	200	mV
		V_{CC} from high to low	50	80	120	
C/10 Termination Current Threshold	Iterm	R_{PROG} =10k	24	30	36	mA
PROG pin Voltage	V_{PROG}	R_{ISET} =10k, Current mode	0.93	1.0	1.07	V
CHRG pin Output low voltage	V_{CHRG}	I_{CHRG}=5mA	-	0.35	0.6	V
Recharge Threshold Voltage	ΔV_{CHRG}	V_{FLOAT}-V_{RECHG}	-	100	200	mV
Recharge Delay Time	t_{RECHG}	V_{BAT} from high to low	0.8	1.8	4	ms
Charge Termination Delay Time	t_{TERM}	I_{BAT} decreases below the termination current threshold	0.63	1.4	3	ms
PROG Pin Pull-up Current	I_{PROG}			2.0		μA

TYPICAL APPLICATION CIRCUIT

Constant- Current / Constant- Voltage 4.2V Charging App

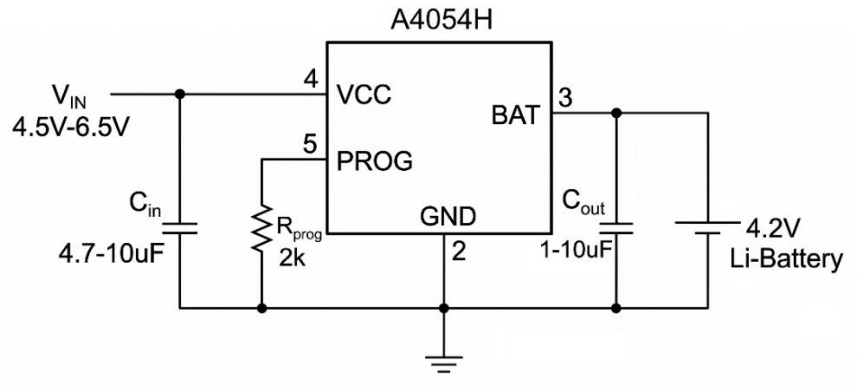
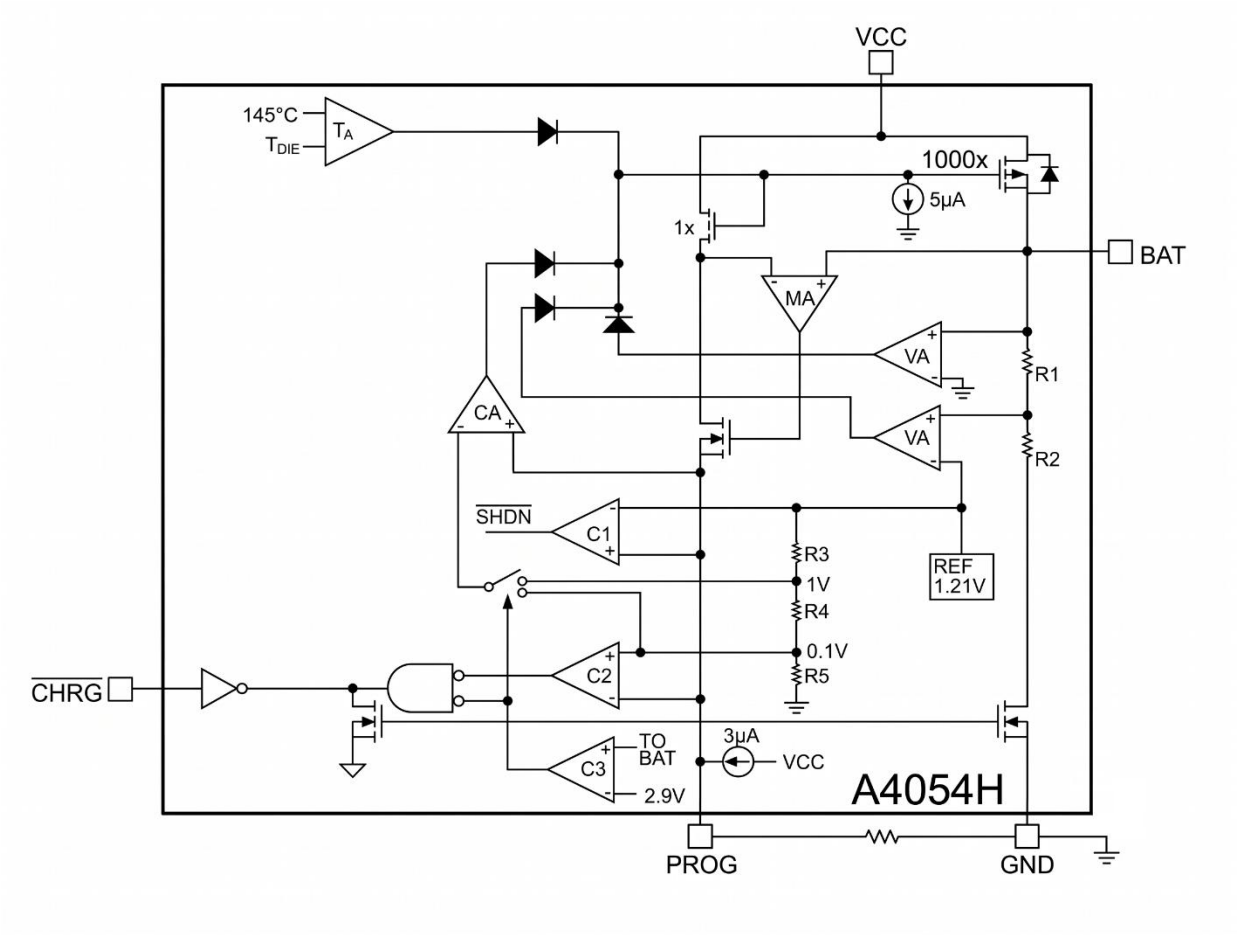


