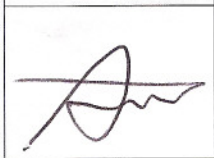
Document No. : IAP-ELI501-00

APPROVAL SHEET

Product	Battery Protect Solution IC
Product code	**ELI501** (001-ELI501-00)
Production Form	TEP - 5L,BD54
Date of Registration	July. 16. 2009

결재	Issued	Checked	Checked	Approved
				
	H.M Jo	S.W Park	S.H Ahn	Y.S Kim

협의	품 질	기 술		
	이종욱			
	11/2	11/2		

ITM

Room 2504 International Science & Technology Building,
Shen Nan Middle Road,Futian,Shen Zhen
TEL:+86-0755-83957788 / +86-0755-82566617
FAX:+86-0755-23919567
E-mail:li@itm-cn.com

■ Contents

■ Features

1. The protection IC and The Dual-Nch MOSFET to use common Drain are integrated into One-packaging IC.
2. Reduced Pin-Count by fully connecting internally.
3. Application Part

1) Protection IC

① Uses high withstand voltage CMOS process.
- The charger section can be connected up to absolute maximum rating 24V.

② Detection voltage precision
- Overcharge detection voltage

±60㎷ (Ta=25℃)
- Overdischarge detection voltage

±110㎷ (Ta=25℃)
- Discharging overcurrent detection voltage

±35㎷ (Ta=25℃)

③ Built-in detection delay times
- Overcharge detection delay time

Min 0.001s / Typ 0.08s / Max 0.20s (Ta=25℃)
- Overdischarge detection delay time)

Min 1㎳ / Typ 40㎳ / Max 100㎳ (Ta=25℃)
- Discharging overcurrent detection delay time)

Min 1㎳ / Typ 10㎳ / Max 30㎳ (Ta=25℃)
- Short detection delay time)

Typ 300㎲ / Max 800㎲ (Ta=25℃)

④ With abnormal charger detection function
⑤ 0V charge function is allowed
⑥ Auto Wake-up function is not allowed

2) FET

① Using advanced trench technology to provide excellent $R_{DS(ON)}$, low gate charge and operation with gate voltage as low as 2.5V while retaining a 12V $V_{GS(MAX)}$.
② Common drain configuration
③ General characteristics
- V_{DS} (V) = 20V
- I_D (A) = 6A
- $R_{SS(ON)}$ < 60mΩ (V_{GS} = 4.5V, I_D = 1A)

■ Outline

This is a battery protect solution IC which is integrated with built-in the protection IC to use a lithium ion/lithium polymer secondary batteries developed for 1-cell series and Dual-Nch MOSFET. It functions to protect the battery by detecting overcharge, overdischarge, discharge overcurrent and other abnormalities as turning off internal Nch MOSFET.
The protection IC is composed of three voltage detectors, short detection circuit, reference voltage sources, oscillator, counter circuit and logical circuits.

The C_{OUT} pin (charge FET control pin) and D_{OUT} pin (discharge FET control pin) outputs are CMOS output, and can drive the internal Nch MOSFET directly. The C_{OUT} output becomes low level after delay time fixed in the IC if overcharge is detected. The D_{OUT} output becomes low level after delay time fixed in the IC if overdischarge, discharge overcurrent or short is detected.

On overcharge state, if the V_{DD} voltage is less than the overcharge release voltage, the C_{OUT} output becomes high level after delay time fixed in the IC. On overdischarge state, if the voltage of the battery rises more than the overdischarge detection voltage with connecting the charger, the D_{OUT} output becomes high level after delay time fixed in the IC. Charging current can be supplied to the battery discharged up to 0V.

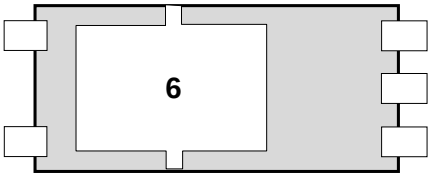
Once discharge overcurrent or short have been detected, if the state of discharge overcurrent or short is released by opening the loads, the D_{OUT} output becomes high level after delay time fixed in the IC. On overdischarge state, the supply current is reduced as less as possible.

