



## SPECIFICATION APPROVAL

APPROVAL NO.

CUSTOMER NAME : FIC

CUSTOMER P/N. :

WELLDONE P/N. : E4FI011202A12

GTA01 / GTC01 BATTERY PACK  
(MAXELL ICP653450AR 1200 mAH)

ISSUE DATE:12,SEP.,2006

CUSTOMER SIGNATURE	WELLDONE SIGNATURE



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## Pack Information



# 統振股份有限公司 WELLDONE COMPANY

**Scope : This specification shall applied to rechargeable Lithium ion Battery pack to be delivered to FIC Incorporated.**

**NAME : Rechargeable Lithium ion battery pack**

**Product Number : GTA01 / GTC01 Battery Pack(E4FI011202A12)**

## **Characteristics and performance:**

ITEM	CONDITION	STANDARD
1. Cell type	MAXELL ICP653450AR 1200mAH	MAXELL ICP653450AR 1200mAH
2. Capacity	When discharged at 240mA to 2.75V after standart charge at 25°C	Minimum 1200mAh
3. Standard charge current	4.2V±0.05V, 600mA, 25°C Constant Current with Constant Voltage.	600mA ( 0.5C )
4. Quick charging current	4.2V±0.05V, 1200mA, 25°C Current with Constant Voltage.	1200mA
5. Standard Discharge current	Constant current, 2.75V end.	240mA
6. Maximum Discharge current	Constant current, 2.75V end.	1800mA
7. Nominal voltage	Within one hour after quick charging.	3.70V
8. Discharge cut-off voltage	Discharge end voltage.	2.75V
9. Charge Method	CC-CV (Constant Current with Constant Voltage)	CC-CV
10. Cycle life	After 500 cycles of complete charge at 600mA(0.5C) & discharge at 240mA(0.2C) until the Voltage reaches 2.75V and measured for the duration time. (at 25°C)	After 500 cycles, (Capacity >= 840 mAh)



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## WELLDONE COMPANY

11. Environmental using conditions	CHARGE	0~+45 °C	52~78% RH
	DISCHARGE	-20~+60 °C	52~78% RH
	STORAGE TEMP	-20~+45 °C	52~78% RH

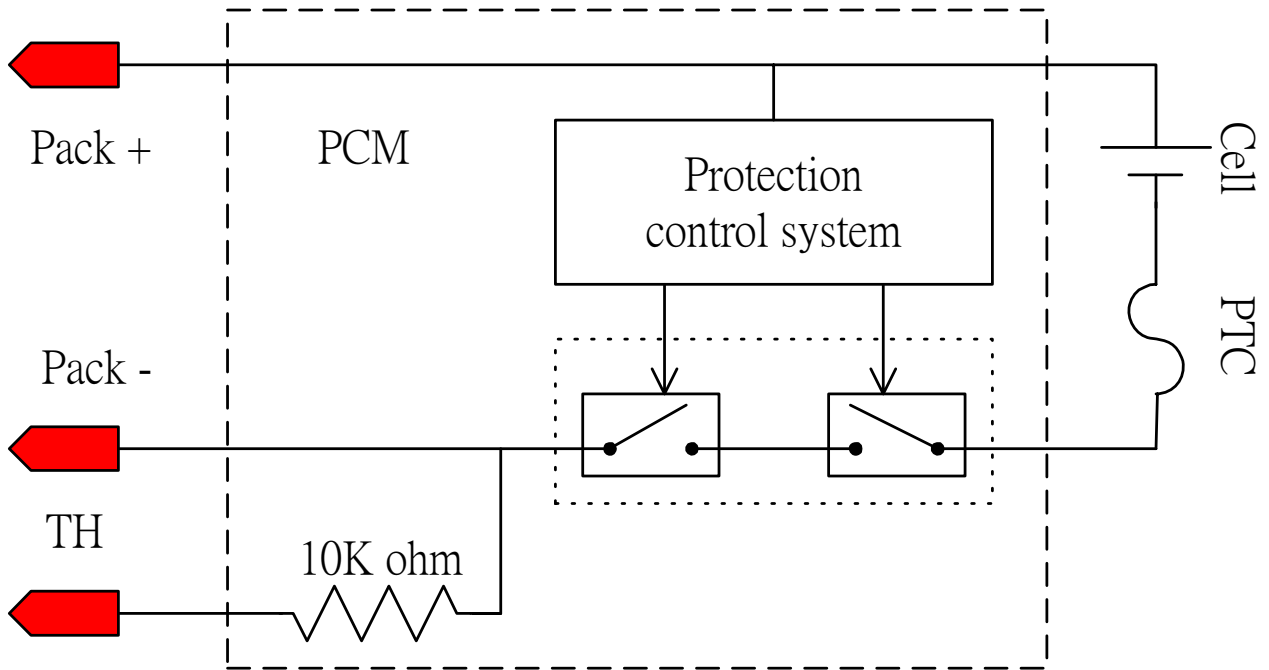
### PCM Part function :

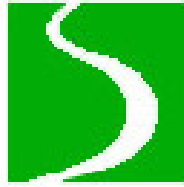
1. Overcharge voltage protection	1.Charge voltage is set at 4.5V by power supply. 2.Charge current is set at 1400mA by power supply.	*.Protection trigger value is 4.280±0.025V *.No smoke. *.No damage. *.No leakage.
2. Overdischarge voltage protection	Discharge in pack positive and Negative terminals by DC Electronic load.	*.Protection trigger value is 2.30±0.058V. *.No smoke. *.No damage. *.No leakage.
3. Pack short protection	To short " Pack+ " terminal and " GND " terminal.	*.No damage after short circuit was removed. *.No smoke. *.No damage. *.No leakage.
4.Over current protection	After fully rated charging Connect DC electric load Between positive and negative terminals and increase current.	*.protection trigger value is 2 ~ 4.5 A *.No smoke. *.No damage. *.No leakage.
5. Pack internal Resistor	Measured between " Pack+ " terminal and " GND " terminal with 1KHz.	Less than 150 mΩ
7. TH	Measured between "TH" terminal and "GND" terminal.	10KΩ ± 5%
8. Cell short protection	Battery cell Short protection component	RAYCHEM : VLR-170F
9. ESD Test	*.Air discharge the pack external connector 3 times with +/- 15 KV. *.Contact discharge the pack external connector 3 times with +/- 8 KV.	*.Electronic function normally. *.No smoke. *.No leakage. *.No damage.
10. Consumption current	Current consumption during normal operation.(Vcell=3.9V)	*. Under 8μA



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**WELLDONE COMPANY**

Schematic Block Diagram :





統振  
ISO 9001:2000

# PCM Specification

## SPECIFICATION

**Model No. : CT-N3650HX-1(Lead Free)**

**(Thermistor 10K $\Omega$ )**

**Document No. : DM-N3650HX-1(Rev. A)**

**Customer : Welldone Company**

### Record of Revisions

Revision	Model. No.	From	Description	Date
A	CT-N3650HX-1	R&D Dept.	New issue from R&D	Sep.,11, 2006

**Prepared by : Kaven Xu Project Engineer**

**Checked by : Jonathan Chiang, Project Manager**

**Approved by : Sam Tsao, R&D Manager**

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## 1. Introduction :

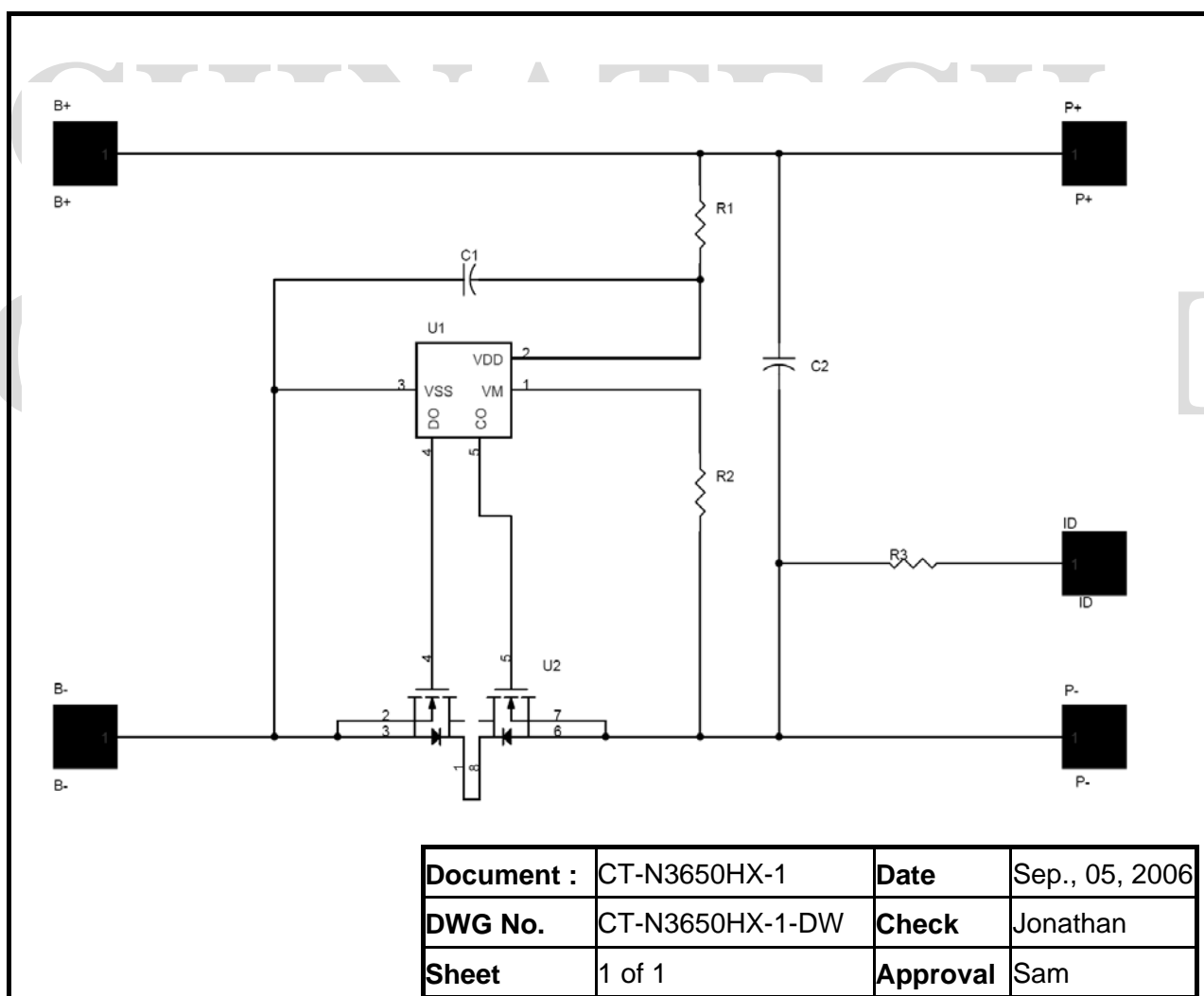
This specification provides engineering information and electrical specifications for the protection circuit module of Li-ion cells.

## 2. Description :

The CT-N3650HX-1 PCM provides protection for single-cell Li-ion battery.

The semiconductor devices with ESD protections are utilized on CT-N3650HX-1 PCM.

## 3. Circuit diagram :



**4. Major components :**

ITEM	P/N	Package
Li-ion Protection IC	<i>R5400N110FA</i>	<i>SOT-23-5</i>
MOSFET	<i>NF216LF</i>	<i>TSSOP-8</i>

**5. Bill of materials :**

Document: CT- N3650HX-1 -BOM					Subject: BOM for CT-N3650HX-1		Revision: 1.0 Date: Sep., 05, 2006
No.	Bill of materials for CT- N3650HX-1				Q'ty	Maker	REMARK
	Ref.	Part Name	DESCRIPTION	Package			
1	C1	Capacitor	0.1uF/16V Y5V	SMD0402	1	Yageo,or TDK	
2	C2	Capacitor	0.1uF/50V Y5V	SMD0603	1	Yageo,or TDK	
3	R1	Resistor	330 ohm ±5%	SMD0603	1	Yageo,or TDK	
4	R2	Resistor	1K ohm ±5%	SMD0603	1	Yageo,or TDK	
5	R3	Thermistor	10K ohm ±5%	SMD0603	1	Mistubishi	TH
6	U1	Protection IC	R5400N110FA	SOT-23-5	1	Ricoh	
7	U2	MOSFET	NF216LF	TSSOP-8	1	3D	
8	-	PCB	PN3650HX-1	-	1	Sunjung	

## 6. Absolute maximum rating :

Parameter	Rating	Unit
Operating temperature range	-20 ~ 75	°C
Operating humidity range	Less than 85% RH	%RH
Storage temperature range	-45 ~ 85	°C
Storage humidity range	Less than 85% RH	%RH
Voltage between terminals of P+ and P-	12.0	V
Voltage Between terminals of B+ and B-	12.0	V

Remarks:

The negative voltage is not allowed to be applied between the charge / discharge terminals (P+ and P-) or between the cell connection terminals (B+ and B-).

## 7. Basic functions :

### (1) Over-charge protection

Over-charge occurs whenever the voltage applied to battery is over  $4.28V \pm 0.025V$ .

Protection circuit on CT-N3650HX-1 should stop charging the battery when over-charge condition occurs and any deformation in the outer appearance of the Lithium cell connected to CT-N3650HX-1 should not occur.

### (2) Over-discharge protection

Over-discharge occurs whenever the battery is discharged with voltage below  $2.3V \pm 0.058V$

Protection Circuit on CT-N3650HX-1 should stop discharging the cells when over-discharge condition occurs.

### (3) Over-current protection

Over-current condition occurs when excessive discharge current occurs (The excessive current threshold is higher than 0.125V when R5400N110FA is used)

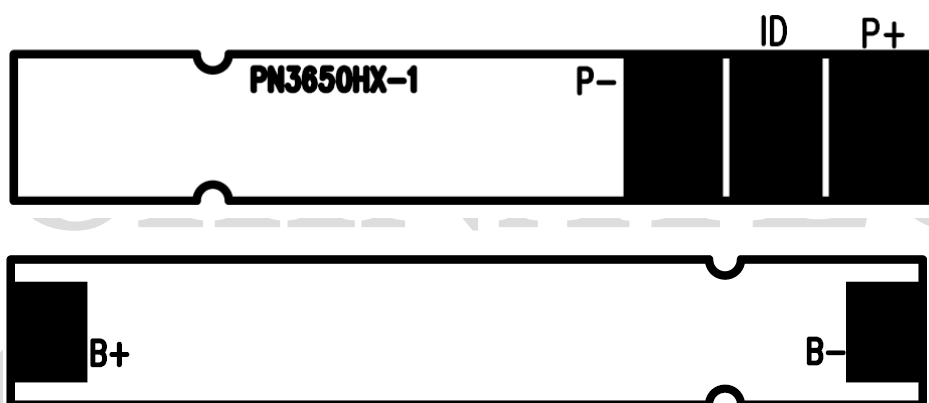
Protection circuit on CT-N3650HX-1 should stop discharging the cell when over- current condition occurs.

(4) Short-circuit protection

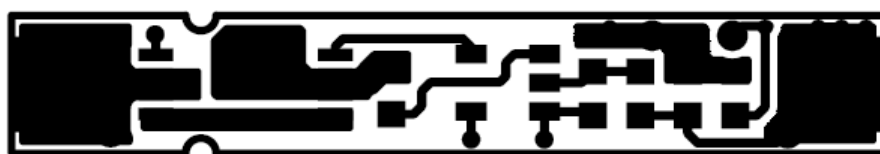
Short-circuit condition occurs when the terminals between + and - is shortened.

Protection circuit on CT-N3650HX-1 should stop discharging the cell when short-circuit condition occurs and temperature of MOSFET should not be overheated.

**8. Pin Layout Diagram :**



Document :	CT-N3650HX-1	Date	Sep., 05, 2006
DWG No.	CT-N3650HX-1	Check by	Jonathan
Revision	A	Approval by	Sam



## TOP SIDE



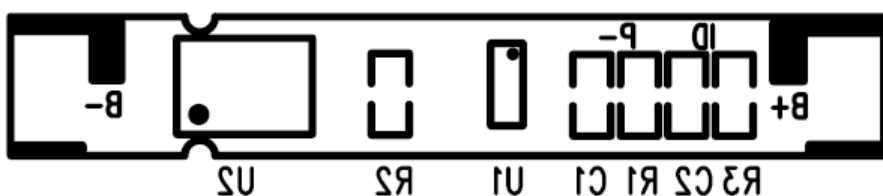
## BOT SIDE



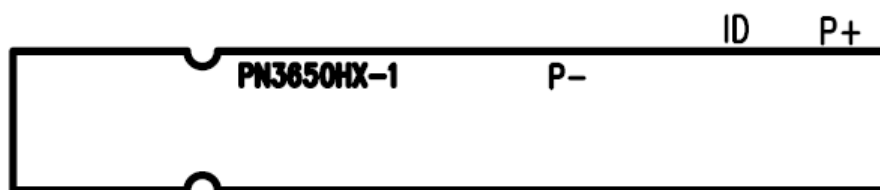
## TOP MASK



## BOT MASK



## TOP SILK



## BOT SILK



## DRILL

<b>Document:</b>	CT-N3650HX-1-AD	<b>Date</b>	Sep., 05, 2006
<b>DWG No.</b>	CT-N365HX-1	<b>Check by</b>	Jonathan
<b>Revision</b>	A	<b>Approval by</b>	Sam

## 10. Electrical characteristics :

### 10.1 Parameters of protection circuit (@25°C) :

No	Item	Specification	Unit
1	Over-charge detection voltage	4.280±0.025	V
2	Over-charge release voltage	Connect by load	
3	Over-discharge detection voltage	2.300±0.058	V
4	Over-discharge release voltage	Reset by charge	
5	Over-current detection voltage	0.125±0.015	V
6	Over-charge detection delay time	0.175~0.325	sec
7	Over-discharge detection delay time	14~26	msec
8	Over current detection delay time	8~16	msec
9	Short circuit detection delay time	230~500	usec
10	Supply current (Normal mode)	< 7	μA
11	Supply current (Sleep mode)	< 0.1	μA

### 10.2 Requirement of protection functions (@25°C) :

No.	Item	Criteria
1	Over-charge inhibition	4.280±0.025 (from cell terminal)
2	Over-charge protection recovery method	When the battery is connected to the device, the protective condition is released.
3	Over-discharge inhibition	2.300±0.058 (from cell terminal)
4	Over-discharge protection recovery method	When the battery is charged, the protective condition is released.
5	Over-current protection	2~4.5A
6	Over-current release	Reset by load release
7	Internal impedance	60m ohm(max,Vgs=4V)

**11. Specification of PCB :**

Material	FR-4
Dimension	L: 28.6+0.1/-0.1mm W: 4.5+0.05/-0.1mm
Thickness	0.5+0.1/-0.1 mm (overall)
UL	94V-0

- (1) Material 1 oz copper double sided bonded to FR-4 base material.
- (2) 2 layers with through hole.
- (3) All through hole connections to have solder resist applied
- (4) Gold Plating 3u inch.

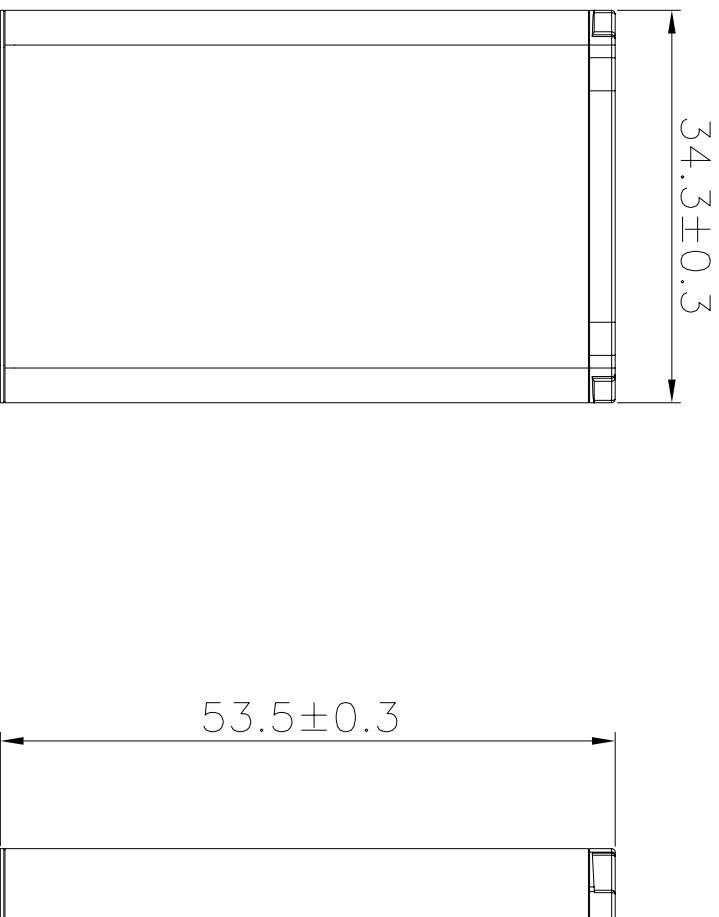
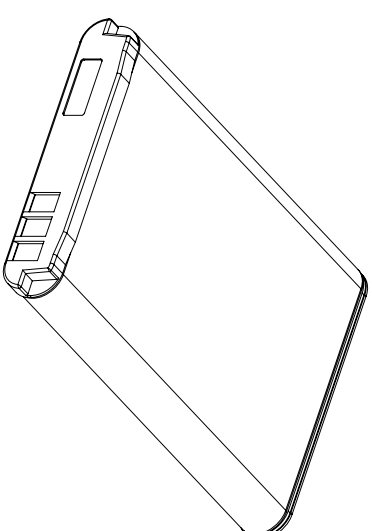
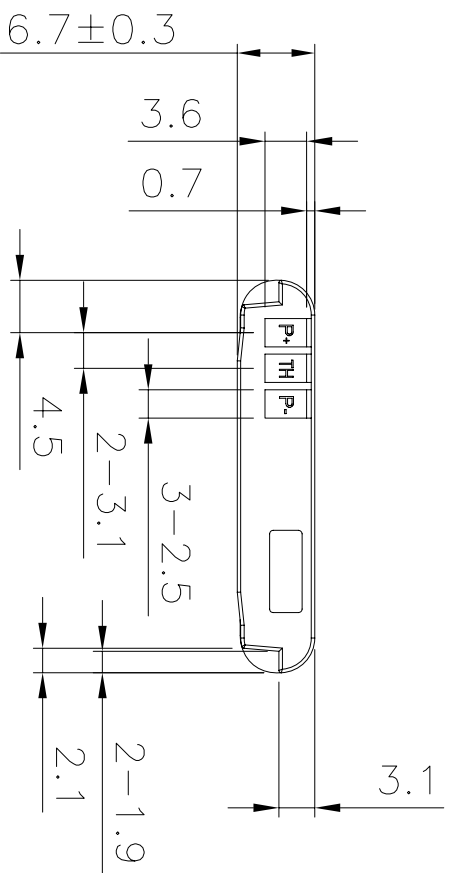
CHINATECH

CONFIDENTIAL



# Mechanical Dimension





DIMENSIONAL TOLERANCES			
( )	(✓)	( )	( )
<30	: ±0.25	DECIMALS	UP~100 : ±0.2
<30~100	: ±0.35	X	100~150 : ±0.25
>100~300	: ±0.5	X.X	150~200 : ±0.3
ABOVE 300	: ±0.6	X.XX	200~250 : ±0.35
HOLD	: ±0.05	ANGLES : ±0.5°	250~300 : ±0.4
			300~350 : ±0.45
			350~400 : ±0.5

Drawn:	kaiwei
Designed:	kaiwei
Checked:	
Approved:	

THIRD ANGLE PROJECTION	
UNIT	MM
SCALE	1:1
DATE	09/06/06"
SHEET	1 TO 1

DESCRIPTION : GTC-01 battery pack	
PART NO. :	
DRAWING NO. :	
REV.	01



IC SPEC.




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**LI-ion/POLYMER 1CELL PROTECTOR**


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**R5400xxxxx SERIES**


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## OUTLINE

The R5400xxxxxx Series are high voltage CMOS-based protection ICs for over-charge/discharge of rechargeable one-cell Lithium-ion (Li+) / Lithium polymer excess load current, further include a short circuit protector for preventing large external short circuit current and excess discharge-current.

Each of these ICs is composed of three voltage detectors, a reference unit, a delay circuit, a short circuit detector, an oscillator, a counter, and a logic circuit. When an over-charge voltage crosses the detector threshold from a low value to a high value, the output of C<sub>OUT</sub> pin switches to low level after internal fixed delay time. After detecting over-charge, the detector can be reset and the output of C<sub>OUT</sub> becomes "H" when a kind of load is connected to V<sub>DD</sub> after a charger is disconnected from the battery pack, and the cell voltage becomes lower than over-charge detector threshold. If a charger is continue to be connected to the battery pack, even the cell voltage becomes lower than over-charge detector threshold, over-charge state is not released.

The output of D<sub>OUT</sub> pin, the output of Over-discharge detector and Excess discharge-current detector, switches to low level after internally fixed delay time, when discharged voltage crosses the detector threshold from a high value to a value lower than V<sub>DET2</sub>.

After detecting over-discharge voltage, connect a charger to the battery pack, and when the battery supply voltage becomes higher than over-discharge detector threshold, VD2 is released and the voltage of D<sub>OUT</sub> pin becomes "H" level.

An excess discharge-current and short circuit state can be sensed and cut off through the built in excess current detector, VD3, with D<sub>OUT</sub> being enabled to low level. Once after detecting excess discharge-current or short circuit, the VD3 is released and D<sub>OUT</sub> level switches to high by detaching a battery pack from a load system.