Fig 1.

BLOCK DIAGRAM



DETAILED INFORMATION

The A4054H is a linear charger specifically designed for single-cell lithium-ion batteries. It uses an internal power MOSFET to provide constant-current/constant-voltage (CC/CV) charging control.

The charging current is programmed by an external resistor, with a maximum charging current of 500mA. The A4054H provides a charge status indicator output (CHRG) through an open-drain output stage. The internal thermal regulation circuit automatically reduces the charging current when the device junction temperature exceeds 135°C, allowing the charger to operate at the maximum charging rate without causing damage to the device or external components due to excessive temperature.

Operation Principle

When the input voltage exceeds the UVLO threshold and the enable input is pulled high, the A4054H starts charging the battery. If the battery voltage is below 2.9V, the charger enters trickle-charge mode and charges the battery with a small current.

When the battery voltage rises above 2.9V, the charger enters constant-current mode. The charging current is programmed by a resistor connected between the PROG pin and GND. As the battery voltage approaches 4.2V, the charging current gradually decreases, and the A4054H enters constant-voltage mode.

The charging cycle terminates when the charging current decreases to the termination threshold, which is 30% of the programmed constant-current value. When the battery voltage falls below the recharge threshold, the A4054H automatically starts a new charging cycle.

The A4054H integrates a high-accuracy voltage reference, error amplifier, and resistor divider network to maintain the BAT pin regulation voltage accuracy within ±1%, meeting the requirements of lithium-ion and lithium-polymer batteries.

When the input supply is removed or the input voltage falls below the battery voltage, the charger enters standby mode. The battery leakage current is reduced to less than 2μA, extending battery standby time.

Charge Termination

The charging cycle terminates when the charging current decreases to 30% of the programmed value after the battery reaches the final float voltage. This condition is detected by an internal filtered comparator monitoring the PROG pin voltage.

When the PROG pin voltage remains below 300mV for more than 1.8ms, charging is terminated and the A4054H enters standby mode. In this state, the input supply current is reduced to approximately 45μA.

During charging, transient loads connected to the BAT pin may temporarily reduce the PROG pin voltage below 300mV even when the average charging current has not reached the termination threshold. The internal 1.8ms delay timer prevents premature termination caused by such transient conditions.

Once the average charging current decreases below the termination threshold, the A4054H stops supplying current to the BAT pin. Any external load connected to the BAT pin must then be powered by the battery.

Charging Current Setting

The charging current is programmed using an external resistor connected between the PROG pin and GND. The battery charging current is approximately 1000 times the PROG pin current.

The programming resistor and charging current can be calculated using the following equation:

$$R_{PROG}=1000 / I_{CHRG}; I_{CHGR=} 1000 / R_{PROG}$$

The charging current from the BAT pin can be monitored by measuring the PROG pin voltage, as shown in the following equation:

$$I_{BAT}= (V_{PROG} /R_{PROG)} \times 1000$$

The relationship between RPROG and the charging current is shown in the following table.

	R_{PROG} (KΩ)	I_{BAT} (mA)
1	1.4	600
2	2	500
3	2.2	400
4	3	300
5	5	200
6	10	100

Table 1: R_{PROG} resistor vs battery charging current (I_{BAT})

Charge Status Indication

The A4054H provides an open-drain status indication output pin, CHRG. During the charging process, the CHRG pin is pulled low. In other states, the CHRG pin remains in a high-impedance state.

Thermal Regulation

An internal thermal feedback loop automatically reduces the programmed charge current if the die temperature exceeds 135°C. This thermal regulation feature prevents the A4054H from overheating and allows the user to increase the maximum power handling capability of the application circuit while reducing the risk of damage to the A4054H.

