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XC6805 Series

One Cell Li-ion/Li-polymer Linear Charger IC with Battery Temperature Detection

■GENERAL DESCRIPTION

The XC6805 is a Constant-Voltage (CV) and Constant-Current (CC) type charging IC for linear charging of single-cell Li-ion batteries and Li-polymer batteries. The basic charging cycle consists of trickle charge mode followed by main charge mode. This IC supports temperature control based on JEITA, making it possible to safely charge Li-ion batteries and Li-polymer batteries by controlling the CV charge voltage and CC charge current according to the temperature. By connecting a resistor to the charge status output pin, it is possible to check the charge condition via the charge status output (CSO) pin voltage. The IC is housed in the small USP-6EL, USP-6B07 package with high heat dissipation, and a charge circuit can be configured using a minimum of external components.

■APPLICATIONS

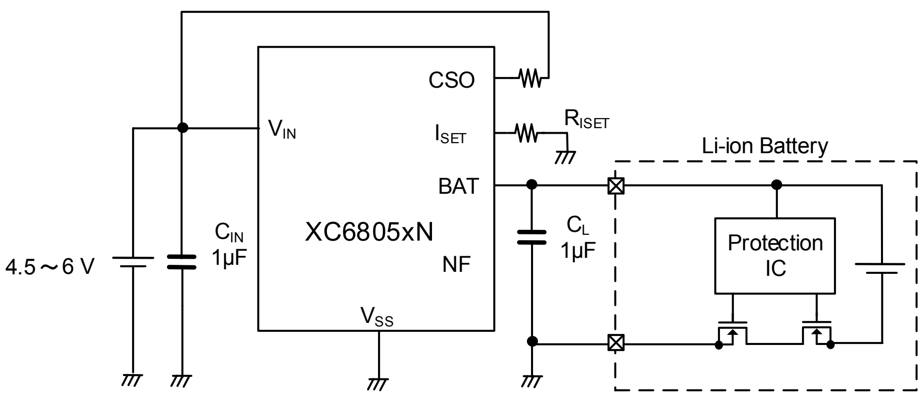
- Small Battery
- Wearable Device
- Fitness Tracker
- Hearing Aid
- Smart Meter

■FEATURES

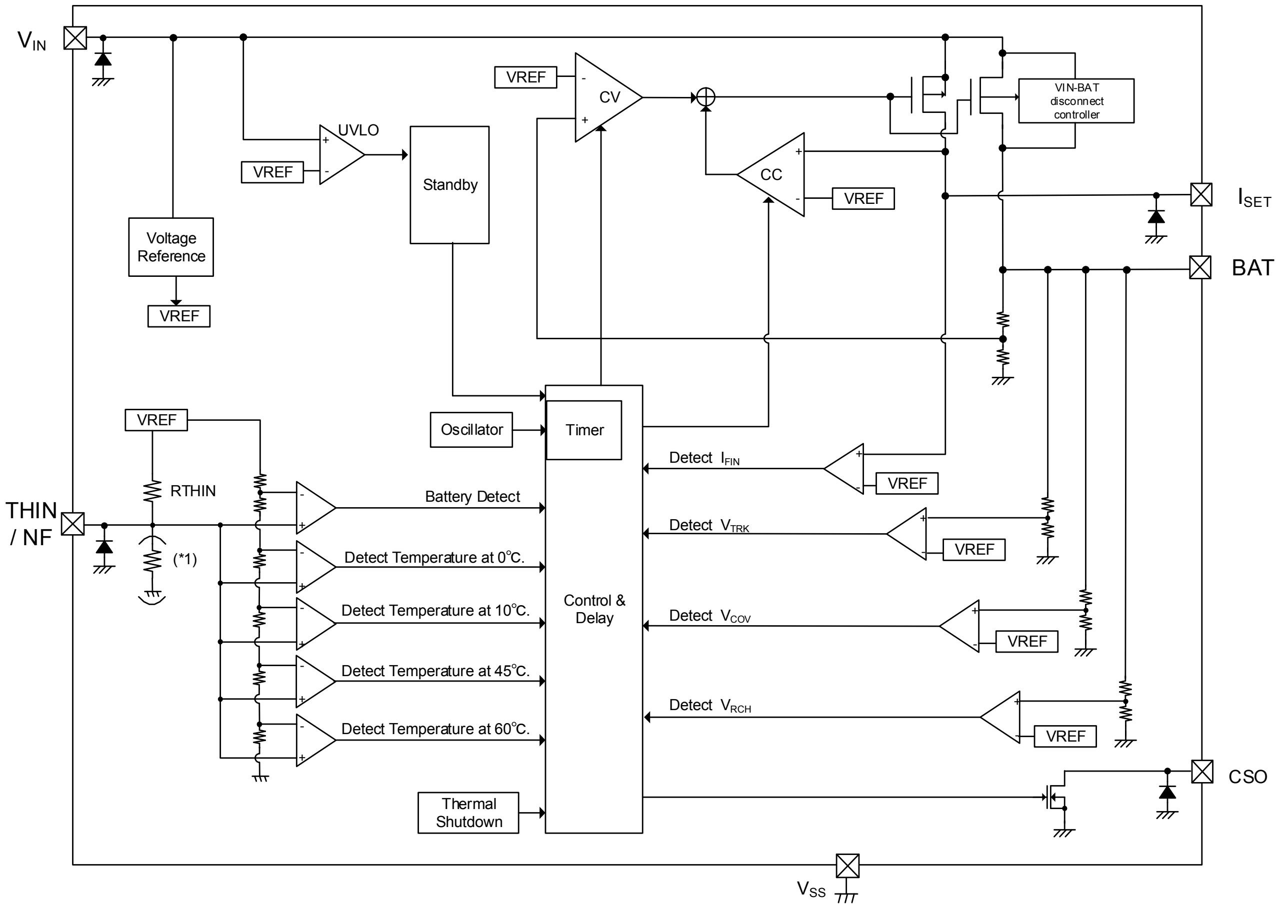
JEITA conforming Thermistor Detect Function Built-in

Operating Voltage Range	: 4.5V ~ 6V
Supply Current	: 100μA (V_{IN}=5V, V_{BAT}=3.5V)
CC Charge Current	: 5mA ~ 40mA Can be set by external resistance
CV Charge Voltage	: 4.2V, 4.05V (at high temperature) Internally fixed
Protection Circuit	: Thermistor detection function
	(Except for the XC6805xN)
	Safety timer function
	UVLO (Under Voltage Lock Out)
	Thermal shutdown (Latch Stop)
	Dropout voltage monitor function
	Charging over-voltage monitor function
	Charging over-current monitor function
	Recharge function
Operating Ambient Temperature	: - 40°C ~ +85°C
Package	: USP-6EL, USP-6B07
Environmentally Friendly	: EU RoHS Compliant, Pb Free

■TYPICAL APPLICATION CIRCUIT



■BLOCK DIAGRAM



(*1) On the XC6805xN, a resistor to the GND is built-in to invalidate the temperature monitor function.

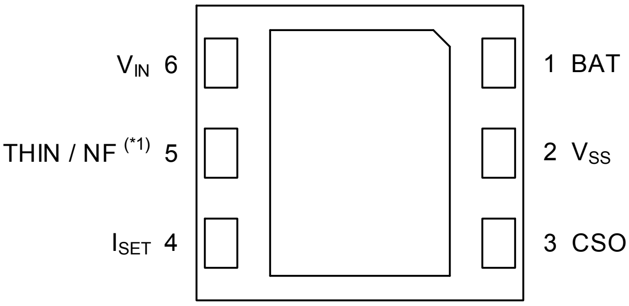
■PRODUCT CLASSIFICATION

XC6805①②③④⑤⑥-⑦ (*1)

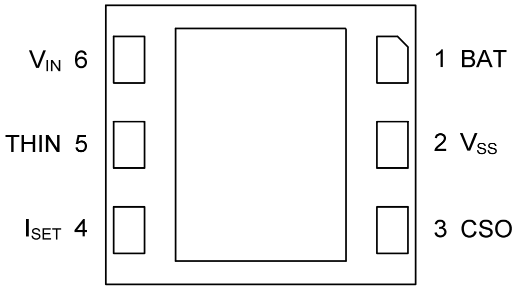
DESIGNATOR	DESCRIPTION	SYMBOL	DESCRIPTION
①	Charge Status Output on Abnormal Mode	A	1kHz ON-OFF
		B	OFF
②	Battery Temperature Monitor Function	2	2 Temperature Monitor
		3	3 Temperature Monitor
		4	4 Temperature Monitor
		N	No Temperature Monitor
③	Trickle Charge Function	E	Enable
		D	Disable
④	CV Charge Voltage	1	4.2V (Fixed)
⑤⑥-⑦(*1)	Packages (Order Unit)	4R-G	USP-6EL (3,000pcs/Reel)
		8R-G	USP-6B07 (5,000pcs/Reel)

(1) The “-G” suffix denotes Halogen and Antimony free as well as being fully EU RoHS compliant.

■PIN CONFIGURATION



USP-6EL
(BOTTOM VIEW)



USP-6B07
(BOTTOM VIEW)

*The dissipation pad for the USP-6EL package should be solder-plated in recommended mount pattern and metal masking so as to enhance mounting strength and heat release.
When taking out a potential of the heat-sink, connect with V_{SS} pin (#2 pin).

■PIN ASSIGNMENT

PIN NUMBER		PIN NAME	FUNCTION
USP-6EL	USP-6B07		
1		BAT	Battery Connection
2		V_{SS}	Ground
3		CSO	Charge Status Output
4		I_{SET}	Charge Current Setup
5 (*1)		THIN	Temperature Detection
		NF	No Function (Please do not connect any terminal.)
6		V_{IN}	Power Supply Input
Back Metal			Internally Connected V_{SS}

(*1) Pin name of #5 is THIN on the XC6805x2, XC6805x3 and XC6805x4, and NF on the XC6805xN.

■ABSOLUTE MAXIMUM RATINGS

Ta=25°C

PARAMETER		SYMBOL	RATING	UNIT
V_{IN} Pin Voltage		V_{IN}	-0.3 ~ +6.5	V
BAT Pin Voltage		V_{BAT}	-0.3 ~ +6.5	V
CSO Pin Voltage		V_{CSO}	-0.3 ~ +6.5	V
THIN Pin Voltage (*2)		V_{THIN}	-0.3 ~ V_{IN} +0.3 or +6.5 (*1)	V
NF Pin Voltage (*3)		V_{NF}	-0.3 ~ V_{IN} +0.3 or +6.5 (*1)	V
I_{SET} Pin Voltage		V_{ISET}	-0.3 ~ V_{IN} +0.3 or +6.5 (*1)	V
BAT Pin Current		I_{BAT}	1000	mA
Power Dissipation	USP-6EL	Pd	120	mW
			750 (PCB mounted)	
	USP-6B07		750 (PCB mounted)	
Operating Ambient Temperature		T_{opr}	-40 ~ +85	°C
Storage Temperature		T_{stg}	-55 ~ +125	°C

Each rating voltage is based on the V_{SS}.
(*1) Either of lower one, V_{IN}+0.3 or +6.5, is applicable.
(*2) Applicable only to XC6805x2, XC6805x3 and XC6805x4
(*3) Applicable only to XC6805xN

■ELECTRICAL CHARACTERISTICS

Unless otherwise stated, V_{IN}=5.0V, V_{THIN}=1.0V, R_{ISET}=59kΩ, C_{IN}=C_L=1μF, Ta=25 °C