After detecting over-discharge, supply current will be kept extremely low by halting internal circuits' operation.

When the C<sub>OUT</sub> is "H", if V<sub>-</sub> is set at the test shorten mode voltage (Typ. -2.0V) or lower than that, the delay time of the PCB can be shortened. Especially, the delay time of over-charge detector can be reduced into approximately 1/60, therefore, testing time of protector circuit board can be reduced. Output type of C<sub>OUT</sub> and D<sub>OUT</sub> is CMOS.

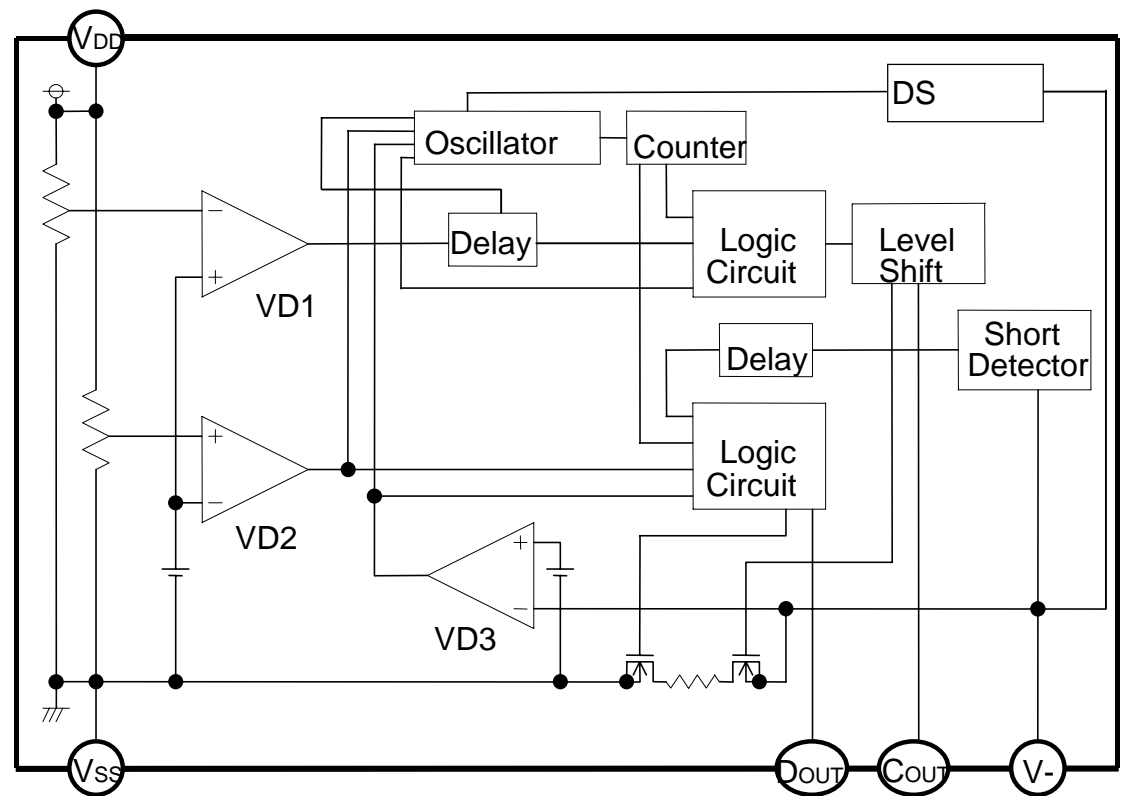
FEATURES

- Manufactured with High Voltage Tolerant Process... Absolute Maximum Rating 35V
- Low supply current..... Supply current(At normal mode)
  - Typ. 3.5μA (0V charge acceptable type)
  - Typ. 4.0μA (0V charge unacceptable type)
  - Standby current (detecting over-discharge) Max. 0.1μA
- High accuracy detector threshold ..... Over-charge detector (Topt=25°C) ±25mV
  - (Topt=-5 to 55°C) ±30mV
  - Over-discharge detector ±2.5%
  - Excess discharge-current detector ±15mV
- Variety of detector threshold ..... Over-charge detector threshold 4.0V-4.5V step of 0.005V
  - Over-discharge detector threshold 2.0V-3.0V step of 0.005V
  - Excess discharge-current threshold 0.05V-0.2V step of 0.005V
- Internal fixed Output delay time.....Over-charge detector Output Delay 1.1s
  - (Select among the options) Over-discharge detector Output Delay 20ms
  - Excess discharge-current detector Output Delay 12ms
  - Short Circuit detector Output Delay 300μs
- Delay Time Reduction Function..... Set V=- (Typ. -2.0V)(Test shorten Mode Voltage) or lower
  - with COUT at "H" level, Output Delay time of all items except excess discharge current and short-circuit can be reduced. (Delay Time for over-charge becomes about 1/60 of normal state.)
- 0V-battery charge option..... acceptable/unacceptable
- With Latch function after over-charge detect
- Ultra Small package..... SOT-23-5 / SON1612-6pin

APPLICATIONS

- Li+ / Li Polymer protector of over-charge, over-discharge, excess-current for battery pack
- High precision protectors for cell-phones and any other gadgets using on board Li+ / Li Polymer battery

BLOCK DIAGRAM



SELECTION GUIDE

In the R5400xxxxx Series four of the input threshold for over-charge, over-discharge, and excess discharge current detectors, package type etc. can be designated.

Part Number is designated as follows:

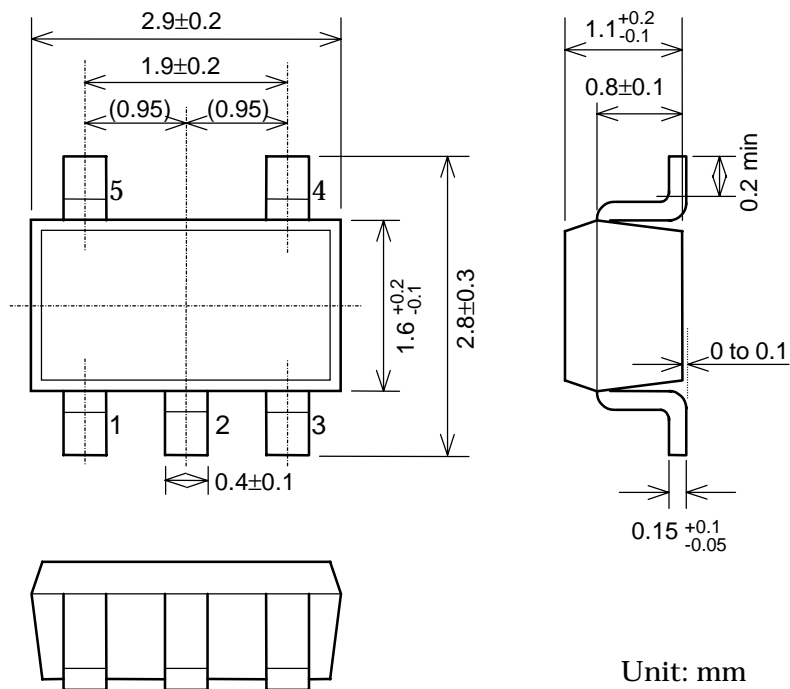
R5400x xxxxx-TR-Fx ←Part Number

↑ ↑ ↑↑↑ ↑  
a b c de f

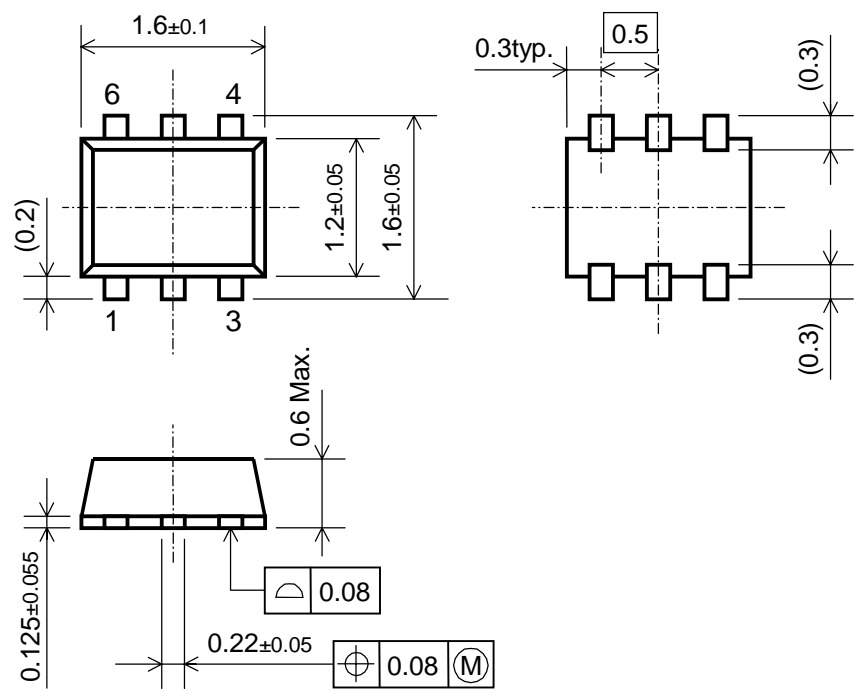
Code	Contents
a	Package Type N: SOT-23-5 D: SON1612-6
b	Serial Number for the R5400 Series designating input three threshold for over-charge, over-discharge, and excess discharge-current detectors.
c	Designation of Output delay time for over-charge and excess discharge-current. C: tVDET1=1.1s, tVDET3=12ms
d	Designation of version symbols A: 0V-charge acceptable B: 0V-charge unacceptable
e	Taping Type: TR (refer to Taping Specification)
f	Designation of Lead-Plating Material

PIN CONFIGURATIONS

SOT-23-5



SON1612-6



PIN DESCRIPTION

Pin No.		Symbol	Description
SOT-23-5	SON1612-6		
1	1	V-	Pin for charger negative input
2	2	V <sub>DD</sub>	Power supply pin, the substrate voltage level of the IC.
5	3	C <sub>OUT</sub>	Output of over-charge detection, CMOS output
4	4	D <sub>OUT</sub>	Output of over-discharge detection, CMOS output
-	5	(V <sub>DD</sub> )	Common with pin#2 in regard to SON1612-6
3	6	V <sub>SS</sub>	Vss pin. Ground pin for the IC

ABSOLUTE MAXIMUM RATINGS

V<sub>SS</sub>=0V

Symbol	Item	Ratings	Unit
V <sub>DD</sub>	Supply voltage	-0.3 to 12	V
V-	Input Voltage V- pin(Charger negative input pin)	V <sub>DD</sub> -35 to V <sub>DD</sub> +0.3	V
V <sub>COUT</sub>	Output voltage C <sub>OUT</sub> pin	V <sub>DD</sub> -35 to V <sub>DD</sub> +0.3	V
V <sub>DOUT</sub>	D <sub>OUT</sub> pin	V <sub>SS</sub> -0.3 to V <sub>DD</sub> +0.3	V
P <sub>D</sub>	Power dissipation	150	mW
T <sub>opt</sub>	Operating temperature range	-40 to 85	°C
T <sub>stg</sub>	Storage temperature range	-55 to 125	°C

ELECTRICAL CHARACTERISTICS

Unless otherwise specified, T<sub>opt</sub>=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V <sub>DD1</sub>	Operating input voltage	Voltage defined asV <sub>DD</sub> -V <sub>SS</sub>	1.5		5.0	V
V <sub>st</sub>	Minimum operating Voltage for 0V charging <sup>*Note 1</sup>	Voltage defined asV <sub>DD</sub> -V <sub>-</sub> , V <sub>DD</sub> -V <sub>SS</sub> =0V			1.8	V
V <sub>nochg</sub>	Maximum Battery Voltage level of low voltage battery charge inhibitory circuit <sup>*Note 2</sup>	Voltage defined as V <sub>DD</sub> -V <sub>SS</sub> , V <sub>DD</sub> -V <sub>-</sub> =4V	0.7	1.1	1.5	V
V <sub>DET1</sub>	Over-charge threshold	Detect rising edge of supply voltage R1=330Ω R1=330Ω (T <sub>opt</sub> =-5 to 55°C) <sup>*Note3</sup>	V <sub>DET1</sub> -0.025 V <sub>DET1</sub> -0.030	V <sub>DET1</sub> V <sub>DET1</sub>	V <sub>DET1</sub> +0.025 V <sub>DET1</sub> +0.030	V V
tV <sub>DET1</sub>	Output delay of over-charge	V <sub>DD</sub> =3.6V to 4.4V	tV <sub>DET1</sub> ×0.7	tV <sub>DET1</sub>	tV <sub>DET1</sub> ×1.3	s
tV <sub>REL1</sub>	Output delay of release from over-charge	V <sub>DD</sub> =4V, V <sub>-</sub> =0V to 1V	12	17	22	ms
V <sub>DET2</sub>	Over-discharge threshold	Detect falling edge of supply voltage	V <sub>DET2</sub> ×0.975	V <sub>DET2</sub>	V <sub>DET2</sub> ×1.025	V
tV <sub>DET2</sub>	Output delay of over-discharge	V <sub>DD</sub> =3.6V to 2.2V	14	20	26	ms
tV <sub>REL2</sub>	Output delay of release from over-discharge	V <sub>DD</sub> =3V V <sub>-</sub> =3V to 0V	0.7	1.2	1.7	ms
V <sub>DET3</sub>	Excess discharge-current threshold	Detect rising edge of 'V-' pin voltage	V <sub>DET3</sub> -0.015	V <sub>DET3</sub>	V <sub>DET3</sub> +0.015	V
tV <sub>DET3</sub>	Output delay of excess discharge-current	V <sub>DD</sub> =3.0V, V <sub>-</sub> =0V to 1V	tV <sub>DET3</sub> ×2/3	tV <sub>DET3</sub>	tV <sub>DET3</sub> ×4/3	ms
tV <sub>REL3</sub>	Output delay of release from excess discharge-current	V <sub>DD</sub> =3.0V, V <sub>-</sub> =3V to 0V	0.7	1.2	1.7	ms
V <sub>short</sub>	Short protection voltage	V <sub>DD</sub> =3.0V	0.9	1.3	1.7	V
T <sub>short</sub>	Output Delay of Short protection	V <sub>DD</sub> =3.0V, V <sub>-</sub> =0V to 3V	230	300	500	μs
R <sub>short</sub>	Reset resistance for Excess discharge-current protection	V <sub>DD</sub> =3.6V, V <sub>-</sub> =1V	30	60	90	kΩ
V <sub>DS</sub>	Output Delay Time Reduction Mode Voltage	V <sub>DD</sub> =4.4V	-1.4	-2.0	-2.6	V
V <sub>OL1</sub>	Nch ON voltage of C <sub>OUT</sub>	I <sub>ol</sub> =50μA, V <sub>DD</sub> =4.5V		0.2	0.5	V
V <sub>OH1</sub>	Pch ON voltage of C <sub>OUT</sub>	I <sub>oh</sub> =-50μA, V <sub>DD</sub> =3.9V	3.4	3.7		V
V <sub>OL2</sub>	Nch ON voltage of D <sub>OUT</sub>	I <sub>ol</sub> =50μA, V <sub>DD</sub> =2.0V		0.2	0.5	V
V <sub>OH2</sub>	Pch ON voltage of D <sub>OUT</sub>	I <sub>oh</sub> =-50μA, V <sub>DD</sub> =3.9V	3.4	3.7		V
I <sub>DD</sub>	Supply current	V <sub>DD</sub> =3.9V, V <sub>-</sub> =0V		3.5 <sup>*Note1</sup> 4.0 <sup>*Note2</sup>	7.0 <sup>*Note1</sup> 8.0 <sup>*Note2</sup>	μA
I <sub>s</sub>	Standby current	V <sub>DD</sub> =2.0V			0.1	μA

\*Note1: Specified for A version (0V Charge is acceptable.)

\*Note2: Specified for B version (0V Charge is unacceptable.)

\*Note3: We compensate for this characteristic related to temperature by laser-trim, however, this specification is guaranteed by design, not mass production tested.



## OPERATION

### • VD1 / Over-Charge Detector

The VD1 monitors  $V_{DD}$  pin voltage while charge the battery pack. When the  $V_{DD}$  voltage crosses over-charge detector threshold  $V_{DET1}$  from a low value to a value higher than the  $V_{DET1}$ , the VD1 can sense a over-charging and an external charge control Nch MOSFET turns off with  $C_{OUT}$  pin being at "L" level.

To reset the VD1 making the  $C_{OUT}$  pin level to "H" again after detecting over-charge, in such conditions that a time when the  $V_{DD}$  voltage is down to a level lower than over-charge voltage. Connecting a kind of loading to  $V_{DD}$  after disconnecting a charger from the battery pack when the  $V_{DD}$  voltage is lower than Over-charge detector threshold, VD1 can be reset. Output voltage of  $C_{OUT}$  pin becomes "H", and it makes an external Nch MOSFET turn on, and charge cycle is available. In other words, once over-charge is detected, even the supply voltage becomes low enough, if a charger is continue to be connected to the battery pack, recharge is not possible. Therefore this over-charge detector has no hysteresis. To judge whether or not load is connected, Excess-discharge current detector is used. In other words, by connecting some load,  $V_{-}$  pin voltage becomes equal or more than Excess-discharge current detector threshold, and reset Over-charge detecting state.

After detecting over-charge with the  $V_{DD}$  voltage of higher than  $V_{DET1}$ , disconnecting a charger and connecting system load to the battery pack makes load current allowable through parasitic diode of external charge control FET.

The  $C_{OUT}$  level would be "H" when the  $V_{DD}$  level is down to a level below the  $V_{DET1}$  by continuous drawing of load current.

Internal fixed output delay times for over-charge detection and release from over-charge exist. Even when the  $V_{DD}$  level becomes a higher level than  $V_{DET1}$  if the  $V_{DD}$  voltage would be back to a level lower than the  $V_{DET1}$  within a time period of the output delay time, VD1 would not output a signal for turning off the charge control FET. Besides, after detecting over-charge, while the  $V_{DD}$  is lower than over-charge detector, even if a charger is removed and connect a load, when the voltage is recovered within output delay time of release from over-charge, over-charge state is not released.

A level shifter incorporated in a buffer driver for the  $C_{OUT}$  pin makes the "L" level of  $C_{OUT}$  pin to the  $V_{-}$  pin voltage and the "H" level of  $C_{OUT}$  pin is set to  $V_{DD}$  voltage with CMOS buffer.

### • VD2 / Over-Discharge Detector

The VD2 is monitoring a  $V_{DD}$  pin voltage. When the  $V_{DD}$  voltage crosses the over-discharge detector threshold  $V_{DET2}$  from a high value to a value lower than the  $V_{DET2}$ , the VD2 can sense an over-discharging and the external discharge control Nch MOSFET turns off with the  $D_{OUT}$  pin being at "L" level.

To reset the VD2 with the  $D_{OUT}$  pin level being "H" again after detecting over discharge, it is necessary to connect a charger to the battery pack. When the  $V_{DD}$  voltage stays under over-discharge detector

threshold  $V_{DET2}$ , charge-current can flow through parasitic diode of an external discharge control MOSFET. Then after the  $V_{DD}$  voltage comes up to a value larger than  $V_{DET2}$ ,  $D_{OUT}$  becomes "H" and discharging process would be able to advance through turning on MOSFET for discharge control.

Connecting a charger to the battery pack makes the  $D_{OUT}$  level being "H" instantaneously when the  $V_{DD}$  voltage is higher than  $V_{DET2}$ .

When a cell voltage equals to zero, operation varies and depends on the mask version.

A version (0V charge acceptable): the voltage of a charger is equal or more than 0V-charge minimum voltage ( $V_{st}$ ),  $C_{OUT}$  pin becomes "H" and system allowable to charge

B Version (0V charge unacceptable): when the  $V_{DD}$  pin voltage is equal or lower than charge inhibitory maximum voltage ( $V_{nochg}$ ), even a charger is connected to a battery pack,  $C_{OUT}$  pin is stacked at "L" and charge current cannot flow.

An output delay time for over-discharge detection is fixed internally. When the  $V_{DD}$  level is down to a lower level than  $V_{DET2}$  if the  $V_{DD}$  voltage would be back to a level higher than the  $V_{DET2}$  within a time period of the output delay time,  $VD2$  would not output a signal for turning off the discharge control FET. Output delay time for release from over-discharge is also set typically at 1.2ms.

After detecting of over-discharge by  $VD2$ , supply current would be reduced to maximum 0.1 $\mu$ A at  $V_{DD}=2.0V$  and be into standby by halting all circuits and consumption current of IC itself is minimized.

The output type of  $D_{OUT}$  pin is CMOS having "H" level of  $V_{DD}$  and "L" level of  $V_{SS}$ .

- **VD3 /Excess discharge-current Detector, Short Circuit Protector**

Both of the excess current detector and short circuit protection can work when the both of control FETs are in "ON" state.

When the V- pin voltage is up to a value between the short protection voltage  $V_{short}$  (Typ. 1.3V) and excess discharge-current threshold  $V_{DET3}$ ,  $VD3$  operates and further soaring of V- pin voltage higher than  $V_{short}$  makes the short circuit protector enabled. This leads the external discharge control Nch MOSFET turns off with the  $D_{OUT}$  pin being at "L" level and prevents the circuit from a large current flowing. The output delay time for detecting excess discharge current is fixed at typically 1.2ms inside the IC.

A quick recovery of V- pin level from a value between  $V_{short}$  and  $V_{DET3}$  within the delay time keeps the discharge control FET staying "H" state. Output delay time for Release from excess discharge-current detection is also set at typically 1.2ms.

When the short circuit protector is enabled, the  $D_{OUT}$  would be "L" and its delay time would be typically 300 $\mu$ s.

The V - pin has a built-in pulled down resistor, typically 60k $\Omega$ , with connecting to the  $V_{SS}$  pin. After an excess discharge-current or short circuit protection is detected, removing a cause of excess discharge-current or external short circuit makes an external discharge control FET to an "ON" state automatically with the V- pin level being down to the  $V_{SS}$  level through built-in pulled down resistor.

When the V- pin voltage is equal or less than excess-discharge current detector threshold, the circuit is released from excess discharge or short circuit. The reset resistor of excess discharge-current is off at normal state. Only when detecting excess discharge-current or short circuit, the resistor is on.

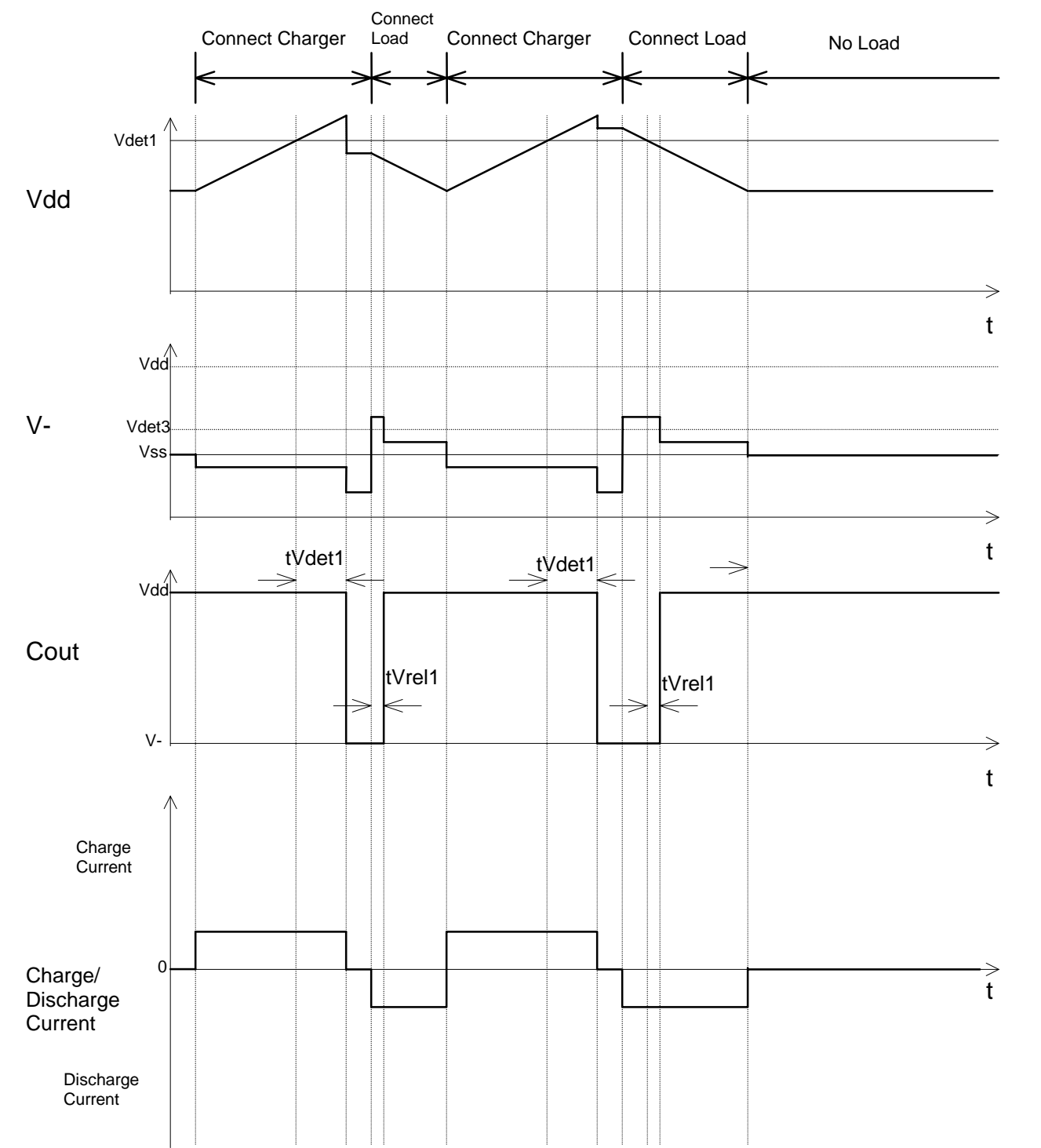
Output delay time of excess discharge-current is set shorter than the delay time for over-discharge detector. Therefore, if  $V_{DD}$  voltage would be lower than  $V_{DET2}$  at the same time as the excess discharge-current is detected, the R5400xxxxxx is at excess discharge-current detection mode. By disconnecting a load, VD3 is automatically released from excess discharge-current.

