Nisshinbo Micro Devices Inc.

NB7123ZA Series

1-cell Li-ion Battery Protection IC for High-side FETS

FEATURES

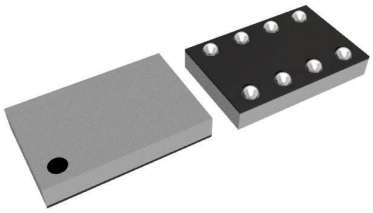
- Supply Current
  Normal mode: Typ. 7.0 µA / Max. 10.0 µA
  Standby mode: Max. 0.04 µA
- Detector Selectable Range and Accuracy
  Overcharge Detection Voltage (V_{DET1}):
  4.3 V to 4.7 V, ±6.5 mV
  Over-discharge Detection Voltage (V_{DET2}):
  2.0 V to 3.0 V, ±17 mV
  Discharge Overcurrent Detection Voltage (V_{DET3}):
  0.0060 V to 0.0400 V, ±1.00 mV
  Charge Overcurrent Detection Voltage (V_{DET4}):
  –0.0060 V to –0.0500 V, ±1.00 mV
  Short Circuit Detection Voltage (V_{SHORT1}):
  0.0200 V to 0.1000 V, ±1.00 mV
  0 V Battery Charging Inhibition Voltage (V_{NOCHG}):
  1.200 V to 2.000 V, ±20.0 mV
  Overtemperature Detection temperature (T_{DET}):
  40°C to 85°C, ±2.0°C
- Functions
  Overcharge Release: Latch
  Over-discharge Release: Latch
  Discharge Overcurrent Release selectable:
  Auto Release / Latch
  0 V Battery Charging: Inhibition
  Temperature Protection: High Temp.
  Forced Standby selectable:
  Available / Unavailable
  Forced Standby Active by STB pin selectable:
  Active-high / Active-low
  Forced Standby Release (V_{STBREL}): V_{REL3}
  NTC Thermistor selectable: 100kΩ / 470 kΩ

APPLICATIONS

- Hearable / Wearable devices,
- Smart Phone,
- Handheld Data Terminals

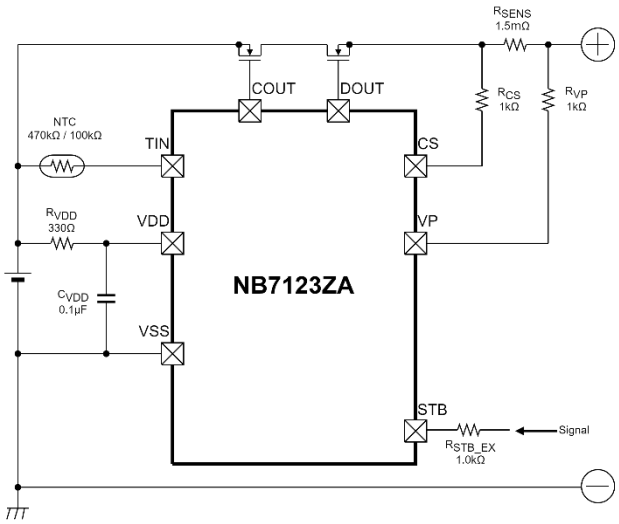
GENERAL DESCRIPTION

The NB7123ZA is a one-cell Li-ion/Li-polymer rechargeable battery protection IC that supports high-side FET.
This IC has overcharge/over-discharge, overcurrent, and temperature protection functions. This IC also has a forced standby function, and the current consumption of this IC can be reduced by using the STB pin.
Each protection function can provide detections with high accuracy.



WLCSP-8-ZA2
1.66 x 1.08 x 0.38 *1 [mm]
*1 Maximum thickness including balls

TYPICAL APPLICATION CIRCUIT



PRODUCT NAME INFORMATION

NB7123	ZA	***	*	*	E2	S
	aa	bbb	c	d	ee	f

Description of configuration

Composition	Item	Description
aa	Package	Indicates the package code.
bbb	Specific Option	Indicates a three-digit number code that combines set voltages and temperatures. Refer to the table of set voltage and temperature for details.
c		Indicates a delay time code. Refer to the table of delay times for details.
d		Indicates a function code. Refer to the table of functions for details.
ee	Packing	Indicates the taping code of the package. Refer to Packing Specification in the appendix Package Information for details.
f	Grade	Indicates the quality grade. S: Standard Refer to the table of grade for details.

Table of set voltage and temperature (bbb)

Symbol	V_{DET1}	V_{DET2} *1	V_{DET3} *1	V_{DET4}	V_{SHORT1} *1	V_{NOCHG} *1	T_{DET}	T_{REL} *2	NTC [kΩ]	R_{STB} [kΩ]
Range (Step) [V] / [°C]	4.300 to 4.700 (0.001)	2.000 to 3.000 (0.001)	0.0060 to 0.0400 (0.0001)	–0.0060 to –0.0500 (0.0001)	0.0200 to 0.1000 (0.0001)	1.200 to 2.000 (0.001)	40 to 85 (5)	T_{DET} – [0 to 10] (5)	100 / 470	100 / 200

*1 $V_{DET2} - V_{NOCHG} \geq 200$ mV,
$V_{SHORT1} - V_{DET3} \geq 14$ mV

*2 T_{REL} can be set to 0°C to 10°C (in steps of 5°C) lower than T_{DET}.

Table of delay times (c)

Symbol	t_{VDET1}	t_{VREL1}	t_{VDET2}	t_{VREL2}	t_{VDET3}	t_{VREL3}	t_{VDET4}	t_{VREL4}	$t_{VSHORT1}$	t_{TDET}	t_{TREL}	t_{TON}	t_{TOFF}	$t_{VSTBDET}$ *1	$t_{VSTBREL}$ *1
Time [ms]	256 / 1024 / 4096	2.1	16 / 32 / 128 / 256	1.1	16 / 32 / 128 / 512 / 1024 / 2048	1.1	8 / 16 / 32 / 512	1.1	0.28 / 0.53 / 1.1 / 2.1	512 / 1024 / 4096	128	8	128 / 512	1.1 / 16	16 / 128
A	4096	2.1	128	1.1	512	1.1	32	1.1	0.53	1024	128	8	128	16	16
B	4096	2.1	128	1.1	512	1.1	32	1.1	1.1	1024	128	8	128	16	16
C	4096	2.1	128	1.1	512	1.1	32	1.1	0.28	1024	128	8	128	16	16

*1 $t_{VSTBDET}$ and $t_{VSTBREL}$ are enabled if the forced standby is available.

Table of functions (d)

Function	Release Options						0 V Battery Charging	Temperature Protection	Forced Standby	Forced Standby Options (STB pin/V_{STBREL}*1)	
	Over-charge	Over-discharge	Discharge Overcurrent (Type / V_{REL3})		Charge Overcurrent (Type / V_{REL4})						
Type / Condition	Latch	Latch	Auto Release / Latch	V_{DD} x 0.87/ V_{DD} – 0.12	Auto Release	V_{DD} / V_{DD} – 0.12	Inhibition	High Temp.	Available / Unavailable	Active-high / low	V_{REL3}
B	Latch	Latch	Latch	V_{DD} x 0.87	Auto Release	V_{DD}	Inhibition	High Temp.	Unavailable	–	-
C	Latch	Latch	Latch	V_{DD} x 0.87	Auto Release	V_{DD}	Inhibition	High Temp.	Available	Active-high	V_{REL3}
D	Latch	Latch	Auto Release	V_{DD} – 0.12	Auto Release	V_{DD}	Inhibition	High Temp.	Available	Active-low	V_{REL3}
E	Latch	Latch	Latch	V_{DD} x 0.87	Auto Release	V_{DD} – 0.12	Inhibition	High Temp.	Available	Active-high	V_{REL3}

*1 V_{STBREL} is specified with a value equal to V_{REL3} if the forced standby is available.

Table of grade (f)

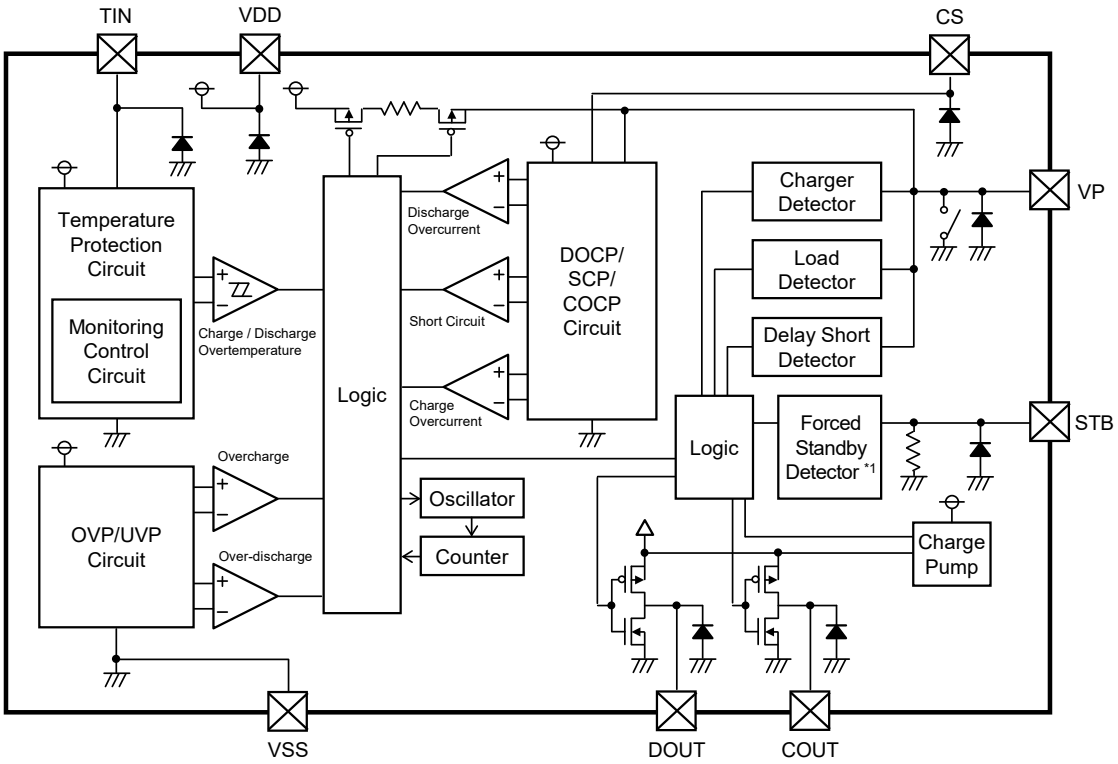
	Applications	Operating Temperature Range	Test Temperature
S	General−purpose and Consumer application	-40°C to 105°C	25°C

ORDER INFORMATION

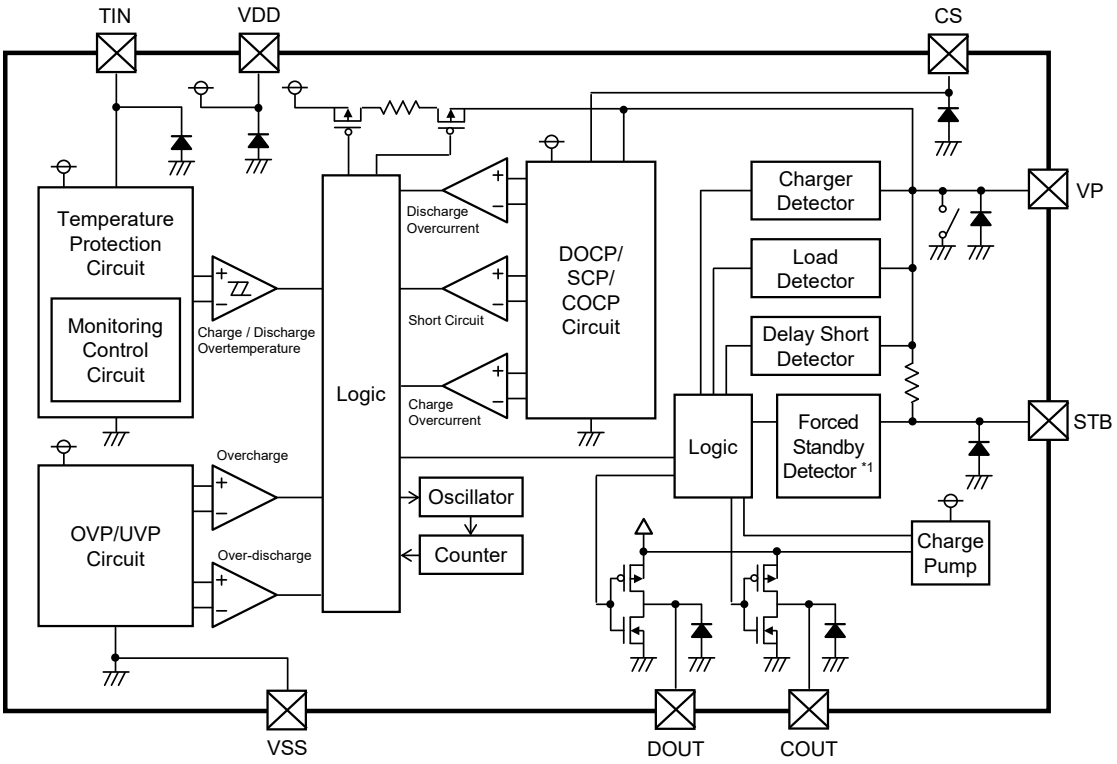
For the mass-produced products, please refer to the Appendix “Product Code List”.

Product Name	Package	RoHS	Halogen-Free	Plating Composition	Weight [mg]	MOQ [pcs]
NB7123ZA*****E2S	WLCSP-8-ZA2	Yes	Yes	Sn-3Ag-0.5Cu	1.2	5,000

BLOCK DIAGRAM



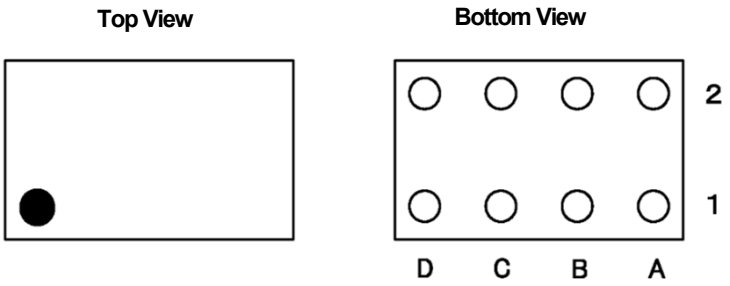
NB7123ZA (STB pin: Active High) Block Diagram



NB7123ZA (STB pin: Active Low) Block Diagram

*1 The forced standby detector works if the forced standby function is available.

