Standalone Linear Li-Ion Battery Charger with Thermal Regulation

DESCRIPTION

The UP4054A is a complete constant-current /constant-voltage linear charger for single cell lithium-ion batteries. It's TSOT23-5 package and low external component count make the UP4054A ideally suited for portable applications. Furthermore, the UP4054A 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 UP4054A automatically terminates the charge cycle when the charge current drops to $1/10^{th}$ the programmed value after the final float voltage is reached. When the input supply (wall adapter or USB supply) is removed, the UP4054A automatically enters a low current state, dropping the battery drain current to less than 2uA. The UP4054A can be put into shutdown mode, reducing the supply current to 25uA. When battery reversed, the internal protected the BAT pin throughout about 0.7mA current from GND. Also, The BAT pin has a 4KV ESD (HBM) capability. Other features include charge current monitor, under-voltage lockout, automatic recharge and a status pin to indicate charge termination and the presence of an input voltage

FEATURE

- Programmable Charge Current Up to 500mA
- No MOSFET, Sense Resistor or Blocking Diode Required
- Complete Linear Charger in TSOT package for single Cell Lithium-Ion Batteries
- Constant-Current/Constant-Voltage Operation with Thermal Regulation to Max Charge Rate without Risk of Overheating
- Charges Single Cell Li-Ion Batteries Directly from USB Port
- Preset 4.2V Charge Voltage with 1% Accuracy
- Charge Current Monitor Output for Gas Gauging
- Automatic Recharge
- Charge Status Output Pin
- C/10 Charge Termination
- 25uA Supply Current in Shutdown
- 2.9V Trickle Charge Threshold
- Soft-Start Limits Inrush Current
- 4KV ESD capability
- Available in 5-lead TSOT23

APPLICATIONS

- Cellular Telephones, PDAs, MP3 Players
- Charging Docks and Cradles
- Buletooth Applications

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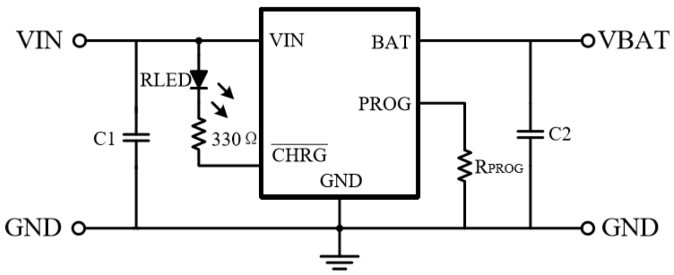
TYPICAL APPLICATION CIRCUIT



Note: C1=4.7uf, C2=10uf, IBAT=(V_{PROG}/R_{PROG})*1000

PART NUMBER INFORMATION

UP4054AVP	V=Regulator Output voltage P=Package Code S: TSOT23-5L

ORDERING INFROMATION

Part Number	Regulator Output Voltage	Part Number	Regulator Output Voltage	Part Number	Regulator Output Voltage
UP4054AAS	4.0	UP4054AES	4.1	UP4054ALS	4.2
UP4054ABS	4.025	UP4054AFS	4.125	UP4054AMS	4.225
UP4054ACS	4.05	UP4054AHS	4.15	UP4054ANS	4.250
UP4054ADS	4.075	UP4054AKS	4.175	UP4054AXS	Customer

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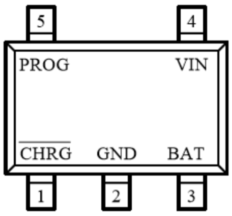
PIN CONFIGURATION



SOT-23-5L
(TOP VIEW)