- **DS (Delay Shorten) function**

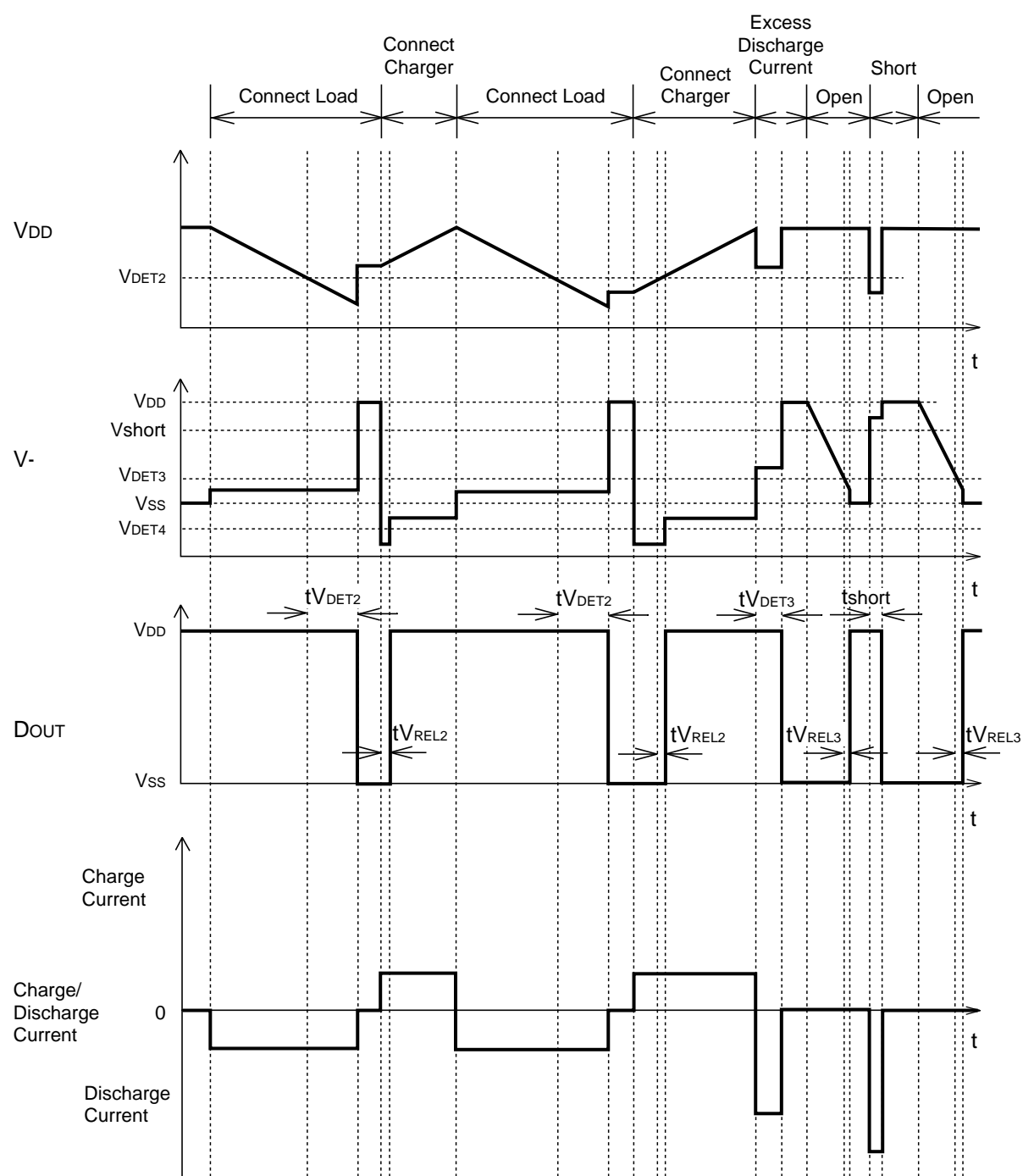
Output delay time of over-charge and over-discharge and release from those detecting modes can be shorter than those setting value by forcing the test shorten mode voltage, Typ. -2.0V or lower than that to V- pin.

TIMING CHART

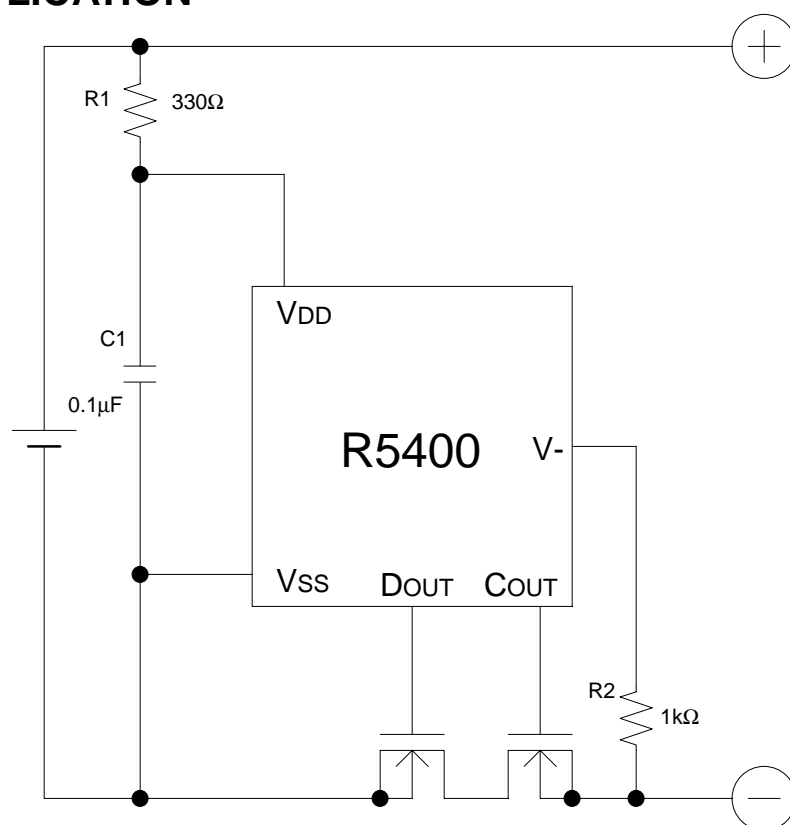
1. Detect and Release from Over-charge Operation



## 2. Over discharge, Excess-discharge current, Short-circuit operation



## TYPICAL APPLICATION



## APPLICATION HINTS

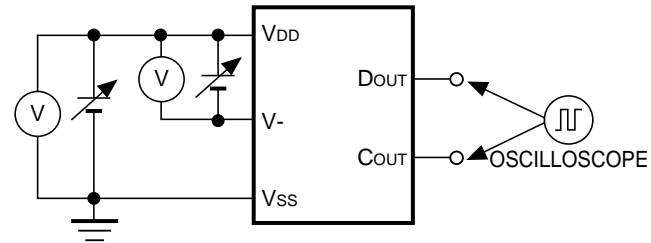
R1 and C1 will stabilize a supply voltage to the R5400xxxxxx. A recommended R1 value is less than 1kΩ.

A larger value of R1 leads higher detection voltage, makes some errors, because of conduction current flown at detecting operation of the R5400xxxxxx. For making stable operation, set C1 with a value of 0.01μF or more.

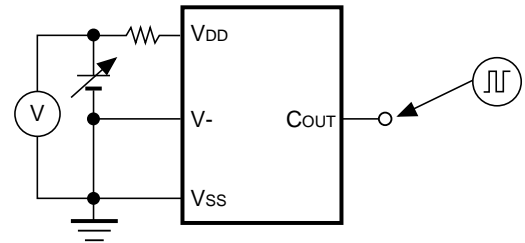
R1 and R2 can operate also as parts for current limit circuit against reverse charge or applying a charger with excess charging voltage to the battery pack. Small value of R1 and R2 may cause over-power consumption rating of power dissipation of the R5400xxxxxx. Therefore, total value of 'R1+R2' should be equal or more than 1kΩ.

On the other hand, if large value of R2 is set, release from over-discharge by connecting a charger might not be possible. Recommended R2 value is equal or less than 10kΩ.

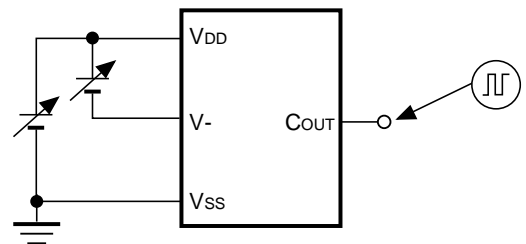
TEST CIRCUITS



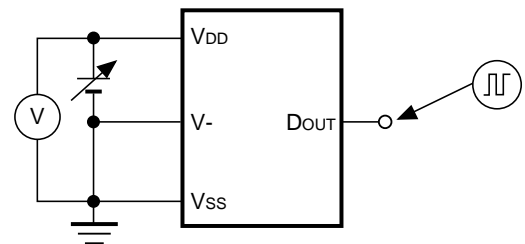
A



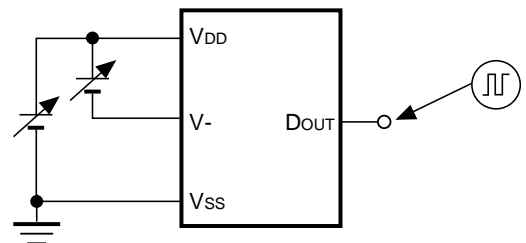
B



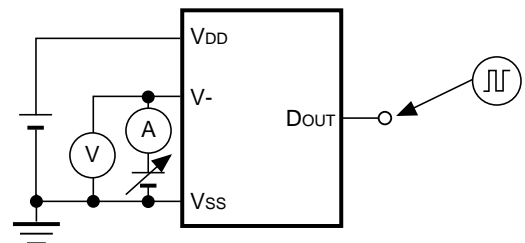
C



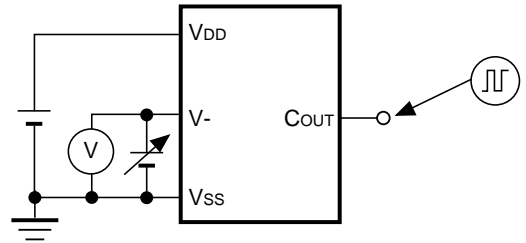
D



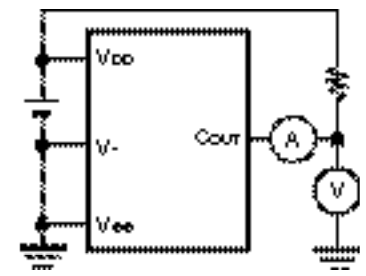
E



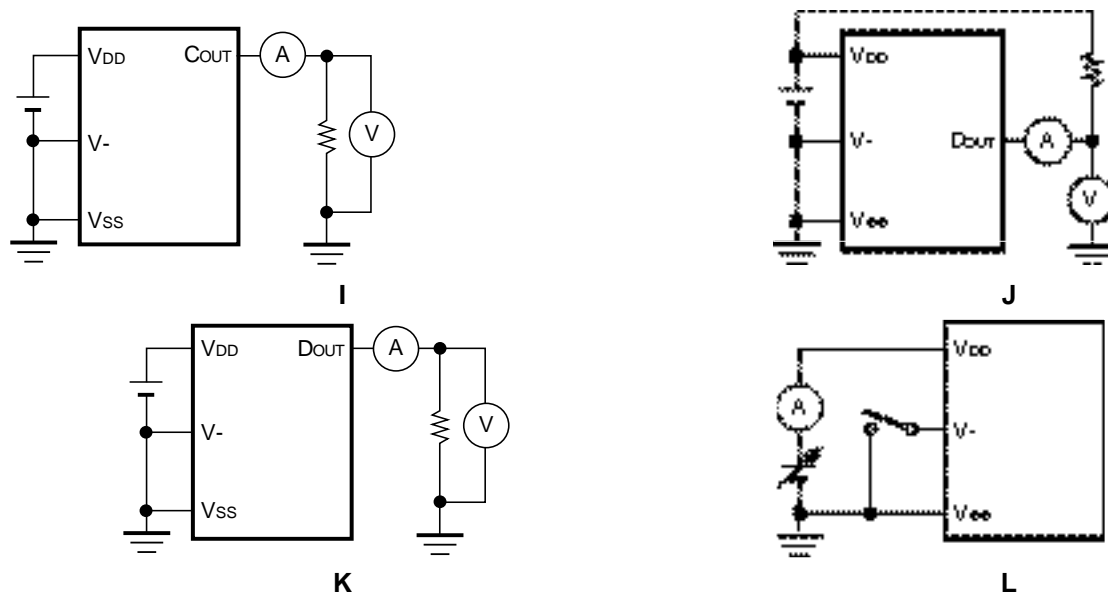
F



G



H



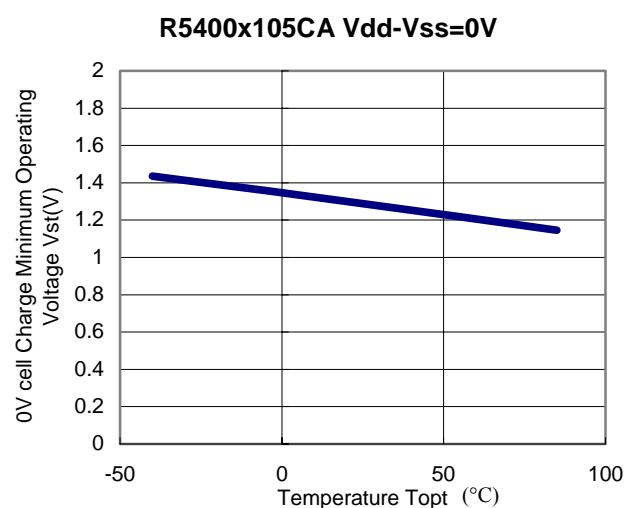
Typical Characteristics were obtained with using those above circuits:

- Test Circuit A: Typical characteristics 1) 2)
- Test Circuit B: Typical characteristics 3) 4)
- Test Circuit C: Typical characteristics 5)
- Test Circuit D: Typical characteristics 6) 7)
- Test Circuit E: Typical characteristics 8)
- Test Circuit F: Typical characteristics 9) 10) 11) 12) 13) 14)
- Test Circuit G: Typical characteristics 15)
- Test Circuit H: Typical characteristics 16)
- Test Circuit I: Typical characteristics 17)
- Test Circuit J: Typical characteristics 18)
- Test Circuit K: Typical characteristics 19)
- Test Circuit L: Typical characteristics 20) 21)
- Test Circuit M: Typical characteristics 22)

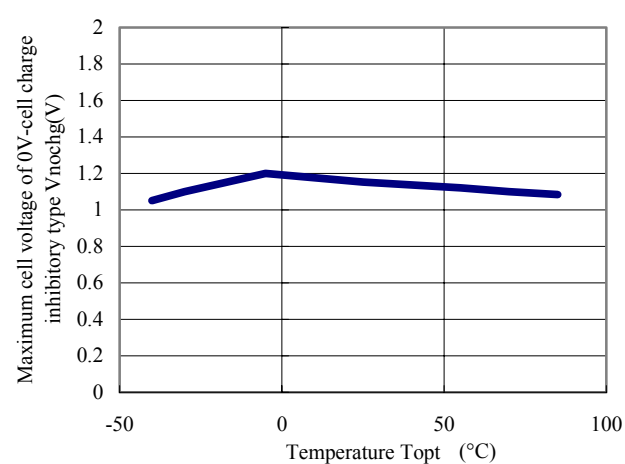


## TYPICAL CHARACTERISTICS (Part 1: Temperature Characteristics)

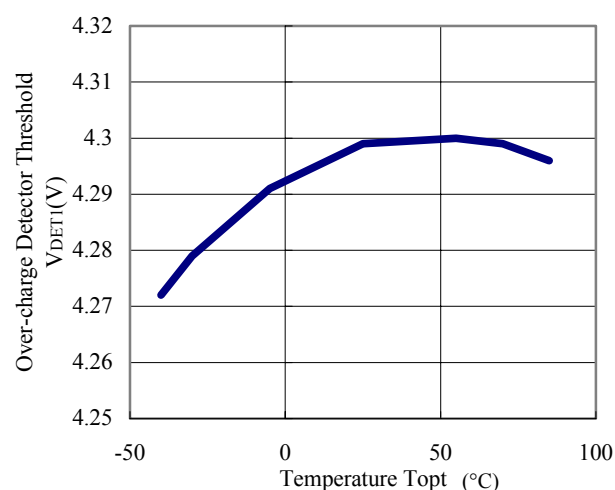
1) Minimum Operating Voltage for 0V Cell Charging vs. Temperature



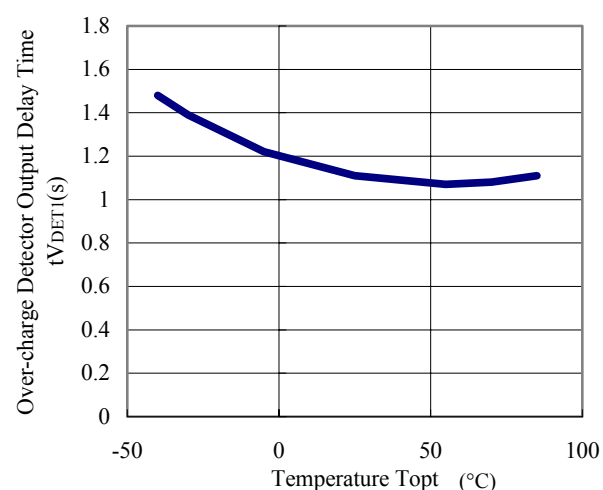
2) Maximum Battery Voltage Level for Low Voltage Battery Charge Inhibitory Circuit vs. Temperature  
**R5400x105CB Vdd-V-=4V**



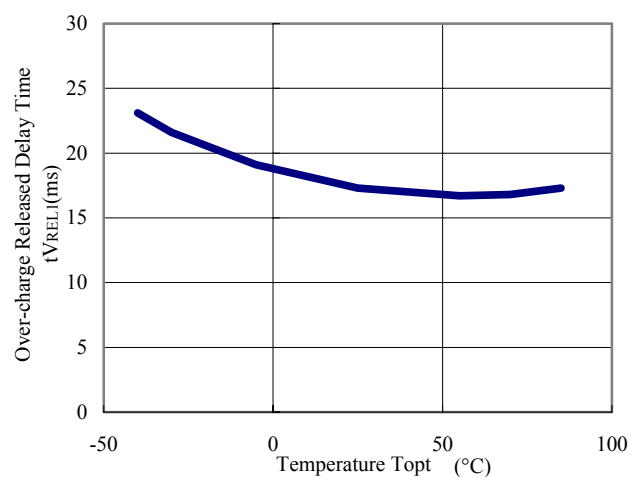
3) Over-Charge Threshold vs. Temperature  
**R5400x105CA**



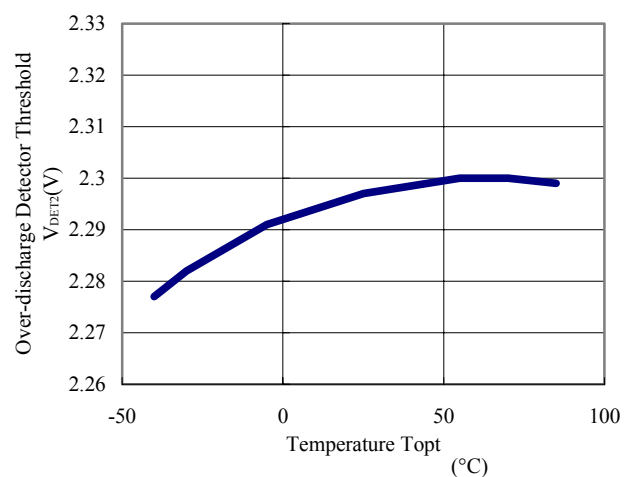
4) Output Delay of Over-charge vs. Temperature  
**R5400x105CA**



5) Output Delay of Release from Over-charge vs. Temperature  
**R5400x105CA**

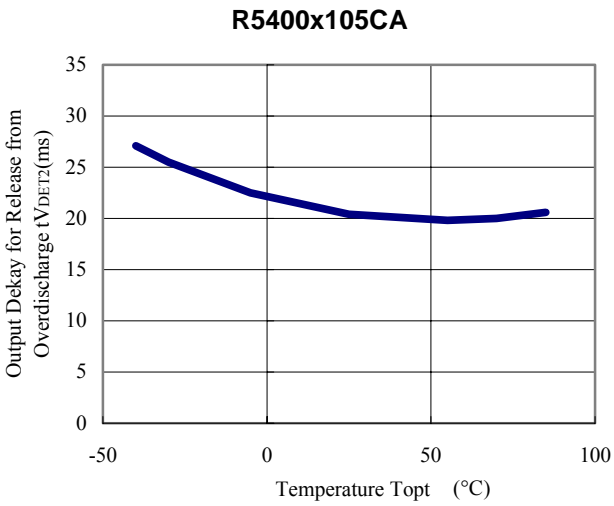


6) Over discharge Threshold vs. Temperature  
**R5400x105CA**

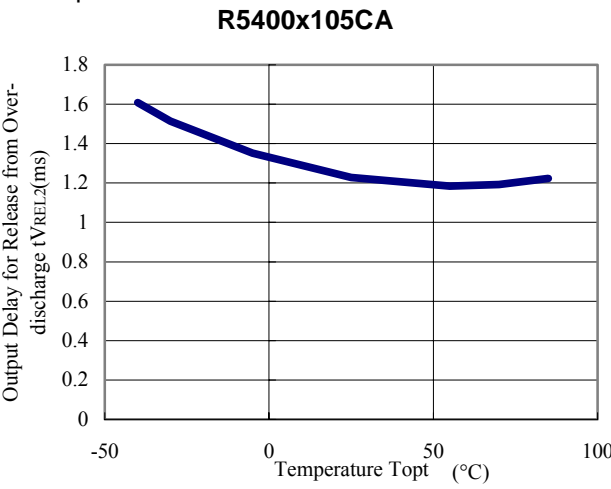


**R5400xxxxx**

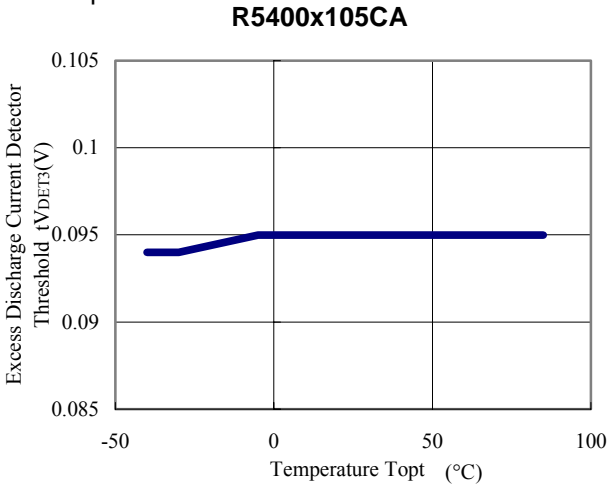
7) Output Delay of Over-discharge vs. Temperature



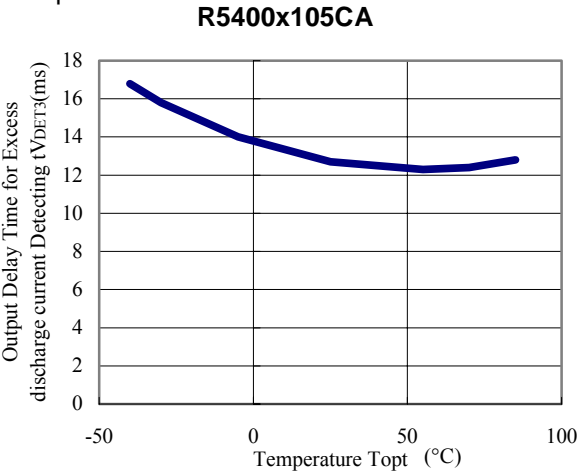
8) Output Delay of Release from Over-discharge vs. Temperature



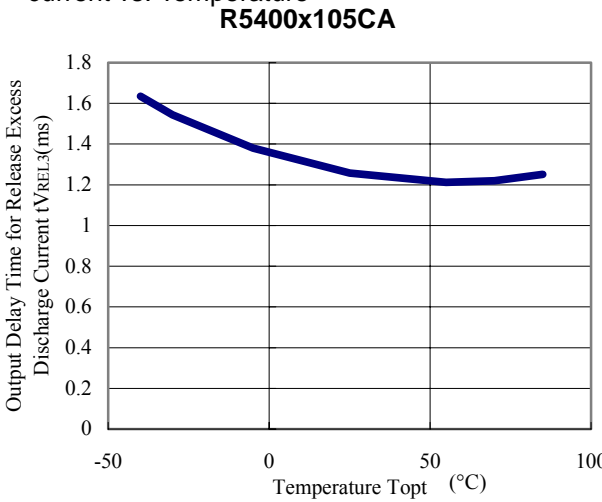
9) Excess Discharge-current Threshold vs. Temperature