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT	CIRCUIT
Operating Voltage Range	V_{IN}		4.5	5	6	V	-
Supply Current (*1)	I_{SS}	V_{BAT}=3.5V	-	100	-	μA	①
Standby Current	I_{STB}	V_{BAT}=4.3V, I_{STB}=I_{IN} - I_{THIN}	-	60	-	μA	①
V_{IN}-V_{BAT} Shut-down Voltage	V_{IBSD}	V_{BAT}=4.1V	-	V_{BAT}+40	-	mV	②
Shut-down Hysteresis Voltage (*1)	$V_{IBSDHYS}$		-	60	-	mV	②
UVLO Voltage	V_{UVLO}		3.6	3.8	4	V	②
UVLO Hysteresis Voltage (*1)	$V_{UVLOHYS}$		-	200	-	mV	②
Trickle Charge Voltage (*2)	V_{TRK}		2.8	2.9	3	V	②
Trickle Charge Hysteresis Voltage (*1) (*2)	V_{TRKHYS}		-	100	-	mV	②
Trickle Charge Current (Min.) (*1) (*2)	I_{TRKI}	R_{ISET}=59kΩ, V_{BAT}=2.4V	-	0.5	-	mA	②
Trickle Charge Current (*2)	I_{TRK}	R_{ISET}=20kΩ, V_{BAT}=2.4V	0.9	1.2	1.8	mA	②
Trickle Charge Current (Max.) (*1) (*2)	I_{TRKA}	R_{ISET}=5.9kΩ, V_{BAT}=2.4V	-	4	-	mA	②
CV Charge Voltage	V_{BAC}	I_{BAT}=20mA	4.17	4.2	4.23	V	③
		I_{BAT}=20mA V_{THIN}=V_{THIN_open} x V_{T45} (*3)	4.02	4.05	4.08	V	③
CC Charge Current (Min.) (*1)	I_{BACI}	R_{ISET}=59kΩ, V_{BAT}=3.1V	-	5	-	mA	②
		R_{ISET}=59kΩ, V_{BAT}=3.1V V_{THIN}=V_{THIN_open} x V_{T10} (*4)	-	2.3	-	mA	②
CC Charge Current	I_{BAC}	R_{ISET}=20kΩ, V_{BAT}=3.1V	11	13	15	mA	②
		R_{ISET}=20kΩ, V_{BAT}=3.1V V_{THIN}=V_{THIN_open} x V_{T10} (*4)	4	6	8	mA	②
CC Charge Current (Max.) (*1)	I_{BACA}	R_{ISET}=5.9kΩ, V_{BAT}=3.1V	-	40	-	mA	②
		R_{ISET}=5.9kΩ, V_{BAT}=3.1V V_{THIN}=V_{THIN_open} x V_{T10} (*4)	-	18.4	-	mA	②
Charge Completion Current (Min.) (*1)	I_{FINI}	R_{ISET}=59kΩ	-	0.5	-	mA	③
Charge Completion Current	I_{FIN}	R_{ISET}=20kΩ	0.9	1.5	2.5	mA	③
Charge Completion Current (Max.) (*1)	I_{FINA}	R_{ISET}=5.9kΩ	-	4.4	-	mA	③
Over Voltage Protection Threshold	V_{COV}		4.3	4.45	4.6	V	②
Over Current Protection Threshold	I_{COP}		-	110	-	mA	③
Driver ON Resistance	R_{ON}	V_{IN}=4.1V, R_{ISET}=5.9kΩ I_{BAT}=15mA	-	3	5.5	Ω	③
Driver Leakage Current	I_{LEAK}	V_{IN}=6.0V, V_{BAT}=0V	-	-	1	μA	⑥
BAT Pin Reverse Current	I_{REV}	V_{BAT}=4.5V, V_{IN}=0V	-	0.5	1.4	μA	⑥
BAT Pin Pull-down Current	I_{BATPD}	V_{BAT}=4.3V	-	3	-	μA	②
Recharge Voltage	V_{RCHG}		3.7	3.9	4.1	V	②
		V_{THIN}=V_{THIN_open} x V_{T45} (*3)	3.55	3.75	3.95	V	②

(*1) Design target

(*2) Applicable only to XC6805xxE. XC6805xxD does not have trickle charge function.

(*3) Applicable only to XC6805x4

(*4) Applicable only to XC6805x3 and XC6805x4

■ELECTRICAL CHARACTERISTICS

Unless otherwise stated, V_{IN}=5.0V, V_{THIN}=1.0V, R_{ISET}=59kΩ, C_{IN}=C_L=1μF, Ta=25 °C

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT	CIRCUIT
Trickle Charge Hold Time (*1)	t_{TRK}		-	0.5	-	hr	②
Main Charge Hold Time	t_{CHG}		-	5	-	hr	②
CSO Pin OFF Current	I_{CSOOFF}	V_{CSO}=6.0V	-	-	1	μA	⑦
CSO Pin ON Voltage	V_{CSO}	I_{CSO}=10mA	-	-	0.5	V	④
Thermal Shut-Down Detection Temperature (*1)	T_{TSD}		-	140	-	°C	②
CSO Frequency (*2)	f_{CSO}		0.75	1	1.25	kHz	②

(*1) Applicable only to XC6805xxE

(*2) Applicable only to XC6805A

■ ELECTRICAL CHARACTERISTICS

XC6805x2, XC6805x3, XC6805x4 (*3) Unless otherwise stated, V_{IN}=5.0V, V_{THIN}=1.0V, R_{ISET}=59kΩ, C_{IN}=C_L=1μF, Ta=25 °C

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT	CIRCUIT
THIN Pin Open Voltage	V_{THIN_open}		1.94	2.0	2.06	V	⑤
Battery Connect Detection	V_{TD}		77	80	83	% (*2)	②
Battery Connect Detection Hysteresis (*1)	V_{TDH}	At temperature fall	-	3	-	% (*2)	②
Thermistor Detection at 0°C	V_{T0}		71.13	73.13	75.13	% (*2)	②
Thermistor Detection Hysteresis at 0°C (*1)	V_{T0H}	At temperature rise	-	2.18	-	% (*2)	②
Thermistor Detection at 10°C (*4)	V_{T10}		62.19	64.19	66.19	% (*2)	②
Thermistor Detection Hysteresis at 10°C (*1)	V_{T10H}	At temperature rise	-	2.38	-	% (*2)	②
Thermistor Detection at 45°C	V_{T45}		30.96	32.96	34.96	% (*2)	②
Thermistor Detection Hysteresis at 45°C (*1)	V_{T45H}	At temperature fall	-	1.94	-	% (*2)	②
Thermistor Detection at 60°C (*5)	V_{T60}		21.16	23.16	25.16	% (*2)	②
Thermistor Detection Hysteresis at 60°C (*1)	V_{T60H}	At temperature fall	-	1.47	-	% (*2)	②
THIN Pin Connected Resistance	R_{THIN}	V_{THIN} = 0 V	9.8	10	10.2	kΩ	⑤

(*1) Design target

(*2) The comparator detect voltage and hysteresis width are indicated as percentages of the THIN pin open voltage, $V_{THIN\_open,}$ (taken to be100%)
$V_{Txx} = V_{Txx'} / V_{THIN\_open}$ ($V_{Txx'}$ Voltage when the external voltage applied to the THIN pin sweeps and the IC internal comparator inverts)

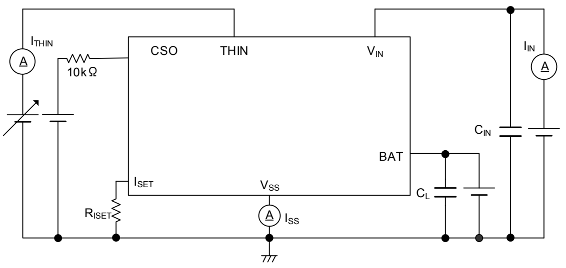
(*3) XC6805xN does not include thermistor temperature monitoring function.

