Standalone Linear Li-Ion Battery Charger with Thermal Regulation in SOT

General Description

The AP5054H is a complete constant current & constant voltage linear charger for single cell lithium-ion batteries. Its SOT package and low external component count make the AP5054H ideally suited for portable applications. Furthermore, the AP5054H is specifically designed to work within USB power specifications.

No external sense resistor is needed, and no blocking diode is required due to the internal MOSFET architecture. 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, and the charge current can be programmed externally with a single resistor. The AP5054H automatically terminates the charge cycle when the charge current drops to 1/10th the programmed value after the final float voltage is reached.

When the input supply (wall adapter or USB supply) is removed, the AP5054H automatically enters a low current state, dropping the battery drain current to less than 0.5µA. The AP5054H can be put into shutdown mode, reducing the supply current to 180µA.

Other features include charge current monitor, under-voltage lockout, automatic recharge and status indication.

Applications

- Cellular Telephones, PDAs, MP3 /MP4 Players
- Charger
- Digital Camera
- Electronic Dictionary
- Bluetooth ,GPS Applications

Features

- Input Voltage up to 20V
- Input Over Voltage Protection：6.1V
- Programmable Charge Current Up to 750mA
- No MOSFET, Sense Resistor or Blocking Diode Required
- Constant-Current/Constant-Voltage Operation with Thermal Regulation to Maximize Charge Rate Without Risk of Overheating
- Charges Single Cell Li-Ion Batteries Directly from USB Port
- Preset 4.2V Charge Voltage
- Charge Current Monitor Output for Gas Gauging
- Automatic Recharge
- Charge state pairs of output, no battery and fault status display
- C/10 Charge Termination
- 180µA Supply Current in Shutdown
- 2.9V Trickle Charge Threshold
- Soft-Start Limits Inrush Current
- Available in SOT23 Package

Package
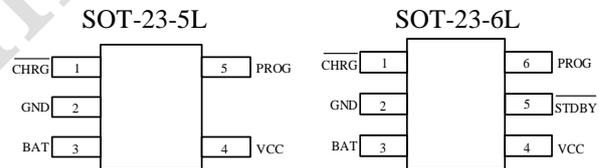
SOT-23-5L   SOT-23-6L

Typical Application Circuit
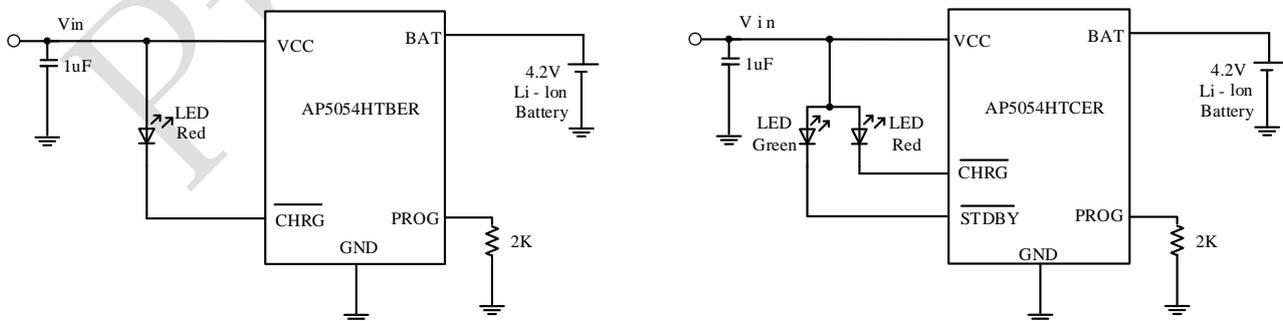
Pin Description