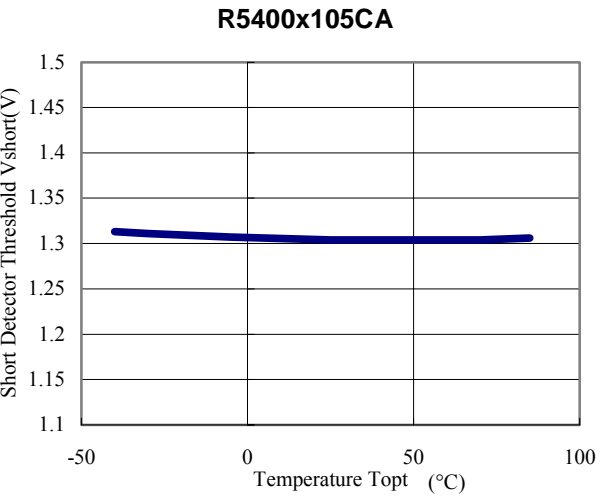
10) Output Delay of Excess Discharge-current vs. Temperature



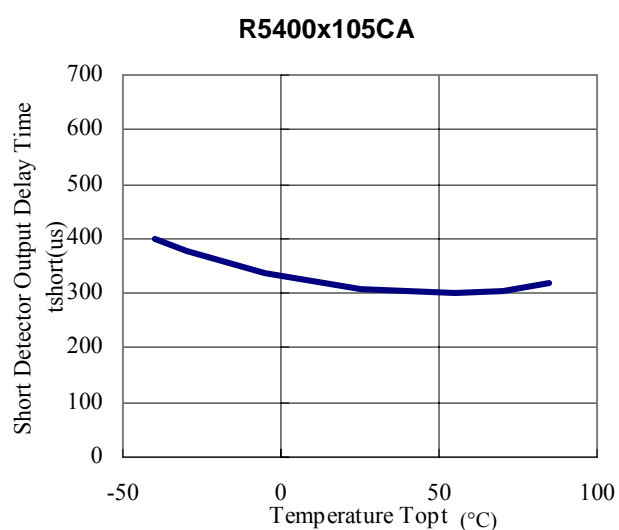
11) Output Delay of Release from Excess Discharge-current vs. Temperature



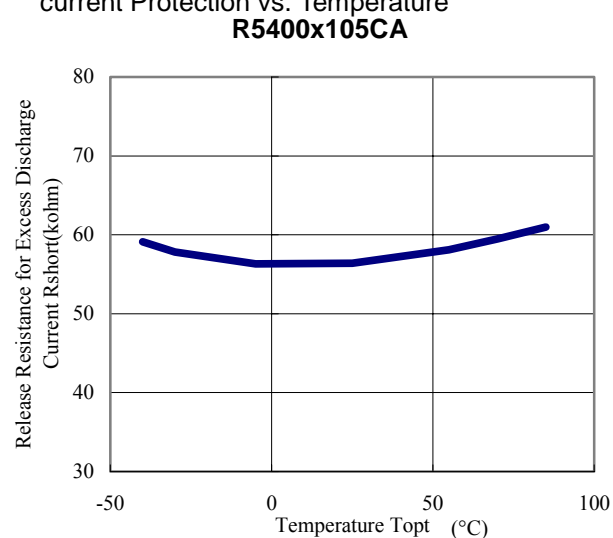
12) Short Detector Voltage vs. Temperature



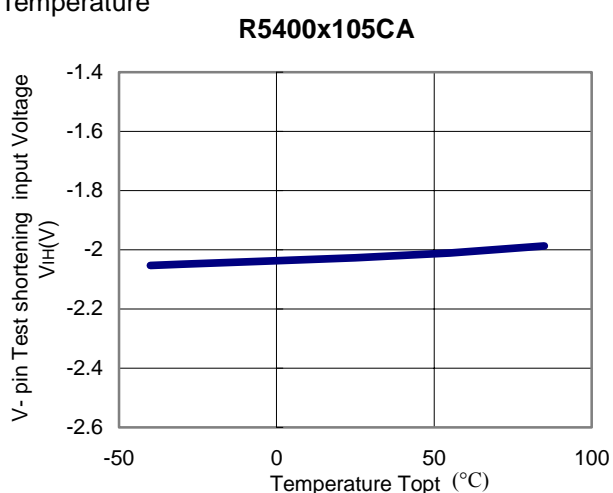
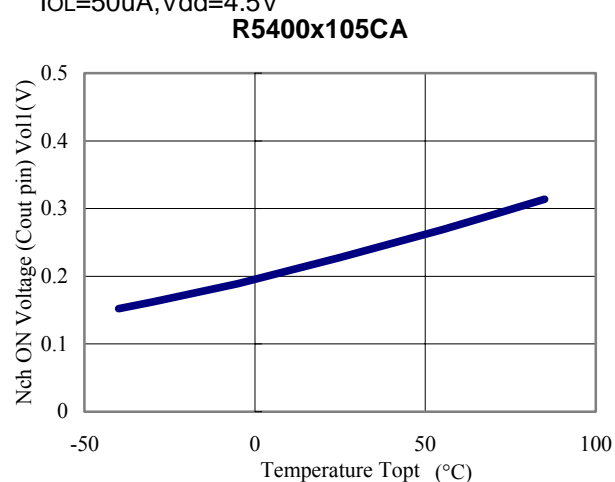
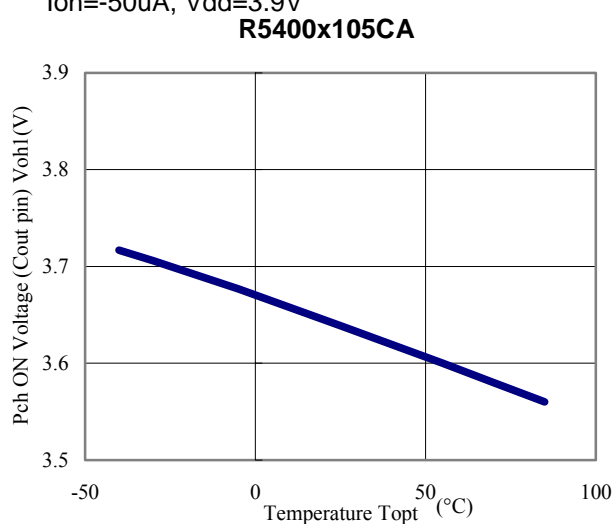
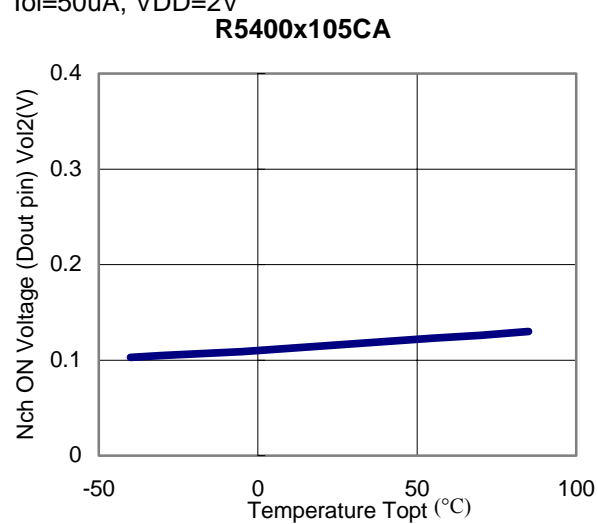
13) Output Delay of Short Protection vs. Temperature



14) Reset Resistance for Excess Discharge current Protection vs. Temperature



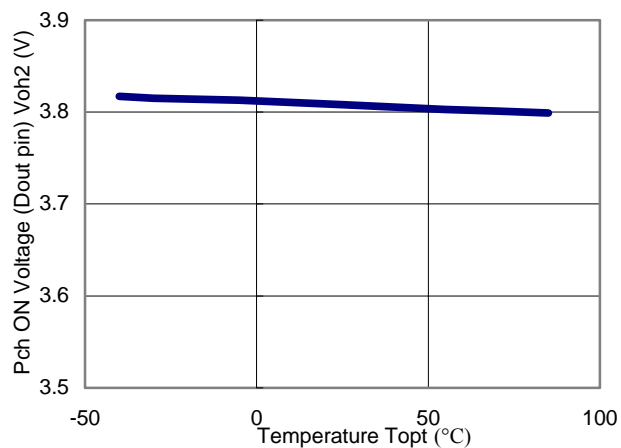
15) V- pin Test time shortening input Voltage vs. Temperature

16) Nch On Voltage (COUT pin) vs. Temperature  
 $I_{OL}=50\mu A, V_{DD}=4.5V$ 17) Pch On Voltage (COUT pin) vs. Temperature  
 $I_{oh}=50\mu A, V_{DD}=3.9V$ 18) Nch On Voltage (DOUT pin) vs. Temperature  
 $I_{ol}=50\mu A, V_{DD}=2V$ 

## R5400xxxxx

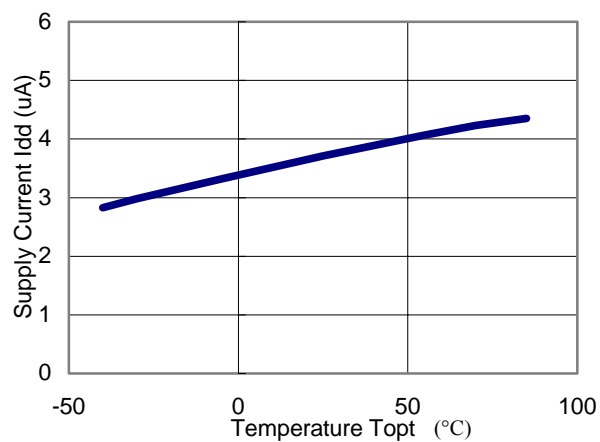
19) Pch ON Voltage of D<sub>OUT</sub> vs. Temperature  
I<sub>oh</sub>=-50uA, V<sub>dd</sub>=3.9V

**R5400x105CA**



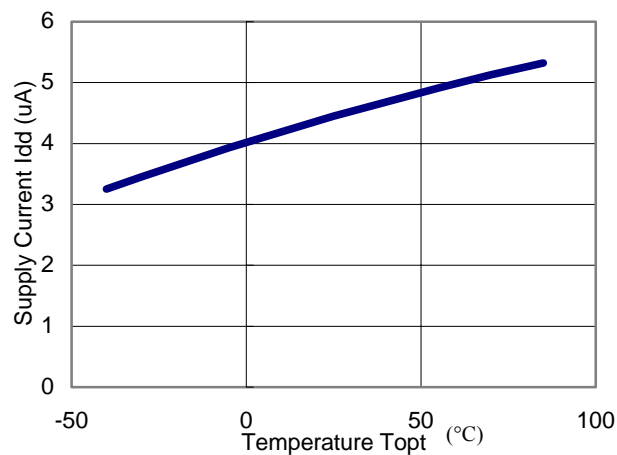
20) Supply Current vs. Temperature  
V<sub>dd</sub>=3.9V, V<sub>-</sub>=0V

**R5400x105CA**



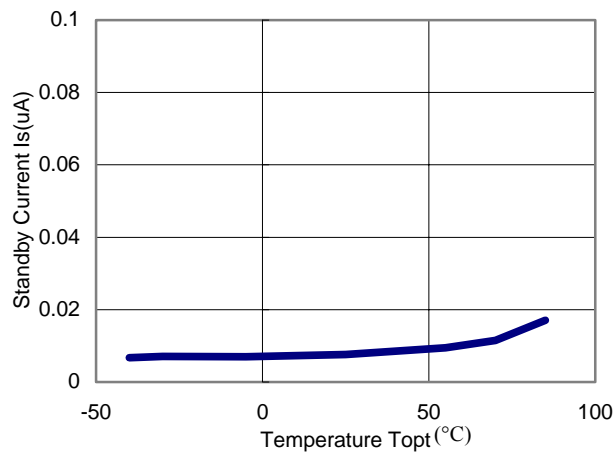
21) Supply Current vs. Temperature  
V<sub>dd</sub>=3.9V, V<sub>-</sub>=0V

**R5400x105CB**



22) Standby Current vs. Temperature  
V<sub>dd</sub>=2.0V

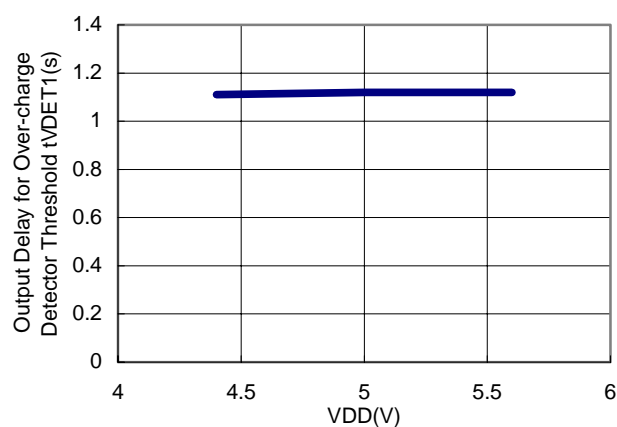
**R5400x105CA**



### Part 2 Delay Time dependence on V<sub>DD</sub>

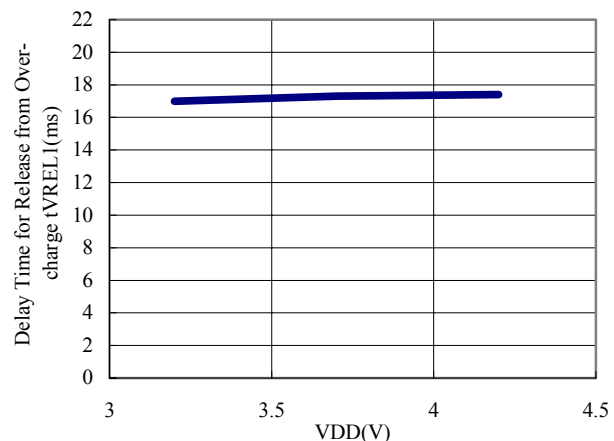
1) Delay Time for Over-charge detect vs. V<sub>DD</sub>  
V<sub>-</sub>=0V, V<sub>dd</sub>=3.6V to 4.4V, 5.0V, 5.6V

**R5400x105CA**



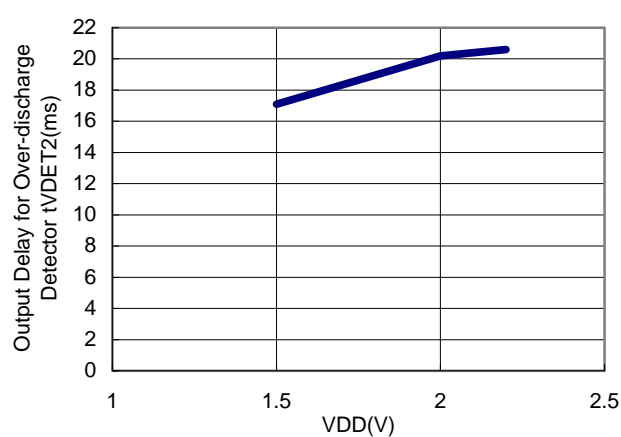
2) Delay Time for Release from Over-charge vs. V<sub>DD</sub>  
V<sub>dd</sub>=3.2V, 3.7V, 4.2V, V<sub>-</sub>=0V to 1V

**R5400x105CA**



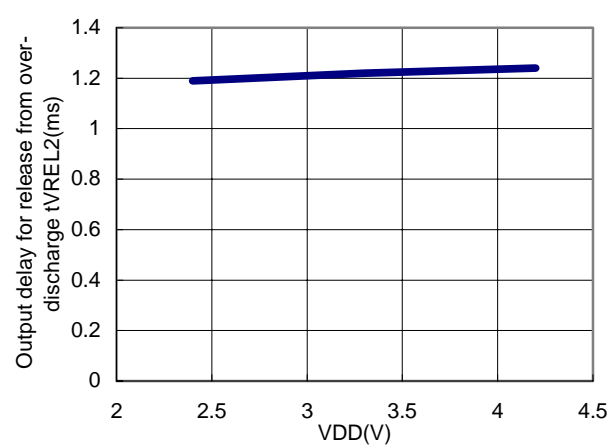
3) Output Delay of Over-discharge detect vs.  $V_{DD}$   
 $V_{-}=0V$ ,  $V_{DD}=3.6V$  to  $2.2V$ ,  $2.0V$ ,  $1.5V$

R5400x105CA



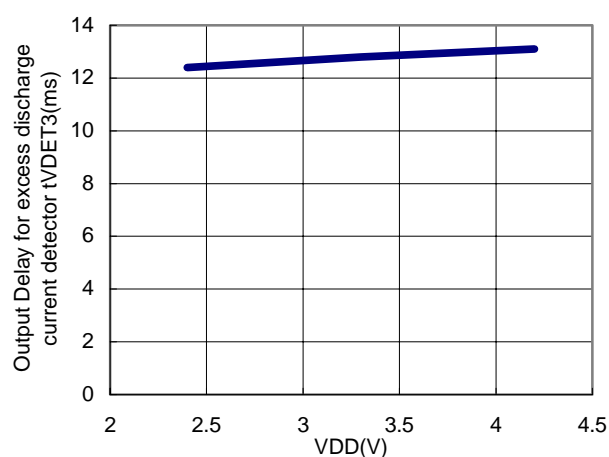
4) Output Delay for Release from Over-discharge vs.  $V_{DD}$   
 $V_{-}=0V$ ,  $V_{DD}=2.2V$  to  $2.4V$ ,  $3.3V$ ,  $4.2V$

R5400x105CA



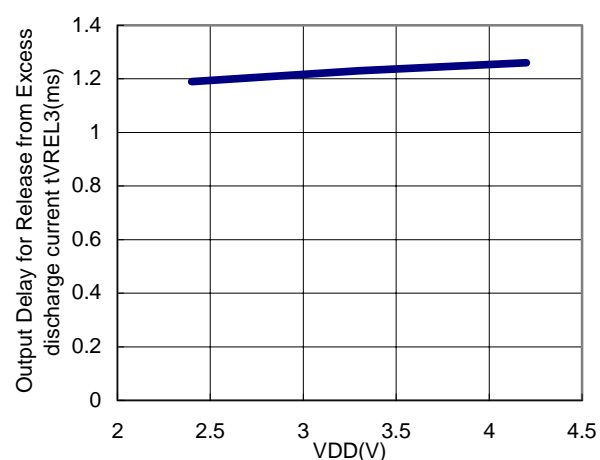
5) Output Delay for Excess Discharge Current vs.  $V_{DD}$   
 $V_{DD}=2.4V$ ,  $3.3V$ ,  $4.2V$ ,  $V_{-}=0V$  to  $1V$

R5400x105CA



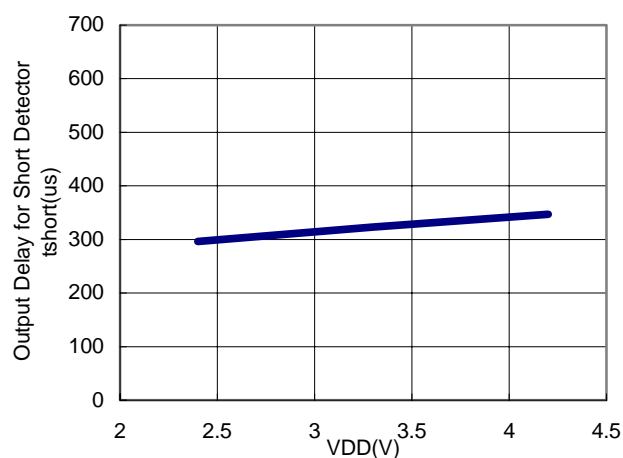
6) Output Delay for Release from Excess Discharge Current Detect vs.  $V_{DD}$   
 $V_{DD}=2.4V$ ,  $3.3V$ ,  $4.2V$ ,  $V_{-}=2.4V$ ,  $3.3V$ ,  $4.2V$  to  $0V$

R5400x105CA



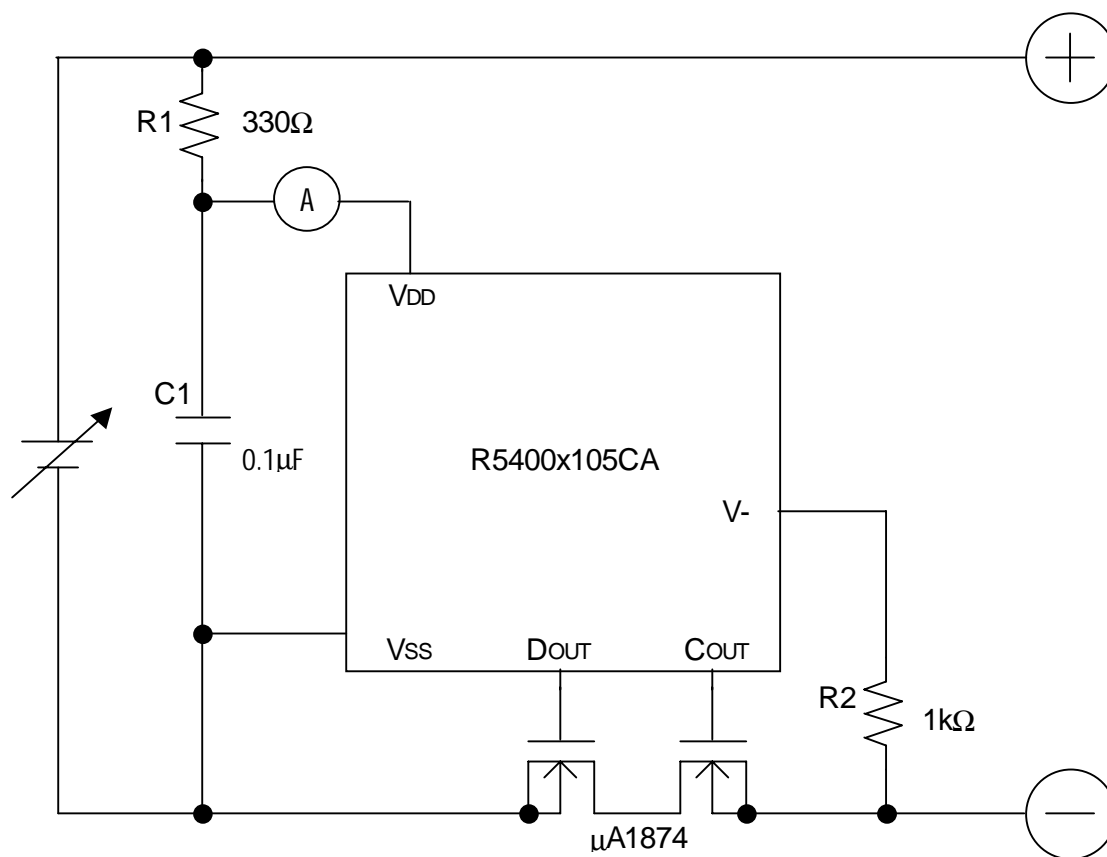
7) Output Delay for Short Detector vs.  $V_{DD}$   
 $V_{DD}=2.4V$ ,  $3.3V$ ,  $4.2V$ ,  $V_{-}=0V$  to  $2.4V$ ,  $3.3V$ ,  $4.2V$

R5400x105CA

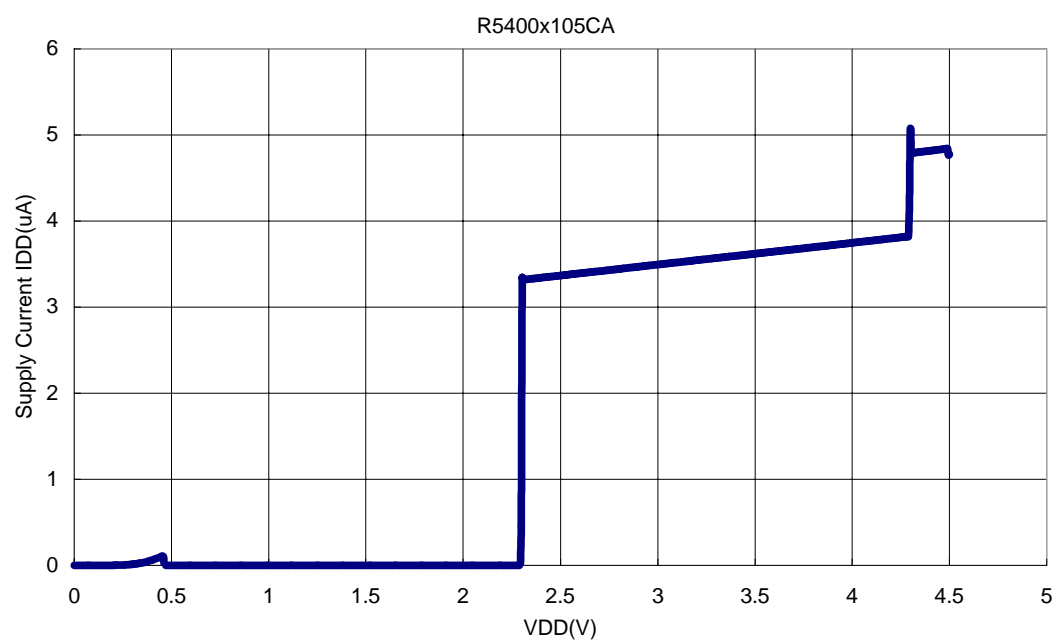


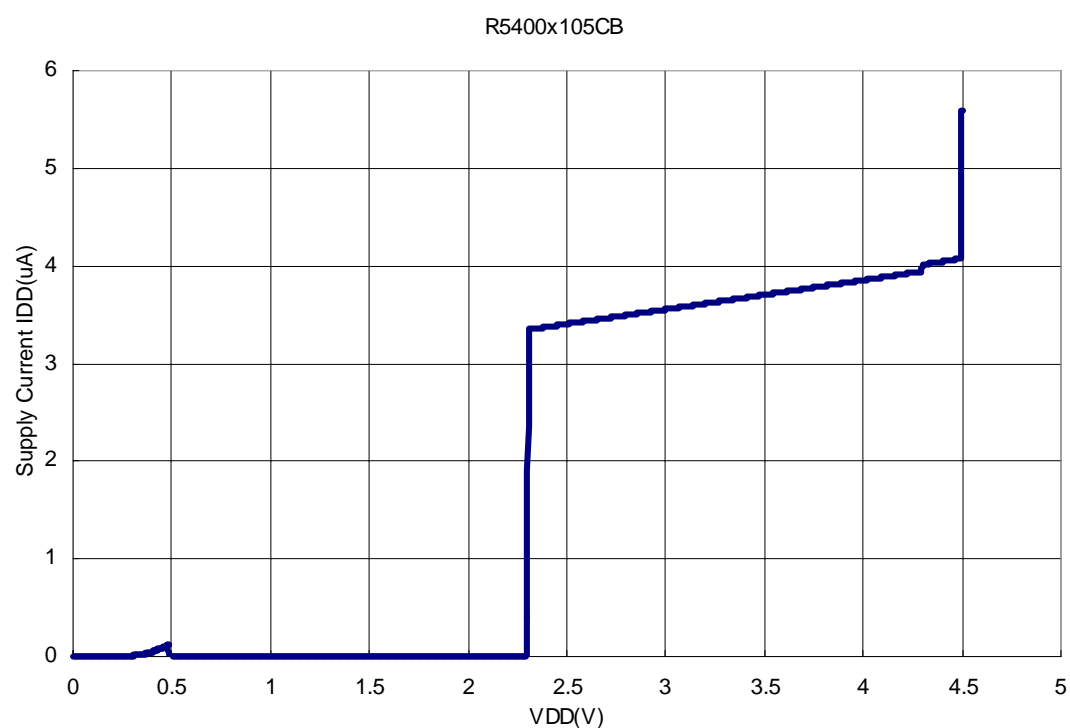
Part 3 Supply Current dependence on  $V_{DD}$