(*4) Applicable only to XC6805x3 and XC6805x4

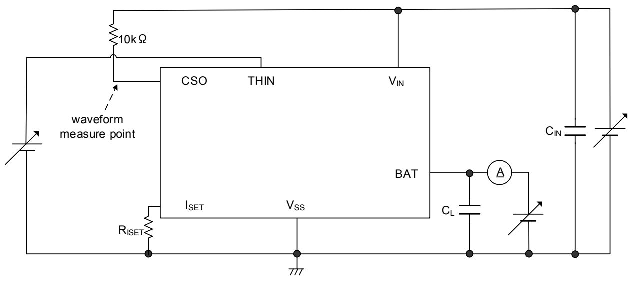
(*5) Applicable only to XC6805x4

■TEST CIRCUITS

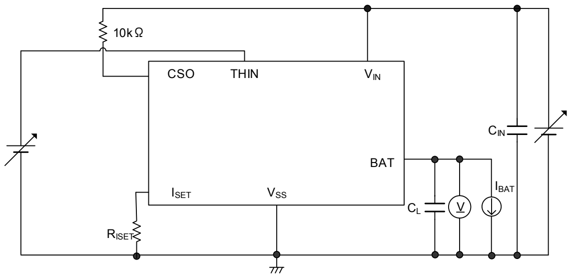
1) Test Circuit ①



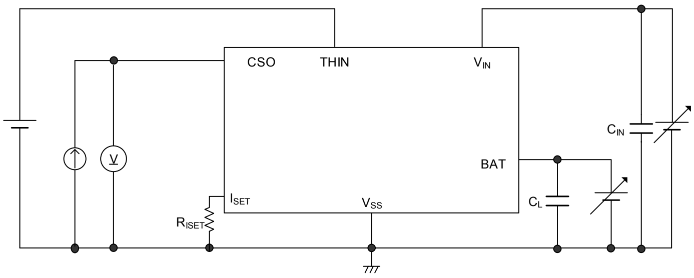
2) Test Circuit ②



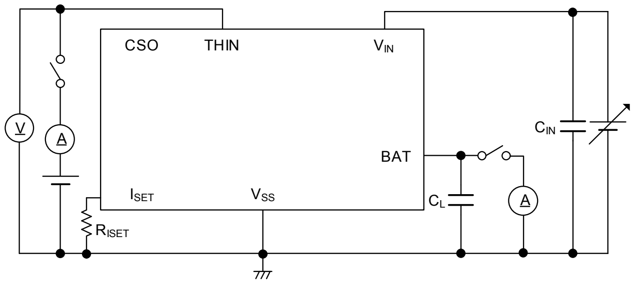
3) Test Circuit ③



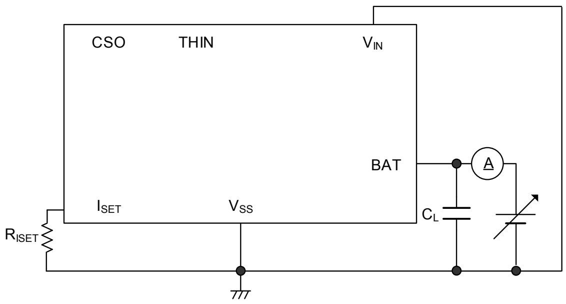
4) Test Circuit ④



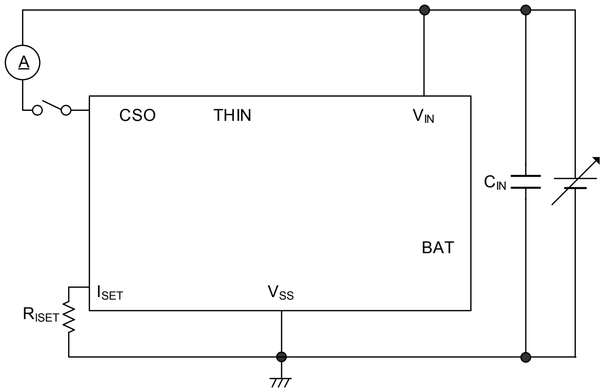
5) Test Circuit ⑤



6) Test Circuit ⑥

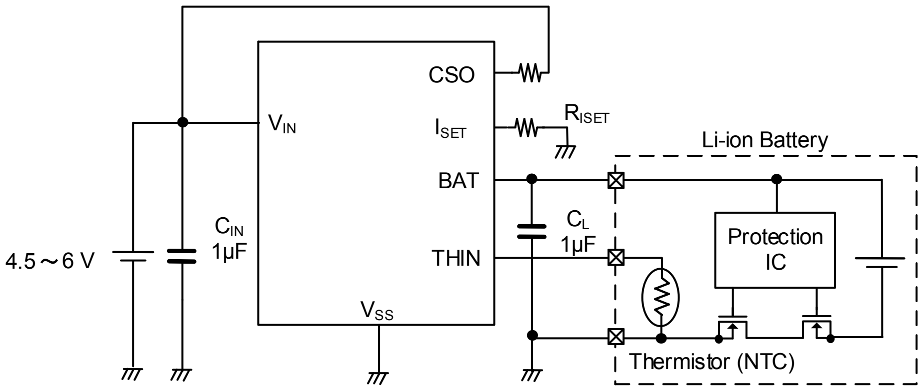


7) Test Circuit ⑦

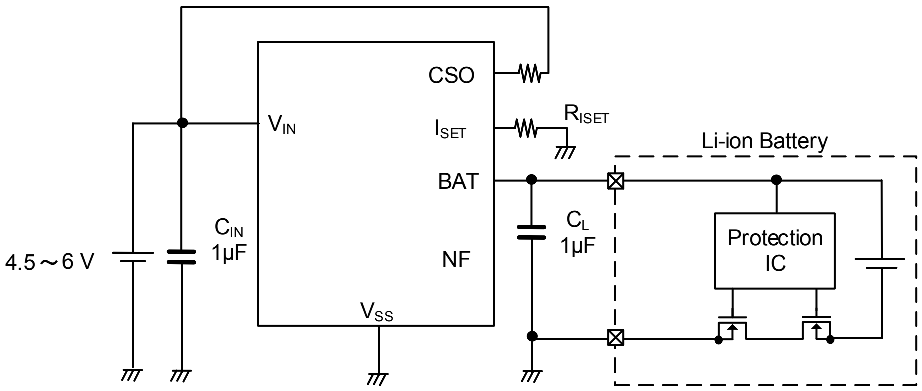


■TYPICAL APPLICATION CIRCUIT

XC6805x2, XC6805x3, XC6805x4



XC6805xN



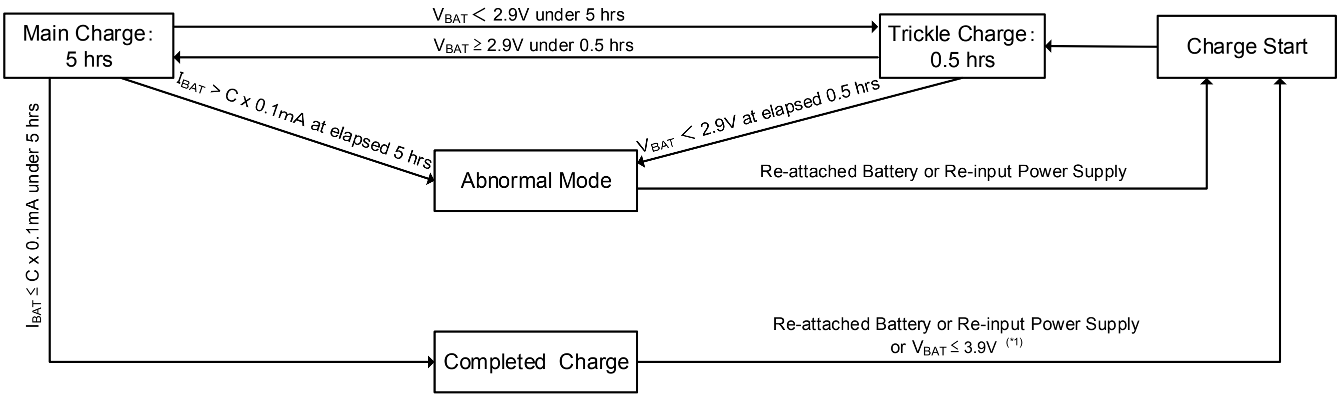
【Recommended Parts】

	MANUFACTURE	PRODUCT NUMBER	VALUE
C_{IN}	TAIYO YUDEN	LMK107BJ105KA	1μF/10V
C_L	TAIYO YUDEN	LMK107BJ105KA	1μF/10V
NTC	Murata	NCP15XH103F03RC	Resistance: 10kΩ @ 25°C B-constant (25 - 50°C): 3380K
R_{ISET}			5.9 ~ 59kΩ

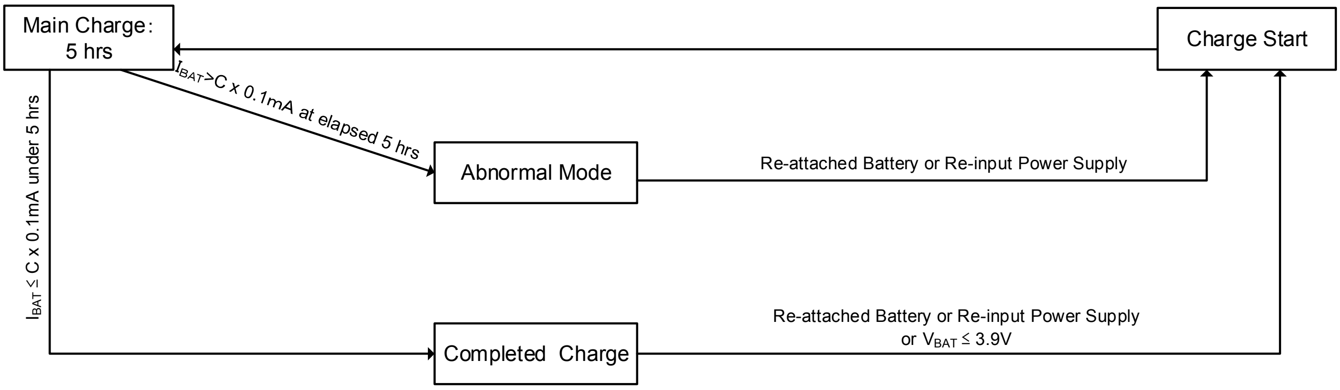
■OPERATIONAL EXPLANATION

<Charge Function>

XC6805xxE



XC6805xxD



●Charging start

When a thermistor is connected to the THIN pin after a voltage is applied to the power input pin (①), or when a voltage is applied to the power input pin after a thermistor is connected to the THIN pin (②), the power on reset function activates and initializes the internal counter. After 200ms elapses in the case of ①, or 150ms in the case of ②, charging starts.

●Trickle charging: Less than 0.5 hour (XC6805xxE only)

Trickle charging determines if main charging of the Li-ion battery is possible. The Li-ion battery is charged at a trickle charge current that is one-tenth the charge current set with the external resistor R_{ISET}. If the BAT pin voltage V_{BAT} is above 2.9V in the charging start state, trickle charging takes place for 1ms and then main charging begins. If V_{BAT} is less than 2.9V, trickle charging takes place, and main charging begins 50ms after 2.9V is detected. If the BAT pin voltage is less than 2.9V after 0.5 hours, the IC changes to the error state and stops charging the Li ion battery. In addition, the error in the trickle charge current increases if V_{BAT} drops below about 1V.

●Main charging: Less than 5 hours

When the condition for transition from trickle charging is satisfied, it is determined that rapid charging of the Li-ion battery is possible and the IC changes to the main charging state. In main charging, the IC charges an Li-ion battery at a CC charge current that is set with the external resistor R_{ISET}. If the BAT pin voltage V_{BAT} rises to the CV charge voltage V_{BAC} within 5 hours, the charge current drops to the charge completed current, and after 50ms elapses, the state changes to charge completed and charging stops.If the charge current is higher than the charge completed current after 5 hours, an error state occurs and charging stops.

●Charging completed

When the charge current reaches the charge completion current, which is one-tenth the charge current set with the external resistor R_{ISET}, and after 50ms elapses, the IC changes to charging completed and stops charging the Li-ion battery. At this time, the charge status output pin changes from ON to OFF. When the BAT pin voltage (V_{BAT}) falls from the charge completion state to the recharge voltage V_{RCHG} or less, charging automatically restarts. When a voltage is reapplied to the power input pin or a Li-ion battery is reconnected to the BAT pin in the charging completed state, the IC starts up and charging begins.

■OPERATIONAL EXPLANATION (Continued)

●Error state

If it is determined that charging is abnormal in any state, the IC treats this as an error state and stops charging. When the power is turned off and then on, or the battery is reinserted, the IC starts up again and chaging starts. An error state occurs if 0.5 hours elapses during trickle charging, if 5 hours elapses during main charging, or if thermal shutdown, charging overvoltage, or charging overcurrent is detected.

●Charging status output pin (CSO)

The charge status output pin turns ON by Nch open drain output during trickle charging and main charging, and turns OFF after charging is completed. If an abnormal condition is detected, the charge status output pin repeats ON-OFF at 1kHz on the XC6805A, and turns off on the XC6805B.

●Charge current

The set charge current of the IC, I_{CHG}, can be set within the range 5mA to 40mA by an external resistance (R_{ISET}).
The R_{ISET} and I_{CHG} are approximated by the following equation.

$$R_{ISET}\ (k\Omega)=351 \times I_{CHG}^{\,-1.11}\ (mA)$$

●IC temperature monitoring function

In order to prevent destruction due to IC heat generation as well as abnormal charging due to thermal runaway, a thermal shutdown circuit is incorporated into the IC. If the chip temperature rises to 140°C or higher and after 50ms elapses, the output driver is turned off and charging is stopped. At this time, the charge status output pin repeats ON-OFF at 1kHz on the XC6805A, and turns off on the XC6805B. When voltage is reapplied to the power input pin or the Li-ion battery is reconnected to the BAT pin, the IC starts and charging begins.

●Dropout voltage monitoring function

To prevent reverse current from the Li-ion battery to the battery charger, this function monitors the dropout voltage between the BAT pin voltage (V_{BAT}) and power input pin voltage (V_{IN}). When the V_{IN} falls to V_{BAT} +40mV, the function turns off the output driver and switches the backgating connection of the driver from the power pin to the BAT pin. When V_{IN} rises higher than V_{BAT}+0.1V, this function is released, the output driver turns ON, and the driver backgate connects to the power pin and charging resumes. In addition, this function continues the t_{CHG} count even when charging is stopped, and the charge status output pin maintains the ON state. After charging is completed, the charge status output pin remains off even if the function activates due to the input power being removed or otherwise.

●UVLO function

A UVLO function is incorporated. If the power input pin falls to 3.8V or lower during charging, this function turns off the output driver and stops charging. In addition, charge status output pin changes to OFF. When the power input pin rises to 4V or higher, the IC starts up and charging begins. This function also detects voltage application to the power input pin.

●Charge over-voltage monitoring function

This function stops charging to prevent charging the over-voltage battery if the BAT pin voltage is 4.45V or higher and after 50ms elapses. At this time, the charge status output pin repeats ON-OFF at 1kHz on the XC6805A, and turns off on the XC6805B. When voltage is reapplied to the power input pin or the Li ion battery is reconnected to the BAT pin, the IC starts and charging begins. (*1)

●Charge over-current monitoring function

To prevent charging of a battery by excessive current, this function stops charging if the charge current rises to 110mA or higher and after 50ms elapses. At this time, the charge status output pin repeats ON-OFF at 1kHz on the XC6805A, and turns off on the XC6805B.
When voltage is reapplied to the power input pin or the Li ion battery is reconnected to the BAT pin, the IC starts up and charging begins. (*1)

●Recharge function

With the completion of charging, when the NTC thermistor temperature is 0°C or higher and less than 45°C, and the BAT pin voltage (V_{BAT}) falls to 3.9V or less, charging resumes. (charging is resumed 150ms after the charge start state is entered).