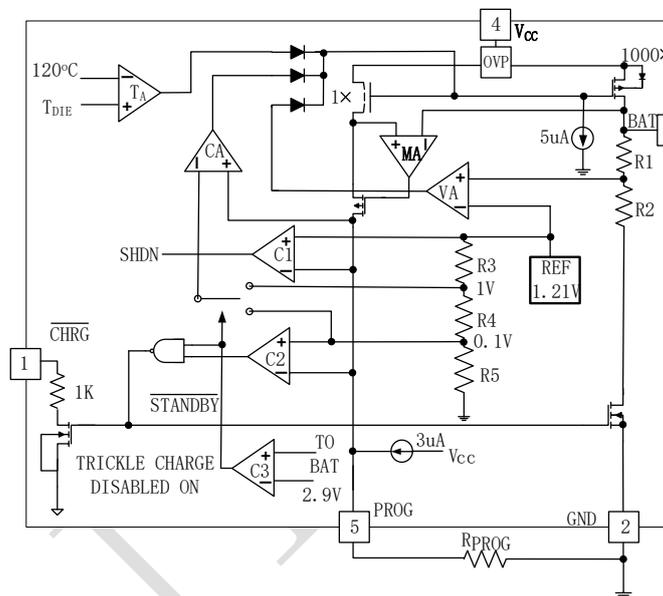| Pin No.		Pin Name	Pin Function
SOT-23-5L	SOT-23-6L		
1	1	CHRG	Open-Drain Charge Status Output.
2	2	GND	Ground.
3	3	BAT	Charge Current Output.
4	4	VCC	Positive Input Supply Voltage.
-	5	STDBY	The completion of battery charging instructions side.
5	6	PROG	Charge Current Program, Charge Current Monitor and Shutdown Pin.

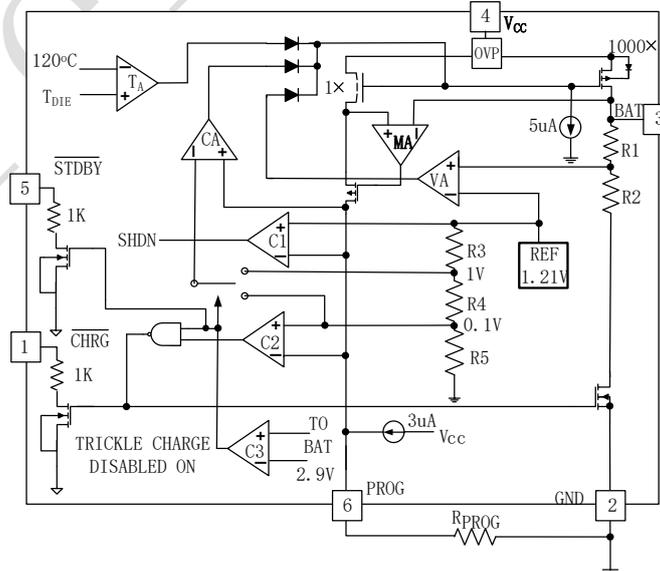## Functional Block Diagram

Figure 1. Block Diagram(AP5054HTBER)

Figure 2. Block Diagram(AP5054HTCER)

Absolute Maximum Ratings

| PARAMETER	SYMBOL	MAXIMUM RATING	UNIT
Input Supply Voltage	V_{cc}	V_{SS}-0.3~V_{SS}+20	V
PROG pin Voltage	Vprog	V_{SS}-0.3~5.5+0.3	
BAT pin Voltage	Vbat	V_{SS}-0.3~8	
CHRG pin Voltage	Vchrg	V_{SS}-0.3~V_{SS}+8	
STDBY pin Voltage	Vstdby	V_{SS}-0.3~V_{SS}+8	
BAT pin Current	Ibat	750	mA
PROG pin Current	Iprog	750	µA
Operating Ambient Temperature	Topa	-40~+85	°C
Storage Temperature	Tstr	-65~+125	
Lead Temperature (Soldering, 10s)		260	

Caution: The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded under any conditions.

Electrical Characteristics

Parameter	Symbol	CONDITION	MIN	TYP	MAX	UNIT
Input supply voltage	Vcc_1		4.25		20	V
Operation Voltage	Vcc_2		4.25		5.5	V
Input Voltage OVP	V_{OVP}	Vcc Rising	5.8	6.1	6.4	V
OVP Hysteresis	$V_{OVP-HYS}$			0.25		V
Input supply current	Icc	Charge mode, R_{PROG}=10K		350		µA
		Standby mode		150	500	µA
		Shutdown mode(R_{PROG} not connected,Vcc<Vbat or Vcc<Vuv)		180		µA
Regulated Output Voltage	Vfloat	T_A=25°C,I_{BAT}= 40mA	4.16		4.24	V
BAT pin Current	Ibat	R_{PROG}=10k,Current mode	85	100	110	mA
		R_{PROG}=2k,Current mode	465	500	530	mA
		Standby mode,Vbat=4.3V	0	-2.5	-6	µA
		Shutdown mode		-1	-2.5	µA
		Sleep mode,Vcc=0V		-0.05	-0.5	µA
Trickle charge current	Itrikl	Vbat<Vtrikl, Rprog=2k	135	150	180	mA
Trickle charge Threshold Voltage	Vtrikl	R_{PROG}=10K,Vbat Rising	2.78	2.9	3.05	V
Trickle voltage hysteresis voltage	Vtrhys	R_{PROG}=10k	100	135	250	mV
Vcc Undervoltage lockout Threshold	Vuv	From Vcc low to high	3.6	3.8	4.05	V
Vcc undervoltage lockout hysteresis	Vuvhys		150	200	300	mV
Vcc-Vbat Lockout Threshold voltage	Vasd	Vcc from low to high	45	280	400	mV
		Vcc from high to low	5	100	230	mV
C/10 Termination Current	Iterm	R_{PROG}=10k		0.06		mA/mA