Test Circuit



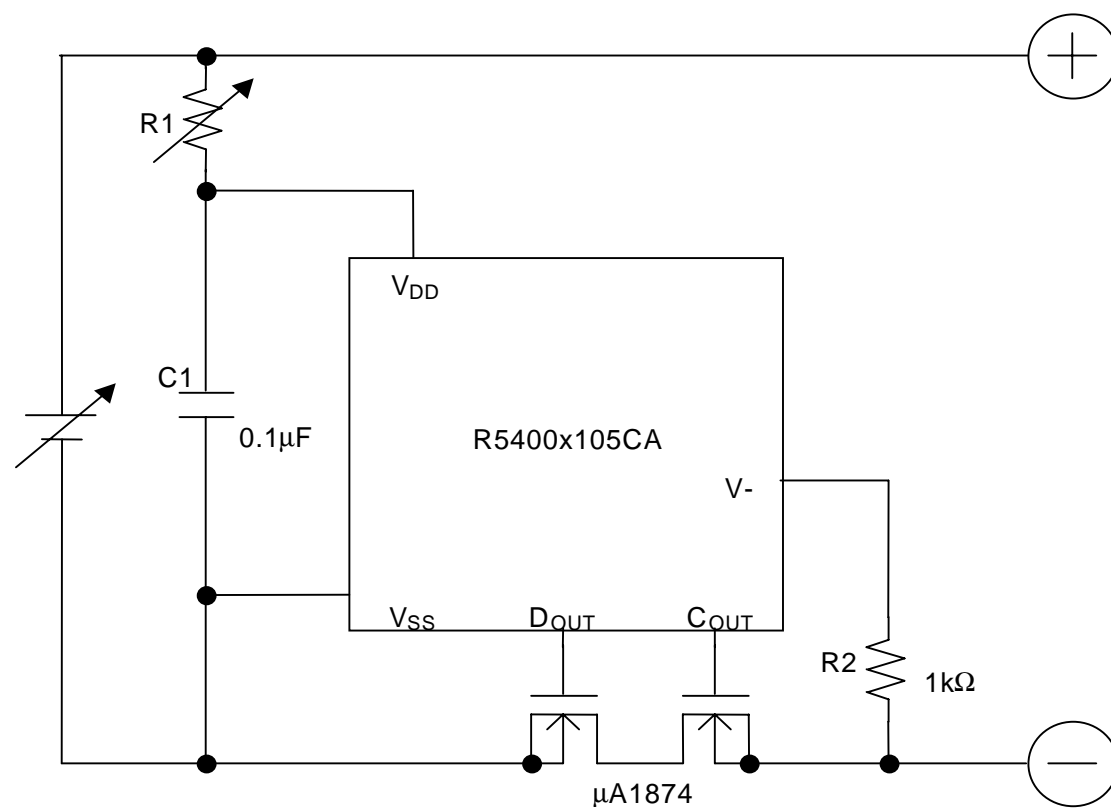
Supply Current vs.  $V_{DD}$



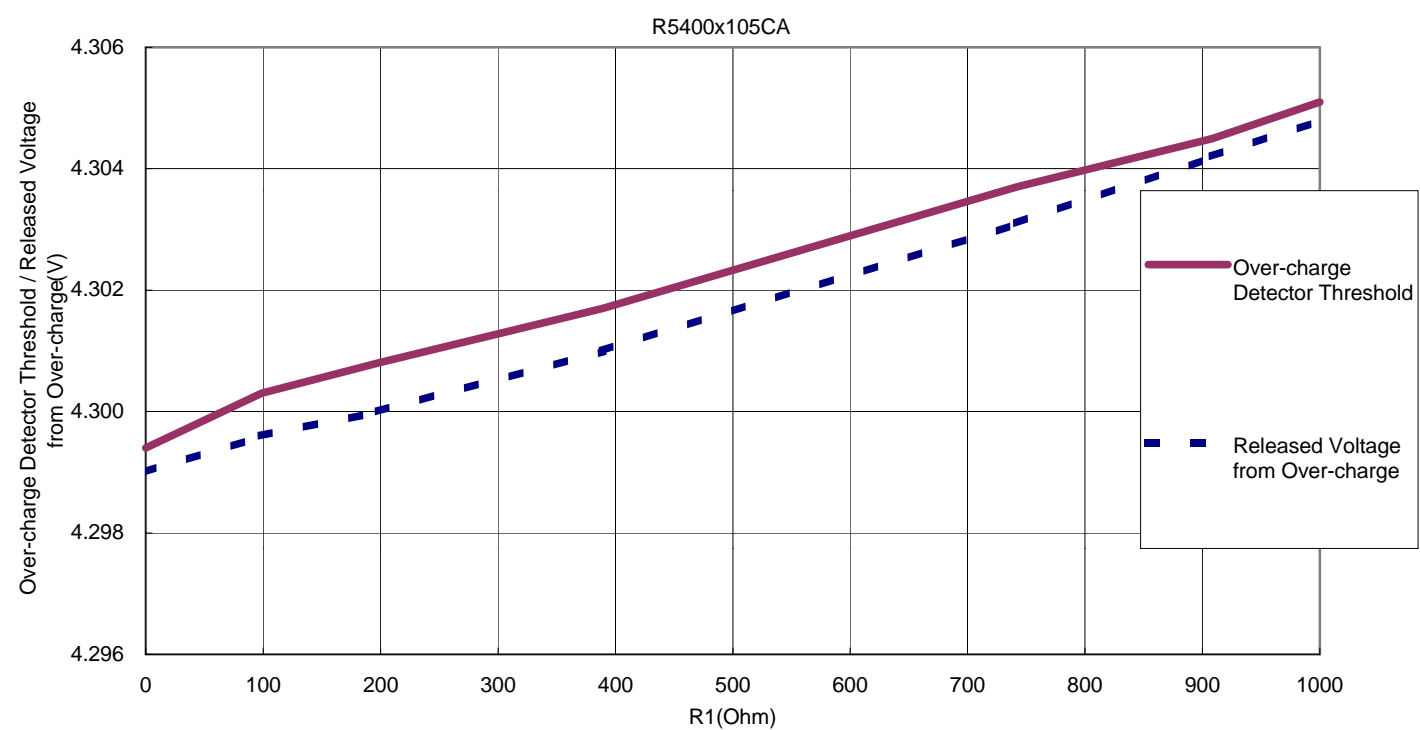


Part 4 Over-charge detector, Release voltage from Over-charge, Over-discharge detector, Release voltage from Over-discharge dependence on External Resistance value

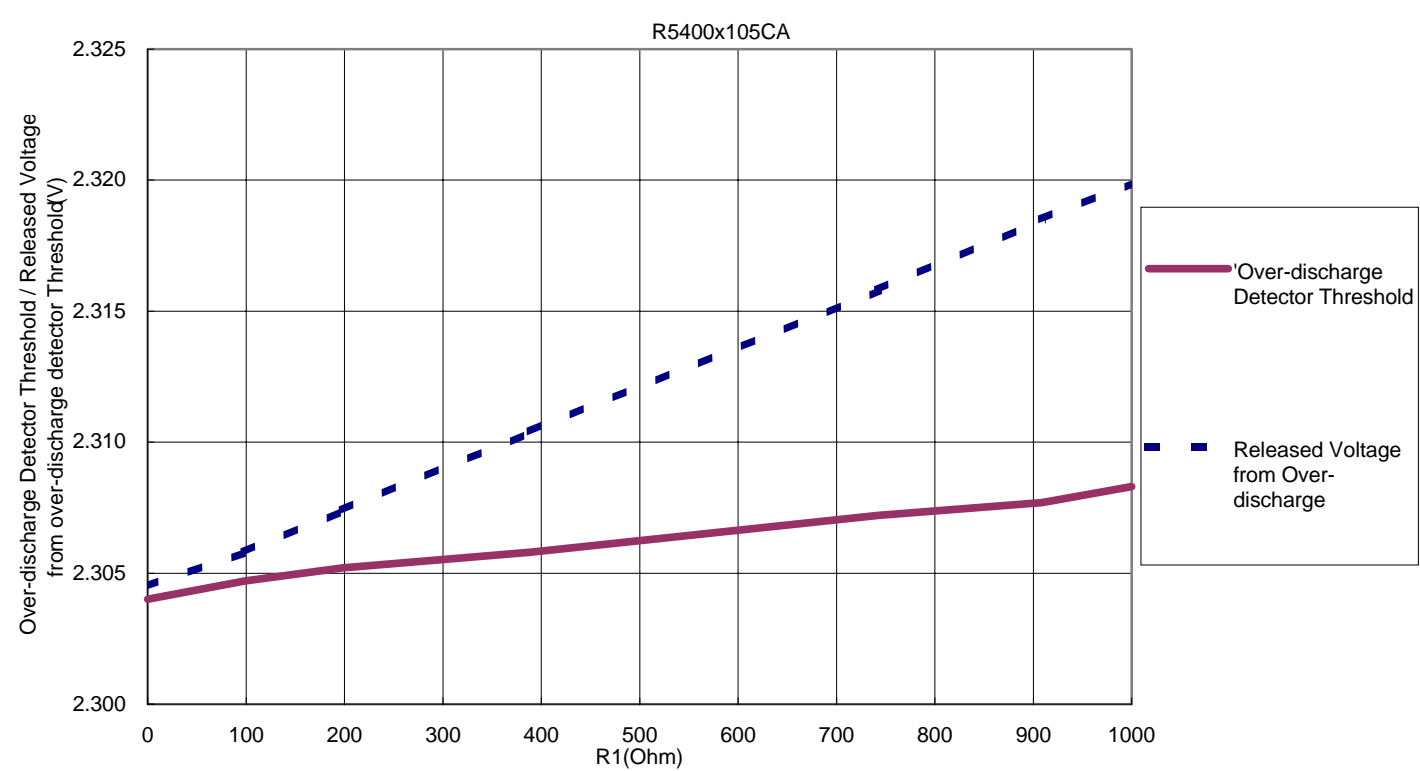
#### Test Circuit



Over-charge Detector Threshold / Released Voltage from Over-charge vs. R1

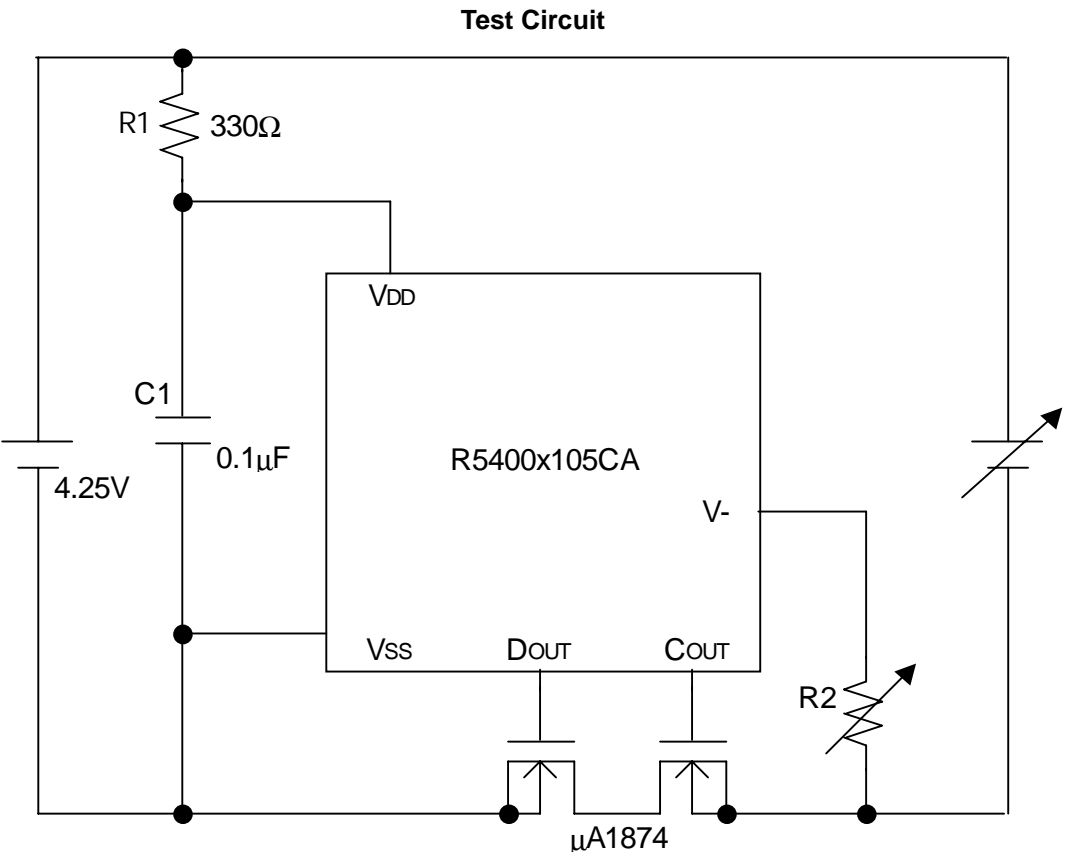


Over-discharge / Released from Over-discharge Threshold vs. R1

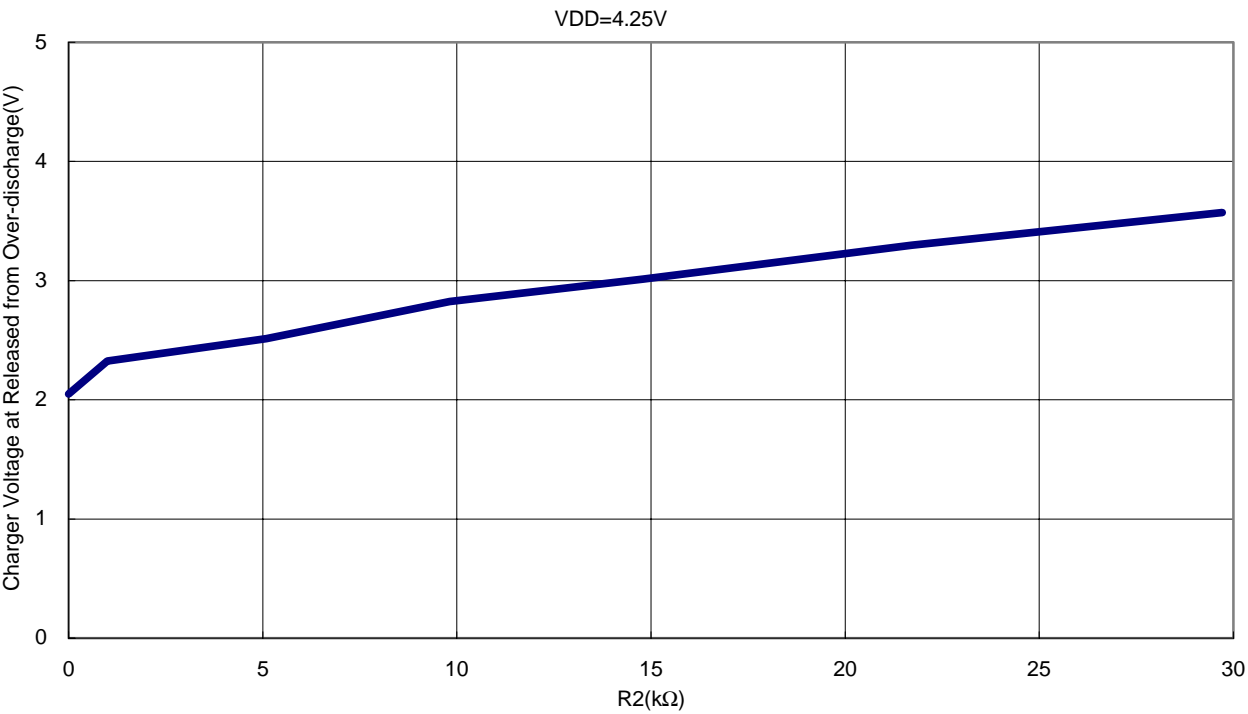




Part 5    Charger Voltage at Released from Over-discharge with a Charger dependence on R2



Charger Voltage at Release from Over-discharge with a charger vs. R2





MOSFET SPEC.

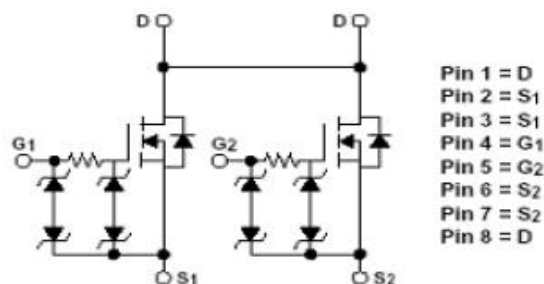


## NF216LF

### Dual N-Channel MOSFET – ESD Protected

#### General Description

- Specially designed for Li-Ion battery packs and battery switch applications
- Pb Free TSSOP-8 package

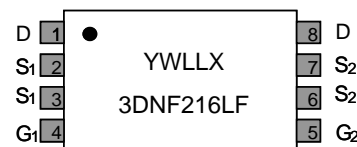


#### Features

- 6.5A, 4.5V  $R_{D(ON)} = 22m\Omega$
- 5.5A, 2.5V  $R_{D(ON)} = 30m\Omega$
- Integrated gate diodes provide Electro Static Discharge (ESD) protection of 4000V Human Body Model (HBM).



TSSOP-8



Top view

YWLLX = Year, Week, Lot#, Sub lot

#### Maximum Ratings and Thermal Characteristics ( $T_A=25^\circ\text{C}$ unless otherwise noted)

Parameter	Symbol	Limit	Unit
Drain-Source Voltage	$V_{DS}$	20	V
Gate-Source Voltage	$V_{GS}$	+/- 12	
Continuous Drain Current <sup>1</sup>	$I_D$	6.5	A
Pulsed Drain Current <sup>2</sup>	$I_{DM}$	30	
Maximum Power Dissipation <sup>1</sup>	$T_A=25^\circ\text{C}$	$P_D$ 1.5	W
	$T_A=70^\circ\text{C}$	0.96	
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	-55 to 150	$^\circ\text{C}$
Junction-to-Ambient Thermal Resistance <sup>3</sup>	$t < 10 \text{ sec}$	$R_{thJA}$ 83	$^\circ\text{C/W}$
	Steady-State	$R_{thJA}$ 120	
Junction-to-Foot (Drain) Thermal Resistance <sup>3</sup>		$R_{thJF}$ 70	

Notes: 1. Surface mounted on FR4 board.  $t < 10 \text{ s}$ .

2. Pulse test; pulse width  $< 300 \mu\text{s}$ , duty cycle  $< 2\%$ .

3. Surface mounted on FR4 board.

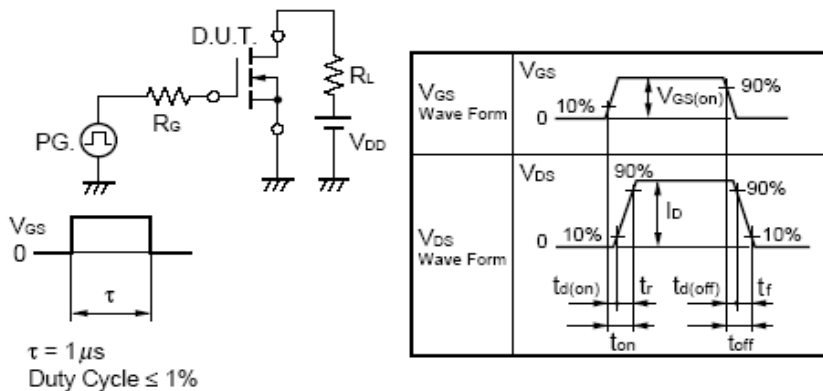


## Third Dimension Semiconductor

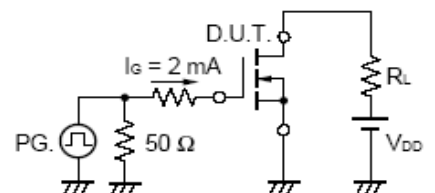
Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Static <sup>1</sup>						
Drain-Source Breakdown Voltage	BV <sub>DSS</sub>	V <sub>GS</sub> = 0V, I <sub>D</sub> = 250uA	20	-	-	V
Drain-Source On-State Resistance	R <sub>DS(on)</sub>	V <sub>GS</sub> = 4.5V, I <sub>D</sub> = 6.5A	-	17	22	mΩ
		V <sub>GS</sub> = 3.5V, I <sub>D</sub> = 6A	-	19	23	
		V <sub>GS</sub> = 2.5V, I <sub>D</sub> = 5.5A	-	25	30	
Gate Threshold Voltage	V <sub>GS(th)</sub>	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250uA	0.5	1	-	V
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>GS</sub> = 0V, V <sub>DS</sub> = 20V	-	-	10	uA
Gate Body Leakage	I <sub>GSS</sub>	V <sub>DS</sub> = 0V V <sub>GS</sub> = +/-12V	-	-	+/-10	uA
On State Drain Current	I <sub>D(on)</sub>	V <sub>DS</sub> = > 5V, V <sub>GS</sub> = 4.5V	30	-	-	A
Forward Transconductance	gfs	V <sub>DS</sub> = 10V, I <sub>D</sub> = 6.5A	-	25	-	S
Dynamic						
Total Gate Charge	Q <sub>g</sub>	V <sub>DS</sub> = 10V, I <sub>D</sub> = 6.5A, V <sub>GS</sub> = 4.5V	-	15.5	30	nC
Gate-Source Charge	Q <sub>gs</sub>		-	2	-	
Gate-Drain Charge	Q <sub>gd</sub>		-	3.5	-	
Turn-On Delay Time	t <sub>d(on)</sub>	V <sub>DD</sub> = 10V, R <sub>L</sub> = 10 ohms, I <sub>D</sub> = 1A, V <sub>GEN</sub> = 4.5V, R <sub>G</sub> = 6 ohms	-	75	100	nS
TurnOn Rise Time	t <sub>r</sub>		-	125	150	
Turn-Off Delay Time	t <sub>d(off)</sub>		-	600	720	
Turn-Off Fall Time	t <sub>f</sub>		-	300	360	
Input Capacitance	C <sub>iss</sub>	V <sub>DS</sub> = 10V, V <sub>GS</sub> = 0V, f = 1 MHz <sub>Z</sub>	-	1360	-	
Output Capacitance	C <sub>oss</sub>		-	220	-	
Reverse Transfer Capacitance	C <sub>rss</sub>		-	130	-	
Source Drain Diode <sup>1</sup>						
Max. Diode Forward Current	I <sub>S</sub>		-	-	1.5	A
Diode Forward Voltage	V <sub>SD</sub>	I <sub>S</sub> = 1.5A, V <sub>GS</sub> = 0V	-	0.71	1.2	V

Note: 1 Pulse test; pulse width < 300 μs, duty cycle < 2%.