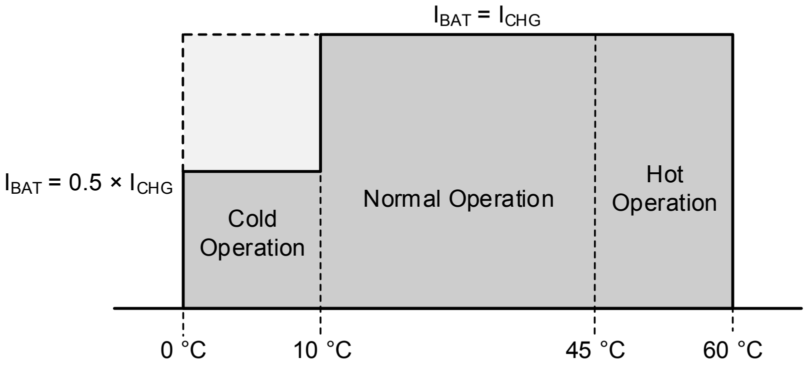
On the XC6805xx4, if the NTC thermistor temperature is 0°C or higher, less than 45°C and BAT pin voltage(V_{BAT}) drops less than 3.9V, charging automatically resumes. If the NTC thermistor temperature is 45°C or higher and less than 60°C, charging automatically resumes when the voltage falls to 3.75V or less.

(*1) Insertion and removal of the battery is detected by thermistor connection (THIN pin voltage). For this reason, restarting of the IC is not possible by battery reinsertion on the XC6805xN, as the THIN voltage is fixed to the internal IC. When voltage is reapplied to the power input pin, the IC starts up and charging begins.

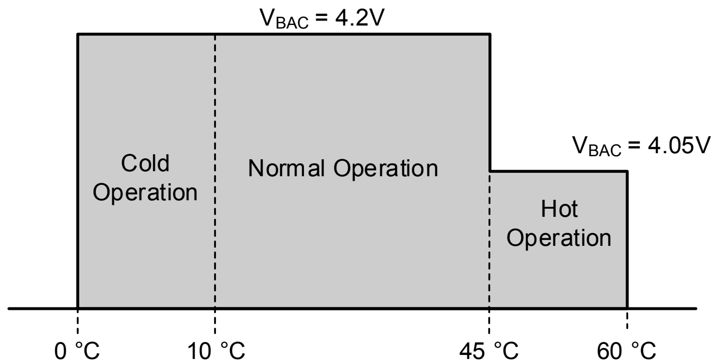
■OPERATIONAL EXPLANATION (Continued)

●Li-ion battery temperature monitoring function (*1)

The IC monitors the Li-ion battery temperature during charging by means of an NTC thermistor ("thermistor" below) connected to the THIN pin. The charge voltage V_{BAC} and the charge current I_{BAT} are controlled based on the Li-ion battery temperature as shown below to enable safe charging. The charge state changes after the Li ion battery temperature reaches each of the change points and after 50ms elapses.



Charge Current vs. Thermistor Temperature



Charge Voltage vs. Thermistor Temperature

●XC6805x4 (4 temperatures monitoring)

Cold Operation

When 0°C < NTC Temperature ≤ 10°C , the CC charge current is limited to I_{CHG} × 0.5. (*2)

When NTC Temperature ≤ 0°C, charging stops. (*3)

Normal Operation

When 10°C < NTC Temperature < 45°C, charging takes place with the charge current I_{CHG} and the charge voltage at 4.2V. (*2)

Hot Operation

When 45°C ≤ NTC Temperature < 60°C, the charge voltage changes to 4.05V and charging continues. (*2)

When 60°C ≤ Thermistor Temperature, charging stops. (*3)

●XC6805x3 (3 temperatures monitoring)

Comparing to the XC6805x4, the XC6805x3 does not monitor at 60°C and charging stops at 45°C ≤ Thermistor Temperature. (*2)

●XC6805x2 (2 temperatures monitoring)

In contrast to the XC6805x4, the XC6805x2 does not have 10°C and 60°C monitoring, and stops charging when Thermistor Temperature ≤0°C and when Thermistor Temperature ≥ 45°C. (*3)

In addition, when 0°C< Thermistor Temperature ≤ 10°C, the charge current does not change from I_{CHG}.(*2)

(*1) On the XC6805xN, battery temperature protection function in not built in.

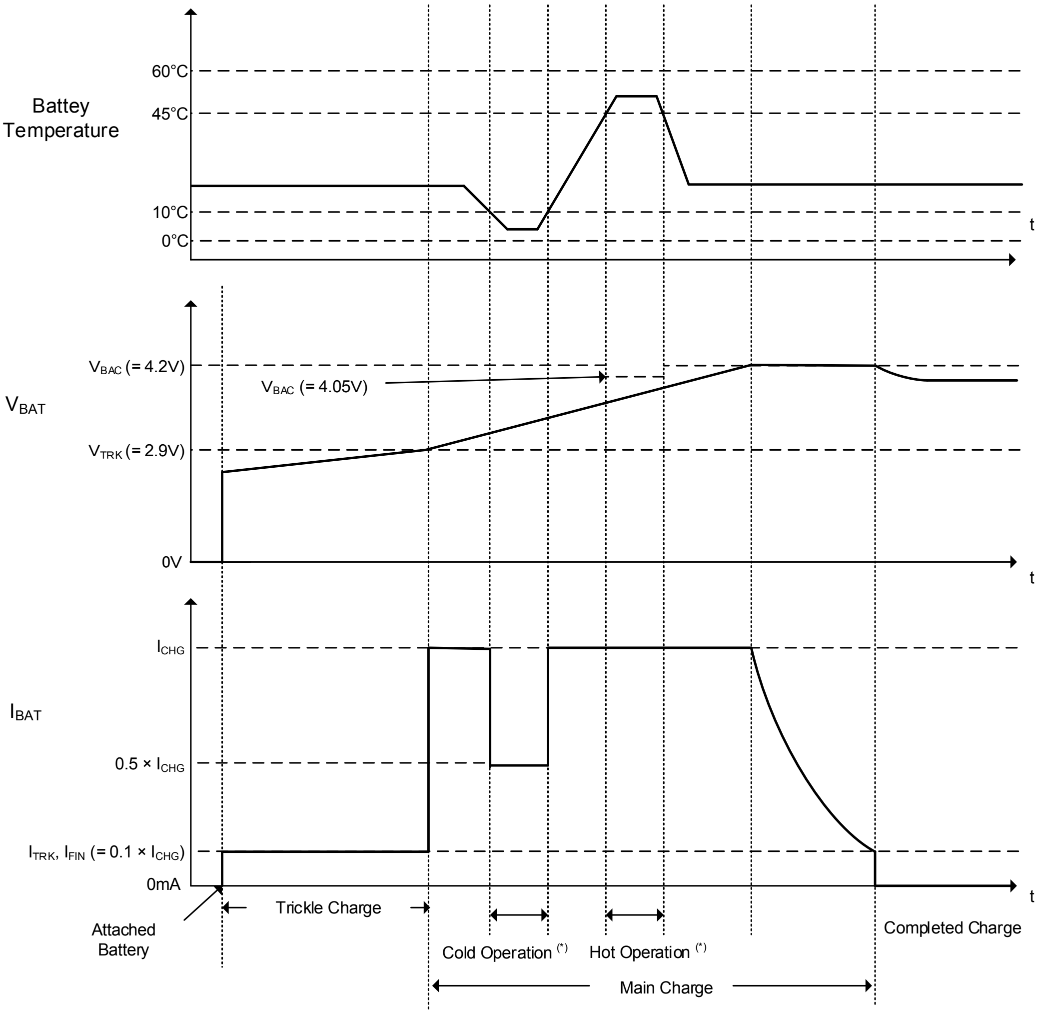
(*2) During trickle charging, the charge current is limited to I_{CHG}× 0.1.

(*3) Even when charging is stopped, t_{TRK} count and t_{CHG} count are continued and the charge status output pin maintains the ON state.

The NTC temperature detection of this IC conforms to the characteristics of the NCP15XH103F03RC of Murata Manufacturing Co., Ltd.

■OPERATIONAL EXPLANATION (Continued)

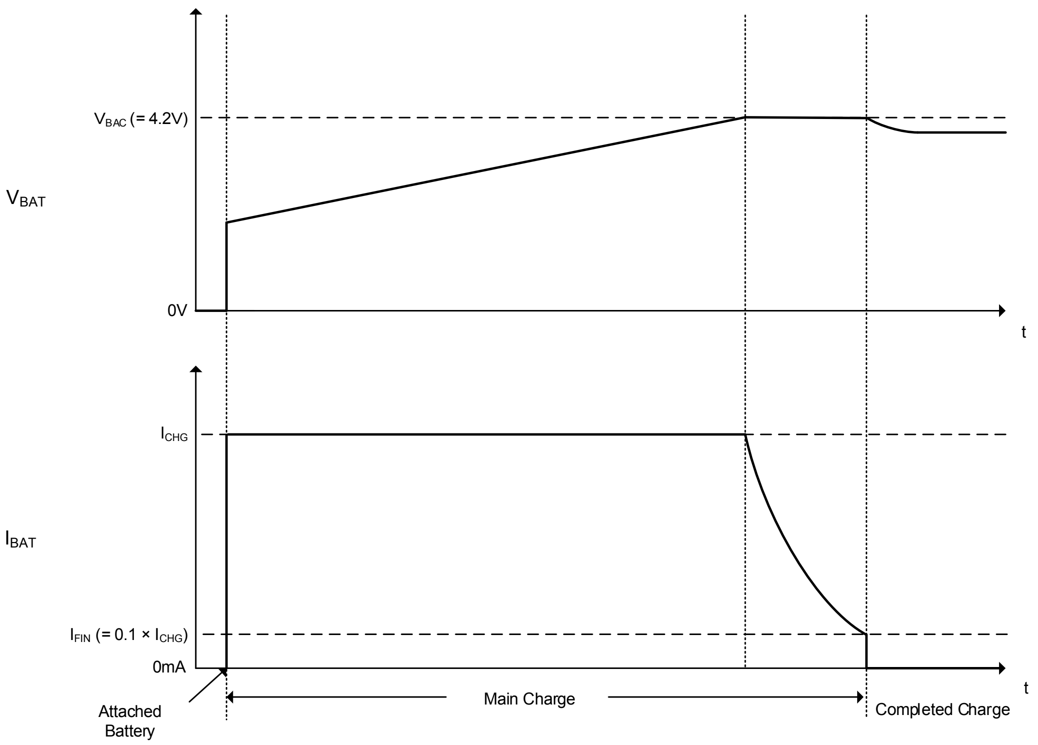
Timing chart example
XC6805x4



(*1) With regard to the details of Cold operation and Hot Operation, please see "Li-ion battery temperature monitoring function" in the Operational Explanation.

■OPERATIONAL EXPLANATION (Continued)

Timing chart example
XC6805xND



■NOTES ON USE

1. For temporary, transitional voltage drop or voltage rising phenomenon, the IC is liable to malfunction should the ratings be exceeded.