PIN ASSIGNMENT

Pin No	Pin Name	Pin Function
1	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 charge cycle is completed, a weak pull-down of approximately 20µA is connected to the CHRG pin, indicating an “AC present” condition. When the UP4054A detects an undervoltage lockout condition, CHRG is forced high impedance.
2	GND	Ground
3	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. When the battery reversed, Internal protection circuitry to protect the chip will not be burned. And about 0.7mA current flows from GND to BAT.
4	VIN	Positive Input Supply Voltage. Provides power to the charger. VIN can range from 4.25V to 6.5V and should be bypassed with at least a 1µF capacitor. When VIN drops to within 30mV of the BAT pin voltage, the UP4054A enters shutdown mode, dropping IBAT to less than 2µA
5	PROG	Charge Current Program, Charge Current Monitor and Shutdown Pin. The charge current is programmed by connecting a 1% resistor, RPROG, to ground. 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: IBAT = (VPROG/RPROG) • 1000 The PROG pin can also be used to shut down the charger. Disconnecting the program resistor from ground allows a 3µA current to pull the PROG 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 25µA. 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 RPROG to ground will return the charger to normal operation.

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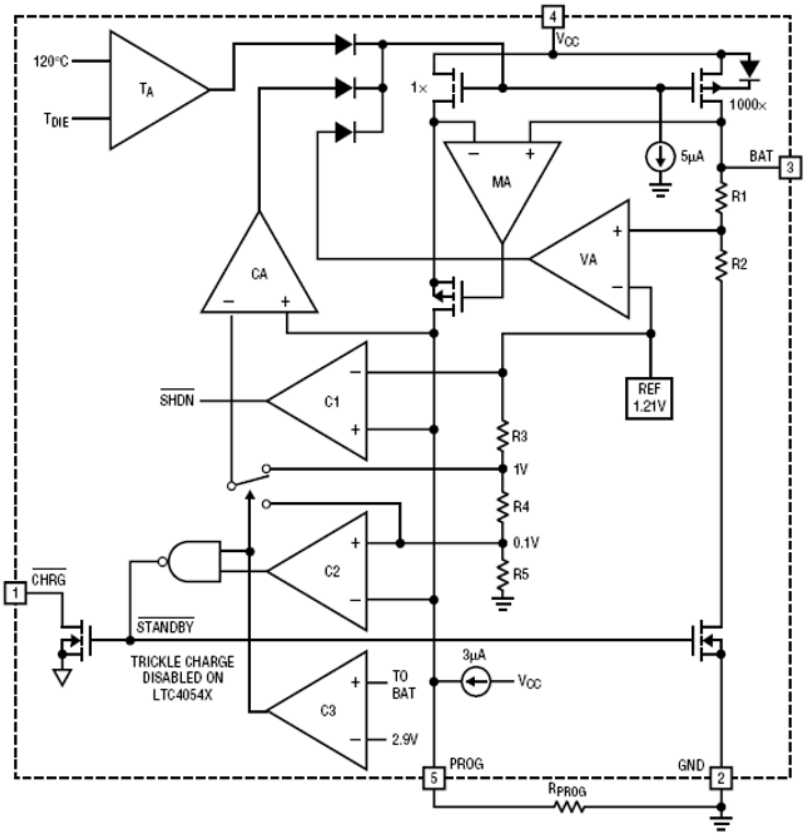
■ *BLOCK DIAGRAM*



■ *ABSOLUTE MAXIMUM RATINGS* *(T_A = 25℃ Unless otherwise noted)*

Symbol	Parameter	Typical	Unit
V_{IN}	Input Supply Voltage	VSS-0.3~VSS+7	V
V_{RPOG}	PROG pin Voltage	VSS-0.3~VIN+0.3	
V_{BAT}	BAT pin Voltage	VSS-0.3~7	
V_{CHRG}	CHAG pin Voltage	VSS-0.3~VSS+7	
I_{BAT}	BAT pin Current	500	mA
I_{PROG}	PROG pin Current	300	uA
P_D	Power Dissipation	250	mW
T_J	Operation Junction Temperature	150	℃
T_{STG}	Storage Temperature Range	-55~+125	℃
T_{OPR}	Operation Temperature	-40~+80	℃

Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress rating only and functional device operation is not implied

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■ *ELECTRICAL CHARACTERISTICS(T_A=25℃ Unless otherwise noted)*