### TEST CIRCUIT 1 SWITCHING TIME



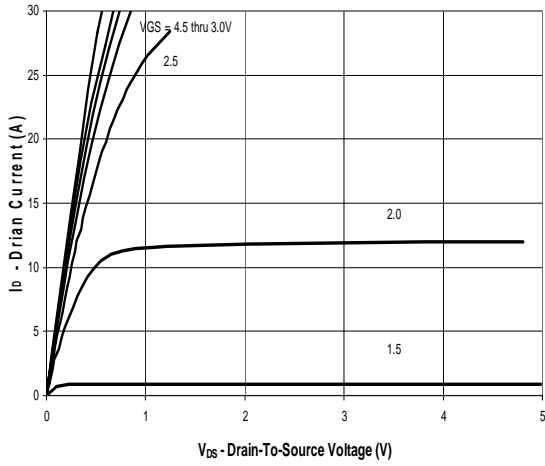
### TEST CIRCUIT 2 GATE CHARGE



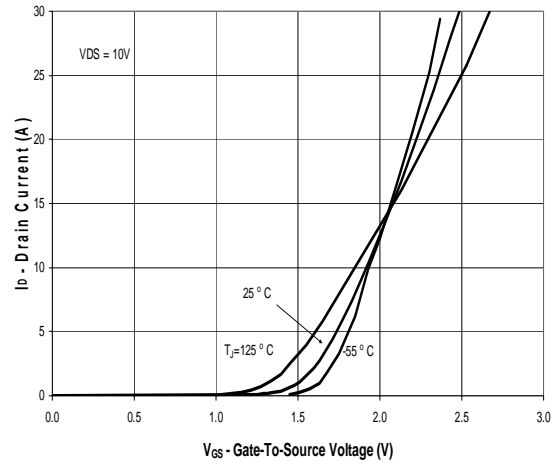


# Third Dimension Semiconductor

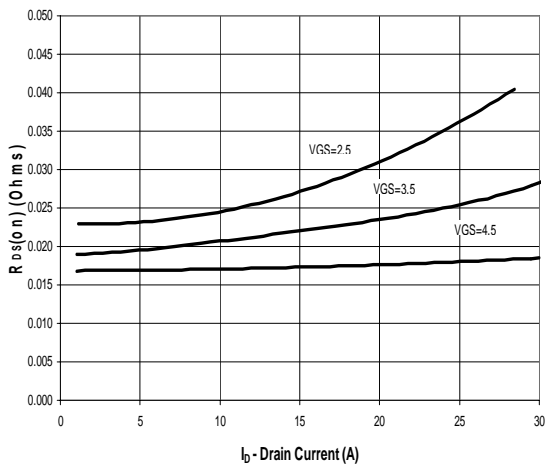
Output Characteristics



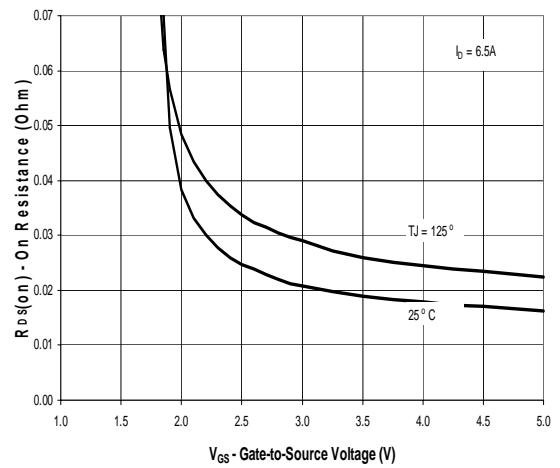
Transfer Characteristics



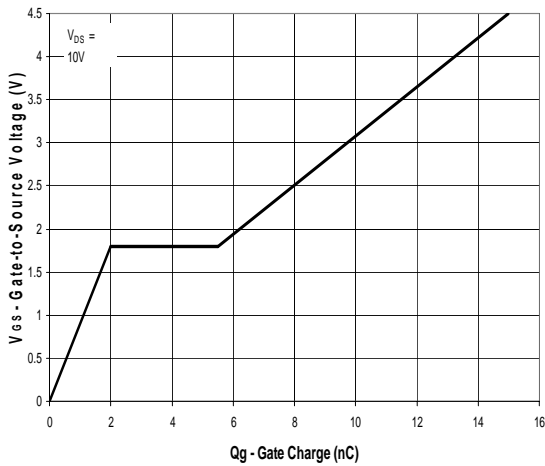
On Resistance Vs. Drain Current



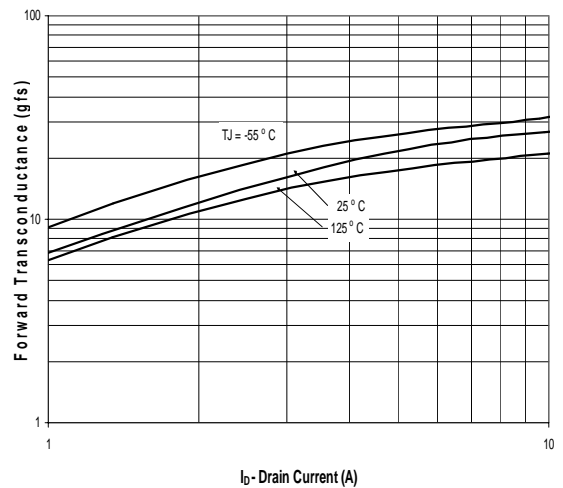
On Resistance Vs. Gate-to-Source Voltage



Gate Charge



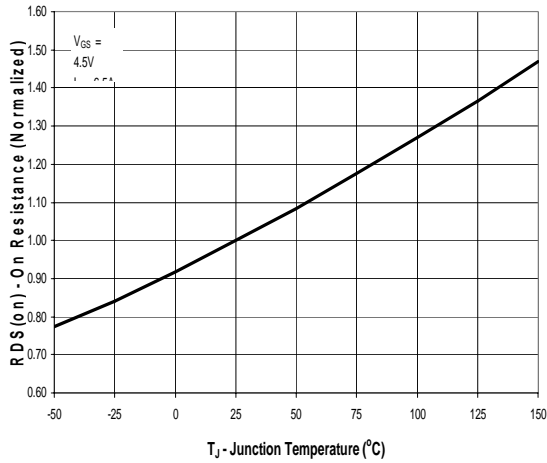
Forward Transconductance Vs. Drain Current



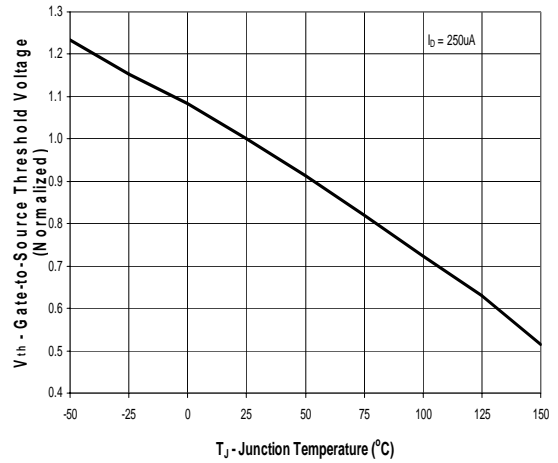


# Third Dimension Semiconductor

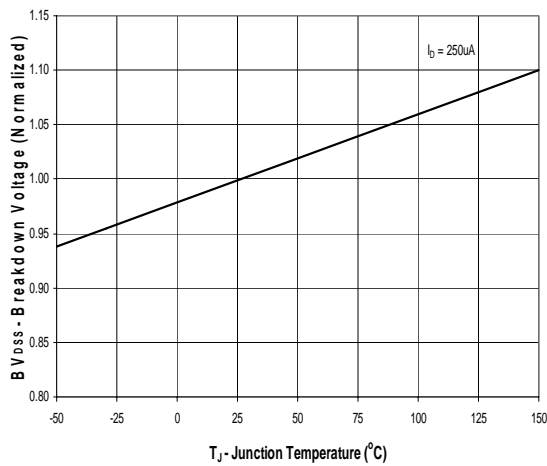
On Resistance Vs. Junction Temperature



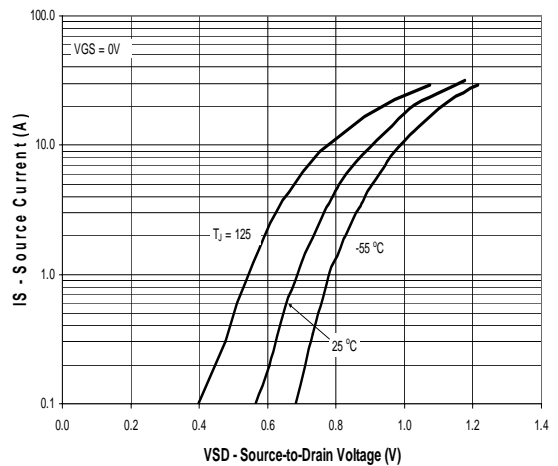
Threshold Voltage Vs. Temperature



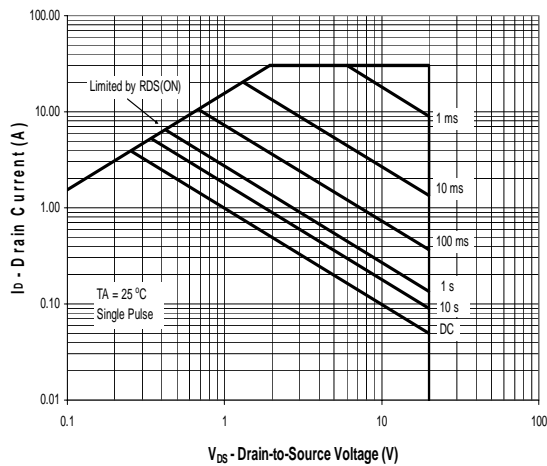
Breakdown Voltage Vs. Junction Temperature



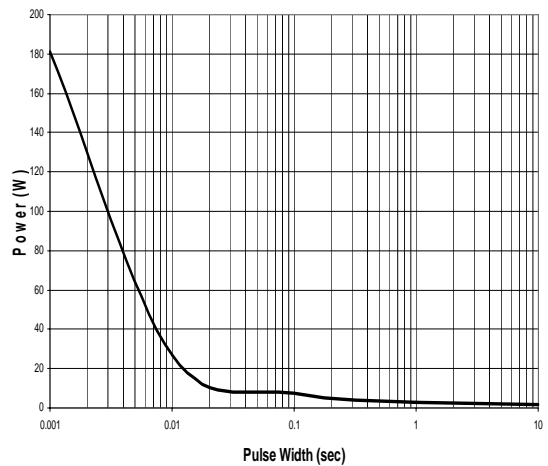
Source Drain Diode Forward Voltage



Safe Operating Area, Junction-to-Ambient



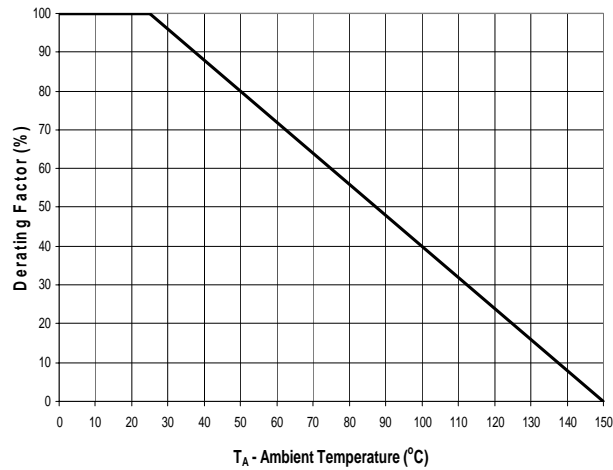
Single Pulse Power



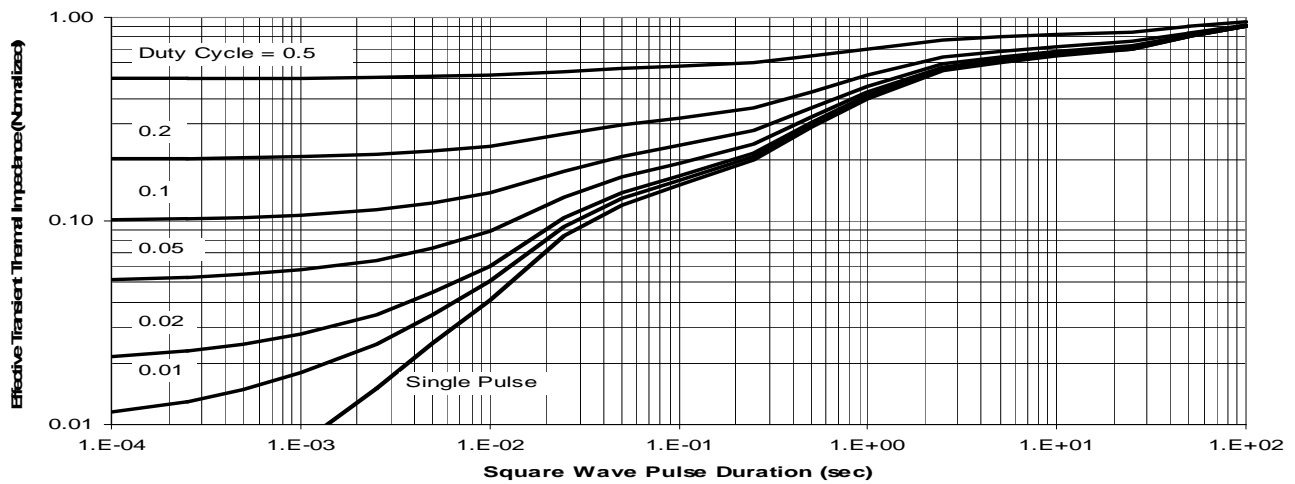


# Third Dimension Semiconductor

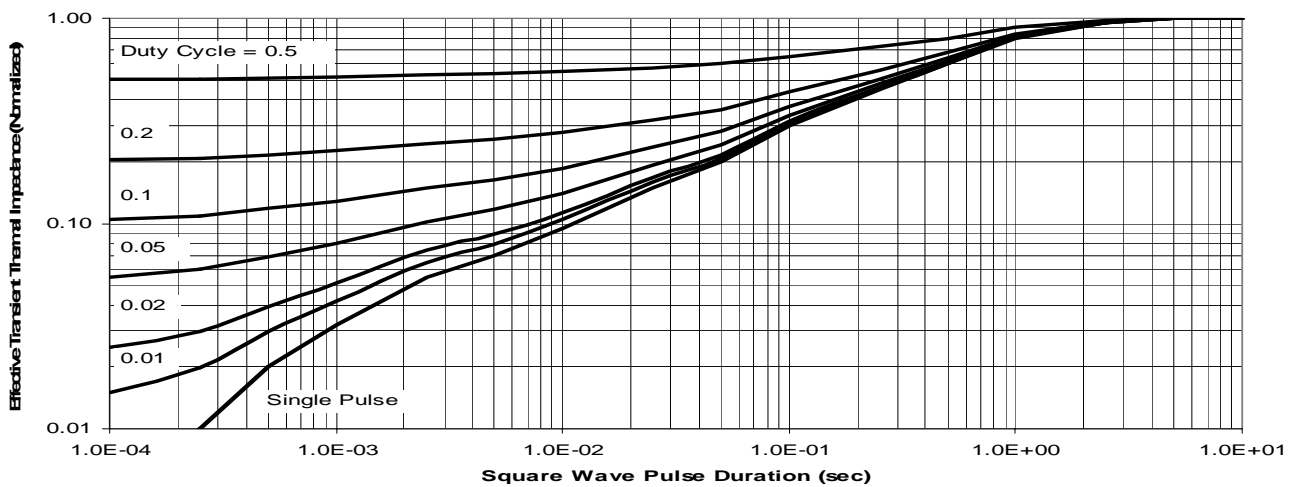
Derating Factor for Forward Bias Safe Operating Area



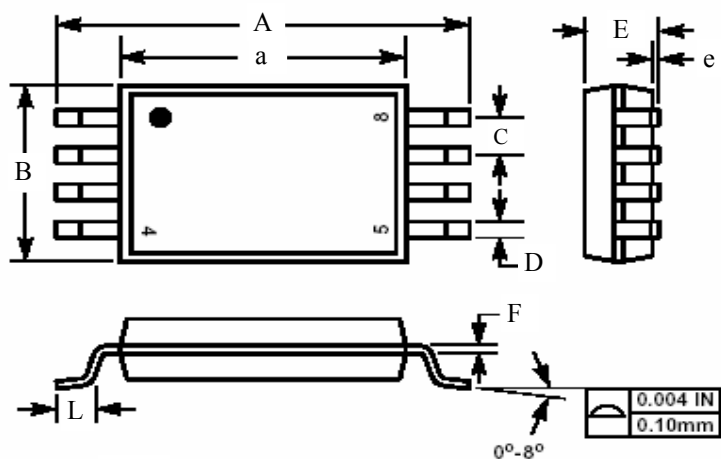
Normalized Transient Thermal Impedance, Junction-to-Ambient



Normalized Transient Thermal Impedance, Junction-to-Foot

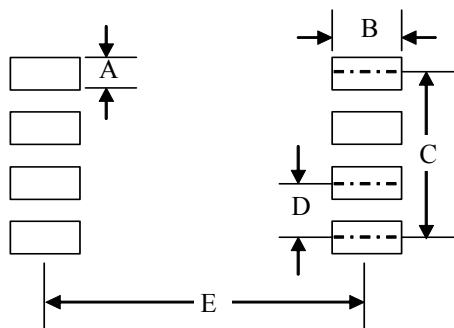


## Package Outline



Symbol	inches		Millimeters	
	Min	Max	Min	Max
A	0.244	0.260	6.20	6.60
a	0.170	0.177	4.30	4.50
B	0.114	0.122	2.90	3.10
C	0.025BSC		0.65BSC	
D	0.010	0.012	0.25	0.30
E	0.041	0.047	1.05	1.20
e	0.002	0.006	0.05	0.15
F	0.005		0.127	
L	0.020	0.028	0.50	0.70
REF	MO-153AA			

## Mounting Pad Layout



Symbol	inches		Millimeters	
	Min	Max	Min	Max
A	0.01	0.012	0.25	0.30
B	0.020	0.028	0.50	0.70
C	0.077	-	1.95	-
D	0.025	-	0.65	-
E	0.260	-	6.60	-

THERE ARE NO IMPLIED OR EXPRESSED WARRANTIES. ANY AND ALL WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NON-INFRINGEMENT OF THIRD PARTY RIGHTS ARE EXPRESSLY DISCLAIMED.





PTC Spec.

**Tyco / Electronics**  
**Raychem Circuit Protection**  
 308 Constitution Drive  
 Menlo Park, CA 94025-1164  
 Phone 800-227-4856  
 Fax 800-227-4866

**PolySwitch®**  
**PTC Devices**  
 Overcurrent Protection Device

**PRODUCT: VLR170F**

DOCUMENT: SCD26025  
 PCN: D91020  
 REV LETTER: A  
 REV DATE: JANUARY 12, 2005  
 PAGE NO.: 1 OF 1

**Specification Status: Released**

**Maximum Electrical Rating**

**Operating Voltage: 12Vdc**

**Interrupt Current: 100A**

Chip Size: 3.6 X 10mm

Leads: Nickel 1/4H  
 0.125mm nominal thickness

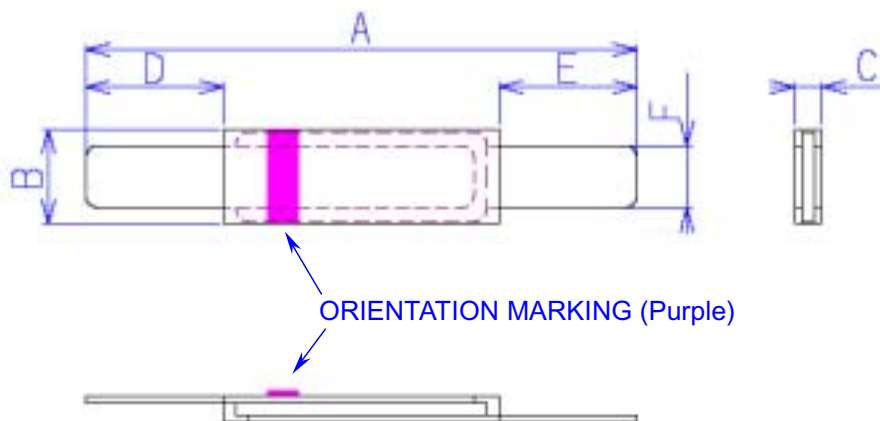
Tape: Polyester (White)  
 11.0 mm nominal width

Solder: Lead-free

Lot Marking Ink Color: Green

Marking:

— Manufacturer's Mark  
 ✕ R17 — Part Identification  
 □ □ □ □ — Lot Identification



ORIENTATION MARKING (Purple)

**TABLE I. DIMENSIONS:**

	A		B		C		D		E		F	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
mm:	20.8	23.2	3.5	3.9	---	0.8	4.5	6.5	4.5	6.5	2.4	2.6
in*:	(0.82)	(0.91)	(0.14)	(0.15)	--	(0.03)	(0.18)	(0.26)	(0.18)	(0.26)	(0.09)	(0.10)

\*Rounded off approximation

**TABLE II. PERFORMANCE RATINGS: As measured in Mueller Kelvin Clips model BU-75K.**

I HOLD	CURRENT TRIP LIMITS								TIME TO TRIP		REFERENCE RESISTANCE		ONE-HOUR POST-TRIP RESISTANCE		TRIPPED-STATE POWER DISSIPATION	
AMPS 25°C HOLD	AMPS AT 0°C		AMPS AT 25°C		AMPS AT 60°C		AMPS AT --°C		SECONDS AT 25°C, 8.5A		OHMS AT 25°C		OHMS AT 25°C		WATTS AT 25°C, 12V	
	HOLD	TRIP	HOLD	TRIP	HOLD	TRIP	HOLD	TRIP	MIN	MAX	MIN	MAX	MIN	MAX		MAX
1.7	2.4	5.6	1.7	4.1	0.7	1.9	---	---	---	5	0.018	0.032	0.018	0.064	---	1.4

Agency Recognitions:  
 Reference Documents:  
 Precedence:  
 Effectivity:  
 CAUTION:  
 Materials Information:

UL, TUV, CSA  
 PS300  
 This specification takes precedence over documents referenced herein.  
 Reference documents shall be the issue in effect on the date of invitation for bid.  
 Operation beyond the rated voltage or current may result in rupture, electrical arcing or flame.

**ROHS Compliant**

Directive 2002/95/EC  
 Compliant

**ELV Compliant**

Directive 2000/53/EC  
 Compliant

**Pb-Free**





TH Spec.

Chip Thermistor Specification		Drawing No.	Page
		RF-AP-0130E	1/2
Type	TN11 Series	Date	November 13, 2000

#### 1.Scope of Application

This specification is applied to chip thermistors(TN11 Series).

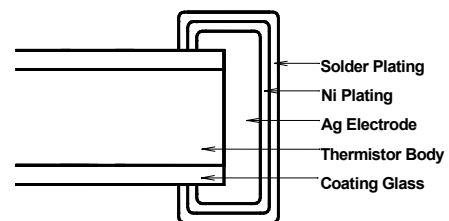
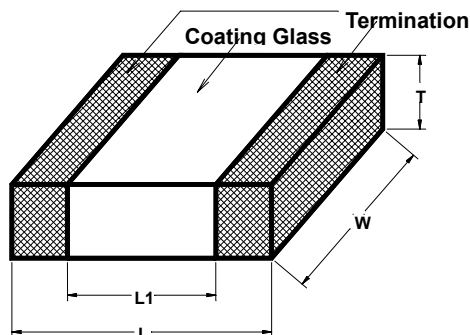
#### 2.Part Numbering System

(Ex.) TN11 - 3V 103 J T  
(1) (2) (3) (4) (5)

#### 3.Specification

No.	Item	Symbol	Specification
(1)	Series	TN11	TN11 series
(2)	Nominal B-value	3V	※ Table 1 B-value 25℃ to 50℃  $B_{25/50} = \left( \frac{1}{25+273.15} - \frac{1}{50+273.15} \right)^{-1} \ln \frac{R_{25}}{R_{50}}$ <i>R</i> <sub>25</sub> :zero-power resistance at 25℃ <i>R</i> <sub>50</sub> :zero-power resistance at 50℃
(3)	Nominal zero-power resistance	103	※ Table 1 zero-power resistance at 25℃
(4)	Tolerance of nominal zero-power resistance	J	J :±5 %
(5)	Packaging form	T	Tape package 4000pcs./reel
		B	Bulk package 500pcs./bag

#### 4.Size and Dimensions



L(mm)	W(mm)	T(mm)	L1(mm)
1.60±0.15	0.80±0.15	0.70max.	0.3min.