2. Where wiring impedance is high, operations may become unstable. Please strengthen VIN and VSS wiring in particular.

3. Please mount the C_{IN}, C_L and charge current setting resistor as close to the IC as possible.

4. Do not connect anything other than a resistance for setting the charge current to the I_{SET} pin.

5. Torex places an importance on improving our products and their reliability.
   We request that users incorporate fail-safe designs and post-aging protection treatment when using Torex products in their systems.

6. This IC uses an external thermistor to detect and control temperature with high accuracy.
   Please sufficiently test the position of the external thermistor to ensure that it enables accurate temperature detection.

7. Reversing the polarity of the battery may cause destruction and is extremely dangerous. Never reverse the polarity of the battery.

8. Short-circuiting to neighboring pins may cause malfunctioning and destruction. Exercise sufficient caution when mounting and using the IC.

9. If a large ripple voltage occurs at the V_{IN} pin, the IC may malfunction. Please test thoroughly.

10. Taking the temperature characteristics and the dispersion into consideration, please set the charge current not to exceed the range of 5mA to 40mA.

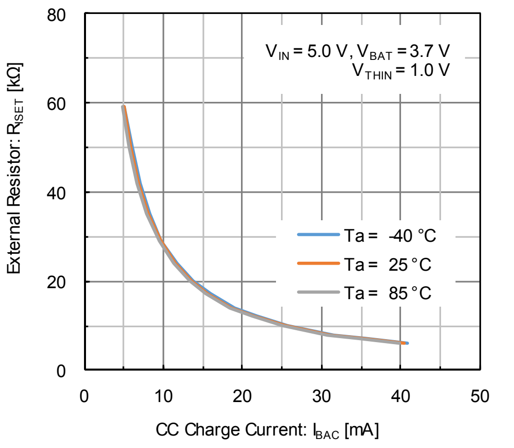
11. If the I_{SET} pin is shorted to the GND, there is a possibility that the IC is destroyed before the over-current monitor function is activated.

12. When V_{BAT} is 1 V or less, the error range of the trickle charge current becomes big. When V_{IN} – V_{BAT} voltage is high in particular, please pay attention when using as there are possibilities that a large trickle current flows.

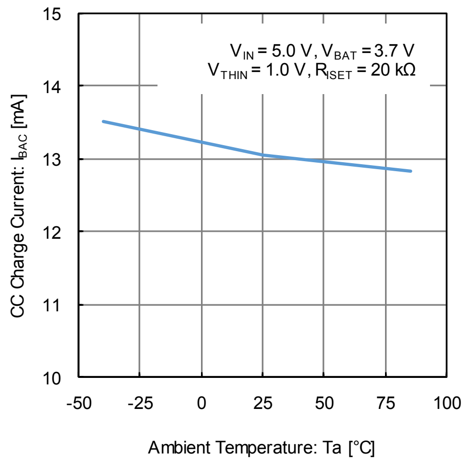
13. On the XC6805xN, please be sure to use the NF pin (pin #5) in the open state.

■TYPICAL PERFORMANCE CHARACTERISTICS

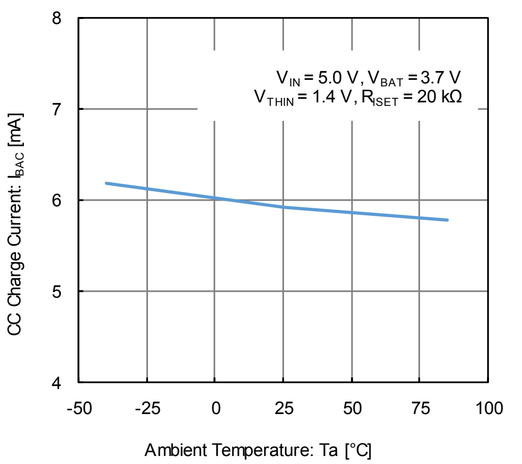
(1) CC Charge Current vs. External Resistor (Normal Operation)



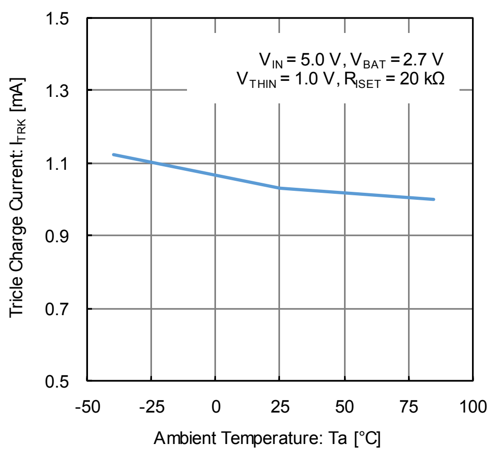
(2) CC Charge Current vs. Ambient Temperature (Normal Operation)



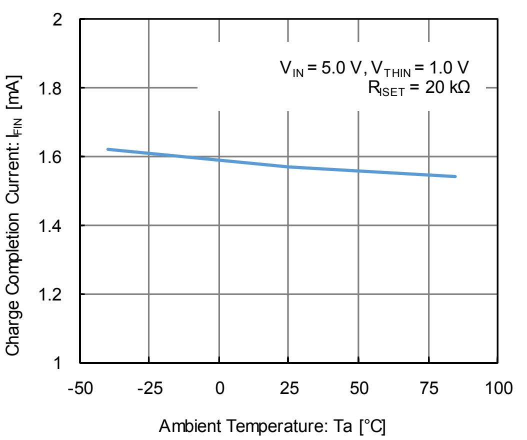
(3) CC Charge Current vs. Ambient Temperature (Cold Operation)



(4) Tricle Charge Current vs. Ambient Temperature

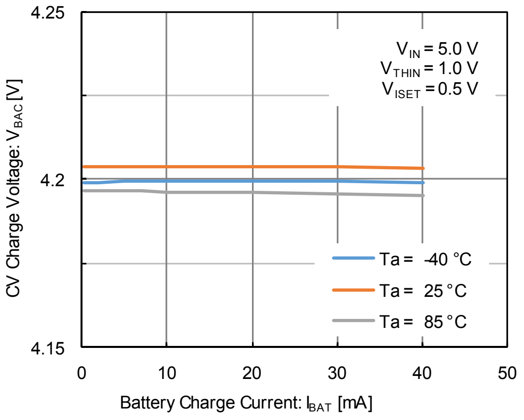


(5) Charge Completion Current vs. Ambient Temperature

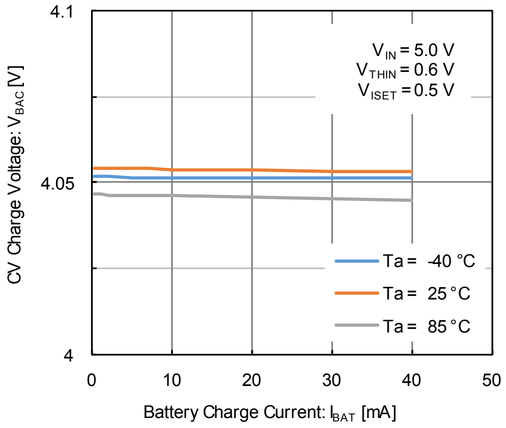


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

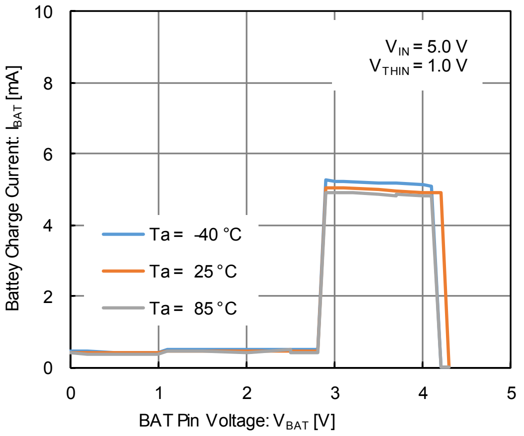
(6) CV Charge Voltage vs. Charge Current (Normal Operation)



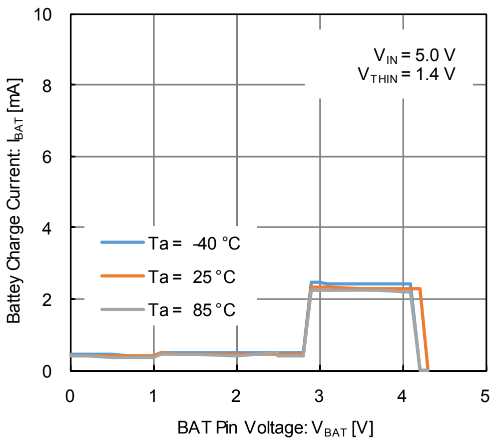
(7) CV Charge Voltage vs. Charge Current (Hot Operation)



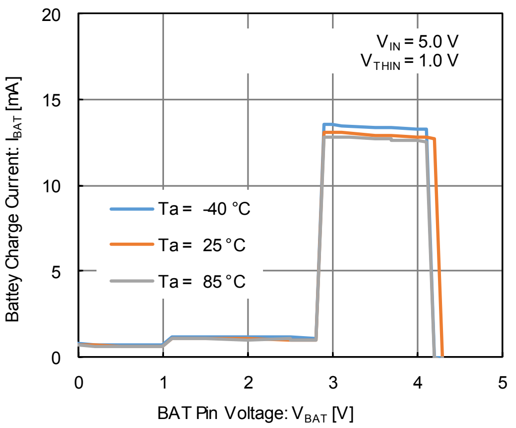
(8) Battey Charge Current vs. BAT Pin Voltage
(R_{ISET} = 59 kΩ, Normal Operation)



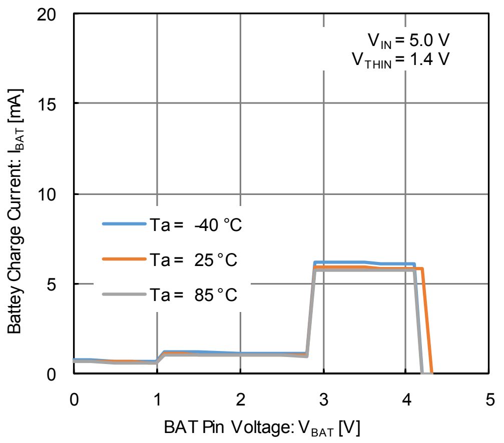
(9) Battey Charge Current vs. BAT Pin Voltage
(R_{ISET} = 59 kΩ, Cold Operation)



(10) Battey Charge Current vs. BAT Pin Voltage
(R_{ISET} = 20 kΩ, Normal Operation)

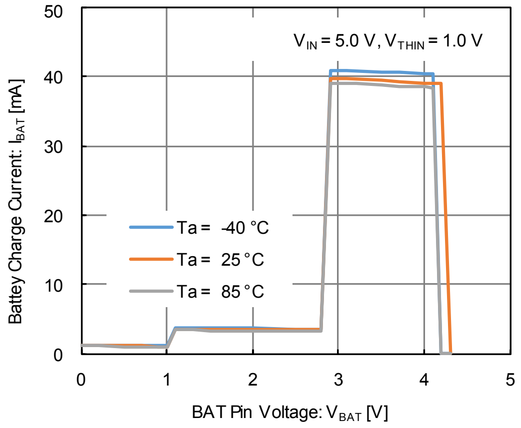


(11) Battey Charge Current vs. BAT Pin Voltage
(R_{ISET} = 20 kΩ, Cold Operation)