PIN DESCRIPTIONS



NB7123ZA (WLCSP-8-ZA2) Pin Configuration

Pin No.	Pin Name	I/O	Description
A1	VSS	-	Ground pin for the IC
B1	TIN	I	Temperature sensing input pin
C1	STB	I	Forced standby control input pin, if the forced standby function available
D1	CS	I	Current sensing input pin
A2	VDD	I	Power supply pin, the substrate level of the IC
B2	COUT	O	Charge control pin, CMOS output
C2	DOUT	O	Discharge control pin, CMOS output
D2	VP	I	Battery pack plus voltage input pin

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit
Supply Voltage	V_{DD}	V_{SS} – 0.3 to V_{SS} + 6.5	V
VP Pin Input Voltage	V_{VP}	V_{SS} – 0.3 to V_{SS} + 30	V
CS Pin Input Voltage	V_{CS}	V_{SS} – 0.3 to V_{SS} + 30	V
TIN Pin Input Voltage	V_{TIN}	V_{SS} – 0.3 to V_{SS} + 6.5	V
STB Pin Input Voltage	V_{STB}	V_{SS} – 0.3 to V_{SS} + 30	V
COUT Pin Output Voltage	V_{COUT}	V_{SS} – 0.3 to V_{DD} + 6.5	V
DOUT Pin Output Voltage	V_{DOUT}	V_{SS} – 0.3 to V_{DD} + 6.5	V
Power Dissipation	P_D	150	mW
Junction Temperature Range	Tj	–40 to 125	°C
Storage Temperature Range	Tstg	–55 to 125	°C

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause permanent damage and may degrade the lifetime and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings is not assured.

ELECTROSTATIC DISCHARGE (ESD) PROTECTION VOLTAGE

	Symbol	Rating	Unit
HBM (Human Body Model)	C = 100 pF, R = 1.5 kΩ	±2000	V
CDM (Charged Device Model)	Field Included CDM (FI-CDM)	±1000	V

ELECTROSTATIC DISCHARGE RATINGS
The electrostatic discharge test is done based on JEDEC JS001, JS002.

RECOMMENDED OPERATING CONDITIONS

	Symbol	Rating	Unit
Operating Input Voltage	V_{OPE}	1.5 to 5.0	V
Operating Temperature Range	Ta	–40 to 105	°C

RECOMMENDED OPERATING CONDITIONS
All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

ELECTRICAL CHARACTERISTICS

Voltages are defined as $V_{DD} - V_{SS}$, Ta = 25°C, unless otherwise specified in Conditions.

NB7123ZA Electrical Characteristics

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
0 V Battery Charging Inhibition Voltage	V_{NOCHG}	R_{VDD} = 330Ω, $V_{CS} = V_{VP} = V_{DD}$	V_{NOCHG} – 0.020	V_{NOCHG}	V_{NOCHG} + 0.020	V
0 V Battery Charging Inhibition Detection Delay Time	$t_{VNOCHGDET}$	$V_{DD} = V_{DET2} - 0.1$ V → $V_{NOCHG} - 0.1$ V, $V_{CS} = V_{VP} = V_{DD}$	-	-	300	µs
0 V Battery Charging Inhibition Release Delay Time	$t_{VNOCHGREL}$	$V_{DD} = V_{NOCHG} - 0.1$ V → $V_{DET2} - 0.1$ V, $V_{CS} = V_{VP} = V_{DD}$	-	-	300	µs
Overcharge Detection Voltage	V_{DET1}	R_{VDD} = 330Ω	V_{DET1} – 0.0065	V_{DET1}	V_{DET1} + 0.0065	V
Overcharge Release Voltage	V_{REL1}	R_{VDD} = 330Ω, $V_{CS} = V_{VP} = V_{DD} - 1.0$ V	V_{DET1} – 0.0115	V_{DET1}	V_{DET1} + 0.0065	V
Overcharge Detection Delay Time	t_{VDET1}	$V_{DD} = 3.9$ V → $V_{DET1} + 0.1$ V, $V_{CS} = V_{VP} = V_{DD}$	t_{VDET1} × 0.80	t_{VDET1}	t_{VDET1} × 1.20	ms
Overcharge Release Delay Time	t_{VREL1}	$V_{DD} = V_{DET1} + 0.1$ V → 3.9 V, $V_{CS} = V_{VP} = V_{DD} - 1.0$ V	1.65	2.10	2.55	ms
Over-discharge Detection Voltage	V_{DET2}	$V_{VP} = V_{DD}$, R_{VDD} = 330Ω	V_{DET2} – 0.017	V_{DET2}	V_{DET2} + 0.017	V
Over-discharge Release Voltage	V_{REL2}	$V_{VP} = V_{DD}$, R_{VDD} = 330Ω	V_{DET2} – 0.017	V_{DET2} + 0.008	V_{DET2} + 0.033	V
Over-discharge Detection Delay Time	t_{VDET2}	$V_{DD} = 3.9$ V → $V_{DET2} - 0.1$ V, $V_{VP} = V_{DD}$	t_{VDET2} × 0.80	t_{VDET2}	t_{VDET2} × 1.20	ms
Over-discharge Release Delay Time	t_{VREL2}	$V_{DD} = V_{DET2} - 0.1$ V → 3.9 V, $V_{VP} = V_{DD}$	0.85	1.10	1.35	ms
Discharge Overcurrent Detection Voltage	V_{DET3}	Defined as $V_{CS} - V_{VP}$, V_{DD} = 3.9 V	V_{DET3} – 0.00100	V_{DET3}	V_{DET3} + 0.00100	V
Discharge Overcurrent Release Voltage	V_{REL3}	Defined as $V_{VP} - V_{SS}$, V_{DD} = 3.9 V $V_{REL3} = V_{DD} - 0.120$ V $V_{REL3} = V_{DD} \times 0.87$ V	V_{DD} – 0.180 V_{DD} × 0.84	V_{DD} – 0.120 V_{DD} × 0.87	V_{DD} – 0.060 V_{DD} × 0.90	V
Discharge Overcurrent Detection Delay Time	t_{VDET3}	V_{DD} = 3.9 V, $V_{CS} - V_{VP} = 0$ V → $V_{DET3} + 0.01$ V	t_{VDET3} × 0.80	t_{VDET3}	t_{VDET3} × 1.20	ms
Discharge Overcurrent Release Delay Time	t_{VREL3}	V_{DD} = 3.9 V, $V_{CS} = V_{VP} = V_{DD} - 1$ V → V_{DD}	0.85	1.10	1.35	ms
Short Circuit Detection Voltage 1	V_{SHORT1}	Defined as $V_{CS} - V_{VP}$, V_{DD} = 3.9 V	V_{SHORT1} – 0.00100	V_{SHORT1}	V_{SHORT1} + 0.00100	V
Short Circuit Detection Voltage 2	V_{SHORT2}	Defined as $V_{VP} - V_{SS}$, V_{DD} = 3.9 V	V_{DD} × 0.35	V_{DD} × 0.45	V_{DD} × 0.65	V
Short Circuit Detection Delay Time 1	$t_{VSHORT1}$	V_{DD} = 3.9 V, $V_{CS} - V_{VP} = 0$ V → $V_{SHORT1} + 0.01$ V	$t_{VSHORT1}$ × 0.75	$t_{VSHORT1}$	$t_{VSHORT1}$ × 1.25	ms
Short Circuit Detection Delay Time 2	$t_{VSHORT2}$	V_{DD} = 3.9 V, $V_{VP} = V_{CS} = V_{DD}$ → 0 V				
Charge Overcurrent Detection Voltage	V_{DET4}	Defined as $V_{CS} - V_{VP}$, V_{DD} = 3.9 V	V_{DET4} – 0.00100	V_{DET4}	V_{DET4} + 0.00100	V
Charge Overcurrent Release Voltage	V_{REL4}	Defined as $V_{VP} - V_{SS}$, V_{DD} = 3.9 V $V_{REL4} = V_{DD}$ $V_{REL4} = V_{DD} - 0.120$ V	V_{DD} – 0.025 V_{DD} – 0.180	V_{DD} V_{DD} – 0.120	V_{DD} + 0.025 V_{DD} – 0.060	V
Charge Overcurrent Detection Delay Time	t_{VDET4}	V_{DD} = 3.9 V, $V_{CS} - V_{VP} = 0$ V → $V_{DET4} - 0.01$ V	t_{VDET4} × 0.80	t_{VDET4}	t_{VDET4} × 1.20	ms
Charge Overcurrent Release Delay Time	t_{VREL4}	V_{DD} = 3.9 V, $V_{CS} = V_{VP} = V_{DD} + 0.1$ V → $V_{DD} - 1$ V	0.85	1.10	1.35	ms

NB7123ZA Electrical Characteristics (Continued)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Load Detection Voltage when Overcharging	V_{LDDET1}	Defined as $V_{VP} - V_{SS}$, V_{DD} = 3.9 V				
		$V_{REL4} = V_{DD}$	V_{DD} – 0.025	V_{DD}	V_{DD} + 0.025	V
		$V_{REL4} = V_{DD}$ – 0.120 V	V_{DD} – 0.180	V_{DD} – 0.120	V_{DD} – 0.060	
Load Detection Voltage when Transition to Standby	V_{LDDET2}	Defined as $V_{VP} - V_{SS}$,				
		V_{DD} = 1.9 V	V_{DD} × 0.30	V_{DD} × 0.58	V_{DD} × 0.80	V
		V_{DD} = 3.9 V	V_{DD} × 0.35	V_{DD} × 0.45	V_{DD} × 0.65	
Load Detection Delay Time when Transition to Standby	$t_{VLDDET2}$	$V_{VP} - V_{SS}$ = 1.9 V → V_{LDDET2} – 0.1V	-	-	300	µs
Charger Detection Voltage	V_{CHGDET}	Defined as $V_{VP} - V_{SS}$, R_{VP} = 1.0kΩ				
		V_{DD} = 1.9 V	V_{DD} × 0.30	V_{DD} × 0.58	V_{DD} × 0.80	V
		V_{DD} = 3.9 V	V_{DD} × 0.40	V_{DD} × 0.50	V_{DD} × 0.70	
Charger Detection Delay Time	$t_{VCHGDET}$	$V_{VP} - V_{SS}$ = 0 → V_{CHGDET} + 0.1V	-	-	300	µs
COUT Pin Output Low Voltage	V_{COL}	I_{COUT} = 10µA, V_{DD} = 4.85 V	-	0.030	0.100	V
COUT Pin Output High Voltage	V_{COH}	V_{DD} = 3.9 V, $V_{VP} = V_{DD}$				
		$I_{COUT} + I_{DOUT}$ = 0uA	V_{DD} + 4.50	V_{DD} + 4.70	-	V
		$I_{COUT} + I_{DOUT}$ = -2uA	V_{DD} + 2.65	V_{DD} + 2.90	-	
DOUT Pin Output Low Voltage	V_{DOL}	V_{DD} = 1.9 V				
		V_{VP} = 1.9 V, I_{DOUT} = 10µA	-	0.065	0.150	V
		V_{VP} = 0.0 V, I_{DOUT} = 1µA	-	0.020	0.100	
DOUT Pin Output High Voltage	V_{DOH}	V_{DD} = 3.9 V, $V_{VP} = V_{DD}$				
		$I_{COUT} + I_{DOUT}$ = 0uA	V_{DD} + 4.50	V_{DD} + 4.70	-	V
		$I_{COUT} + I_{DOUT}$ = -2uA	V_{DD} + 2.65	V_{DD} + 2.90	-	
VP Pin Output Pullup Resistance	R_{VPPU}	Pulled up to V_{DD}, V_{DD} = 3.9 V, V_{VP} = 3.8 V V_{DET3}: Auto Release type	15	45	70	kΩ
VP Pin Output Pulldown Resistance 1 for V_{DET2}	R_{VPPD1}	Pulled down to V_{SS}, $V_{DD} = V_{VP}$ = 1.9 V	75	150	500	kΩ
VP Pin Output Pulldown Resistance 2 for V_{DET3}	R_{VPPD2}	Pulled down to V_{SS}, V_{DD} = 3.9 V, V_{VP} = 3.8 V V_{DET3}: Latch type	150	700	1500	kΩ
VP Pin Output Pulldown Resistance 3 for V_{DET4}	R_{VPPD3}	Pulled down to V_{SS}, V_{DD} = 3.9 V, V_{VP} = 4.0 V	2.00	7.50	20.00	MΩ
Supply Current	I_{DD}	V_{DD} = 3.9 V, $V_{VP} = V_{DD}$	-	7.0	10.0	µA
Temperature Sensing Input Current	I_{TIN}	V_{DD} = 3.9 V, $V_{VP} = V_{DD}$				
		NTC Resistance = 470 kΩ / t_{TOFF} = 128ms	-	-	0.50	µA
		NTC Resistance = 100 kΩ / t_{TOFF} = 128ms	-	-	2.00	
		NTC Resistance = 470 kΩ / t_{TOFF} = 512ms	-	-	0.15	
		NTC Resistance = 100 kΩ / t_{TOFF} = 512ms	-	-	0.50	
Standby Current	$I_{STANDBY}$	V_{DD} = 1.9 V	-	-	0.04	µA