Symbol	Parameter	Condition	Min	Typ	Max	Unit
V_{IN}	Input Supply Voltage		4.25		6.5	V
I_{IN}	Input Supply Current	Charge mode, R_{PROG}=10K		300	2000	uA
		Standby mode		200	500	uA
		Shutdown mode		25	50	uA
V_{FLOAT}	Regulated Output Voltage	I_{BAT}=40mA	4.158	4.2	4.342	V
I_{BAT}	BAT pin Current	R_{PROG}=10K, Current mode	93	100	107	mA
		R_{PROG}=2K, Current mode	465	500	535	mA
		Standby mode, V_{BAT}=4.2V	0	-2.5	-6	uA
		Shutdown mode		1	2	uA
		Sleep mode, Vin=0V		1	2	uA
I_{TRIKL}	Trickle charge current	V_{BAT}<V_{TRIKL}, R_{PROG}=2K	20	45	70	mA
V_{TRIKL}	Trickle charge threshold Voltage	R_{PROG}=10K, V_{BAT} Rising	2.8	2.9	3.0	V
V_{TRHYS}	Trickle voltage hysteresis Voltage	R_{PROG}=10K	60	80	110	mV
V_{UV}	Vin Undervoltage lockout threshold	From V_{IN} low to high	3.7	3.8	3.9	V
V_{UVHYS}	Vin Undervoltage lockout hysteresis		150	200	300	mV
V_{MSD}	Manual shutdown threshold voltage	PROG pin rising	1.15	1.21	1.30	V
		PROG pin falling	0.9	1.0	1.1	V
V_{ASD}	Vin-Vbat lockout threshold voltage	VIN from low to high	70	100	140	mV
		VIN from high to low	5	30	50	mV
I_{TERM}	C/10 Termination Current Threshold	R_{PROG}=10K	0.085	0.10	0.115	mA/ mA
		R_{PROG}=2K	0.085	0.10	0.115	mA/ mA
V_{PROG}	PROG pin Voltage	R_{PROG}=10K, Current mode	0.93	1.0	1.07	V
I_{CHRG}	CHRG pin weak pull-down Current	V_{CHRG}=5V	8	20	35	uA
V_{CHRG}	CHRG pin Output low Voltage	I_{CHRG}=5mA		0.35	0.6	V
ΔV_{RECG}	Recharge Battery threshold voltage	V_{FLOAT}-V_{RECHRG}		100	200	mV

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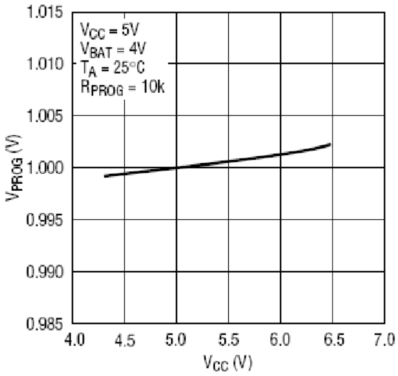
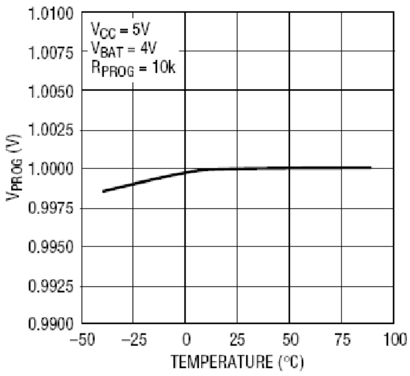
■ *TYPICAL PERFORMANCE CHARACTERISTICS*

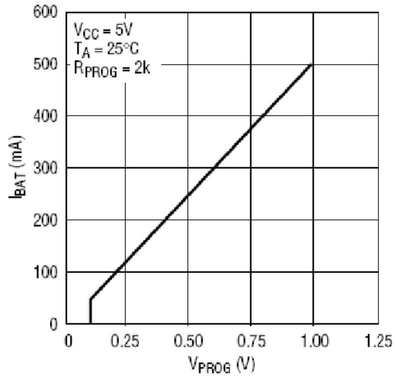
PROG Pin Voltage vs Supply Voltage(Constant Current Mode)