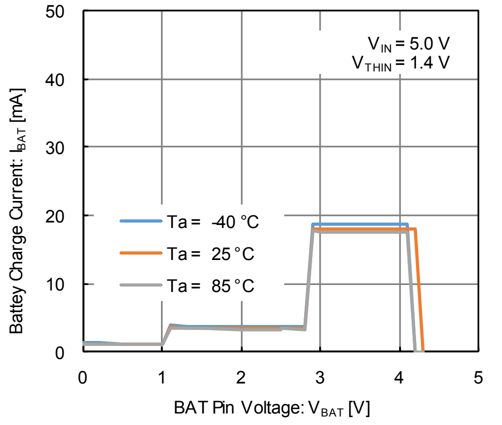


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

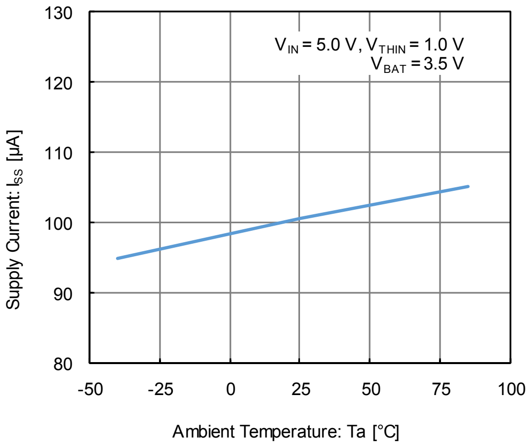
(12) Battey Charge Current vs. BAT Pin Voltage
(R_{ISET} = 5.9 kΩ, Normal Operation)



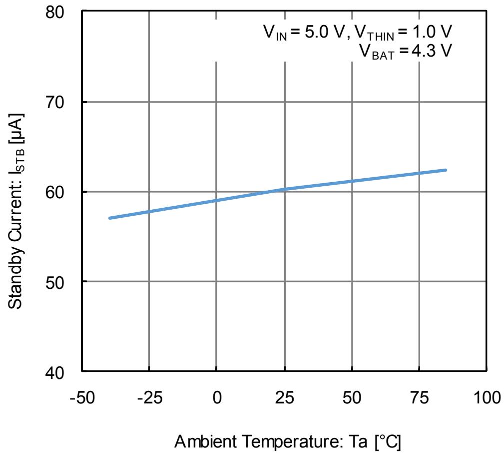
(13) Battey Charge Current vs. BAT Pin Voltage
(R_{ISET} = 5.9 kΩ, Cold Operation)



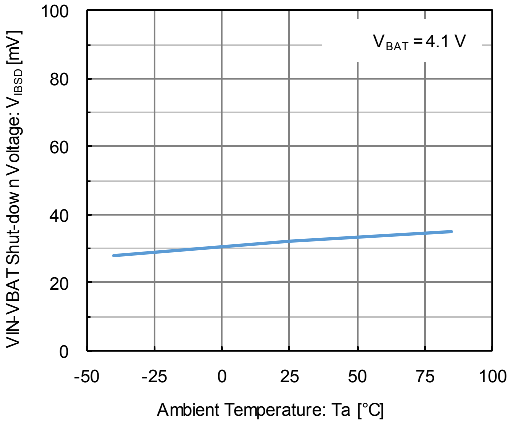
(14) Supply Current vs. Ambient Temperature



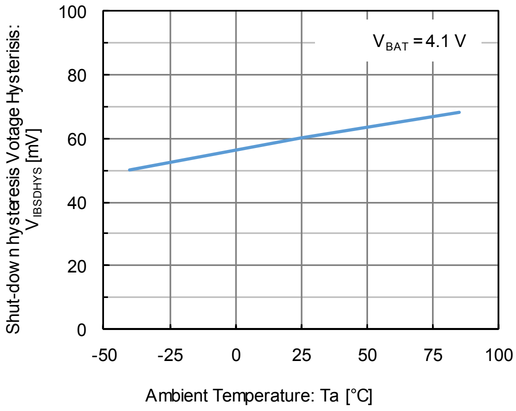
(15) Standby Current vs. Ambient Temperature



(16) VIN - VBAT Shut-down Voltage vs. Ambient Temperature

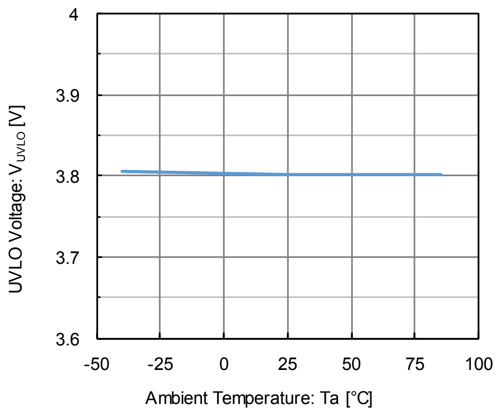


(17) Shut-down Hysteresis Voltage vs. Ambient Temperature

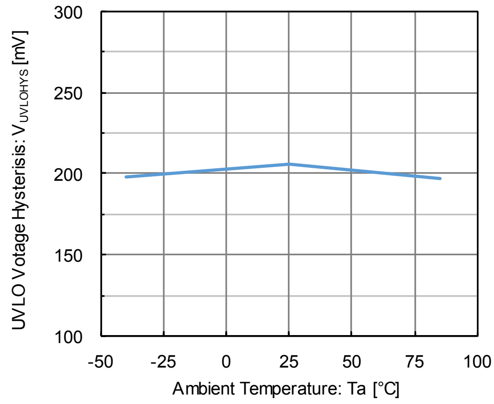


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

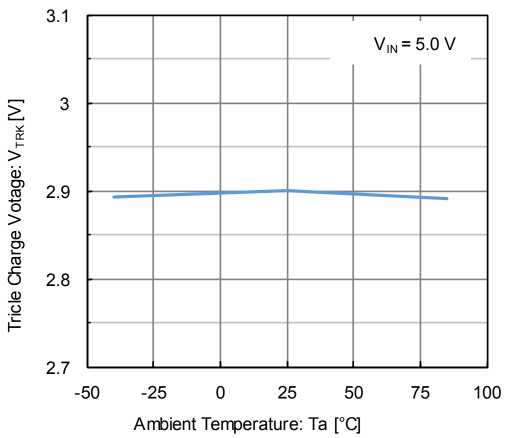
(18) UVLO Voltage vs. Ambient Temperature



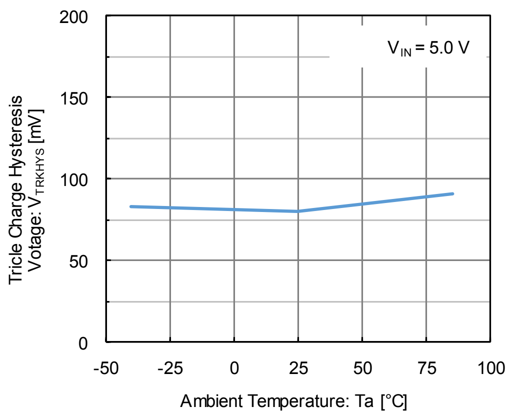
(19) UVLO Hysteresis Voltage vs. Ambient Temperature



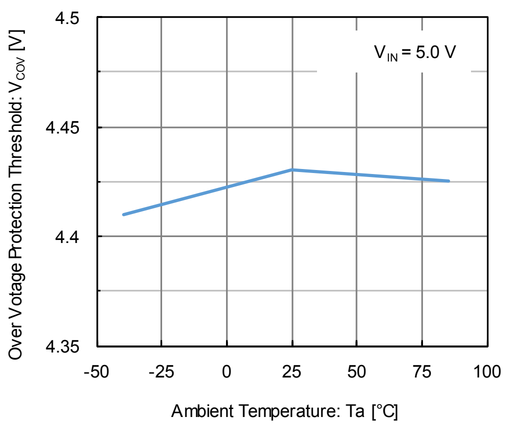
(20) Tricle Charge Voltage vs. Ambient Temperature



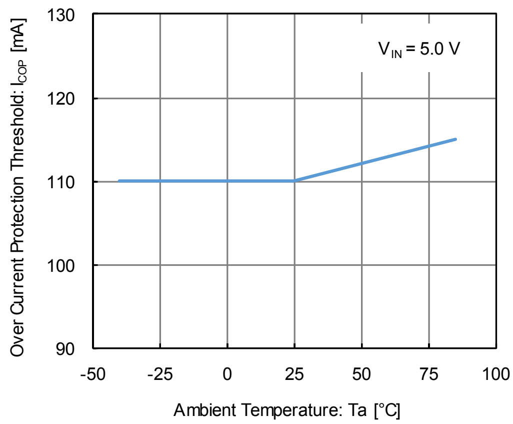
(21) Tricle Charge Hysteresis Voltage vs. Ambient Temperature



(22) Over Voltage Protection Threshold vs. Ambient Temperature

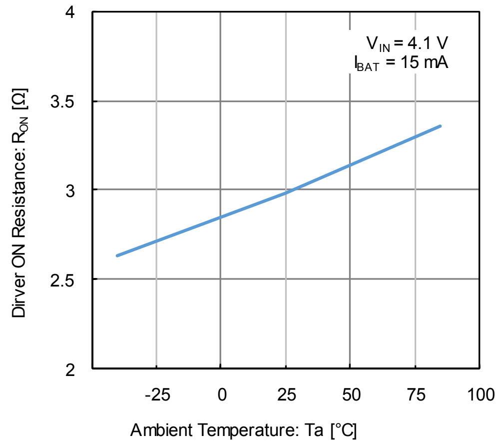


(23) Over Current Protection Threshold vs. Ambient Temperature

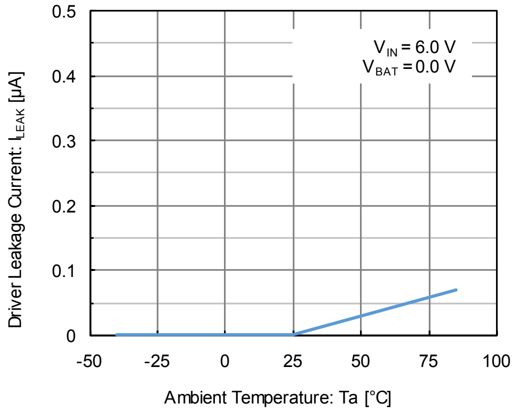


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

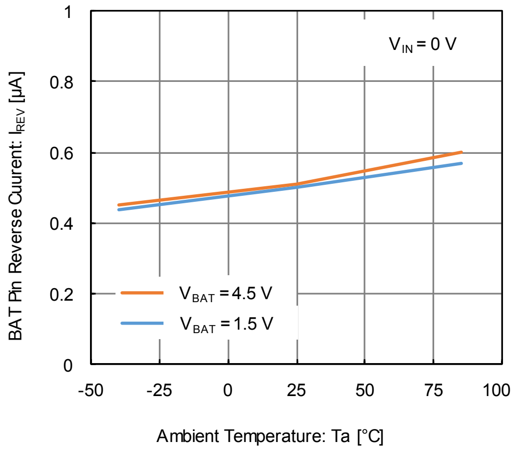
(24) Driver ON Resistance vs. Ambient Temperature



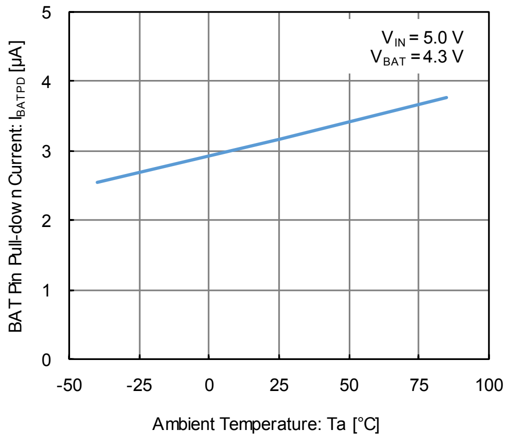
(25) Driver Leakage Current vs. Ambient Temperature