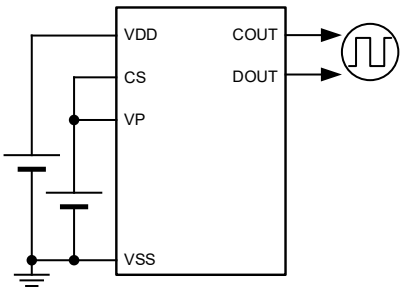
NB7123ZA Electrical Characteristics (Continued)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Charge/Discharge Overtemperature Detection Temperature	T_{DET}	V_{DD} = 3.9 V, [NTC performance] Vender: muRata Part: NCP02WF474F05RH Resistance: 470kΩ±1%(25°C) Part: NCP03WF104F05RL Resistance: 100kkΩ±1%(25°C) B-Constant: 4250K±1%	T_{DET} – 2.0	T_{DET}	T_{DET} + 2.0	°C
Charge/Discharge Overtemperature Release Temperature	T_{REL}		T_{REL} – 3.0	T_{REL}	T_{REL} + 3.0	°C
Temperature Detection Delay Time	t_{TDET}	V_{DD} = 3.9 V	t_{TDET} × 0.80	t_{TDET}	t_{TDET} × 1.20	ms
Temperature Release Delay Time	t_{TREL}	V_{DD} = 3.9 V	102	128	154	ms
Temperature Sensing Intermittent ON Time	t_{TON}	V_{DD} = 3.9 V	6.4	8	9.6	ms
Temperature Sensing Intermittent OFF Time	t_{TOFF}	V_{DD} = 3.9 V	t_{TOFF} × 0.80	t_{TOFF}	t_{TOFF} × 1.20	ms
TIN Pin Internal Resistance	R_{TIN}	Pulled down to V_{SS} NTC Resistance = 470 kΩ NTC Resistance = 100 kΩ	 90 19	 150 33	 210 47	kΩ
Forced Standby Detection Voltage	V_{STBDET}	Active-high STB pin: Defined as $V_{STB} – V_{SS}$, V_{DD} = 3.9 V Active-low STB pin: Defined as $V_P – V_{STB}$, V_{DD} = 3.9 V	0.7	1.2	1.7	V
Forced Standby Release Voltage	V_{STBREL}	Defined as $V_P – V_{SS}$, V_{DD} = 3.9 V	Same as V_{REL3}			V
Forced Standby Detection Delay Time	$t_{VSTBDET}$	Active-high STB pin: V_{DD} = 3.9 V, V_{STB} - V_{SS} = 0 V → 3.9 V, $t_{VSTBDET}$ = 1.1 ms $t_{VSTBDET}$ = 16 ms Active-low STB pin: V_{DD} = 3.9 V, $V_P – V_{STB}$ = 3.9 V → 0 V, $t_{VSTBDET}$ = 1.1 ms $t_{VSTBDET}$ = 16 ms	 0.85 $t_{VSTBDET}$ × 0.80 0.85 $t_{VSTBDET}$ × 0.80	 1.10 $t_{VSTBDET}$ 1.10 $t_{VSTBDET}$	 1.35 $t_{VSTBDET}$ × 1.20 1.35 $t_{VSTBDET}$ × 1.20	ms
Forced Standby Release Delay Time	$t_{VSTBREL}$	V_{DD} = 3.9 V, V_{VP} = V_{DD} x 0.75 → V_{DD} + 0.1 V $t_{VSTBREL}$ = 16 ms $t_{VSTBREL}$ = 128 ms	 $t_{VSTBREL}$ × 0.80	 $t_{VSTBREL}$	 $t_{VSTBREL}$ × 1.20	ms
STB Pin Internal Resistance	R_{STB}	Active-high STB pin: Pulled down to V_{SS}, R_{STB} = 100 kΩ R_{STB} = 200 kΩ Active-low STB pin: Pulled up to V_P, R_{STB} = 100 kΩ R_{STB} = 200 kΩ	 50 100 50 100	 100 200 100 200	 170 340 170 340	kΩ
COUT Pin Boost Detection Voltage	$V_{BSTDETC}$	Defined as $V_{COUT} – V_{SS}$, V_{DD} = 3.9 V	V_{DD} + 0.8	V_{DD} + 1.3	V_{DD} + 1.6	V
DOUT Pin Boost Detection Voltage	$V_{BSTDETD}$	Defined as $V_{DOUT} – V_{SS}$, V_{DD} = 3.9 V	V_{DD} + 0.8	V_{DD} + 1.3	V_{DD} + 1.6	V

All test parameters listed in Electrical Characteristics are done under Ta = 25°C only.

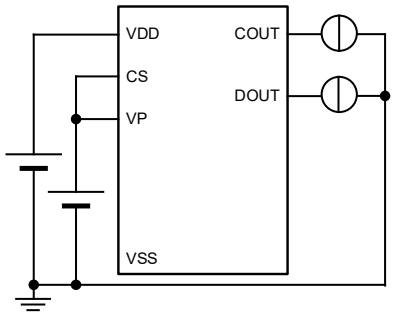
● Test Circuits

Voltage Detection and Current Consumption



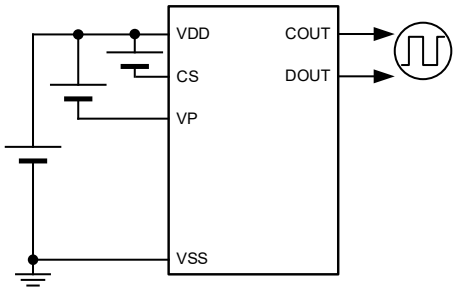
V_{DET1}, V_{REL1}, V_{DET2}, V_{REL2}, t_{VDET1}, t_{VREL1}, t_{VDET2}, t_{VREL2}, V_{NOCHG}, V_{CHGDET}, V_{LDDET1}, V_{LDDET2}, V_{SHORT2}, $t_{VNOCHGDET}$, $t_{VNOCHGREL}$, $t_{VCHGDET}$, $t_{VLDDET2}$, $t_{VSHORT2}$, I_{DD}, $I_{STANDBY}$

Output Voltage



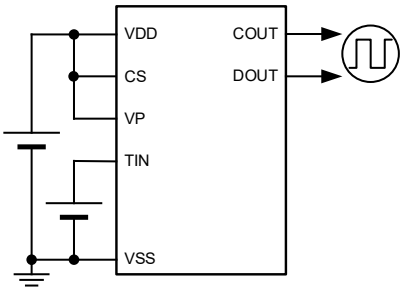
V_{COH}, V_{COL}, V_{DOH}, V_{DOL}

Current Detection



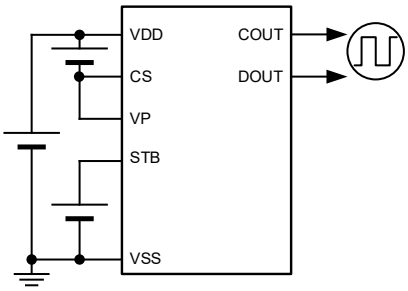
V_{DET3}, V_{REL3}, V_{DET4}, V_{REL4}, t_{VDET3}, t_{VREL3}, t_{VDET4}, t_{VREL4}, V_{SHORT1}, $t_{VSHORT1}$, R_{VPPU}, R_{VPPD1}, R_{VPPD2}, R_{VPPD3}

Temperature Protection



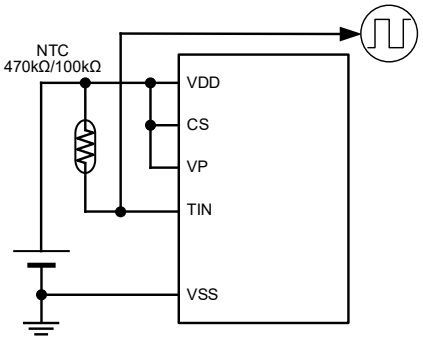
T_{DET}, T_{REL}, t_{TDET}, t_{TDET}, R_{TIN}, I_{TIN}

Forced Standby Control



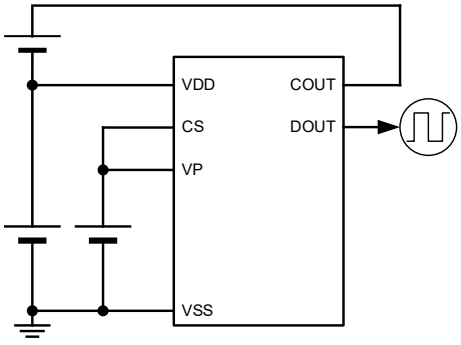
R_{STB}, V_{STBDET}, V_{STBREL}, $t_{VSTBREL}$, $t_{VSTBDET}$

Intermittent Time for Temperature Sensing



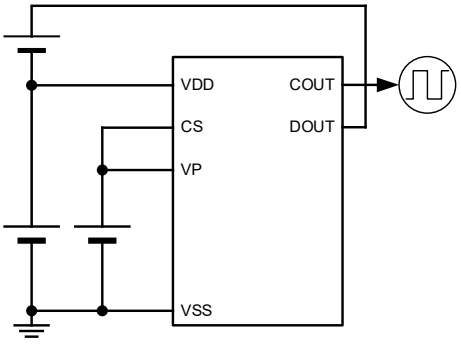
t_{TON}, t_{TOFF}

Boost Detection Voltage for COUT Pin



$V_{BSTDETC}$

Boost Detection Voltage for DOUT Pin



$V_{BSTDETD}$

THEORY OF OPERATION

● Overcharge Protection

If the VDD pin voltage (V_{DD}) remains above the overcharge detection voltage (V_{DET1}) for longer than the overcharge detection delay time (t_{VDET1}), this IC enters the overcharge state. In this state, the COUT pin becomes Low, and the charge control FET is turned off to stop charging.
The VP pin voltage decreases by the Vf voltage at the internal parasitic diode compared to the VDD pin voltage(V_{DD}), as the discharge current flows via the parasitic diode even when the charge control FET is off.

To exit the overcharge state, the following requirements must be met.

Type	Pin Condition	Delay Time	Remarks
Latch	$V_{VP} < V_{LDDET1}$ and $V_{DD} < V_{REL1}$	t_{VREL1}	-

● Over-discharge Protection

If the VDD pin voltage (V_{DD}) stays below the over-discharge detection voltage (V_{DET2}) for longer than the over-discharge detection delay time (t_{VDET2}), this IC enters the over-discharge state. In this state, the DOUT pin becomes Low, and the discharge control FET is turned off to stop discharging.
The VP pin voltage (V_{VP}) increases by the Vf voltage at the internal parasitic diode compared to the VDD pin voltage (V_{DD}), as the charge current flows via the parasitic diode even when the discharge control FET is off.
In addition, when V_{VP} is pulled down to VSS level and falls below the load detection voltage (V_{LDDET2}), this IC enters the standby state. In this state, this IC minimizes current consumption.

To exit the over-discharge state, the following requirements must be met.

Type	Pin Condition	Delay Time	Remarks
Latch	$V_{VP} > V_{CHGDET}$ and $V_{DD} > V_{REL2}$	t_{VREL2}	The VP pin is internally pulled down to VSS.

● Discharge Overcurrent Protection

This IC measures the voltage across the sense resistor (R_{SENS}) between the CS and the VP pins to monitor the discharge current. If the discharge current, converted to a voltage by R_{SENS}, exceeds the discharge overcurrent detection voltage (V_{DET3}) for longer than the discharge overcurrent detection delay time (t_{VDET3}), this IC enters the discharge overcurrent state.
In this state, the DOUT pin becomes Low, and the discharge control FET is turned off to shut off the discharge current.
If the short circuit current, converted to a voltage by R_{SENS}, exceeds the short circuit detection voltage (V_{SHORT1}) for longer than the short circuit detection delay time ($t_{VSHORT1}$), this IC enters the discharge overcurrent state.

To exit the discharge overcurrent state, the following requirements must be met.

Type	Pin Condition	Delay Time	Remarks
Latch	$V_{VP} > V_{REL3}$	t_{VREL3}	The VP pin is internally pulled down to VSS.
Auto Release	$V_{VP} > V_{REL3}$	t_{VREL3}	The VP pin is internally pulled up to VDD.

● Charge Overcurrent Protection

This IC measures the voltage across the sense resistor (R_{SENS}) between the CS and the VP pins to monitor the charge current. If the charge current, converted to a voltage by R_{SENS}, remains below the charge overcurrent detection voltage (V_{DET4}) for longer than the charge overcurrent detection delay time (t_{VDET4}), this IC enters the charge overcurrent state.
In this state, the COUT pin becomes Low, and the charge control FET is turned off to shut off the charge current.

To exit the charge overcurrent state, the following requirements must be met.

Type	Pin Condition	Delay Time	Remarks
Auto Release	$V_{VP} < V_{REL4}$	t_{VREL4}	The VP pin is internally pulled down to VSS.

● 0 V Battery Charging Inhibition

0 V Battery Charge Function "Inhibition"

If the battery voltage is below the 0 V battery charging inhibition voltage (V_{NOCHG}), this IC prohibits charging, even if the charger is connected.

● Temperature Protection

This IC monitors the voltage converted from the temperature detected by the external thermistor connected to the TIN pin through the temperature-to-voltage converter using the internal resistor (R_{TIN}). The thermistor operates only for t_{TON} in each (t_{TOFF} + t_{TON}) cycle to reduce current consumption.
If the temperature detected by the external NTC (T_{DET}) remains above the threshold for longer than T_{TDET}, the COUT and DOUT pins become Low, the charge and discharge control FETs turn off, and the charge and discharge current stop.
If the temperature falls below the release temperature for external NTC (T_{REL}) for longer than the temperature delay time (T_{TREL}), the COUT and DOUT pin becomes High.

Type	Pin Condition	Delay Time	Remarks
High Temp.	Temp.< T_{REL}	t_{TREL}	-

● Forced Standby Detection

If the forced standby function is available, the IC can enter the forced standby state by controlling the STB pin. To detect the pre-forced standby state, the following pin conditions and delay times must be met.

Type	Pin Condition	Delay Time	Remarks
Forced Standby Active-high	V_{STB} > V_{STBDET}	$t_{VSTBDET}$	The STB pin is internally pulled down to VSS.
Forced Standby Active-low	V_{STB} < V_{STBDET}	$t_{VSTBDET}$	The STB pin is internally pulled up to VP.

In this state, the DOUT pin becomes Low, and the discharge control FET is turned off to stop discharging.
Afterward, if V_{VP} is pulled down to VSS level and falls below the load detection voltage (V_{LDDET2}), this IC enters the standby state. [Note] In the standby state, this IC minimizes current consumption.

To exit the standby state, the following requirements must be met.