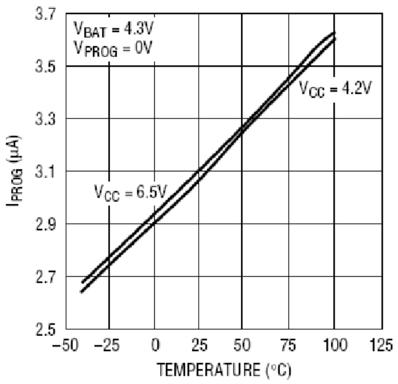
PROG Pin Voltage vs Temperature



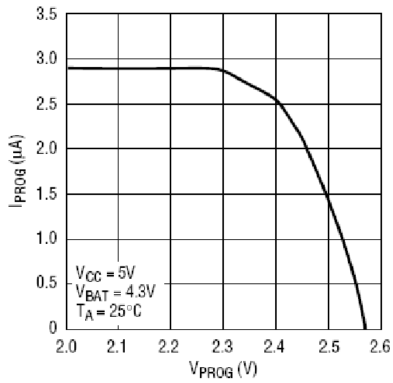
Charge Current vs PROG Pin Voltage



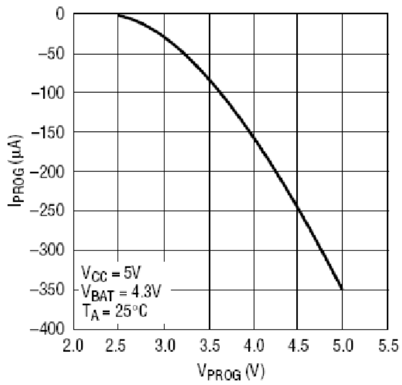
PROG Pin Pull-Up Current vs Temperature and Supply Voltage



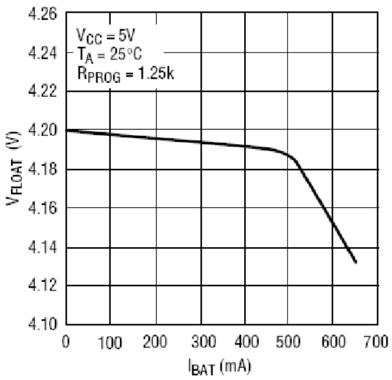
PROG Pin Current vs PROG Pin Voltage (Pull-Up Current)



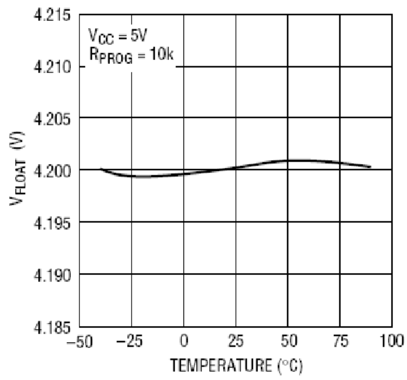
PROG Pin Current vs PROG Pin Voltage (Clamp Current)



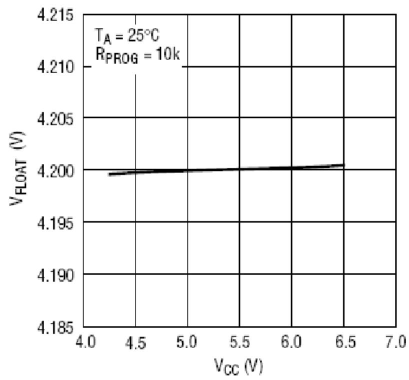
Regulated Output (Float) Voltage vs Charge Current