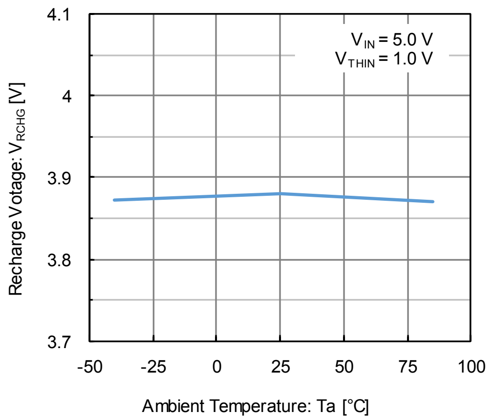
(26) BAT Pin Reverse Cuurent vs. Ambient Temperature



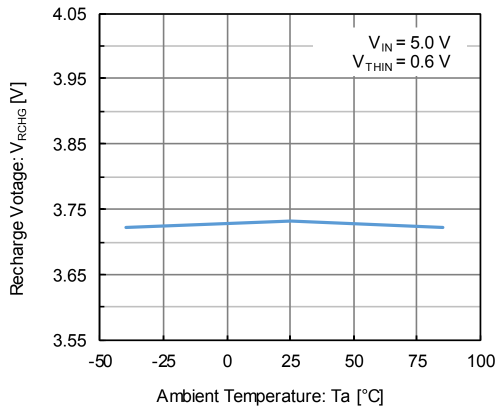
(27) BAT Pin Pull-down Current vs. Ambient Temperature



(28) Recharge Voltage vs. Ambient Temperature (Normal Operation)

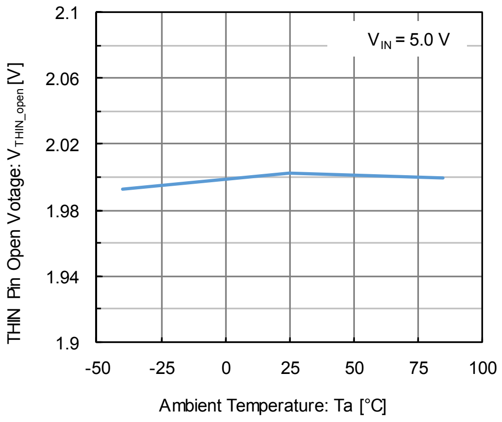


(29) Recharge Voltage vs. Ambient Temperature (Hot Operation)

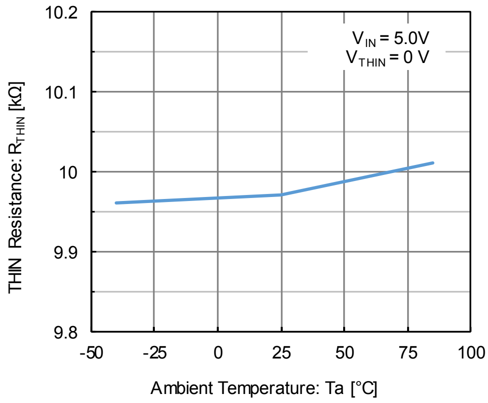


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

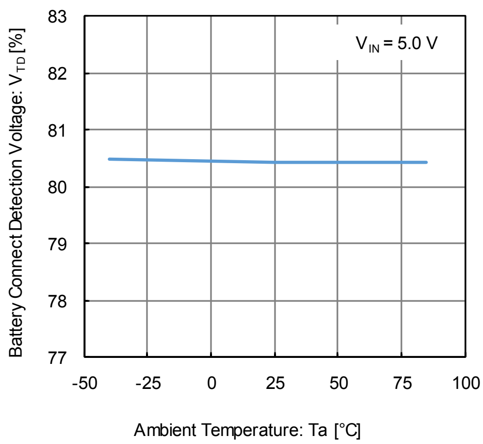
(30) THIN Pin Open Voltage vs. Ambient Temperature



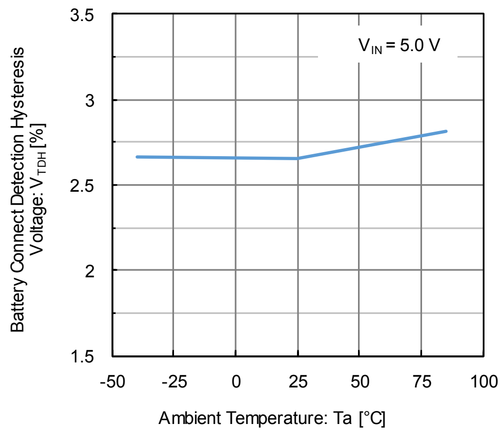
(31) THIN Pin Connected Resistance vs. Ambient Temperature



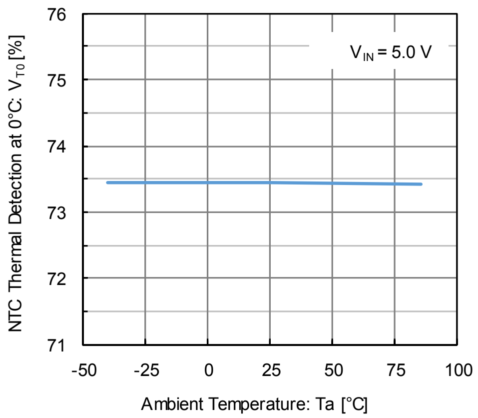
(32) Battery Connect Detection Voltage vs. Ambient Temperature



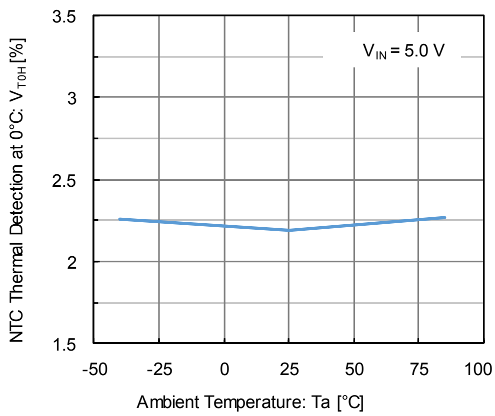
(33) Battery Connect Detection Hysteresis Voltage vs. Ambient Temperature



(34) Thermistor Detection at 0°C vs. Ambient Temperature

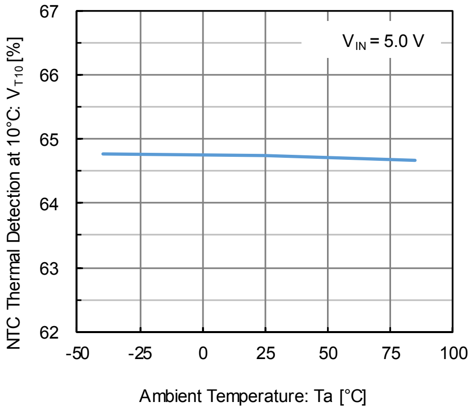


(35) Thermistor Detection Hysteresis at 0°C vs. Ambient Temperature

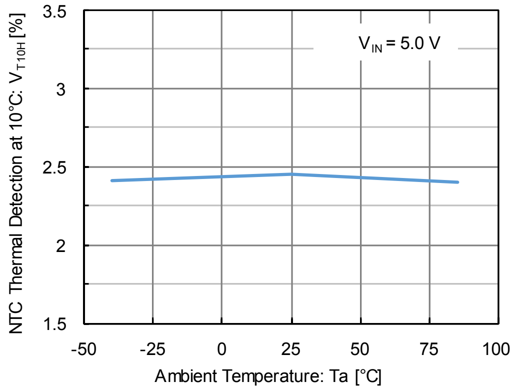


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

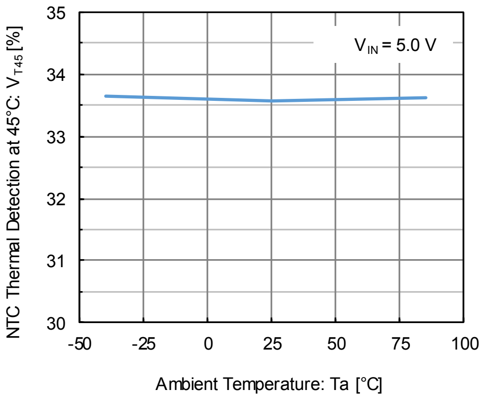
(36) Thermistor Detection at 10°C vs. Ambient Temperature



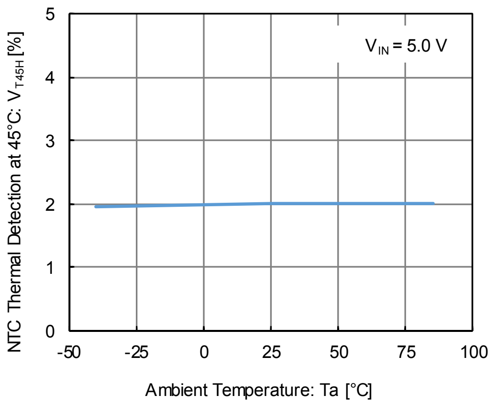
(37) Thermistor Detection Hysteresis at 10°C vs. Ambient Temperature



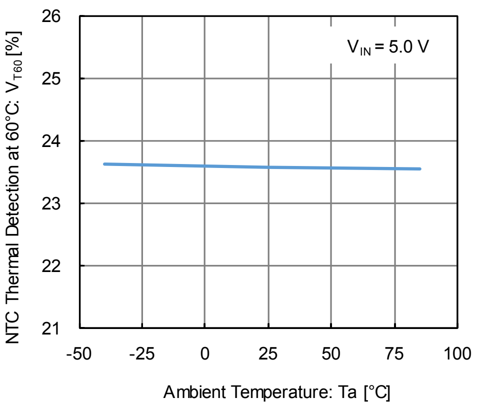
(38) Thermistor Detection at 45°C vs. Ambient Temperature



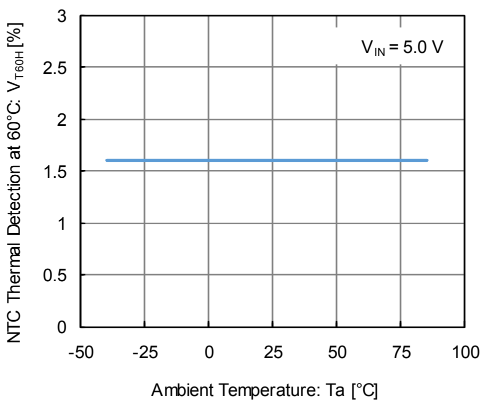
(39) Thermistor Detection Hysteresis at 45°C vs. Ambient Temperature