Undervoltage Lockout (UVLO)

The A4054H includes an internal undervoltage lockout circuit that monitors the input supply voltage. The device remains in shutdown mode until the VCC voltage rises above the UVLO threshold. When the VCC

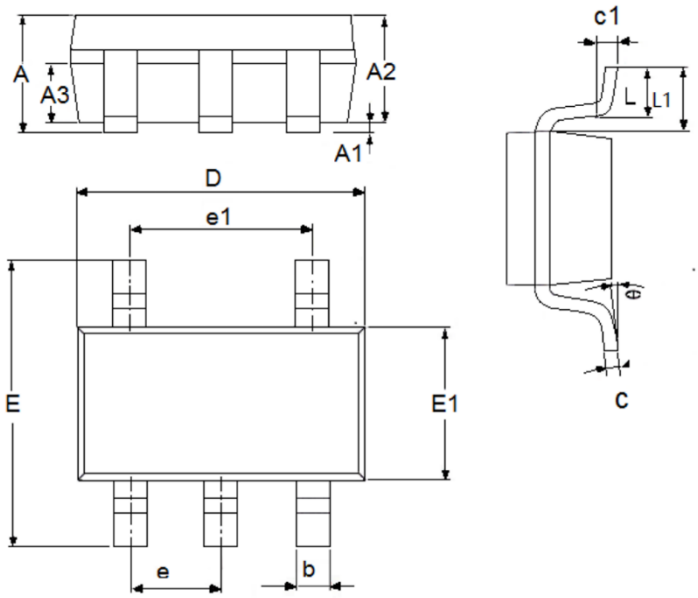
voltage exceeds 3.8V, the A4054H exits UVLO mode and begins normal operation. The UVLO hysteresis voltage is 200mV during the falling VCC condition.

Automatic Recharge Cycle

After the battery voltage reaches the regulation voltage and the charging cycle is terminated, the A4054H continuously monitors the BAT pin voltage. When the BAT voltage falls below 4.1V, a new charging cycle automatically starts. This feature maintains the battery at a near-full charge level while eliminating the need for periodic manual recharge initiation.

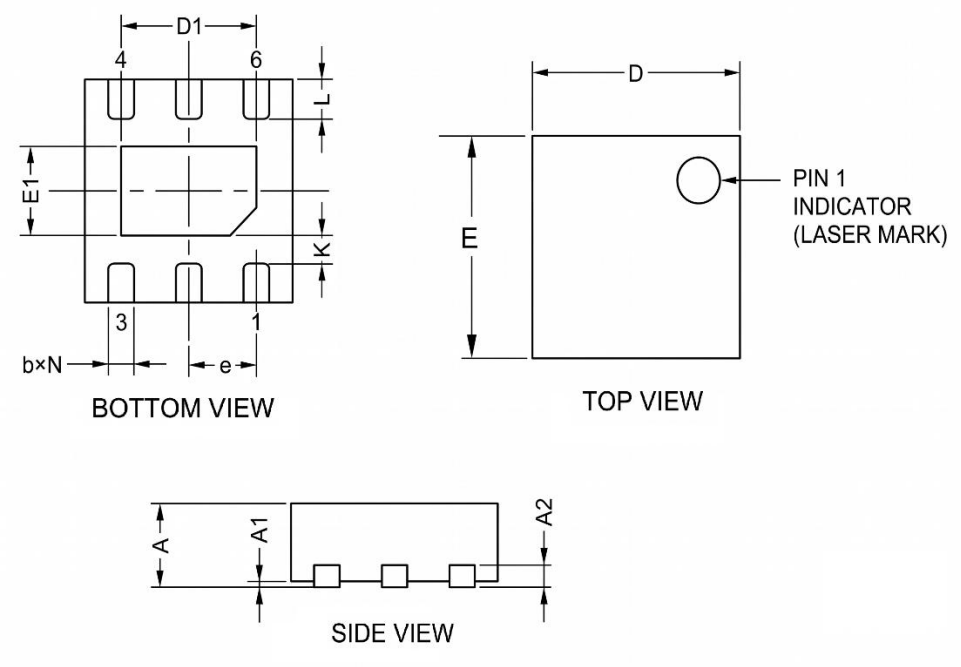
PACKAGE INFORMATION

Dimension in SOT-25 Package (Unit: mm)



Symbol	Min	Max
A	1.050	1.450
A1	0.000	0.150
A2	0.900	1.300
A3	0.600	0.700
b	0.250	0.500
c	0.100	0.230
c1	0.200 TYP	
D	2.820	3.050
E	2.650	3.050
E1	1.500	1.750
e	0.950 TYP	
e1	1.900 TYP	
L	0.300	0.600
L1	0.590 TYP	
θ	0°	8°

Dimension in DFN6 (2x2) Package (Unit: mm)



Symbol	Min	Max
A	0.700	0.800
A1	0.000	0.050
A2	0.203 TYP	
b	0.200	0.350
D	1.950	2.050
D1	1.200	1.400
E	1.950	2.050
E1	0.700	0.900
e	0.650 TYP	
L	0.300	0.400
K	0.200	

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