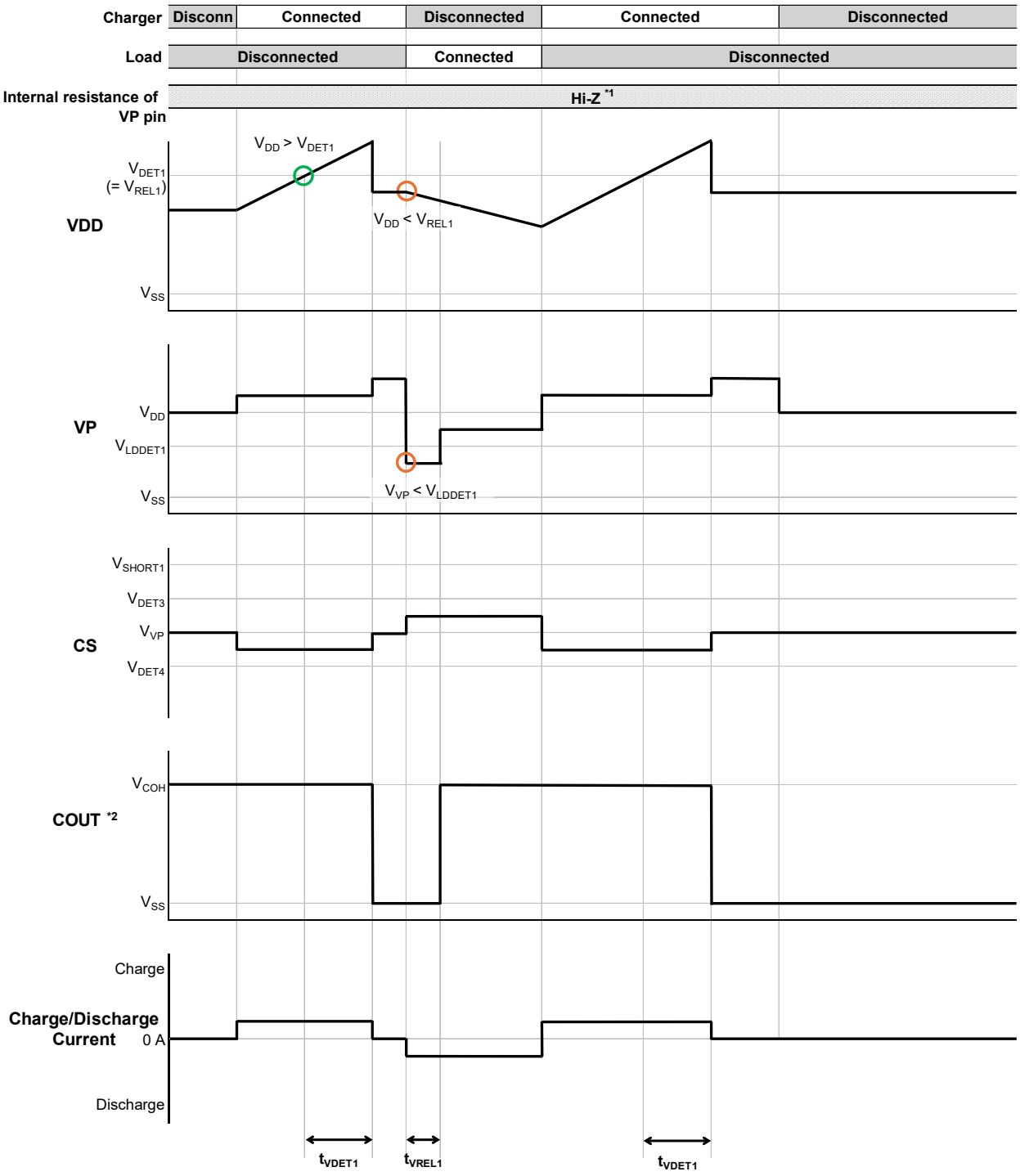
Type	Pin Condition	Delay Time	Remarks
Over-discharge Latch	V_{VP} > V_{CHGDET} and V_{DD} > V_{REL2}	t_{VREL2}	The VP pin is internally pulled down to VSS.

Note: After detecting the forced standby state, this IC returns to the normal state once V_{VP} is higher than V_{STBREL} for $t_{VSTBREL}$ without dropping below V_{STBREL}.

● Voltage Boost Function

This IC has an internal charge pump that raises the COUT and DOUT pins by approximately 5.0V above the VDD pin voltage. This IC stops the charge pump in the standby state.
To prevent false detection of the short circuit detection voltage2 (V_{SHORT2}), this IC masks V_{SHORT2} until the COUT/DOUT pin voltage (V_{COUT}/V_{DOUT}) exceeds the boost detection voltage ($V_{BSTDETC}$/$V_{BSTDETD}$).

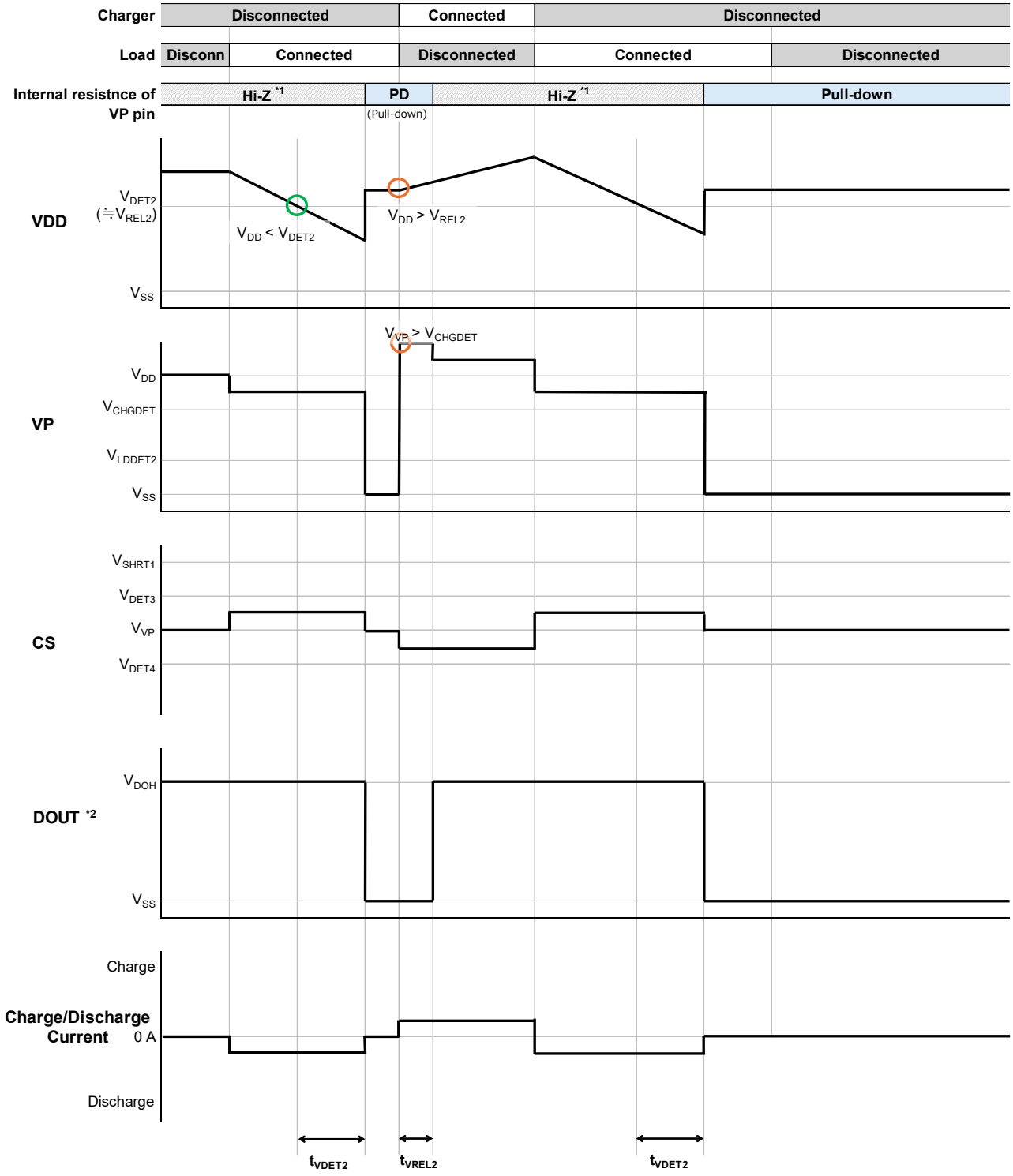
● Timing Diagrams



*1: Small pull-down current occurs due to supply current of the internal circuit.
*2: The COUT pin output is an approximate value of V_{COH} but it is simplified to draw with a square wave in the diagram.

State	Pin Condition	Delay Time
Detection	$V_{DD} > V_{DET1}$	t_{VDET1}
Release	$V_{DD} < V_{REL1}$ and $V_{VP} < V_{LDDET1}$	t_{VREL1}

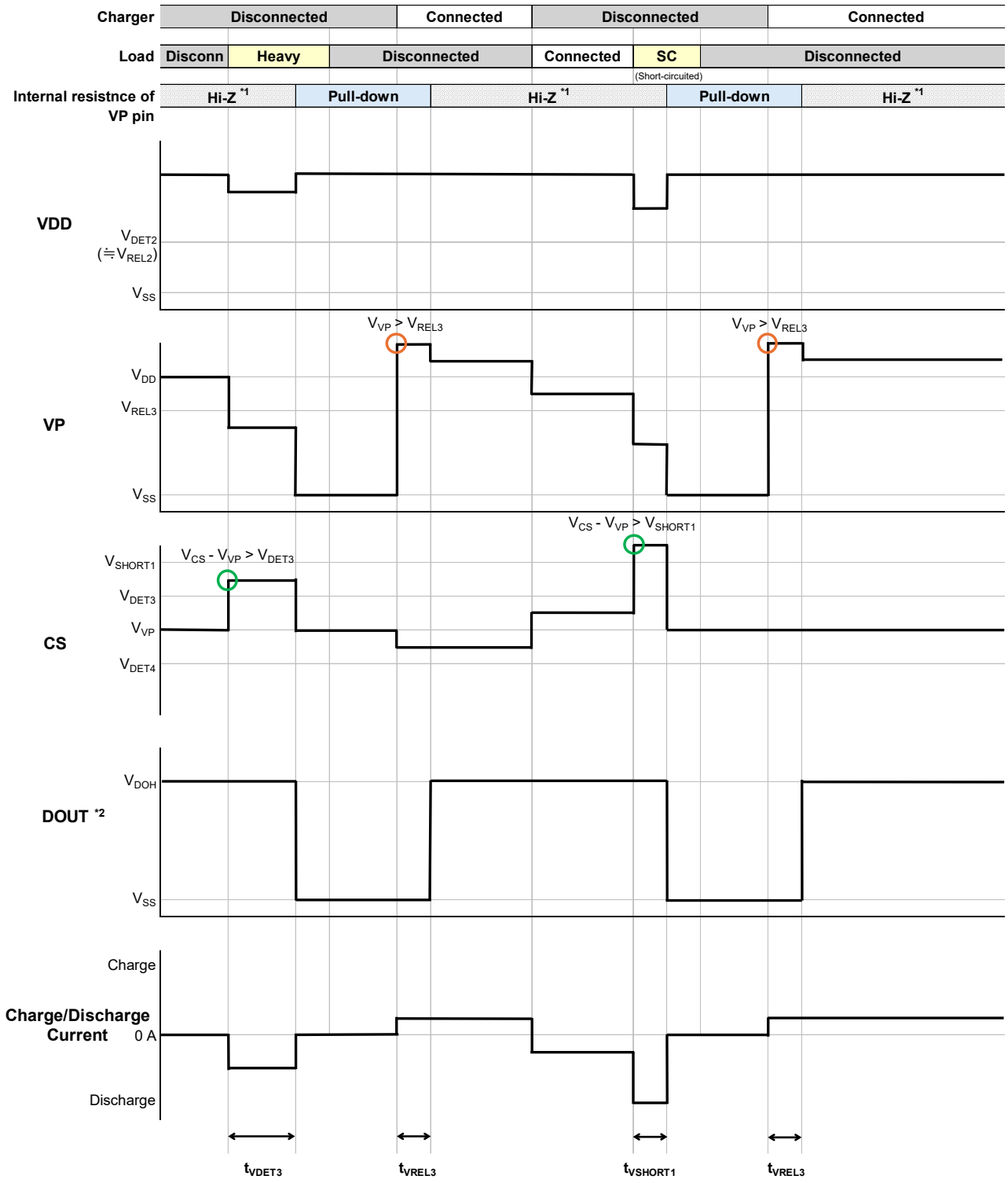
Overcharge ProtectionTiming Diagram



*1: Small pull-down current occurs due to supply current of the internal circuit.
*2: The DOUT pin output is an approximate value of V_{DOH} but it is simplified to draw with a square wave in the diagram.

State	Pin Condition	Delay Time
Detection	$V_{DD} < V_{DET2}$	t_{VDET2}
Release	$V_{DD} > V_{REL2}$ and $V_{VP} > V_{CHGDET}$	t_{VREL2}

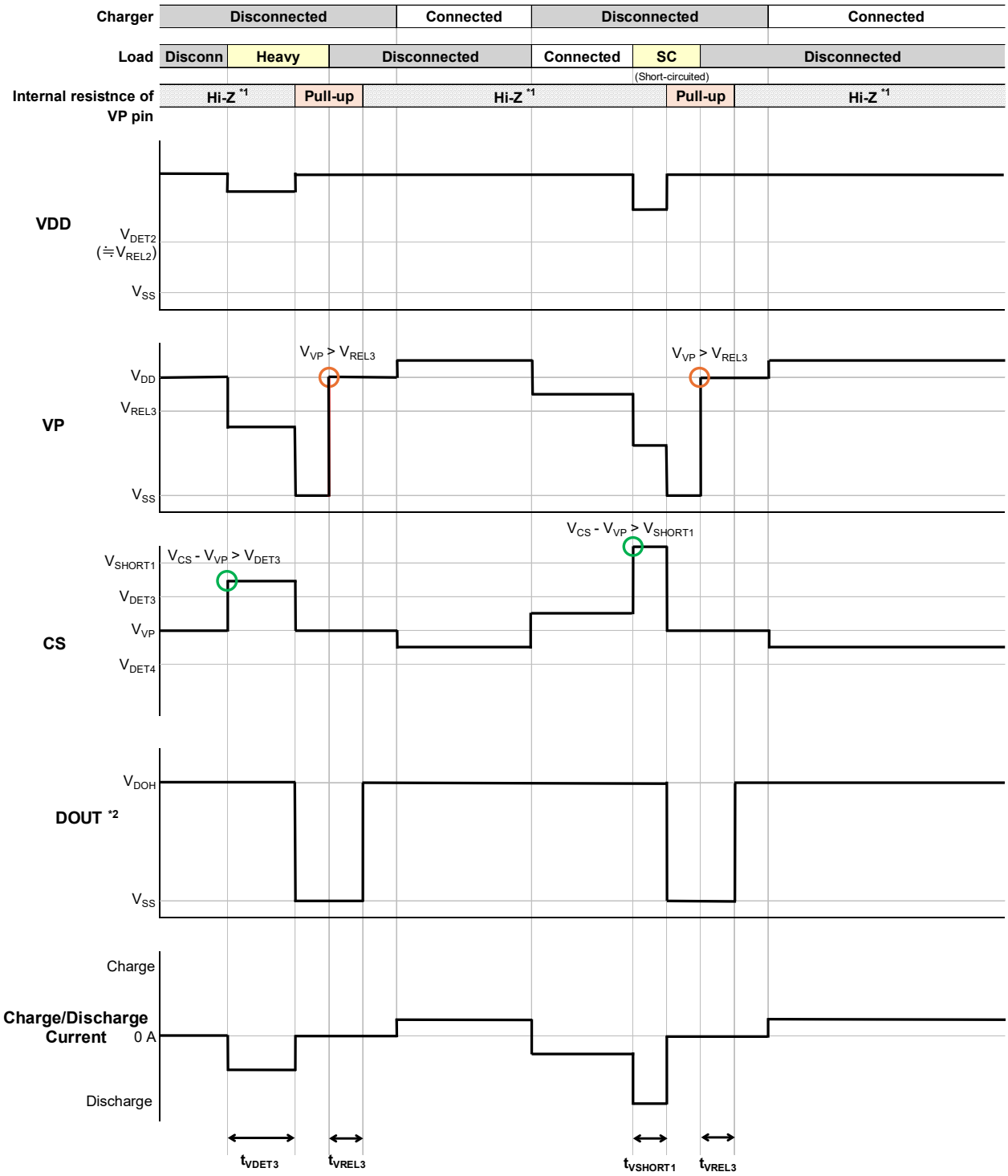
Over-discharge Protection Timing Diagram



*1: Small pull-down current occurs due to supply current of the internal circuit.
*2: The DOUT pin output is an approximate value of V_{DOH} but it is simplified to draw with a square wave in the diagram.