Regulated Output (Float) Voltage vs Temperature



Regulated Output (Float) Voltage vs Supply Voltage



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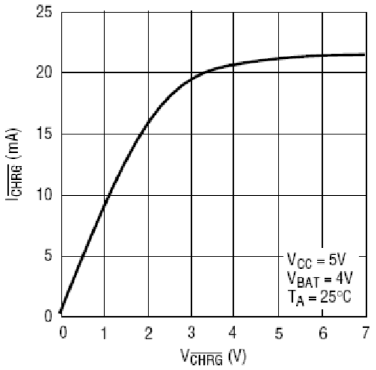
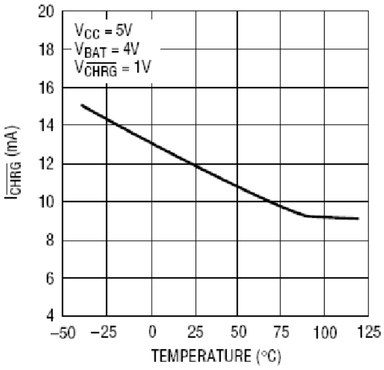
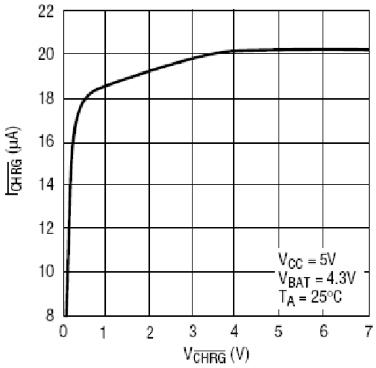
CHRG Pin I-V Curve
(Strong Pull-Down State)



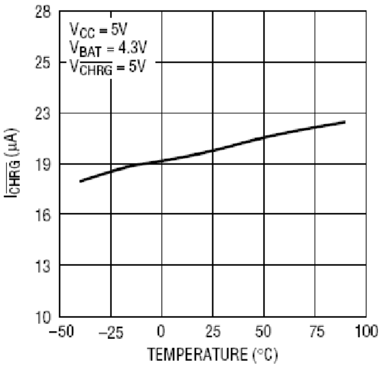
CHRG Pin Current vs Temperature
(Strong Pull-Down State)



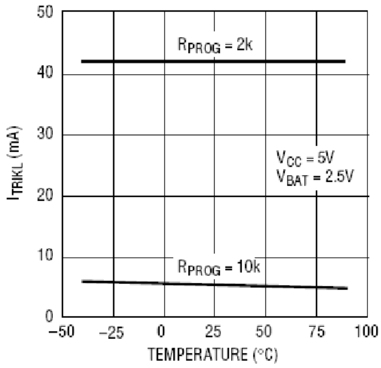
CHRG Pin I-V Curve
(Weak Pull-Down State)



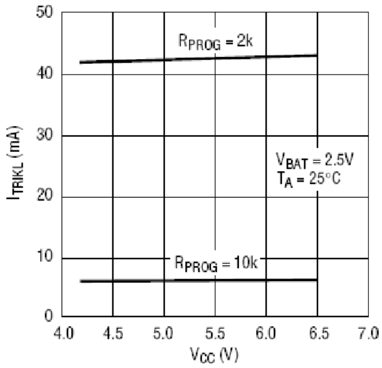
CHRG Pin Current vs Temperature
(Weak Pull-Down State)



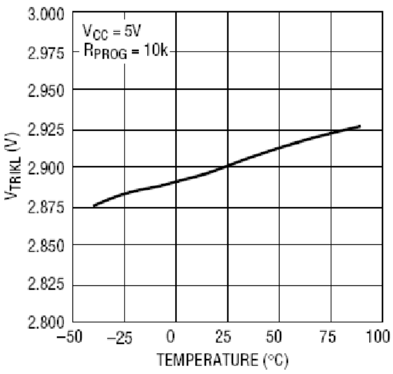
Trickle Charge Current
vs Temperature



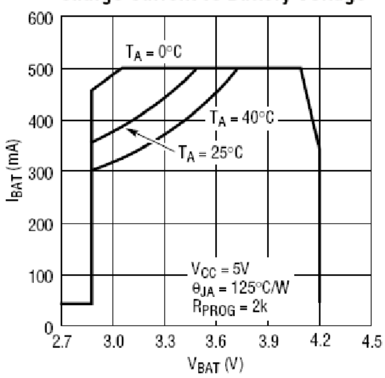
Trickle Charge Current vs
Supply Voltage