Threshold		R_{PROG}=2k		0.10		mA/mA
PROG pin Voltage	Vprog	R_{PROG} =10k, Current mode	0.93	1.0	1.07	V
CHRG pin Output low voltage	Vchrg	Ichrg=1mA		1.2	1.5	V
STDBY pin Output low voltage	Vstdby	Istdby=1mA		1.2	1.5	V
Recharge Battery threshold Voltage	ΔVrecg	V_{FLOAT} - V_{RECHRG}	80	160	280	mV
Limited temperature patterns in the junction temperature	Tlim			145		°C

Typical Performance Characteristics

Itrickl vs Vcc

Rprog=2K
Rprog=10k

Ibat vs Vcc

Rprog=2K
Rprog=10k
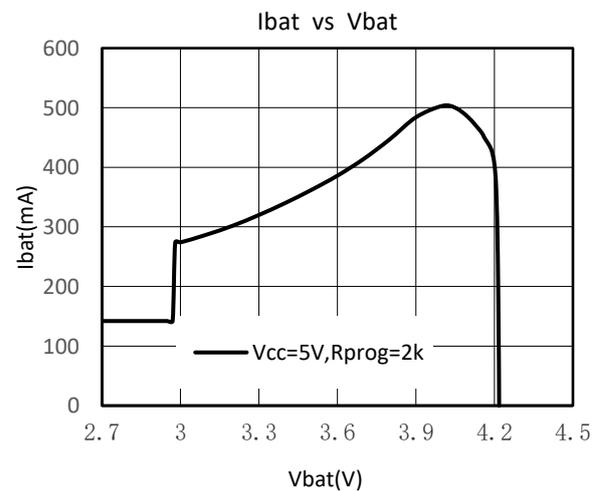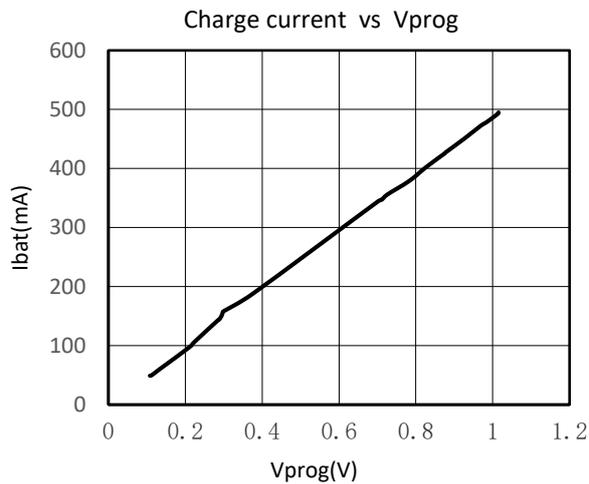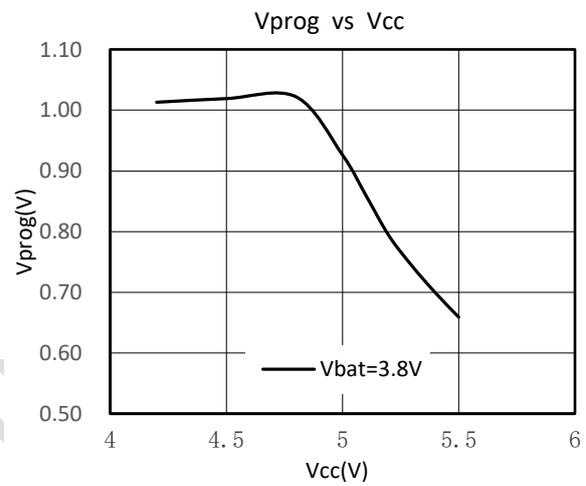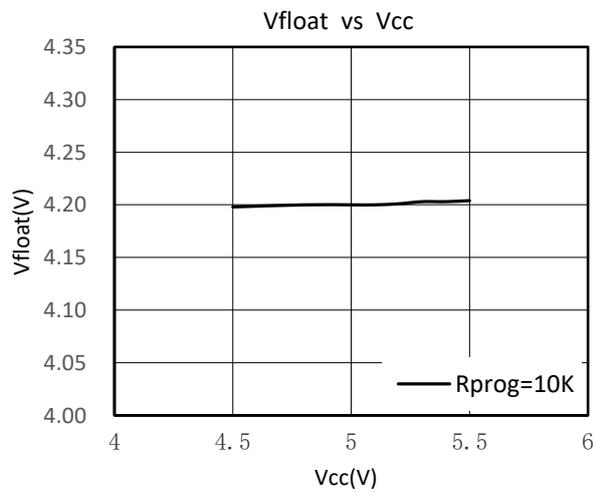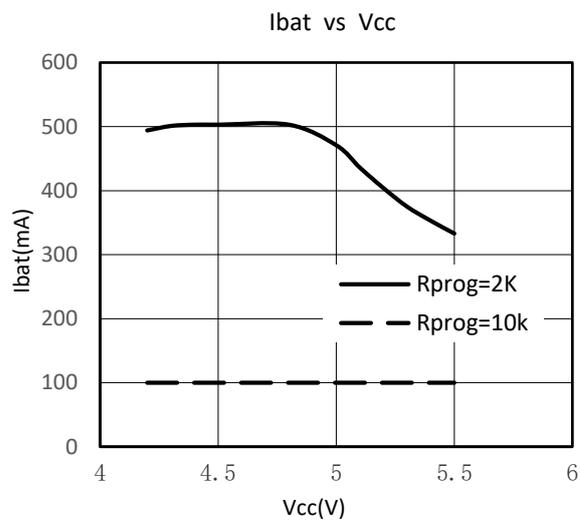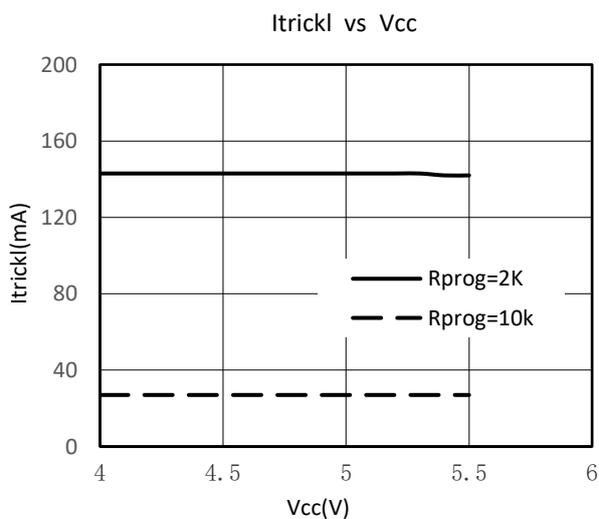
Ordering Information