State	Pin Condition	Delay Time
Detection of V_{DET3}	$V_{CS} - V_{VP} > V_{DET3}$	t_{VDET3}
Detection of V_{SHORT1}	$V_{CS} - V_{VP} > V_{SHORT1}$	$t_{VSHORT1}$
Release	$V_{VP} > V_{REL3}$	t_{VREL3}

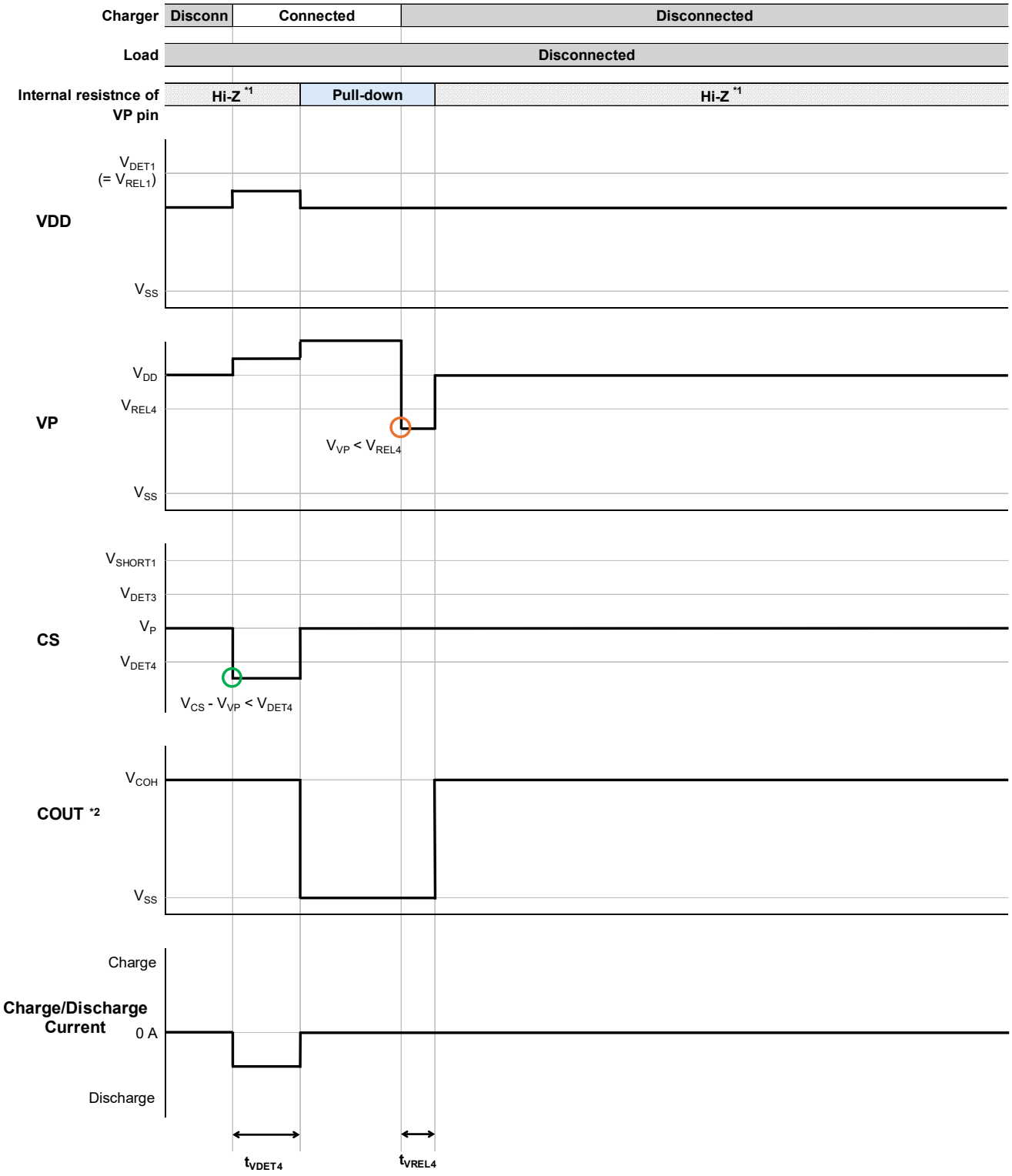
Discharge Overcurrent Protection (Latch Type) Timing Diagram



*1: Small pull-down current occurs due to supply current of the internal circuit.
*2: The DOUT pin output is an approximate value of V_{DOH} but it is simplified to draw with a square wave in the diagram.

State	Pin Condition	Delay Time
Detection of V_{DET3}	$V_{CS} - V_{VP} > V_{DET3}$	t_{VDET3}
Detection of V_{SHORT1}	$V_{CS} - V_{VP} > V_{SHORT1}$	$t_{VSHORT1}$
Release	$V_{VP} > V_{REL3}$	t_{VREL3}

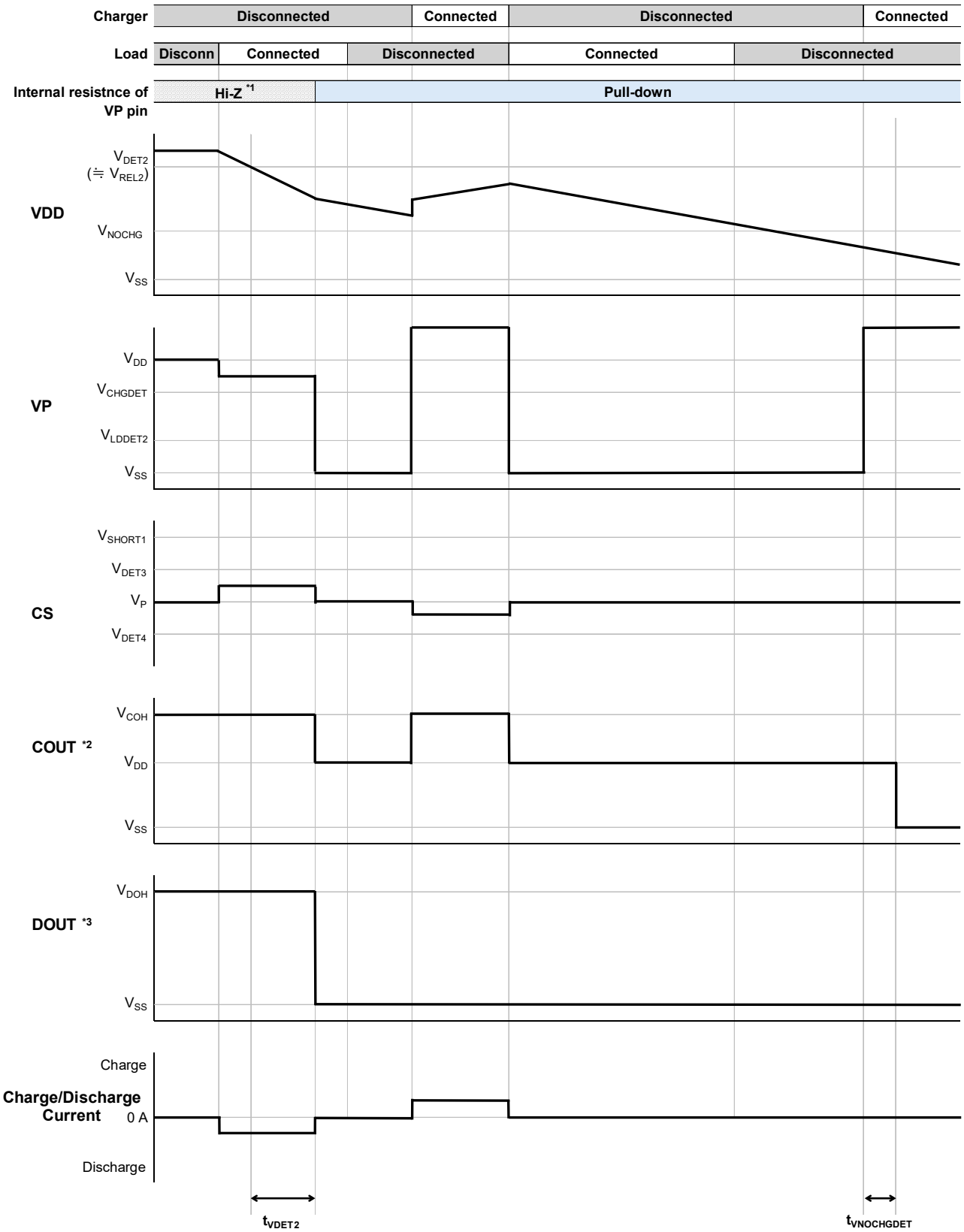
Discharge Overcurrent Protection (Auto release Type) Timing Diagram



*1: Small pull-down current occurs due to supply current of the internal circuit.
*2: The COUT pin output is an approximate value of V_{COH} but it is simplified to draw with a square wave in the diagram.

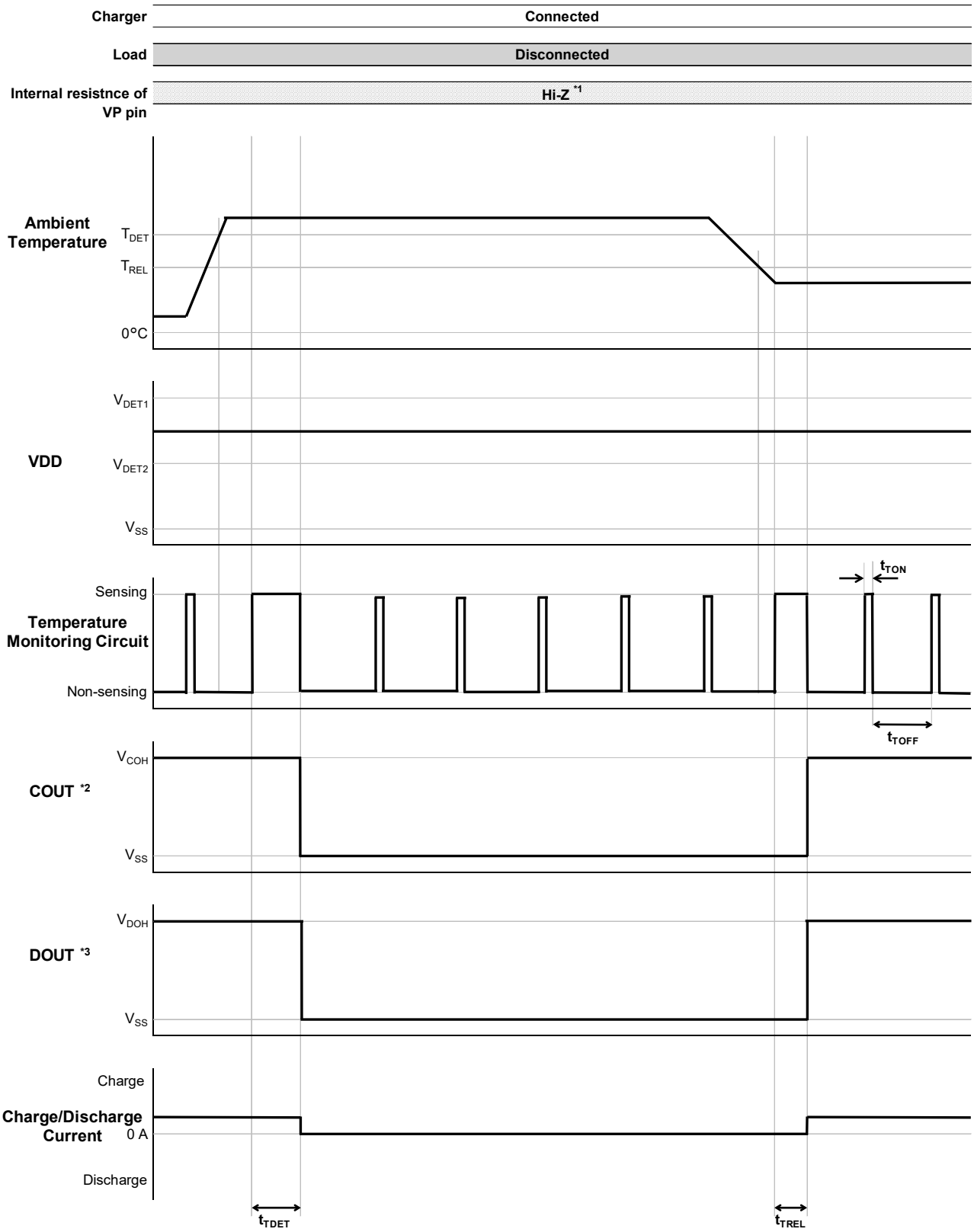
State	Pin Condition	Delay Time
Detection	$V_{CS} - V_{VP} < V_{DET4}$	t_{VDET4}
Release	$V_{VP} < V_{REL4}$	t_{VREL4}