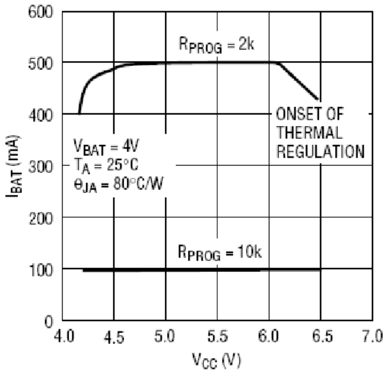
Trickle Charge Threshold vs
Temperature



Charge Current vs Battery Voltage



Charge Current vs Supply Voltage



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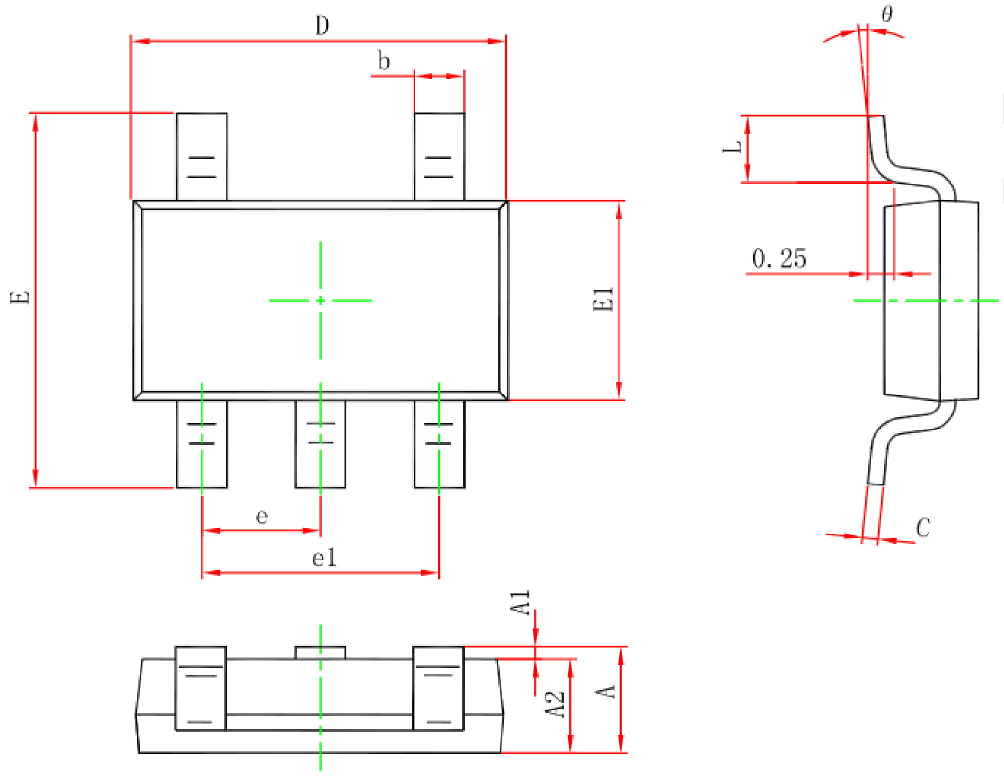
■ *PACKAGE DIEMSIONS*

TSOT-23-5L PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	---	0.900	---	0.035
A1	0.020	0.090	0.001	0.004
A2	0.700	0.800	0.028	0.031
b	0.350	0.500	0.014	0.020
c	0.080	0.200	0.003	0.008
D	2.820	3.020	0.111	0.119
E1	1.600	1.700	0.063	0.067
E	2.650	2.950	0.104	0.116
e	0.95 （BSC）		0.037(BSC)	
e1	1.90 （BSC）		0.075(BSC)	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