Table 1 Resistance and B-value  
of Chip Thermistor (TN11 Series)

Part Number TN11-	Resistance ( k $\Omega$ )	B-value ( K )	Tolerance of B-value
3H103	10	3370	$\pm 3\%$
3V103	10	3910	
4C153	15	4110	
3T223	22	3820	
3K333	33	3480	
3J473	47	3440	
4B473	47	4050	
3K683	68	3500	
3M104	100	3590	
4H104	100	4360	
3R154	150	3680	

<i>Chip Thermistor Characteristics Specification</i>		<i>Drawing No.</i>	<i>Page</i>
		<i>RF-AQ-0022E</i>	<i>1/3</i>
<i>Type</i>	<i>TN11 Series</i>	<i>Date</i>	<i>December 24, 1999</i>

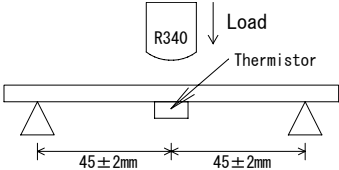
*1. Scope of Application*

*This specification is applied to chip thermistors(TN11 series).*

*2. Mechanical Quality*

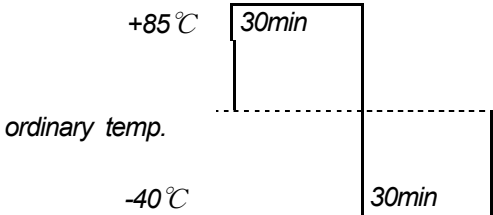
<i>Item</i>	<i>Test method</i>	<i>Performance</i>
2-1. <i>Resistance to Soldering Heat Test</i>	<i>Immerse into melted solder.</i> <i>Solder: H-63A</i> <i>Flux:Rosin 25wt%</i> <i>Soldering temperature: 260°C±5°C</i> <i>Duration of immersion:10sec.±1sec.</i> <i>Preheating: 150°C, 1min.</i> <i>(According to JIS C 2571 )</i>	<i>Visual:</i> <i>No mechanical damage</i> <i>Zero-power resistance</i> <i>at 25°C</i> <i>Change as against pretest</i> <i>values within ±10%</i>
2-2. <i>Solderability Test</i>	<i>Immerse into melted solder.</i> <i>Solder: H-63A</i> <i>Flux: Rosin 25wt%</i> <i>Soldering temperature: 235°C±5°C</i> <i>Duration of immersion: 5sec.±1sec.</i> <i>Preheating: 150°C, 1min.</i> <i>(According to JIS C 2571 )</i>	<i>At least 75% of the electrode</i> <i>on each end of the ceramic</i> <i>chip must be covered with</i> <i>new solder.</i>
2-3. <i>Vibration Test</i>	<i>Vibration frequency: 10 to 55Hz</i> <i>Full amplitude: 1.5mm</i> <i>10 to 55 to 10Hz about 1 min./cycle</i> <i>In each X,Y,Z direction 2 hrs.</i> <i>Total 6 hrs.</i> <i>(According to JIS C 2571 )</i>	<i>Visual:</i> <i>No mechanical damage</i> <i>Zero-power resistance</i> <i>at 25°C</i> <i>Change as against pretest</i> <i>values within ±10%</i>
2-4. <i>Adhesion</i>	<i>The pressurizing force shall be 5N</i> <i>(0.5 kgf) and the duration of</i> <i>application shall be 10±1 sec.</i> <i>(According to JIS C 6429 )</i>	<i>Visual:</i> <i>No mechanical damage</i>

Chip Thermistor Characteristics Specification	Drawing No.	Page
	RF-AQ-0022E	2/3

Item	Test method	Performance
2-5. Resistance to flexure of substrate	<p>The substrate shall be so placed with its surface on which thermistor is mounted downwards that the center of thermistor coincides with the center of support as illustrated in fig. 1.</p>  <p>Fig. 1. Testing Condition</p> <p>The middle part of substrate shall, successively, be pressurized by means of the pressurizing rod at a rate of about 1 mm/sec until the deflection becomes 1 mm and then the pressure shall be maintained for 5 sec. Then the thermistor shall be measured with the pressure applied. After the measurement the pressurizing force is removed and the substrate is taken out from the test stand.</p> <p>(According to JIS C 6429 )</p>	<p>Visual: No mechanical damage Zero-power resistance at 25°C Change as against pretest values within ±10 %</p>

Chip Thermistor Characteristics Specification	Drawing No.	Page
	RF-AQ-0022E	3/3

### 3. Climatic Quality

Item	Test method	Performance
3-1. Dry Heat Test	Test temperature: $125^{\circ}\text{C} \pm 2^{\circ}\text{C}$ Test duration: 1000hrs. +48/-0hrs. After completion of the test, allow the sample to stand under the standard conditions for at 24hrs. $\pm 2$ hrs. (According to JIS C 2571 )	Zero-power resistance at $25^{\circ}\text{C}$ : Change as against pretest values within $\pm 10\%$
3-2. Cold Test	Test temperature: $-40^{\circ}\text{C} \pm 3^{\circ}\text{C}$ Test duration: 1000hrs. +48/-0hrs. After completion of the test, allow the sample to stand under the standard conditions for at 24hrs. $\pm 2$ hrs. (According to JIS C 2571 )	Zero-power resistance at $25^{\circ}\text{C}$ : Change as against pretest values within $\pm 10\%$
3-3. Damp Heat Test (Steady State)	Test temperature: $40^{\circ}\text{C} \pm 2^{\circ}\text{C}$ Test duration: 500hrs. +24/-0hrs. Test relative humidity: 90%~95% After completion of the test, allow the sample to stand under the standard conditions for at 24hrs. $\pm 2$ hrs. (According to JIS C 2571 )	Zero-power resistance at $25^{\circ}\text{C}$ : Change as against pretest values within $\pm 10\%$
3-4. Thermal Shock Test	 <p>Fig. 2. Operations per One Cycle</p> <p>One cycle is the operation shown in Fig. 2. This cycle is repeated 25 times. After completion of the test, allow the sample to stand under the Standard conditions for at 24hrs. <math>\pm 2</math>hrs. Material of testing substrate is glass fabric base epoxy resin (specified in JIS 6484 or equivalent)</p> <p>(According to JIS C 2571 )</p>	Visual: No mechanical damage Zero-power resistance at $25^{\circ}\text{C}$ : Change as against pretest values within $\pm 10\%$



Chip Thermistor Packaging Specification		Drawing No.		Page
		RF-AR-0012E		1/3
Type	TN11,TH11 Series	Date	July 26,1999	

### 1.Scope of application

This specification is applied to thermistors.(TN11,TH11 series)

### 2.Packaging(Bulk package)

Bulk Packaging must be made so that thermistors must not be damaged during transportation or custody.

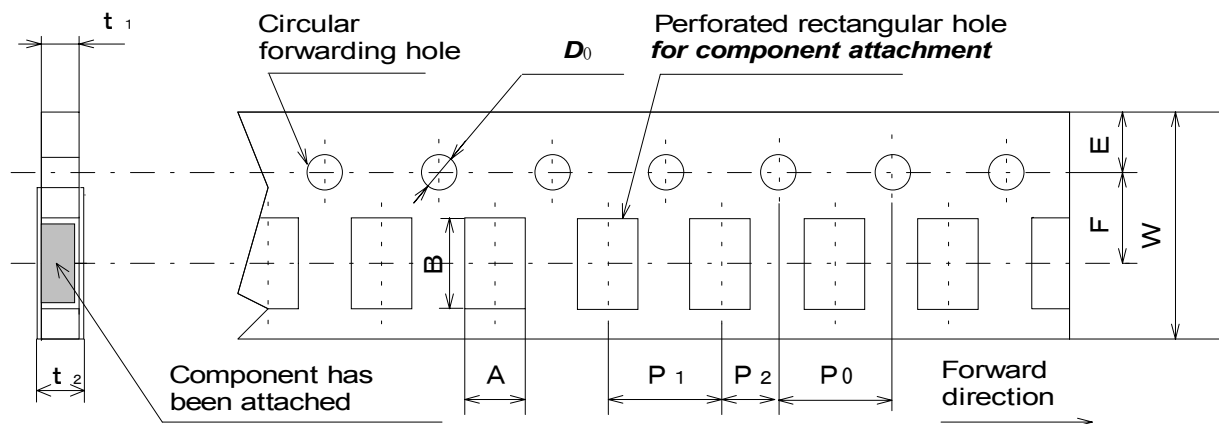
Packaging quantity 500 (pcs./Bag)

#### 2-1.Items described on label

- (1) Product name
- (2) Part No.
- (3) Inspec.No.
- (4) Quantity

### 3.Packaging ( Tape package )

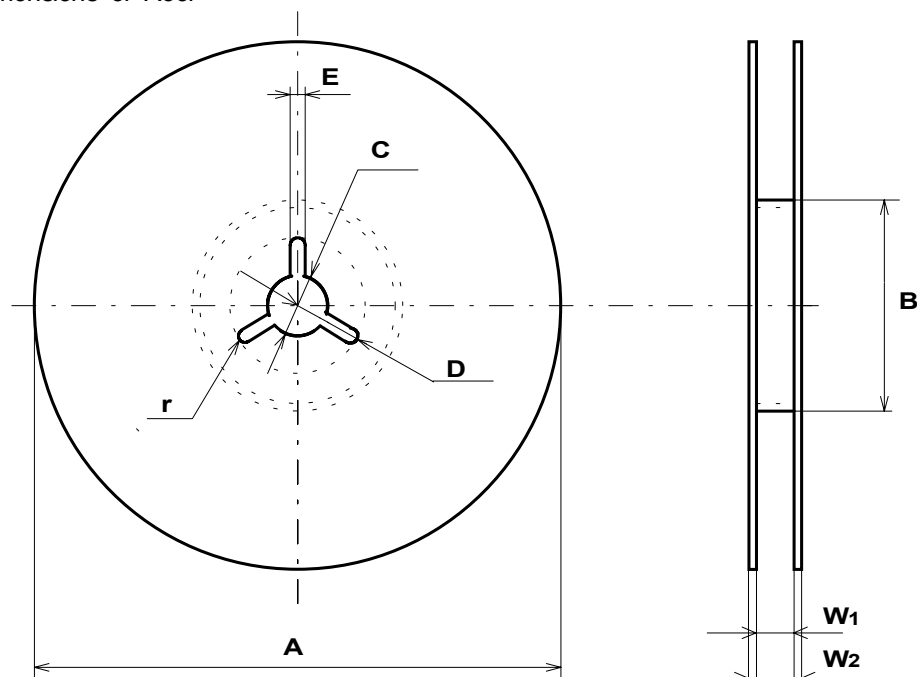
#### 3-1.Dimensions of Taping



Unit:mm

A	B	W	F	E	P1	P2	P0
1.1 ±0.2	1.9 ±0.2	8.0 ±0.3	3.5 ±0.05	1.75 ±0.1	4.0 ±0.1	2.0 ±0.05	4.0 ±0.1
D0	t1	t2	Insert hole				
φ 1.5 +0.1 -0	1.1 or less	1.4 or less	Perforated rectangular holes				

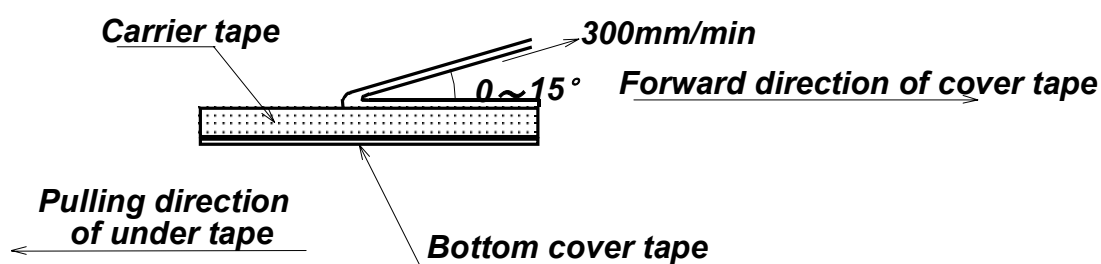
## 3-2.Dimensions of Reel



Unit:mm

Symbol	A	B	C	D	E	W1	W2	r
RRM08B	$\phi 180$	$\phi 60$	$\phi 13.0$	R10.5	2.0	9.0	11.4	0.5
	+ 0 - 3	+ 1 - 0	$\pm 0.2$	$\pm 0.4$	$\pm 0.5$	$\pm 0.3$	$\pm 1.0$	

## 3-3.Peel Force of Top Cover Tape



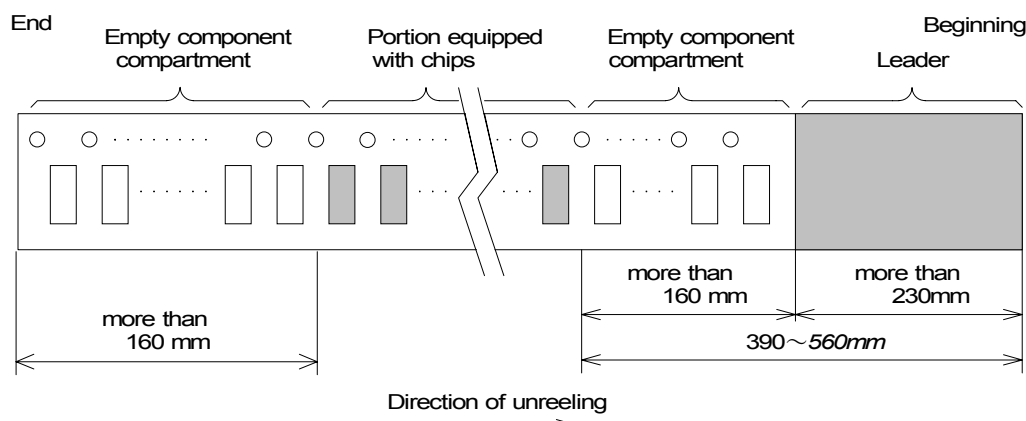
In the case, the top cover tape is pulled off under the above conditions.  
The peel force of the top cover tape should be as the following table.

kind of tape	peel force
top cover tape	0.196N~0.588N

Chip Thermistor Packaging Specification	Drawing No.	Page
	RF-AR-0012E	3/3

### 3-4. Structure of Taping

Taping must have Leader and empty component compartments as shown in the following rough sketch.



- (1) Chips should not be stick on both the top cover tape and the bottom cover tape.
- (2) When the top cover tape is released, the adhesive should remain on the cover tape.
- (3) When the top cover tape is released, there should not be any difficulty in taking out the chip from the tape because of clearance troubles. Also there should not be any tape troubles that will cause pick-up troubles because of nozzle clogging.

### 3-5. Packaging quantity

4000 ( pcs./Reel )

### 3-6. Items described on shipping label

- (1) Ordered part number (PART NO)
- (2) Packaging quantity (QUANTITY)
- (3) Recieved order number (SERIAL)
- (4) Part number (ITEM)

### 3-7. Items described on shipping box

- (1) Recieved order number (PACKAGE ID)
- (2) Number of shipping box (PACKAGE COUNT)
- (3) Packaging quantity (QUANTITY)
- (4) Order number (TRANS ID)
- (5) Ordered part number (CUST PROD)
- (6) Part number (ITEM)
- (7) Customer name (CUSTOMER)
- (8) Customer's machine name (MODEL NO)

# NTC THERMISTOR R-T CHARACTERISTICS

TYPE	TN11-3H103J T,B
------	-----------------

RESISTANCE(at25℃)	10000 ohm
B-VALUE(25/50℃)	3370 K

R-TOLERANCE( )	5 %
B-TOLERANCE( )	3 %

T(?)	Rmin(ohm)	Rnom(ohm)	Rmax(ohm)
-40	1.468E+05	1.698E+05	1.960E+05
-39	1.395E+05	1.611E+05	1.856E+05
-38	1.326E+05	1.528E+05	1.757E+05
-37	1.261E+05	1.450E+05	1.665E+05
-36	1.199E+05	1.377E+05	1.578E+05
-35	1.141E+05	1.308E+05	1.496E+05
-34	1.086E+05	1.243E+05	1.419E+05
-33	1.034E+05	1.181E+05	1.346E+05
-32	9.850E+04	1.123E+05	1.278E+05
-31	9.386E+04	1.069E+05	1.214E+05
-30	8.947E+04	1.017E+05	1.153E+05
-29	8.529E+04	9.678E+04	1.095E+05
-28	8.135E+04	9.214E+04	1.041E+05
-27	7.761E+04	8.776E+04	9.899E+04
-26	7.407E+04	8.362E+04	9.416E+04
-25	7.071E+04	7.970E+04	8.960E+04
-24	6.753E+04	7.599E+04	8.529E+04
-23	6.451E+04	7.247E+04	8.121E+04
-22	6.165E+04	6.914E+04	7.736E+04
-21	5.893E+04	6.599E+04	7.371E+04
-20	5.635E+04	6.300E+04	7.026E+04
-19	5.388E+04	6.014E+04	6.697E+04
-18	5.154E+04	5.744E+04	6.386E+04
-17	4.931E+04	5.488E+04	6.092E+04
-16	4.721E+04	5.245E+04	5.813E+04
-15	4.520E+04	5.015E+04	5.549E+04
-14	4.330E+04	4.796E+04	5.300E+04
-13	4.148E+04	4.589E+04	5.063E+04
-12	3.976E+04	4.391E+04	4.838E+04
-11	3.812E+04	4.204E+04	4.625E+04
-10	3.656E+04	4.026E+04	4.422E+04
-9	3.507E+04	3.856E+04	4.230E+04
-8	3.365E+04	3.695E+04	4.047E+04
-7	3.230E+04	3.541E+04	3.873E+04
-6	3.101E+04	3.395E+04	3.708E+04
-5	2.978E+04	3.255E+04	3.550E+04
-4	2.860E+04	3.122E+04	3.401E+04
-3	2.747E+04	2.996E+04	3.258E+04
-2	2.640E+04	2.875E+04	3.122E+04
-1	2.537E+04	2.759E+04	2.992E+04
0	2.439E+04	2.649E+04	2.869E+04

T(?)	Rmin(ohm)	Rnom(ohm)	Rmax(ohm)
0	2.439E+04	2.649E+04	2.869E+04
1	2.346E+04	2.544E+04	2.752E+04
2	2.257E+04	2.444E+04	2.640E+04
3	2.171E+04	2.348E+04	2.533E+04
4	2.089E+04	2.256E+04	2.431E+04
5	2.010E+04	2.168E+04	2.333E+04
6	1.934E+04	2.083E+04	2.239E+04
7	1.861E+04	2.002E+04	2.149E+04
8	1.791E+04	1.924E+04	2.063E+04
9	1.724E+04	1.850E+04	1.980E+04
10	1.659E+04	1.778E+04	1.901E+04
11	1.597E+04	1.710E+04	1.825E+04
12	1.538E+04	1.644E+04	1.753E+04
13	1.481E+04	1.581E+04	1.684E+04
14	1.426E+04	1.521E+04	1.617E+04
15	1.373E+04	1.463E+04	1.554E+04
16	1.323E+04	1.407E+04	1.493E+04
17	1.274E+04	1.354E+04	1.435E+04
18	1.228E+04	1.303E+04	1.379E+04
19	1.183E+04	1.254E+04	1.326E+04
20	1.140E+04	1.207E+04	1.275E+04
21	1.099E+04	1.162E+04	1.226E+04
22	1.059E+04	1.119E+04	1.179E+04
23	1.021E+04	1.078E+04	1.134E+04
24	9.850E+03	1.038E+04	1.091E+04
25	9.500E+03	1.000E+04	1.050E+04
26	9.143E+03	9.635E+03	1.013E+04
27	8.802E+03	9.286E+03	9.772E+03
28	8.474E+03	8.950E+03	9.430E+03
29	8.160E+03	8.629E+03	9.101E+03
30	7.860E+03	8.320E+03	8.785E+03
31	7.572E+03	8.024E+03	8.482E+03
32	7.296E+03	7.740E+03	8.190E+03
33	7.031E+03	7.467E+03	7.910E+03
34	6.777E+03	7.205E+03	7.641E+03
35	6.534E+03	6.954E+03	7.383E+03
36	6.301E+03	6.713E+03	7.134E+03
37	6.077E+03	6.481E+03	6.895E+03
38	5.862E+03	6.258E+03	6.665E+03
39	5.656E+03	6.044E+03	6.444E+03
40	5.458E+03	5.839E+03	6.231E+03

# NTC THERMISTOR R-T CHARACTERISTICS

TYPE	TN11-3H103J T,B
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RESISTANCE(at25℃)	10000 ohm
B-VALUE(25/50℃)	3370 K

R-TOLERANCE( )	5 %
B-TOLERANCE( )	3 %

T(?)	Rmin(ohm)	Rnom(ohm)	Rmax(ohm)
40	5.458E+03	5.839E+03	6.231E+03
41	5.267E+03	5.641E+03	6.027E+03
42	5.085E+03	5.451E+03	5.830E+03
43	4.910E+03	5.269E+03	5.640E+03
44	4.741E+03	5.093E+03	5.457E+03
45	4.579E+03	4.924E+03	5.282E+03
46	4.424E+03	4.762E+03	5.113E+03
47	4.274E+03	4.605E+03	4.950E+03
48	4.131E+03	4.455E+03	4.793E+03
49	3.993E+03	4.310E+03	4.642E+03
50	3.860E+03	4.171E+03	4.496E+03
51	3.732E+03	4.037E+03	4.356E+03
52	3.610E+03	3.908E+03	4.221E+03
53	3.491E+03	3.784E+03	4.090E+03
54	3.378E+03	3.664E+03	3.965E+03
55	3.268E+03	3.549E+03	3.844E+03
56	3.163E+03	3.438E+03	3.727E+03
57	3.062E+03	3.331E+03	3.614E+03
58	2.964E+03	3.227E+03	3.505E+03
59	2.870E+03	3.128E+03	3.400E+03
60	2.779E+03	3.032E+03	3.299E+03
61	2.692E+03	2.939E+03	3.201E+03
62	2.608E+03	2.850E+03	3.106E+03
63	2.526E+03	2.763E+03	3.015E+03
64	2.448E+03	2.680E+03	2.927E+03
65	2.373E+03	2.600E+03	2.842E+03
66	2.300E+03	2.522E+03	2.759E+03
67	2.230E+03	2.448E+03	2.680E+03
68	2.162E+03	2.375E+03	2.603E+03
69	2.097E+03	2.306E+03	2.529E+03
70	2.034E+03	2.239E+03	2.457E+03
71	1.973E+03	2.174E+03	2.388E+03
72	1.915E+03	2.111E+03	2.321E+03
73	1.858E+03	2.050E+03	2.257E+03
74	1.804E+03	1.992E+03	2.194E+03
75	1.751E+03	1.935E+03	2.133E+03
76	1.700E+03	1.881E+03	2.075E+03
77	1.651E+03	1.828E+03	2.018E+03
78	1.603E+03	1.776E+03	1.963E+03
79	1.557E+03	1.727E+03	1.910E+03
80	1.513E+03	1.679E+03	1.859E+03

T(?)	Rmin(ohm)	Rnom(ohm)	Rmax(ohm)
80	1.513E+03	1.679E+03	1.859E+03
81	1.470E+03	1.633E+03	1.809E+03
82	1.428E+03	1.588E+03	1.760E+03
83	1.388E+03	1.544E+03	1.714E+03
84	1.349E+03	1.502E+03	1.668E+03
85	1.312E+03	1.461E+03	1.624E+03
86	1.275E+03	1.422E+03	1.582E+03
87	1.240E+03	1.384E+03	1.540E+03
88	1.206E+03	1.347E+03	1.500E+03
89	1.173E+03	1.311E+03	1.462E+03
90	1.141E+03	1.276E+03	1.424E+03
91	1.110E+03	1.243E+03	1.388E+03
92	1.080E+03	1.210E+03	1.352E+03
93	1.051E+03	1.179E+03	1.318E+03
94	1.023E+03	1.148E+03	1.285E+03
95	9.961E+02	1.118E+03	1.253E+03
96	9.698E+02	1.090E+03	1.221E+03
97	9.443E+02	1.062E+03	1.191E+03
98	9.196E+02	1.035E+03	1.161E+03
99	8.956E+02	1.008E+03	1.133E+03
100	8.724E+02	9.831E+02	1.105E+03
101	8.498E+02	9.583E+02	1.078E+03
102	8.280E+02	9.344E+02	1.052E+03
103	8.068E+02	9.111E+02	1.026E+03
104	7.863E+02	8.886E+02	1.002E+03
105	7.663E+02	8.667E+02	9.777E+02
106	7.470E+02	8.454E+02	9.544E+02
107	7.283E+02	8.248E+02	9.318E+02
108	7.101E+02	8.048E+02	9.098E+02
109	6.925E+02	7.853E+02	8.884E+02
110	6.754E+02	7.665E+02	8.677E+02
111	6.588E+02	7.482E+02	8.475E+02
112	6.427E+02	7.304E+02	8.279E+02
113	6.270E+02	7.131E+02	8.089E+02
114	6.119E+02	6.963E+02	7.904E+02
115	5.971E+02	6.800E+02	7.724E+02
116	5.828E+02	6.641E+02	7.549E+02
117	5.689E+02	6.487E+02	7.379E+02
118	5.554E+02	6.338E+02	7.213E+02
119	5.423E+02	6.192E+02	7.052E+02
120	5.296E+02	6.051E+02	6.896E+02
121	5.172E+02	5.913E+02	6.743E+02
122	5.052E+02	5.780E+02	6.595E+02
123	4.935E+02	5.650E+02	6.451E+02
124	4.822E+02	5.523E+02	6.311E+02
125	4.711E+02	5.400E+02	6.174E+02



CELL Spec.

**PRELIMINARY SPECIFICATIONS  
FOR  
LITHIUM ION RECHARGEABLE CELL  
TYPE ; ICP653450AR X/S**

March 7, 2005

Received by:

RECHARGEABLE BATTERY DIVISION  
HITACHI MAXELL, LTD.

Issued by; \_\_\_\_\_

Checked by; \_\_\_\_\_

Approved by; \_\_\_\_\_

## SPECIFICATIONS

### 1. Scope and Application

#### 1.1 Scope

These specifications apply to the lithium ion rechargeable cells supplied by Hitachi Maxell, Ltd. to XXXXXXXXXXXX.

#### 1.2 Application

The cells described in these specifications shall be used for a XXXXXXXXXXXX.

#### 1.3 Cell composition

These cells shall be limited only for the composition of single cell battery or 2 cell battery (2 cell in series).