Charge Overcurrent Protection (Auto release Type) Timing Diagram



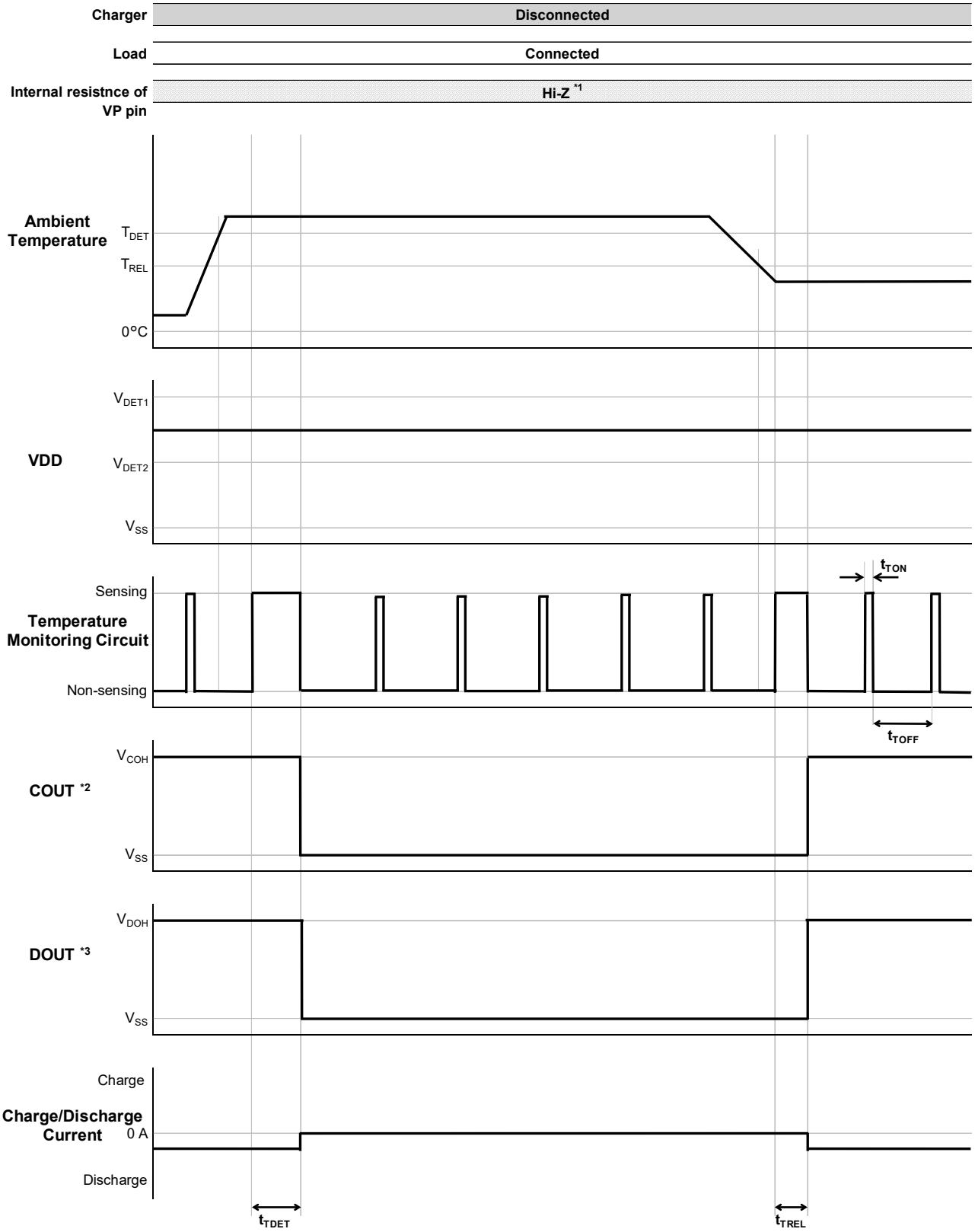
*1: Small pull-down current occurs due to supply current of the internal circuit.
*2: The COUT pin output is an approximate value of V_{COH} but it is simplified to draw with a square wave in the diagram.
*3: The DOUT pin output is an approximate value of V_{DOH} but it is simplified to draw with a square wave in the diagram.

0V Battery Charging Timing Diagram



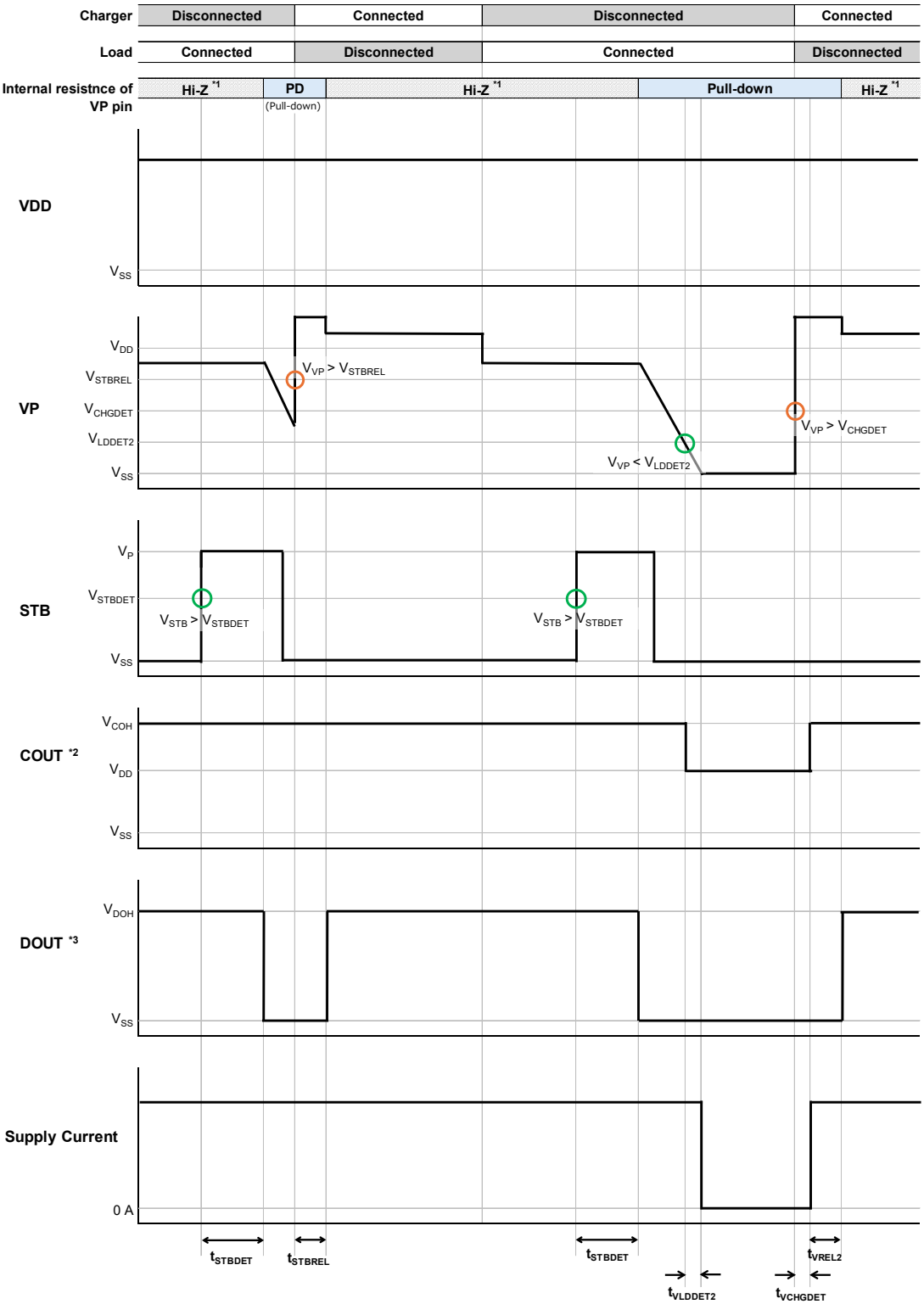
*1: Small pull-down current occurs due to supply current of the internal circuit.
*2: The COUT pin output is an approximate value of V_{COH} but it is simplified to draw with a square wave in the diagram.
*3: The DOUT pin output is an approximate value of V_{DOH} but it is simplified to draw with a square wave in the diagram.

Charge/Discharge Overtemperature Protection (with Chager) Timing Diagram



*1: Small pull-down current occurs due to supply current of the internal circuit.
*2: The COUT pin output is an approximate value of V_{COH} but it is simplified to draw with a square wave in the diagram.
*3: The DOUT pin output is an approximate value of V_{DOH} but it is simplified to draw with a square wave in the diagram.

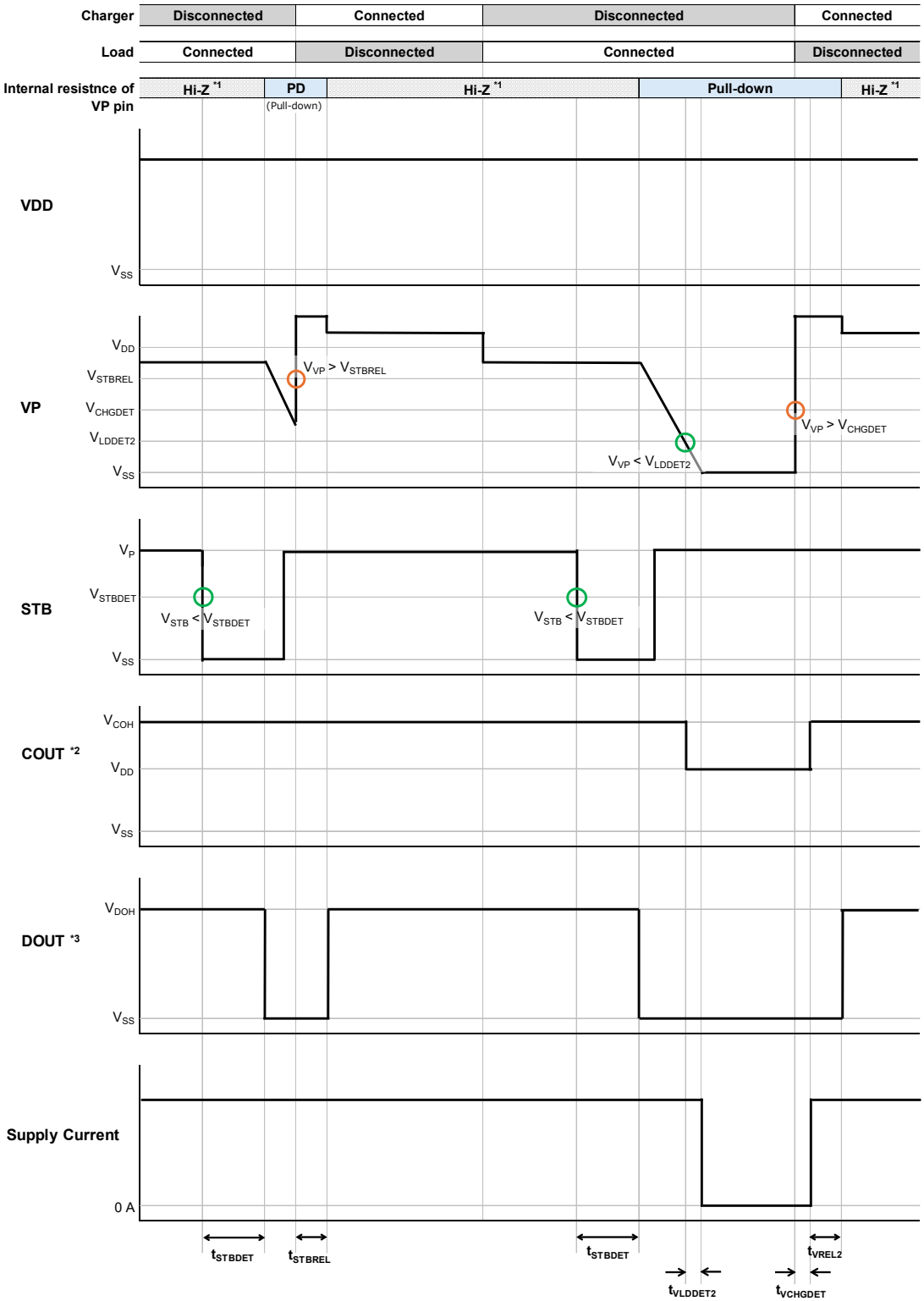
Charge/Discharge Overtemperature Protection (with Load) Timing Diagram



*1: Small pull-down current occurs due to supply current of the internal circuit.
*2: The COUT pin output is an approximate value of V_{COH} but it is simplified to draw with a square wave in the diagram.
*3: The DOUT pin output is an approximate value of V_{DOH} but it is simplified to draw with a square wave in the diagram.