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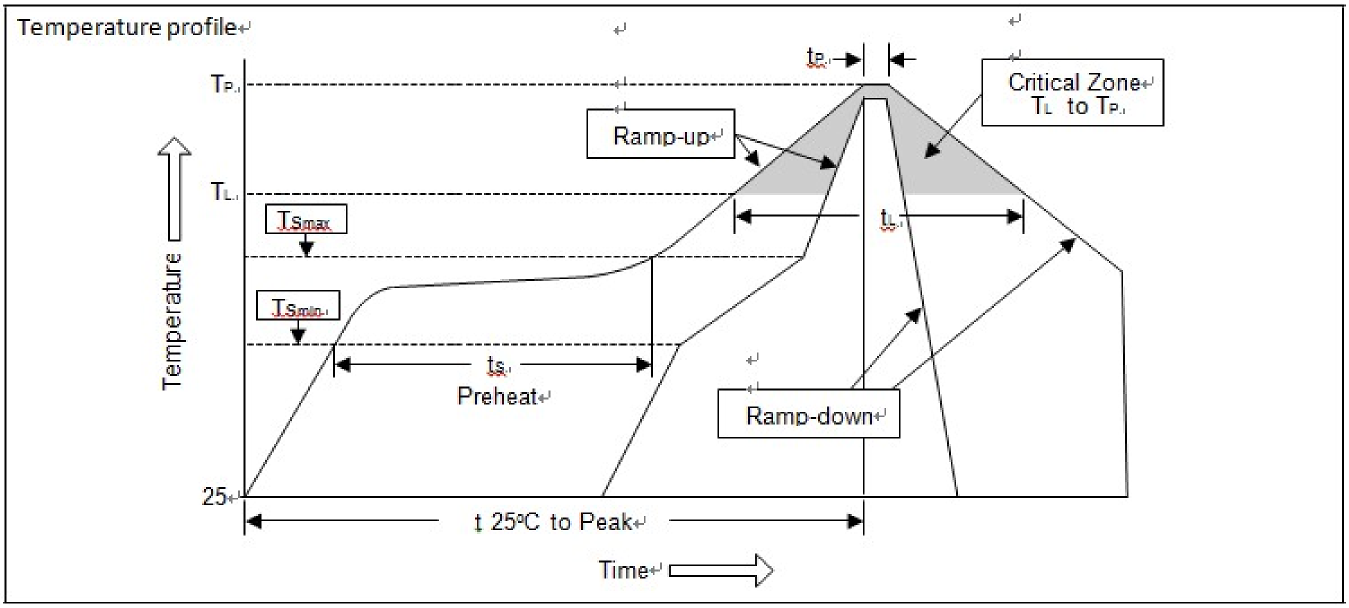
■ *SOLDERING METHODS FOR UNIVERCHIP*

Storage environment Temperature=10℃~35℃ Humidity=65%±15%

Reflow soldering of surface mount device



Profile Feature	Sn-Pb Eutectic Assembly	Pb free Assembly
Average ramp-up rate (T_L to T_P)	<3℃/sec	<3℃/sec
Preheat -Temperature Min (Ts_{min}) -Temperature Max (Ts_{max}) -Time (min to max) (ts)	 100℃ 150℃ 60~120 sec	 150℃ 200℃ 60~180 sec
Tsmax to T_L -Ramp-up Rate	<3℃/sec	<3℃/sec
Time maintained above -Temperature (T_L) -Time (t_L)	 183℃ 60~150 sec	 217℃ 60~150 sec
Peak Temperature (T_P)	240℃+0/-5℃	260℃+0/-5℃
Time within 5℃ of actual Peak Temperature (t_P)	10~30 sec	20~40 sec
Ramp-down Rate	<6℃/sec	<6℃/sec
Time 25℃ to Peak Temperature	<6 minutes	<6 minutes

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Flow (wave) soldering (solder dipping)

Product	Peak Temperature	Dipping Time
Pb device	245℃±5℃	5sec±1sec
Pb-Free device	260℃+0/-5℃	5sec±1sec

This integrated circuit can be damaged by ESD UniverChip Corporation recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedure can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

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