Part Numbers	Marks	Packages
AP5054HTBER	K5YWW[1]	SOT-23-5L
AP5054HTCER	K5YWW[1]	SOT-23-6L

1.YWW= date code

Pin Function

CHRG : Open-Drain Charge Status Output. When the battery is charging, the CHRG pin is pulled low by an internal N-channel MOSFET. When the AP5054H detects an under voltage lockout condition and the charge cycle is completed, CHRG is forced high impedance.

GND: Ground.

BAT: Charge Current Output. Provides charge current to the battery and regulates the final float voltage to 4.2V. An internal precision resistor divider from this pin sets the float voltage which is disconnected in shutdown mode.

VCC: Positive Input Supply Voltage. Provides power to the charger, VCC range from 4.25V to 20V and operation voltage from 4.25V to 5.5V. VCC pin should be bypassed with at least a 1μF capacitor. When VCC drops to within 30mV of the BAT pin voltage, the AP5054H enters shutdown mode, dropping I_{BAT} to less than 2μA.

STDBY(AP5054HTBER): The completion of battery charging instructions side. When the battery charge is complete, STDBY pulled low by internal switches, indicating the completion of charging. In addition, STDBY pin will be in a high-impedance state.
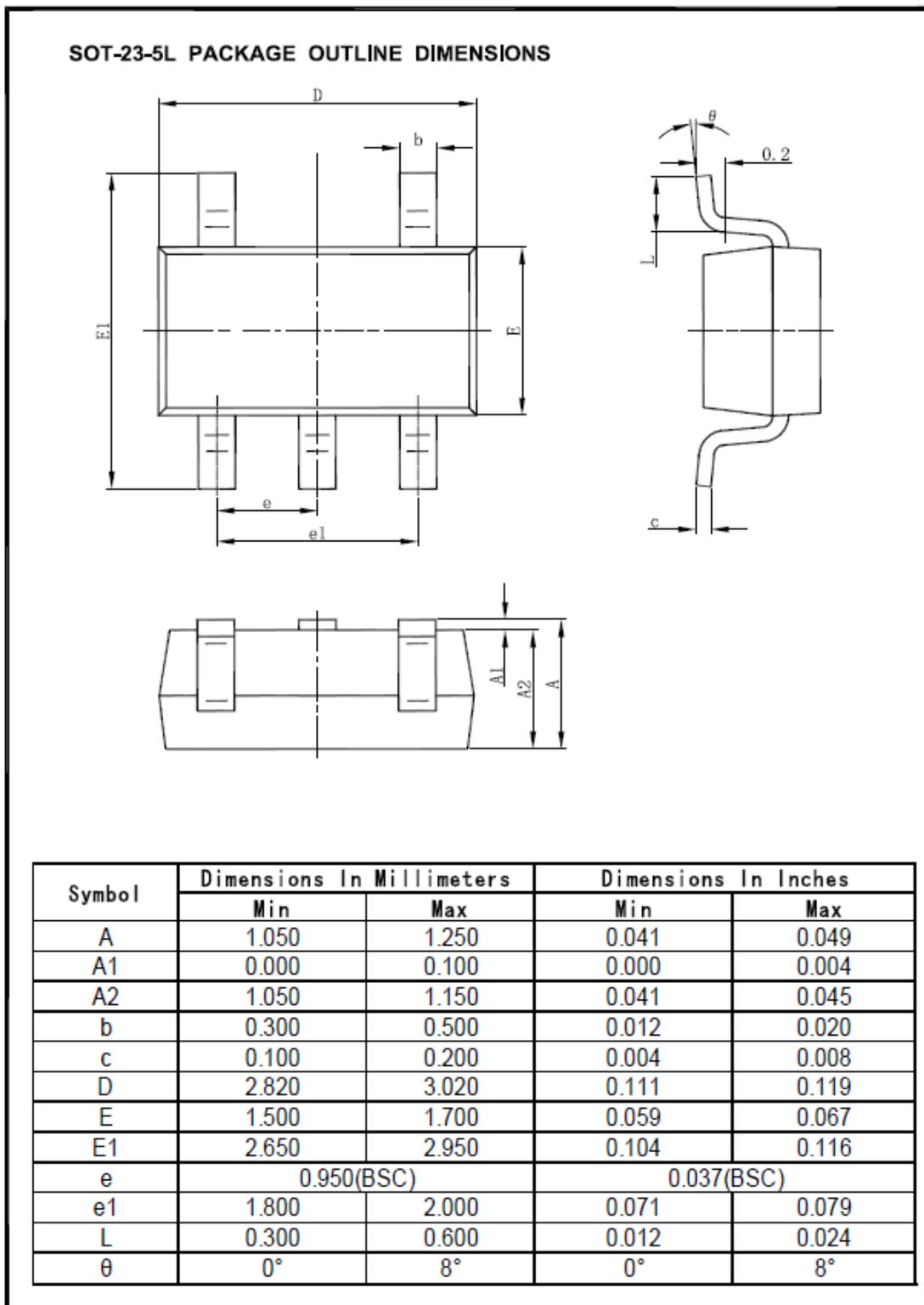
PROG: Charge Current Program, Charge Current Monitor and Shutdown Pin. The charge current is programmed by connecting a 1% resistor, R_{PROG}, to ground. When charging in trickle-current mode, this pin servos to 0.1V. When charging in constant-current mode, this pin servos to 1V. In all modes, the voltage on this pin can be used to measure the charge current using the following formula:

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

The P_{ROG} pin can also be used to shut down the charger. Disconnecting the program resistor from ground allows a 3uA current to pull the P_{ROG} pin high. When it reaches the 1.21V shutdown threshold voltage, the charger enters shutdown mode, charging stops and the input supply current drops to 180μA. This pin is also clamped to approximately 2.4V. Driving this pin to voltages beyond the clamp voltage will draw currents as high as 1.5mA. Reconnecting R_{PROG} to ground will return the charger to normal operation.

Package Information

SOT-23-5L

SOT-23-5L PACKAGE OUTLINE DIMENSIONS

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

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SOT-23-6L

SOT-23-6L PACKAGE OUTLINE DIMENSIONS

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

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