State	Pin Condition	Delay Time
Detection	$V_{STB} > V_{STBDET}$	t_{STBDET}
Detection	$V_{VP} < V_{LDDET2}$	$t_{VLDDET2}$
Release	$V_{VP} > V_{STBREL}$	t_{STBREL}
Release	$V_{VP} > V_{CHGDET}$	t_{CHGDET} & t_{VREL2}

Forced Standby Protection (Active-high STB Pin) Timing Diagram



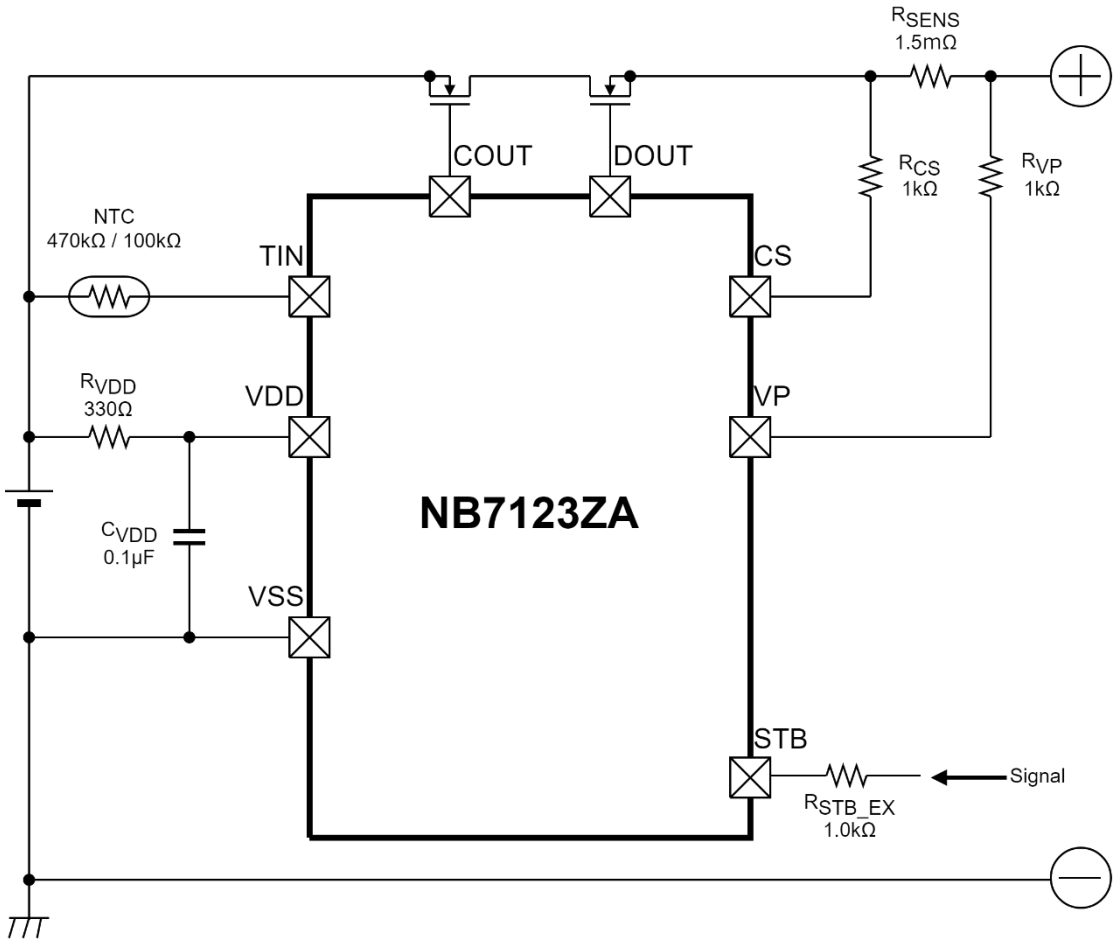
*1: Small pull-down current occurs due to supply current of the internal circuit.
*2: The COUT pin output is an approximate value of V_{COH} but it is simplified to draw with a square wave in the diagram.
*3: The DOUT pin output is an approximate value of V_{DOH} but it is simplified to draw with a square wave in the diagram.

State	Pin Condition	Delay Time
Detection	$V_{STB} < V_{STBDET}$	t_{STBDET}
Detection	$V_{VP} < V_{LDDET2}$	$t_{VLDDET2}$
Release	$V_{VP} > V_{STBREL}$	t_{STBREL}
Release	$V_{VP} > V_{CHGDET}$	t_{CHGDET} & t_{VREL2}

Forced Standby Protection (Active-low STB Pin) Timing Diagram

APPLICATION INFORMATION

● Typical Application Circuit



NB7123ZA Typical Application Circuit

External Components

Symbol	Min.	Typ.	Max.
Resistor			
R_{VDD}	-	330Ω	1kΩ
R_{VP}	-	1.0kΩ	1.3kΩ
R_{CS}	-	1.0kΩ	1.3kΩ
R_{STB_EX}	-	1.0kΩ	-
R_{SENS}	-	1.5mΩ	-
Capacitor			
C_{VDD}	0.01µF	0.10µF	1.00µF

The NTC thermistor with the following characteristics is required.

Vendor	muRata	
Part Number	NCP02WF474F05RH	NCP03WF104F05RL
Resistance	470kΩ±1% (25°C)	100kΩ±1% (25°C)
B-Constant	4250K ±1%	4250K ±1%

The voltage flucuation is stabilized by R_{VDD} and C_{VDD}. If R_{VDD} is too large, the detection voltage rises by the conduction current at detection. To stabilize the operation, it is recommended to use a resistor of 330Ω or less for R_{VDD} and a capacitor of 0.01μF to 1.00μF for C_{VDD}.

When the R_{SENS} of the resistor sensing the overcurrent is too large, the power loss also become large. If the R_{SENS} is inappropriate for the overcurrent, the power loss may exceed the allowable loss of the R_{SENS}. The appropriate R_{SENS} should be selected according to the cell specifications.

In addition, when a reverse charger is connected, the external resistors must meet the following requirements to suppress the current flowing from the pack+ side pin to the VDD pin.

Reverse Charge Current Path	Recommended Resistance Conditions
From CS pin to VSS pin	$R_{VP} = R_{CS} = 1k\Omega$ Note
From VP pin to VSS pin	

Note: If R_{VP} is larger than the requirement, charger connection may not be recognized that is required to release from some abnormal detection states.

This application circuit diagram is an example. The performance of the circuit depends on the PCB layout and external components. In the actual application, fully evaluation is required.

TECHNICAL NOTES

A peripheral component or the device mounted on PCB should not exceed a rated voltage, a rated current or a rated power. When designing a peripheral circuit, please be fully aware of the following points.

- Please evaluate the product at the PCB level before use, as some symptoms may remain that cannot be confirmed by the evaluation at the IC level.
- When using any coating or underfill to improve moisture resistance or joining strength, evaluate them adequately before using. In certain materials or coating conditions, corrosion by contained constituents, current leakage by moisture absorption, crack and delamination by physical stress can happen. If the curing temperature of the coating material or underfill material exceeds the absolute maximum rating, the electrical characteristics of this product may change.
- When performing X-ray inspection in mass production process and evaluation build stage such as the product functions and characteristics confirmation, please confirm X-ray irradiation does not exceed 1.5Gy (absorbed dose for air).

Nisshinbo Micro Devices Inc.

NB7123ZA CodeList

	Set Voltage [V] / Delay Time [ms]													Set Temperature [°C] / Delay Time [ms]					Optional Function										
	V_{DET1} t_{VDET1}	V_{REL1} t_{VREL1}	V_{DET2} t_{VDET2}	V_{REL2} t_{VREL2}	V_{DET3} t_{VDET3}	V_{REL3} t_{VREL3}	V_{DET4} t_{VDET4}	V_{REL4} t_{VREL4}	V_{SHORT1} $t_{VSHORT1}$	V_{NOCHG} -	- $t_{VSTBDET}$	- $t_{VSTBREL}$	Unit	T_{DET} t_{TDET}	T_{REL} t_{TREL}	- t_{TON}	- t_{TOFF}	Unit	Overcharge Release	Over-discharge Release	Discharge Overcurrent Release	Charge Overcurrent Release	0V Battery Charging	Temperature Protection	Forcd Standby	Forced Standby Option: STB pin	V_{STBREL}	NTC Thermistor [kΩ]
NB7123ZA601CE	4.57	4.57	2.3	2.308	0.0395	VDD x 0.87	-0.0245	VDD - 0.120	0.0885	1.45	-	-	V	85	80	-	-	°C	Latch	Latch	Latch	Auto Release	Inhibition	High Temp.	Available	Active-high	VREL3	470
	4096	2.1	128	1.1	512	1.1	32	1.1	0.28	-	16	16	ms	1024	128	8	128	ms										

Please contact our sales representatives if required a product code other than the above combinations.

Nisshinbo Micro Devices Inc.

NB7123ZA series

MK-7123ZA-AA

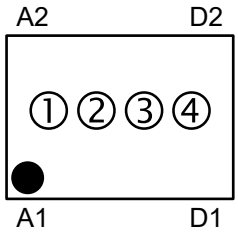
NB7123 ZA xxxxx E2 S

- ZA: Package Type (ZA: WLCSP)
- xxxxx: Specific code
- E2: Orientation in taping pocket
- S: Grade

①②: Product code (See the table below)

③④: Lot No. (series) EE,EF,EG,...,EY,FE,...,FY,GE,...,YY
(except B,D,I,M,O,Q,S,W,Z)

PKG: WLCSP-8-ZA2



NOTICE

There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used.
In the case of recognizing the marking characteristic with AOI, please contact our sales or distributor before attempting to use AOI.

Product Name	①②
NB7123ZA601CE	V0

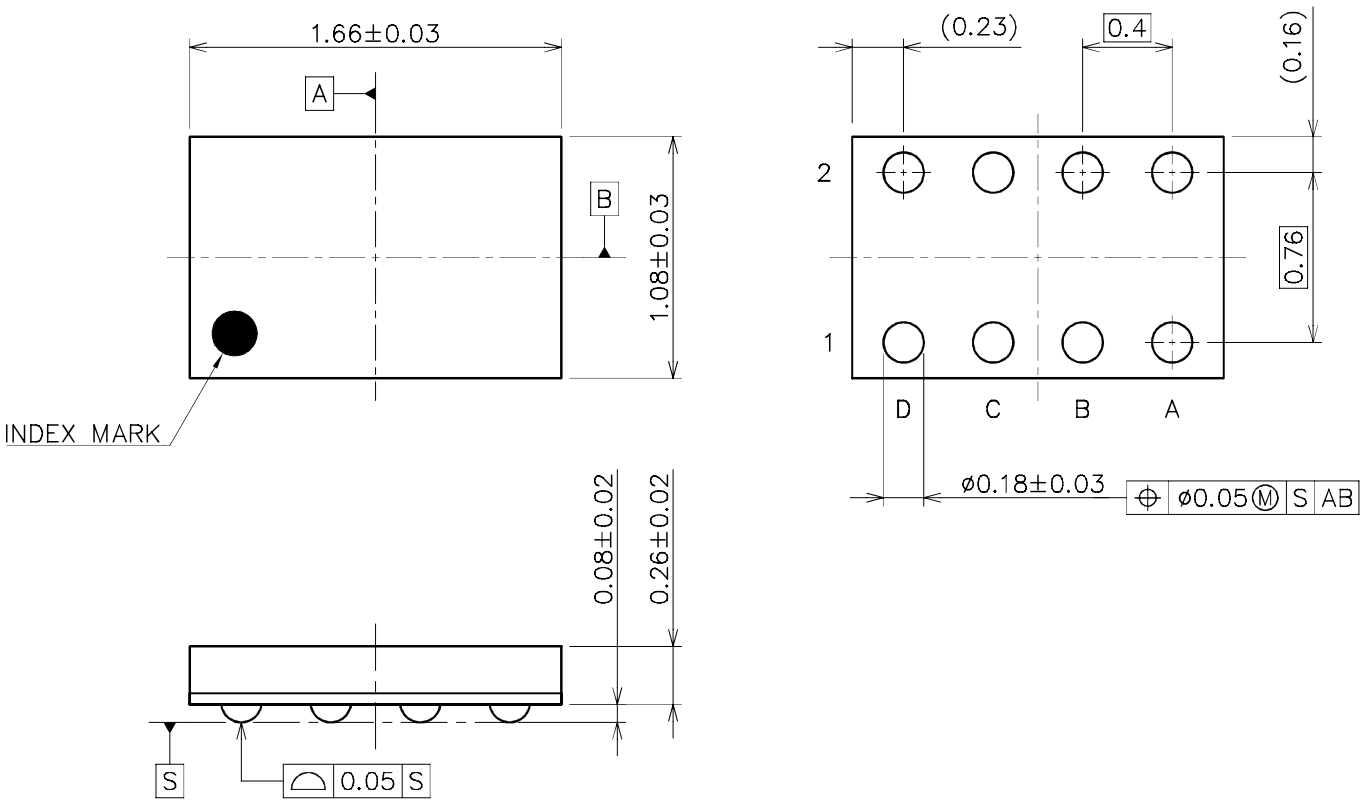
Nisshinbo Micro Devices Inc.

WLCSP-8-ZA2

PI-WLCSP-8-ZA2-E-B

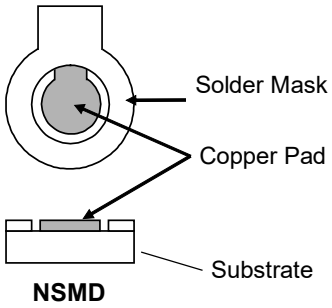
■ PACKAGE DIMENSIONS

UNIT: mm



■ EXAMPLE OF SOLDER PADS DIMENSIONS

Recommended Land Pattern



NSMD Pad Definition		
Pad definition	Copper Pad	Solder Mask Opening
NSMD (Non-Solder Mask defined)	0.18mm	MIN. 0.28mm

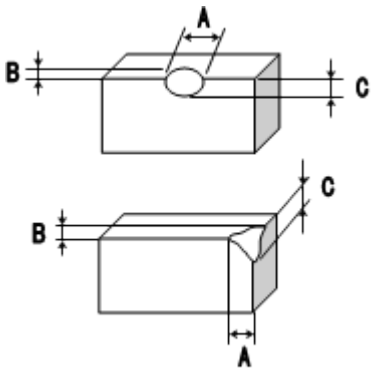
*) Pad Layout and size can modify by customers material, equipment and method.
*) Please adjust pad layout according to your conditions.
*) Recommended Stencil Aperture Size: ϕ0.26mm

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WLCSP-8-ZA2

PI-WLCSP-8-ZA2-E-B

■ Visual Inspection Criteria

No.	Inspection Items	Inspection Criteria	Figures
1	Package chipping	A ≥ 0.2mm is rejected B ≥ 0.2mm is rejected C ≥ 0.2mm is rejected And, Package chipping to Si surface and to bump is rejected.	
2	Si surface chipping	A≥0.2mm is rejected B≥0.2mm is rejected C≥0.2mm is rejected But, even if A ≥ 0.2mm, B ≤ 0.1mm is acceptable.	
3	No bump	No bump is rejected.	
4	Marking miss	To reject incorrect marking, such as another product name marking or another lot No. marking.	
5	No marking	To reject no marking on the package.	
6	Reverse direction of marking	To reject reverse direction of marking character.	
7	Defective marking	To reject unreadable marking. (Microscope: X15/ White LED/ Viewed from vertical direction)	
8	Scratch	To reject unreadable marking character by scratch. (Microscope: X15/ White LED/ Viewed from vertical direction)	
9	Stain and Foreign material	To reject unreadable marking character by stain and foreign material. (Microscope: X15/ White LED/ Viewed from vertical direction)	