(40) Thermistor Detection at 60°C vs. Ambient Temperature

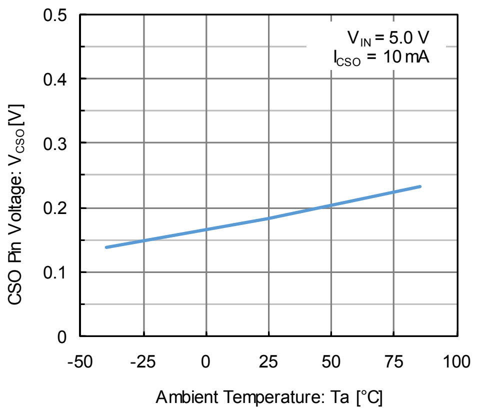


(41) Thermistor Detection Hysteresis at 60°C vs. Ambient Temperature

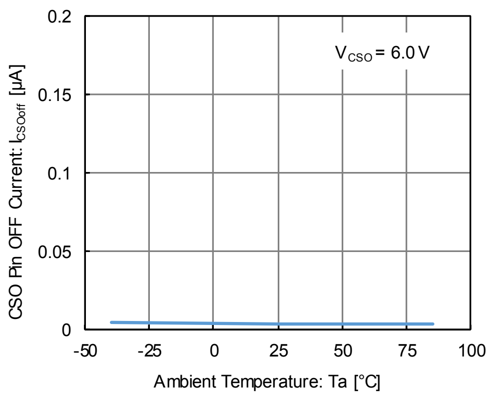


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

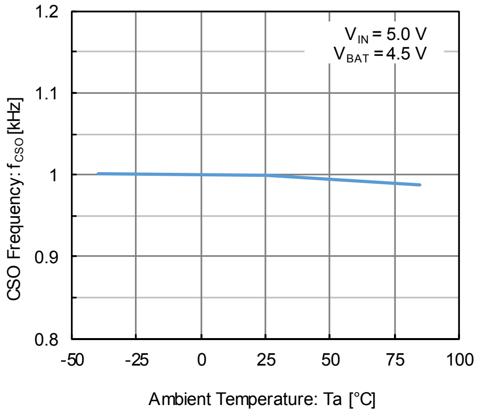
(42) CSO Pin ON Voltage vs. Ambient Temperature



(43) CSO Pin OFF Current vs. Ambient Temperature

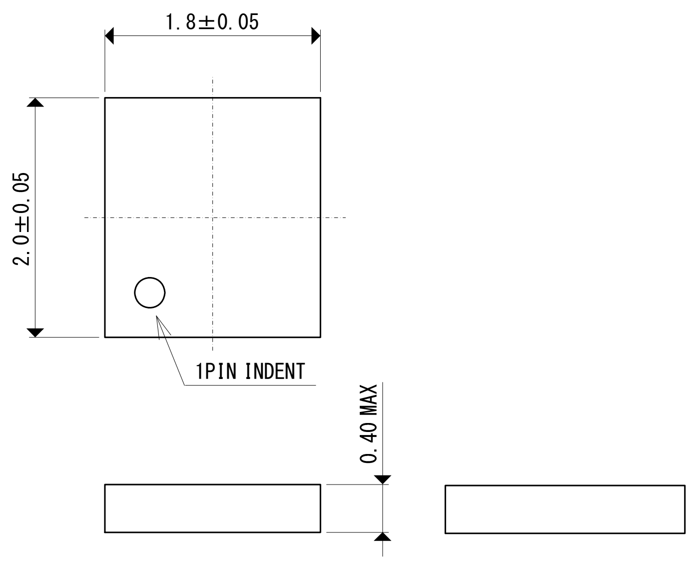


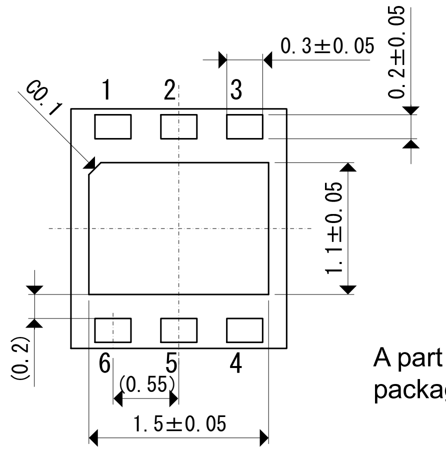
(44) CSO Frequency vs. Ambient Temperature



■PACKAGING INFORMATION

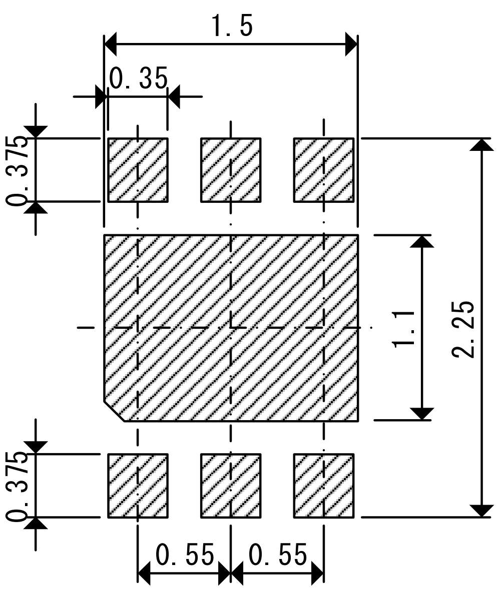
● USP-6EL (unit: mm)



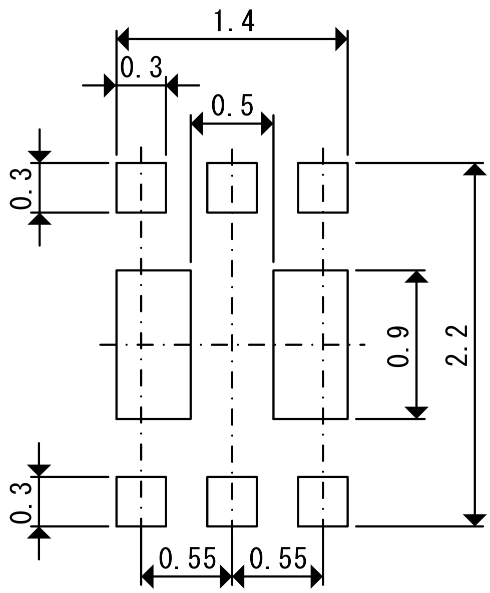


A part of the pin may appear from the side of the package because of its structure.

● USP-6EL Reference pattern layout

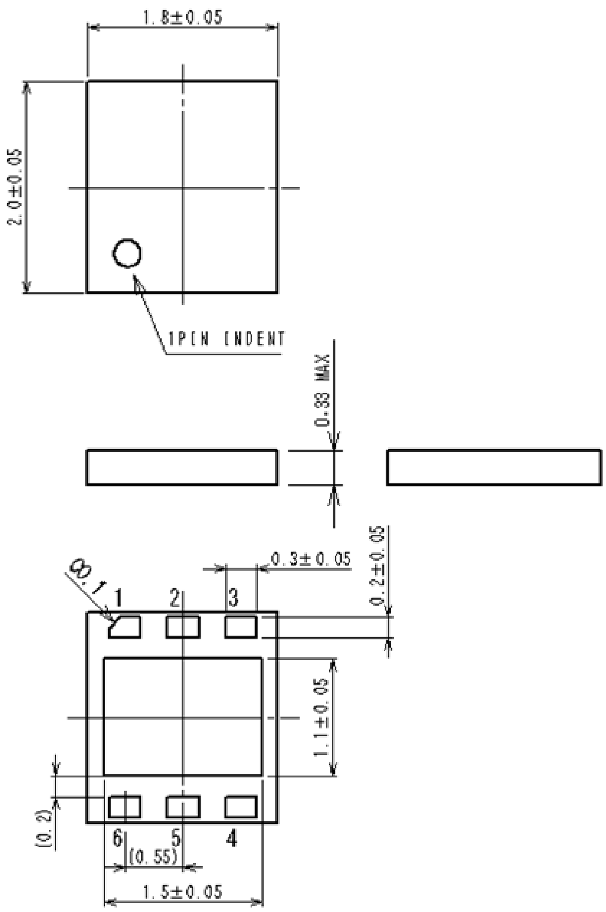


● USP-6EL Reference metal mask design

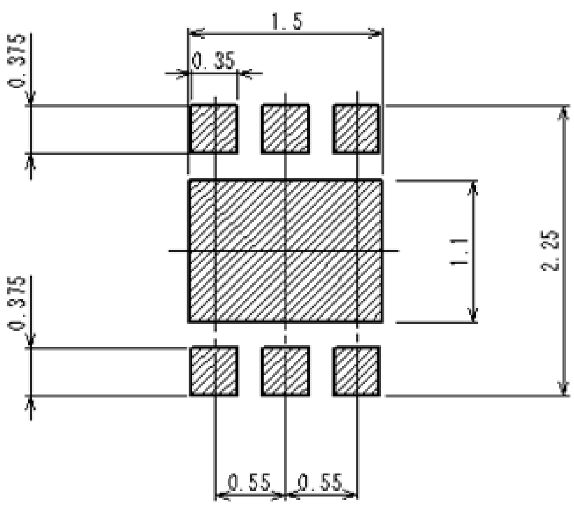


■PACKAGING INFORMATION (Continued)

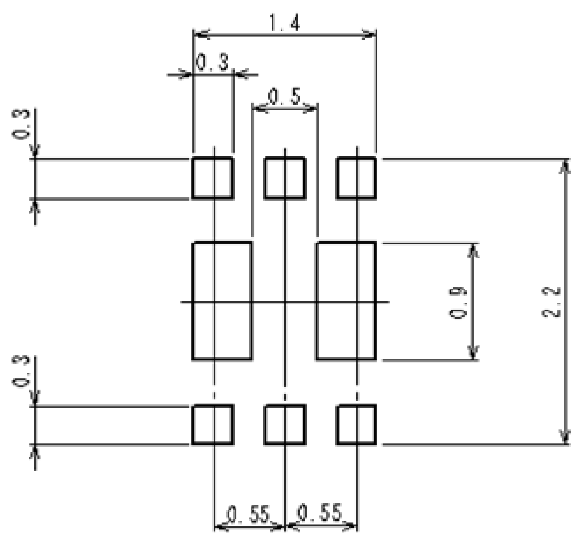
●USP-6B07 (unit: mm)



● USP-6B07 Reference pattern layout



● USP-6B07 Reference metal mask design

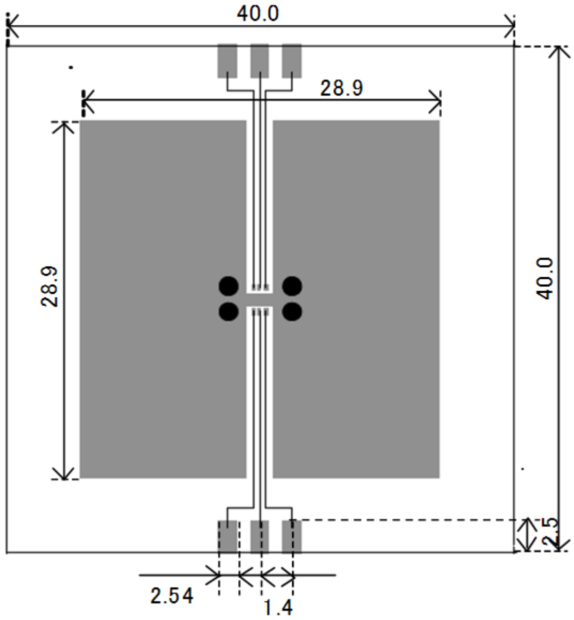


● USP-6EL (DAF), USP-6B07(DAF) Power Dissipation

Power dissipation data for the USP-6EL(DAF),USP-6B07(DAF) is shown in this page.
The value of power dissipation varies with the mount board conditions.
Please use this data as one of reference data taken in the described condition.

1. Measurement Condition (Reference data)

Condition: Mount on a board
Ambient: Natural convection
Soldering: Lead (Pb) free
Board: Dimensions 40 x 40 mm (1600 mm^2 in one side)
Copper (Cu) traces occupy 50% of the board area
in top and back faces
Package heat-sink is tied to the copper traces
Material: Glass Epoxy (FR-4)
Thickness: 1.6 mm
Through-hole: 4 x 0.8 mm Diameter



Evaluation board layout (Unit: mm)

2. Power Dissipation vs. Ambient temperature

Board Mount (Tj max=125℃)

Ambient Temperature (℃)	Power Dissipation Pd (mW)	Thermal Resistance (℃/W)
25	750	133.33
85	300