### 2. Type and Name

2.1 Name : Lithium Ion Rechargeable Cell

2.2 Item : ICP653450AR

### 3. Rating

3.1 Nominal Voltage : 3.7 V

3.2 Rated Capacity : 1200 mAh

Typical Capacity : 1250 mAh

Note : When discharged at 240 mA(0.2C) to 2.75 V after standard charge at 25°C

#### 3.3 Charge Conditions

(1) Charge Voltage :  $4.20 \pm 0.05$  V

(2) Maximum Charge Current : 1200 mA (1C)

(3) Charge Method : CC-CV (Constant Current - Constant Voltage)

#### 3.4 Discharge Conditions

(1) Maximum Continuous Discharge Current : 1800 mA (1.5C)

(2) Discharge End Voltage : 2.75 V

#### 3.5 Temperature

(1) Charge : 0 ~ +45°C

(2) Discharge : -20 ~ +60°C

(3) Storage : -20 ~ +50°C within 30 days (Shipped conditions)

(4) Long term storage : -20 ~ +35°C within 90 days (Shipped conditions)

3.6 Relative Humidity :  $65 \pm 20\%$  RH

3.7 Weight : About 24.5 g

3.8 Dimensions : Refer to attached drawing. Drawing No.0443638317

3.9 Appearance : Shall be free from noticeable flaws, breaks, damage, discoloration, deformation, uneven, and other defects which impair the value of the commodity.

3.10 Packing : Refer to attached drawing. TBD.



**4. Indication**

The manufacture code and origin shall be indicated on the surface of the cell.

**5. Required functions for charger, protection circuit and application**

To insure the safety, charger and the protection circuit shall be satisfied all the following items. As safety device, please use in combination with the temperature fuse, PTC (Positive Temperature Coefficient), Thermistor, and Thermostat. The standard charging method is CC-CV (Constant Current-Constant Voltage).

**5.1 Required functions for charger**

No.	Items	Condition	Notes
1	Charging Method	CC-CV	
2	Maximum Charge Current	1200 mA	Per Cell
3	Rated Charge Voltage	4.20 V	Per Cell
4	Maximum Charge Voltage	4.25 V	Per Cell
5	Timer	5 hours Charge	Current: 1200 mA
6	Operating Temperature (Charge)	0~+45 °C	

**5.2 Required protection circuit**

No.	Items	Condition	Notes
1	Overvoltage Limit	4.325±0.025 V	Per Cell
2	Charge Enable Voltage	4.20 ±0.05 V	Per Cell
3	Undervoltage Limit	2.20 V~2.75V	Per Cell
4	Discharge Enable Voltage	2.20 V~2.75V	Per Cell
5	Charge Prohibition Voltage	0.4 V or less	Per Cell
6	Overcurrent Limit	3600 mA (3C)	
7	PTC	VTP210 (Raychem Corporation) or PTC with same function	

**5.3 Application**

No.	Items	Condition	Notes
1	Maximum Continuous Discharge Current	1800 mA(1.5C)	Per Cell
2	Operating Temperature (Discharge)	-20~+60 °C	

**6. Performance and Characteristics**

The cell shall satisfy all for Electrical (Table-1), Mechanical (Table-2) and Safety (Table-3) characteristics.

Table-1 Electrical Characteristics

No.	Items	Performances	Conditions	Test Methods
1	Discharge capacity	More than 300 min. discharge ( more than 1200 mAh )	Discharge at 240 mA (0.2C)	7.2.6
2	High rate discharge capacity	More than 54 min. discharge ( more than 1080 mAh )	Discharge at 1200 mA (1C)	7.2.7
3	Endurance in cycles	More than 210 min. discharge ( more than 840 mAh )	After 500 cycles Discharge at 240 mA (0.2C)	7.2.8
4	Discharge capacity at -20°C	More than 150 min. discharge ( more than 600 mAh )	Discharge at -20°C, 240 mA (0.2 C)	7.2.9
5	Charge retention	More than 255 min. discharge ( more than 1020 mAh )	Stored at 20°C for 28 days, Discharge at 240 mA (0.2 C)	7.2.10
6	Capacity recovery	More than 270 min. discharge ( more than 1080 mAh )	Stored at 20°C for 28 days, Re-charge, Discharge at 240 mA (0.2 C)	7.2.11
7	Capacity recovery after long term storage	More than 210 min. discharge ( more than 840 mAh )	Discharge at 1200 mA (1C) Stored at 40°C for 90 days, Re-charge, Discharge at 240 mA (0.2 C)	7.2.12
8	Impedance	Less than 70 mΩ	AC 1kHz	7.2.13

Table-2 Mechanical Characteristics

No.	Items	Performances	Test Methods
1	Drop	No failure of appearance and construction More than 276 min. discharge at 240 mA (0.2 C)	7.2.14
2	Vibration	No failure of appearance and construction More than 276 min. discharge at 240 mA (0.2 C)	7.2.15

Table-3 Safety Characteristics

No.	Items	Performances	Conditions	Test Methods
1	Terminal short circuit	No explosion, no fire and no smoke.	Short circuit at 10 mΩ	7.2.16
2	Overcharge	Ditto	Charge at 4.5V, 2 hours	7.2.17
3	Constant resistance over discharge	Ditto	Discharge at 30 Ω (Equivalent to 120 mA(0.1C)) 24 hours	7.2.18
4	High temperature exposure	Ditto	Exposure at 100°C 5 hours	7.2.19
5	Over voltage forced discharge	Ditto	Charge at -5 V, 2 hours	7.2.20

## 7. Test

### 7.1 Test conditions and instruments

#### 7.1.1 Temperature and humidity

Unless otherwise specified, the measurement is executed at a temperature of  $25 \pm 2^\circ\text{C}$  and at a relative humidity of  $65 \pm 20\%$ .

#### 7.1.2 Initial test

Initial test is started within 20 days after delivery.

#### 7.1.3 Measuring instruments and devices

- (1) Dimension measurement is carried out using a caliper whose measuring range is from 0 mm to 300 mm and precision is 1/20 mm or more precise.
- (2) Voltage measurement is carried out using a DC voltmeter, which can measure from 0 V to 20 V. The precision of the voltmeter is  $\pm 1$  mV or more precise, and input impedance is more than 10 M $\Omega$ .
- (3) Discharge is carried out using electronic load equipment. The precision of the current is  $\pm 0.5\%$  or more precise.
- (4) Impedance is carried out using an LCR meter with 4 terminals at 1 kHz. To eliminate the direct current component, 1  $\mu\text{F}$  of condenser in series to current pole is added.

### 7.2 Test methods

#### 7.2.1 Appearance

Appearance is judged visually.

#### 7.2.2 Dimensions

The measuring instrument as specified 7.1.3(1) is used. However, the measurement which might cause any short circuit is carried out with insulator inserted.

#### 7.2.3 Complete Charge

In the case of finding the capacity by discharging, the cell is charged at 1200 mA (1C) of constant current and 4.20 V constant voltage for 3 hours. Complete Charge means the state of the cell after completing the charge with these conditions.

#### 7.2.4 Standard Discharge

Standard Discharge means the cell is discharged at 240 mA (0.2C) of constant current until the output voltage reaches 2.75 V.

#### 7.2.5 Fast Discharge

Fast Discharge means the cell is discharged at 1200 mA (1C) of constant current until the output voltage reaches 2.75 V.

#### 7.2.6 Discharge capacity

After Complete Charge, within 1 hour, the duration time of Standard Discharge is measured.

#### 7.2.7 High rate discharge capacity

After Complete Charge, within 1 hour, the duration time of Fast Discharge is measured.

#### 7.2.8 Endurance in cycles

After 499 cycles of Complete Charge and Fast Discharge, Discharge capacity as specified 7.2.6 is measured.

#### 7.2.9 Discharge capacity at $-20^\circ\text{C}$

After Complete Charge at  $25 \pm 2^\circ\text{C}$ , the duration time of Standard Discharge at  $-20^\circ\text{C}$  is measured.

7.2.10 Charge retention

After Complete Charge, the sample cells are stored at 20°C for 28 days, respectively. After taking them out of a chamber, they are cooled in normal room conditions for more than 1 hour and the duration time of Standard Discharge is measured.

7.2.11 Capacity recovery

After Complete Charge, the samples cells are stored at 20°C for 28 days, respectively. They taken out of a chamber are cooled in normal room conditions for more than 1 hour, and Standard Discharge. After the discharge, Complete Charge is made again and the duration time of Standard Discharge is measured.

7.2.12 Capacity recovery after long term storage

After Complete Charge, Fast Discharge and then, the sample cells are stored at +40°C for 90 days. After the storage, they are taken out of a storage chamber and cooled in normal room conditions for more than 1 hour. Complete Charge is made again and the duration time of Standard Discharge is measured.

7.2.13 Impedance

The measurement is carried out in accordance with the item of 7.1.3(4).

7.2.14 Drop

The sample cells are dropped from a height of 1 m onto an oak board, top down, bottom down, and 4 times horizontally down. Appearance of the sample cells is visually examined.

After that, Standard Discharge and then, Complete Charge is made again and the duration time of Standard Discharge is measured.

7.2.15 Vibration

The sample cells is given vibrations of amplitude of 4 mm and a frequency of 16.7 Hz for consecutive 1 hour in an arbitrary direction.

After that, Standard Discharge and then, Complete Charge is made again and the duration time of Standard Discharge is measured.

7.2.16 Terminal short circuit

After Complete Charge, (+) and (-) terminals are connected with 10 mΩ of the 4 terminal precision type metal clad resistor by soldering. After 1 hour, all cells being tested are visually examined.

7.2.17 Overcharge

After Complete Charge, the sample cells are charged at 1200 mA(1C) of a constant current and 4.5V of a constant voltage for 2 hours. All cells being tested are visually examined.

7.2.18 Constant resistance over discharge

After Complete Charge, both terminals (+,-) of each cell are connected with a resistor of 30 Ω (equivalent to 120 mA(0.1C)) by soldering. After 24 hours discharge, all cells being tested are visually examined.

7.2.19 High temperature exposure

After Complete Charge, all cells being tested are stored in a chamber of 100°C for 5 hours. After taking the cells out of the chamber, all the cells are visually examined.

7.2.20 Over voltage forced discharge

After Complete Charge, all cells being tested are reversely charged at a constant current of 2400 mA(2C) and a constant voltage of 5 V for 2 hours. All the cells are visually examined.

## 8. Cell Capacity at Shipment

The cell capacity at shipment is 30 - 60 % of the full capacity.

## 9. Prior Notice of Change

In the case specifications, materials, production processes, and control systems for the products are to be changed, Hitachi Maxell, Ltd. will inform notice of the change in writing together with quality and reliability data to the customer in advance. Also, the customer will inform requirement of the change in writing to Hitachi Maxell, Ltd.

## 10. Product Liability

You are kindly requested to use the cell which is delivered from Hitachi Maxell, Ltd. in strict accordance with the specification and remarks include at the end of this document. Improper usage of the cell, an accident of a fire may occur due to the cell generating heat, catching fire or exploding. Hitachi Maxell, Ltd. shall not be responsible against any accidents occurring due to use outside those written in this specification. Hitachi Maxell, Ltd. shall not be responsible against any accident caused by matters which is not written in this specification.

## 11. Limited Warranty

- (1) Hitachi Maxell Ltd. will be responsible for replacing the cell against defects in workmanship and materials for a period of 1 year from manufacture code that Hitachi Maxell Ltd. can confirm such defects are coming from manufacturing abnormality. Any other problem is not under this limited warranty. The manufacture code is indicated in attached TBD.
- (2) Hitachi Maxell, Ltd. makes no warranties against any accidents occurring due to use outside scope and application written in this document.
- (3) Hitachi Maxell, Ltd. makes no warranties against any losses or lost earnings incurred by the customer or third parties arising from any usage of the cell.
- (4) Hitachi Maxell, Ltd. makes no other warranties expressed or implied except as provided in this limited warranty.

## 12. Indications on Battery Pack

The following warnings should be indicated on the battery packs.

- \* Use a specified charger by (the manufacturer).
- \* Do not throw the battery in fire, or add heat.
- \* Do not short circuit the battery terminals.
- \* Do not disassemble, alter, or solder the battery.
- \* Do not use the battery any purpose other than specified.

## 13. Notice of the battery pack assembly

The following procedures must be taken note during the battery pack assembly to avoid any damage, burn, and performance failure of the battery. However, Hitachi Maxell, Ltd. will not guarantee against any defects or accident caused by processing method which is not written here.

### (1) Storage

The battery contains chemical material. Storage in unsuitable condition (temperature, humidity, etc.) may reduce initial performance (OCV, impedance, capacity, etc.).

- Do not storage the battery in hot and/or humid environment.
- Use the decided packing box.
- Do not storage the battery as fully charge state.
- Do not storage the battery as a load is connected.

(2) Handling

The battery can doubles as a positive or negative terminal. The battery is easily short-circuited, when any metal touch the terminal and can of battery. Short-circuit of the battery may result in heat generation, leakage, or impedance increment.

- Do not short-circuit (+) and (-) of the battery.
- Do not contact batteries mutually.

The battery has the weak spot that made intentionally (the gas release vent). Applied pressure to it and/or terminal of the battery may result in leakage, or impedance increment.

- Do not apply pressure and impact to the battery (particularly, the gas release vent).
- Do not use the battery which was dropped once
- Do not reuse the battery, which was assembled (welding, etc) once and then disassembled.

(3) Resistance welding, Case welding (Ultrasonic welding)

Improper welding condition (abnormal pressure, etc.) may cause damage of the insulator of the battery terminal and crack of the can, resulting in leakage. And damage of the terminal may result in impedance increment.

- Carefully examine welding condition in advance, and carry out it with optimal condition
- Do not apply heavy pressure to the battery.

(4) PCB (Protection Circuit Board) installation

In the case the semiconductor on PCB is damaged, the battery is charged with abnormal current or voltage, resulting in heat generation, explosion, or fire.

- Do not touch the parts on PCB directly.
- Do not treat the PCB without electrostatic protection.
- Do not put the PCB in position received the influence of the accidental leakage.

(5) Soldering

Heat applied during soldering may damage the insulator (resin) of the battery terminal, resulting in leakage, or impedance increment. In the case the parts on PCB is displaced or unfastened, the battery is charged with abnormal current or voltage, resulting in heat generation, explosion, or fire.

- Do not solder the battery directly.
- Do not heat the battery and PCB (except the terminal) during the soldering operation.
- Do not short-circuit terminal-to-terminal and/or other parts of PCB


If you have any question about battery pack assembly, please consult with Hitachi Maxell, Ltd.


The following hazard alarm signals and words must appear in manuals and/or instructions for users, especially at the point of use.

## HANDLING INSTRUCTIONS FOR LITHIUM ION RECHARGEABLE BATTERY

Please read and follow the handling instructions for the battery before use. Improper use of the battery may cause heat, fire, explosion, damage or capacity deterioration of the battery. However, the manufacturer will not guarantee against any accident caused by the usage which is not written here.

(When using the battery)

 <b>DANGER</b>
<ul style="list-style-type: none"> <li>● Do not dip or wet the battery in water, seawater, or other liquid. If the protecting device assembled in the battery is damaged, the battery may be charged with an abnormal current and voltage, which may result in the cause of heat generation, explosion, or fire of the battery.</li> </ul>
<ul style="list-style-type: none"> <li>● The battery has a predetermined polarity. If the battery will not connect well to the charger or equipment, do not try to connect the battery forcefully. Check the polarity first. In the case the battery is connected in reverse, it is charged reversely and may cause acid leakage, heat generation, explosion, or fire due to an abnormal chemical reaction.</li> </ul>
<ul style="list-style-type: none"> <li>● Do not put the battery into a fire or heat it. In such a case, the insulator in the battery may be melted, the gas release vent and protection mechanism may be damaged, all of which may cause heat generation, explosion, or fire.</li> </ul>
<ul style="list-style-type: none"> <li>● Do not connect the battery reversed in positive (+) and negative (-) terminals in the charger or equipment. In the case the battery is connected in reverse, it is charged reversely during charge, and causes an excessive current during discharge, and may cause heat generation, explosion, or fire due to an abnormal chemical reaction.</li> </ul>
<ul style="list-style-type: none"> <li>● Do not let the battery terminals ( + and - ) contact a wire or any metal ( like a metal necklace or a hairpin ) with which it carried or stored together. In such a case, the battery is shorted and causes an excessive current, which may result in heat generation, explosion, or fire.</li> </ul>
<ul style="list-style-type: none"> <li>● Do not apply heavy impact to the battery, or throw or drop it. Strong impact may damage the protecting device, which may result in heat generation, explosion, or fire of the battery.</li> </ul>
<ul style="list-style-type: none"> <li>● Do not drive a nail in, hit with a hammer, or stamp on the battery. In such a case, the battery may be deformed and shorted, and the protecting device may be damaged, which may cause heat generation, explosion, or fire of the battery.</li> </ul>
<ul style="list-style-type: none"> <li>● Do not solder the battery directly. Heat applied during soldering may damage the insulator or the gas release vent and protection mechanism, which may result in acid leakage, heat generation, explosion, or fire of the battery.</li> </ul>
<ul style="list-style-type: none"> <li>● Do not disassemble or alter the battery. The battery contains the protection mechanism and protection device in order to avoid any danger. If these are damaged, heat, explosion or fire may be caused.</li> </ul>
<ul style="list-style-type: none"> <li>● Charge the battery every 6 months to the amount specified by the manufacturer, even if the battery is not used. An excessive over-discharge may cause an abnormal chemical reaction, which may result in the cause of acid leakage, or fire of the battery.</li> </ul>

 <b>WARNING</b>
<ul style="list-style-type: none"> <li>● Do not place or leave the battery and equipment in the reach of infants. Improper use of the battery may cause danger.</li> </ul>

**WARNING**

- Do not put the battery in a microwave oven or a pressure cooker. Sudden heat may damage the seal of the battery and may cause heat generation, explosion, or fire of the battery.
- Do not use the battery together with a dry battery or other primary battery or other battery of a different capacity, types and / or brand. In such a case, over-discharge during use, or over-charge during charge may occur and abnormal chemical reactions may cause heat generation, explosion, or fire of the battery.
- If you notice any bad odor, heating, discoloration, deformation, or any other change from what you are used to while using, charging, storing the battery, take it out of equipment or charger, and avoid using it. Using it in such state may result in heat generation, explosion, or fire.
- If the battery leaks or emits a bad odor, take it away from any fire immediately. The electrolyte may catch fire, which may cause heat generation, explosion, or fire.
- Do not let leaked electrolyte come into contact with eyes. In such a case, immediately wash the area of contact with clean water and seek help from a doctor. If not treated soon, prolonged contact may cause serious injury.

**CAUTION**

- Do not use or leave the battery in a place exposed to strong direct sunlight, or in a car under the blazing sun, or high temperature sources. Such a high temperature may cause acid leakage.
- If you find the battery rusty, bad odor, heating, or any other defective before using the battery for the first time after purchase, do not use it. Take it back to the dealer instead.
- In case young children use the battery, instruct them on the contents of the instructions and ensure the battery is correctly used by them at all times.
- If the battery leaks and its electrolyte contact with skin or clothes, wash it well with tap water or other clean water right away. Leaving it, it is may cause a rash on skin.
- If you have any question regarding the battery, contact the following place. Keep the handling instructions and your equipment instructions in a suitable place for future reference
  - Contact address :
  - Phone :
  - Fax :
- Read the instructions of your equipment regarding the battery installation and removal from the equipment so as not to mishandle and waste the battery.
- The battery was charged a little before shipment for temporary use by an end user. In case your equipment does not operate with the battery or in the case of a long use, charge the battery with a specified charger once.
- Carerfully read the instructions of your equipment before use.
- When the battery is expected not to be used for a long time, take the battery out of the equipment and store it in a less humid area
- Turn off your equipment power switch after use
- In the case the battery terminals are dirty, clean the terminals with a dry cloth before use, otherwise, the contact with equipment might cause insufficiency, and power failure or charge failure
- Despite being rechargeable, the battery has a limited life span. Replace it, when usage time becomes short.
- As for a used battery, please recycle, after covering the battery terminals ( + and - ) with a insulation tape or inserting it to individual poly-bag.



**(When charging the battery)****DANGER**

- Do not use any battery charger not specified by ( manufacturer's name ), also, follow the charge conditions specified by ( manufacturer's name ) If the battery is charged under other conditions ( a high temperature, a high voltage / current, or an altered charger ) not specified by ( manufacturer's name ), the battery may cause heat generation, explosion, or fire with abnormal chemical reactions.
- Do not connect the battery directly to an electric outlet or cigarette heater socket in a car. Applying a high voltage may generate an excessive current, and get an electric shock. In such a case, the battery may leak electrolyte, overheat, explode, or cause fire.
- Do not charge the battery near fire or in a car under the blazing sun. Such a high temperature may cause damage of the protecting device in the battery, which may result in heat generation, explosion, or fire.

**WARNING**

- Discontinue charging after specified charging time even if the charge is not complete. Otherwise, the battery might cause heat generation, explosion, or fire.

**CAUTION**

- Do not use the battery in other than the following conditions. Otherwise, the battery might cause heat generation, damage.  
Charge: 0°C ~ +45°C
- Carefully read the instructions for the specified charger to learn how to charge the battery.
- Do not charge the battery over the specified time described in the instructions.

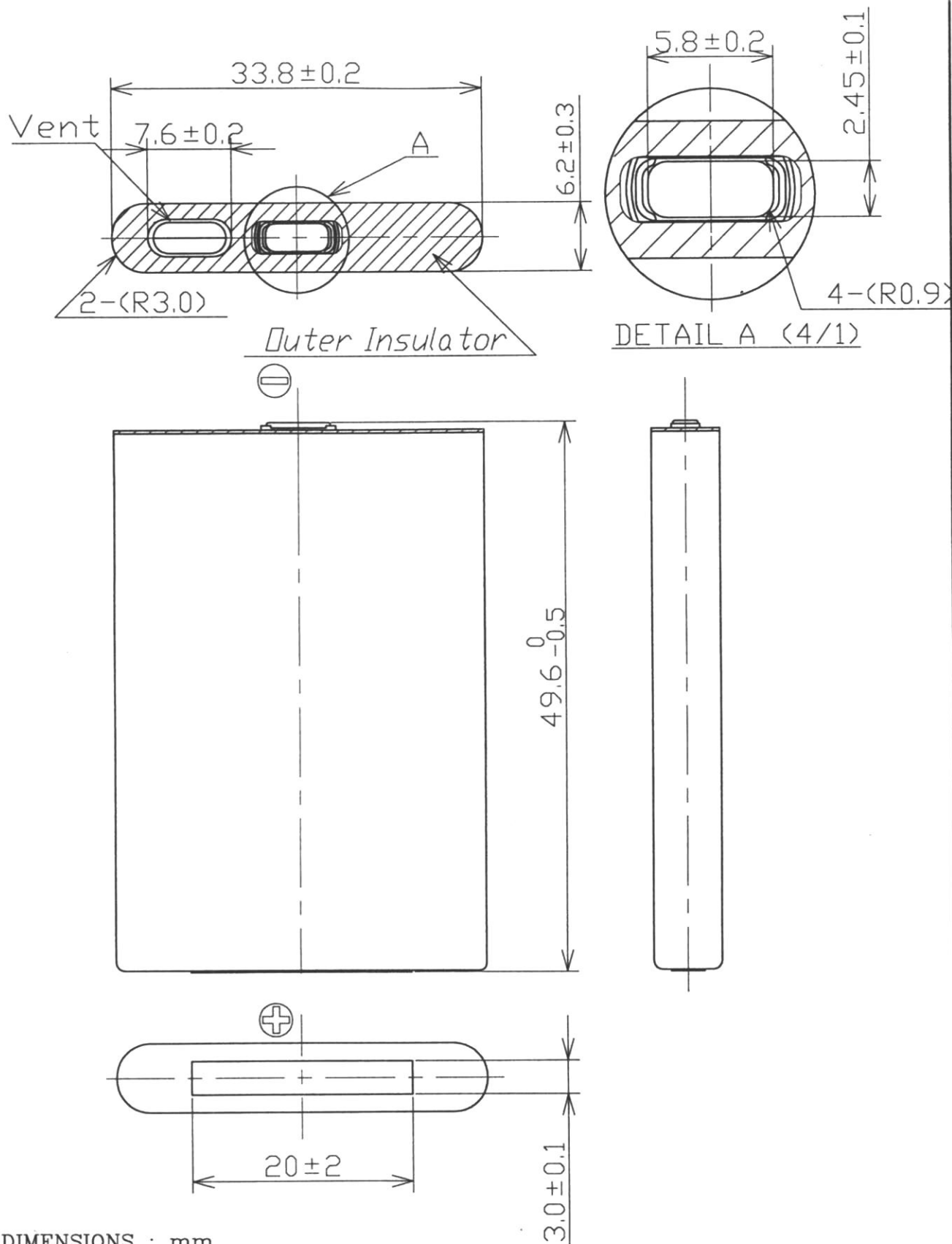
**(When discharging the battery)****DANGER**

- Do not use or leave the battery in a place near fire, heaters, or high temperature sources. Such a high temperature may cause heat generation, explosion, or fire.
- Do not use the battery with any equipment other than specified. Any such practice may expose some types of equipment to an abnormal current, which may result in heat generation, explosion, or fire.

**CAUTION**

- Do not use the battery in the place where the static electricity ( more than the limit of the manufacturer's guarantee ) occurs. Otherwise, the protecting device in the battery might be damaged and cause heat generation, explosion, or fire.
- Do not use the battery in other than the following conditions
 

Discharge	:	-20°C ~ +60°C
Store (less than a month)	:	-20°C ~ +50°C (on the charge of 50 %)
Store (more than a month)	:	-20°C ~ +35°C (on the charge of 50 %)



DIMENSIONS : mm

				PROJECTION	SCALE	TITLE	SH.
					2/1	ICP653450AR	
REGD.	DWN.	<i>K. Urawa</i>	Feb. 02. 05	Hitachi Maxell, Ltd Kyoto Japan			REV.
	CHKD.	<i>Y. Shimizu</i>	Feb. 02. 05				
	APPD.	<i>Y. Shimizu</i>	Feb. 02. 05				
				KYOTO WORKS DWG. No.			
				044 3638317			