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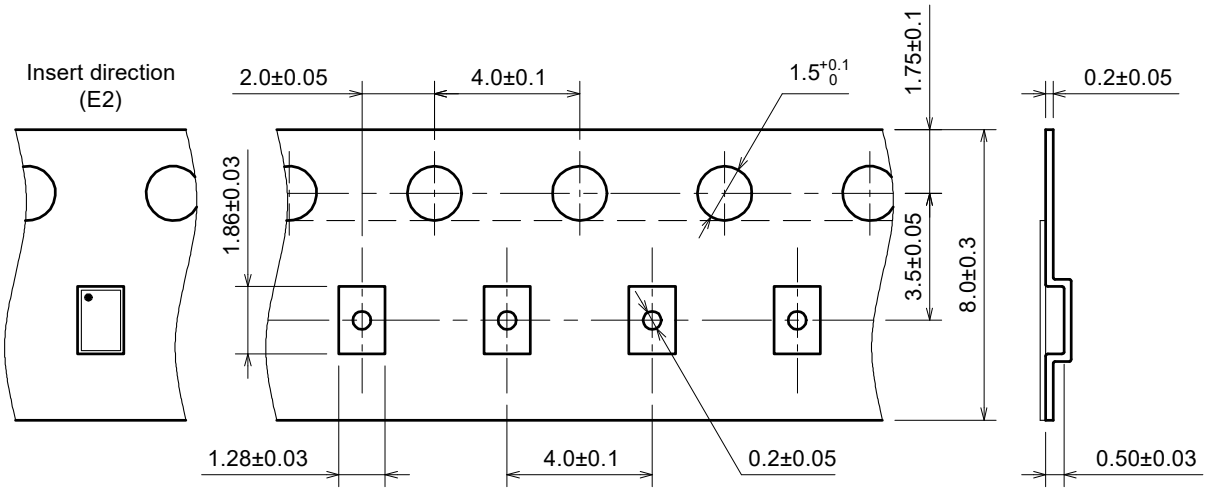
WLCSP-8-ZA2

PI-WLCSP-8-ZA2-E-B

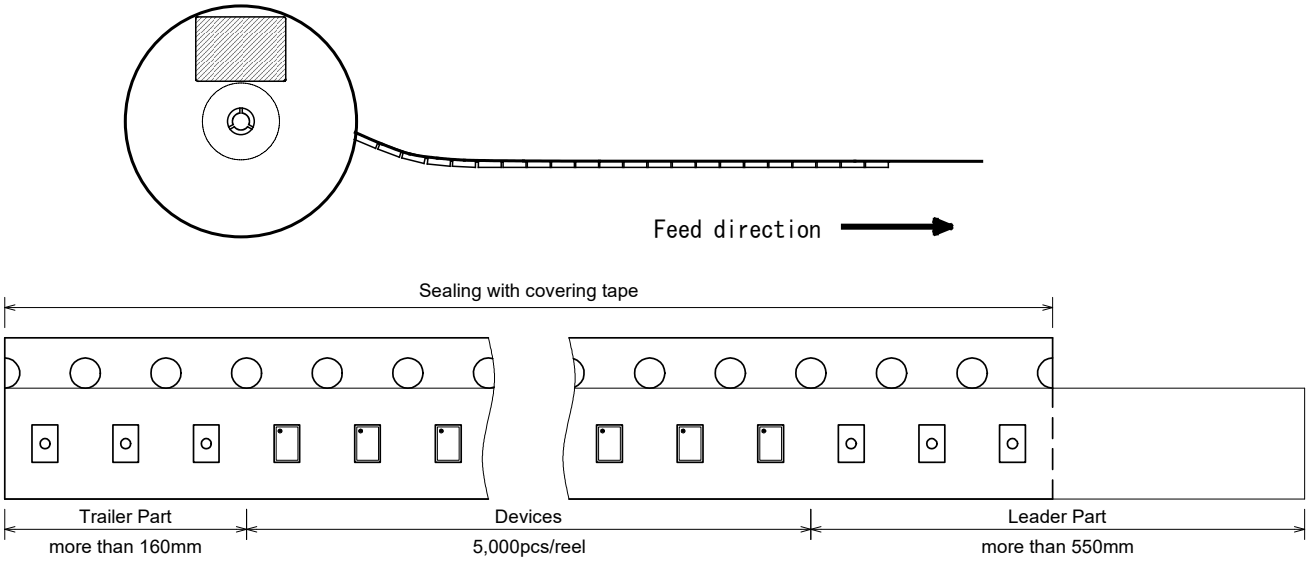
■ PACKING SPEC

UNIT: mm

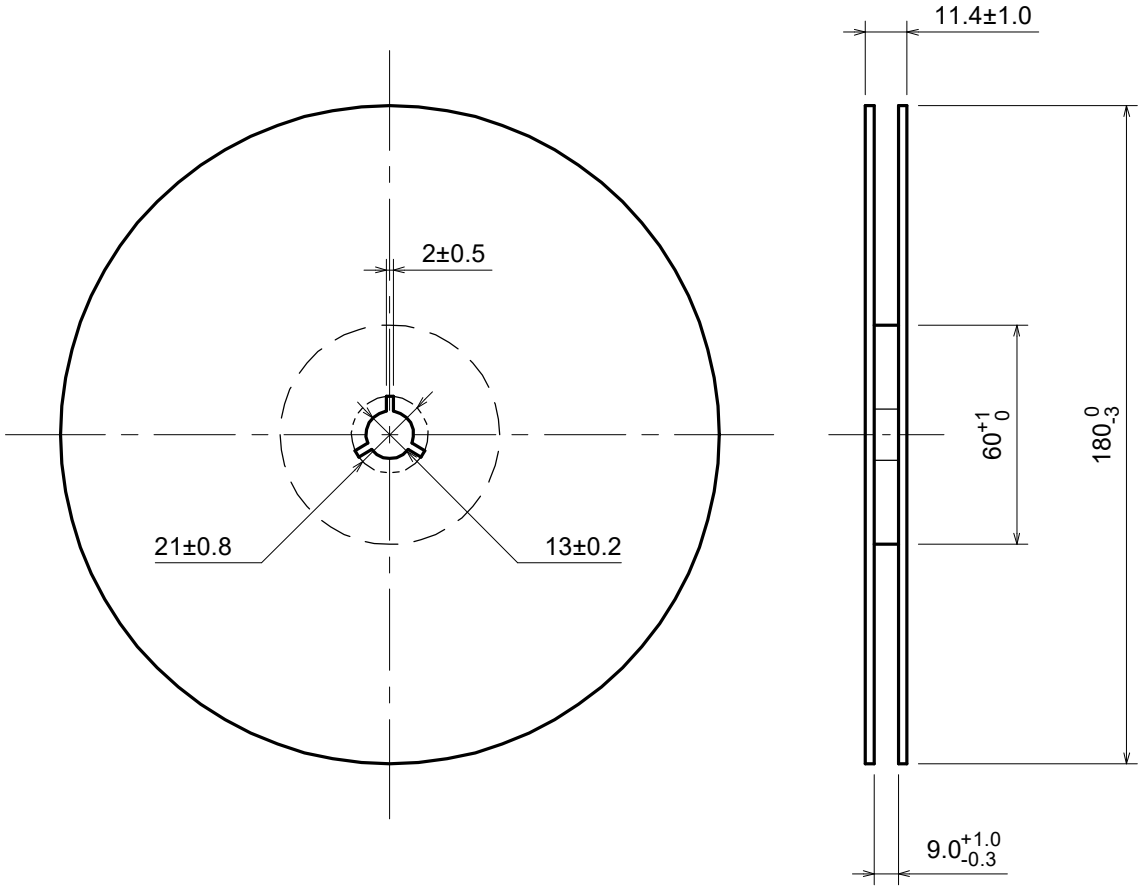
(1) Taping dimensions / Insert direction



(2) Taping state



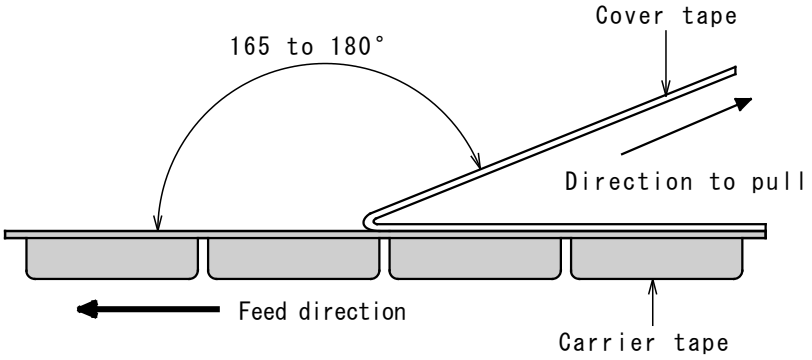
(3) Reel dimensions



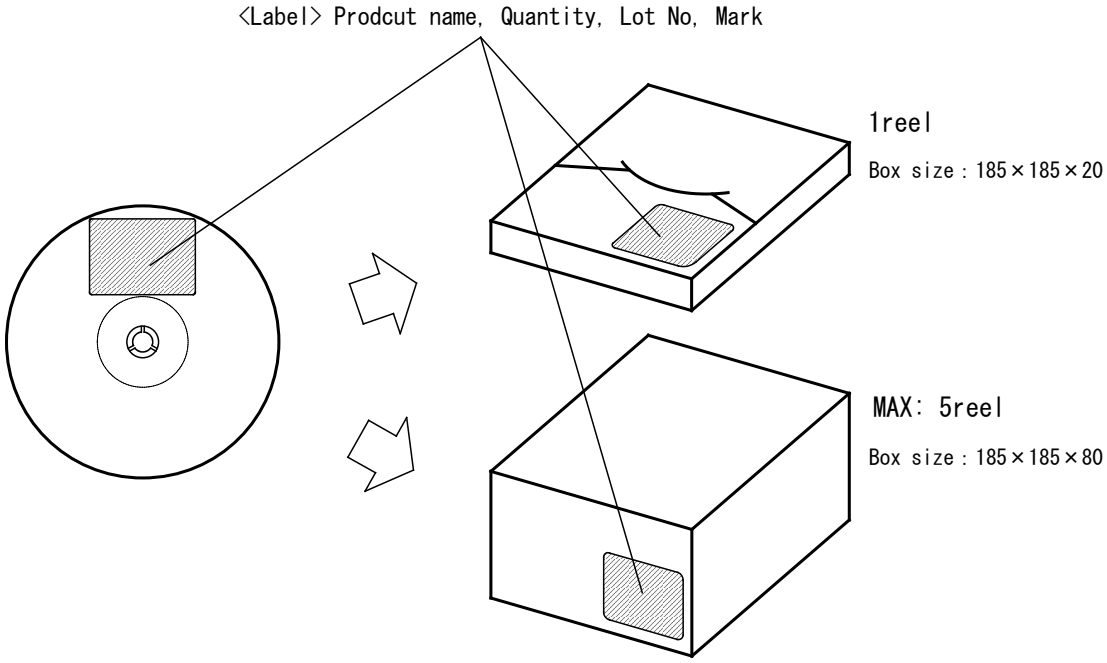
(4) Peeling strength

Peeling strength of cover tape

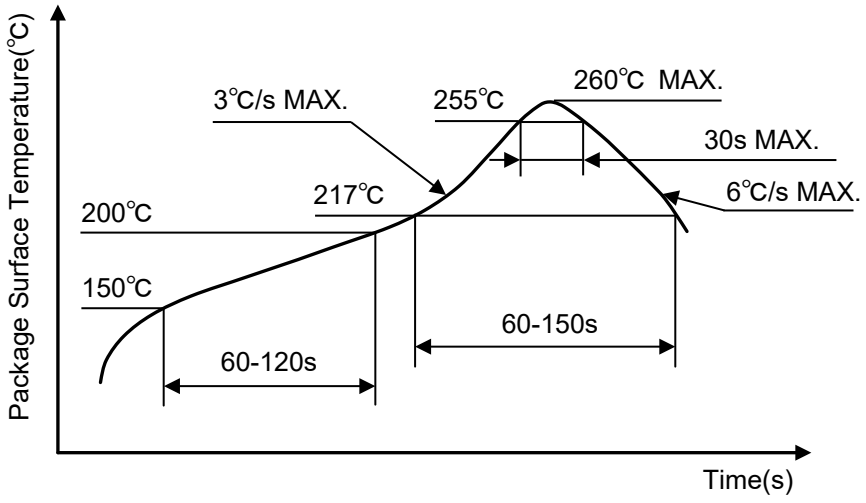
・Peeling angle	165 to 180° degrees to the taped surface.
・Peeling speed	300mm/min
・Peeling strength	0.1 to 1.0N



(5) Packing state



■ **HEAT-RESISTANCE PROFILES**



Reflow profile

REVISION HISTORY

Date	Version		Changes
April 1, 2025	1.0	a	First official datasheet release
June 10, 2025	1.1	a	Updated the typical application circuit to add R_{STB_EX}. Updated the package information in the appendixes: Ver. A → Ver. B

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    - Various Safety Devices
    - Traffic control system
    - Combustion equipment

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    In the case of a product purchased through an authorized distributor or directly from us, the warranty period for this product shall be one (1) year after delivery to your company. For defective products that occurred during this period, we will take the quality warranty measures described in section 8-2. However, if there is an agreement on the warranty period in the basic transaction agreement, quality assurance agreement, delivery specifications, etc., it shall be followed.
    8-2. Quality Warranty Remedies
    When it has been proved defective due to manufacturing factors as a result of defect analysis by us, we will either deliver a substitute for the defective product or refund the purchase price of the defective product.
    Note that such delivery or refund is sole and exclusive remedies to your company for the defective product.
    8-3. Remedies after Quality Warranty Period
    With respect to any defect of this product found after the quality warranty period, the defect will be analyzed by us. On the basis of the defect analysis results, the scope and amounts of damage shall be determined by mutual agreement of both parties. Then we will deal with upper limit in Section 8-2. This provision is not intended to limit any legal rights of your company.
9. Anti-radiation design is not implemented in the products described in this document.
10. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
11. WLCSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.
12. Warning for handling Gallium and Arsenic (GaAs) products (Applying to GaAs MMIC, Photo Reflector). These products use Gallium (Ga) and Arsenic (As) which are specified as poisonous chemicals by law. For the prevention of a hazard, do not burn, destroy, or process chemically to make them as gas or power. When the product is disposed of, please follow the related regulation and do not mix this with general industrial waste or household waste.
13. Please contact our sales representatives should you have any questions or comments concerning the products or the technical information.

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