■ Pin Assignment

[Package: TEP-5L]

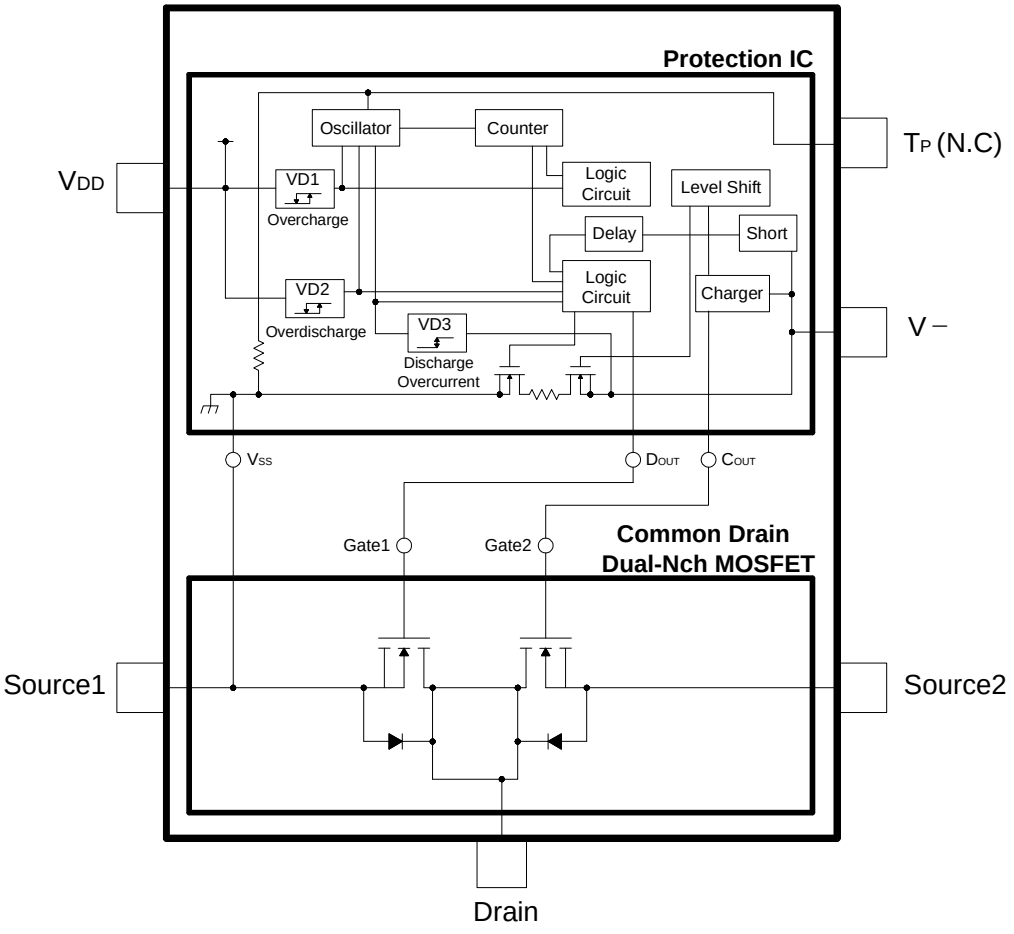
<Top view>

<Bottom view>



1	T_P (N.C)
2	Source 1(same as V_{SS})
3	Source 2
4	V_{DD}
5	V–
6	Drain

■ Block Diagram



■ Absolute Maximum Rating

※ T_{OPR}=25℃, Source1(V_{SS})=0V

Item	Symbol	Rating	Unit
Supply Voltage	V_{DD}	-0.3 ~ 10	V
V- Terminal Input Voltage	V-	V_{DD}-24 ~ V_{DD}+0.3	V
C_{OUT} Terminal Output Voltage	V_{COUT}	V_{DD}-24 ~ V_{DD}+0.3	V
D_{OUT} Terminal Output Voltage	V_{DOUT}	V_{SS}-0.3 ~ V_{DD}+0.3	V
Storage Temperature	T_{STG}	-40 ~ 125	℃
Drain-Source Voltage	V_{DS}	20	V
Gate-Source Voltage	V_{GS}	±12	V

■ Electrical Characteristics

※ T_{OPR}=25℃

Item	Symbol	Measure Condition	Min.	Typ.	Max.	Unit	*1
Operating Input Voltage	$V_{DD}1$	V_{DD} - V_{SS}	1.5	-	8.0	V	A
Minimum Operating Voltage for 0V Charging	V_{ST}	V_{DD} − V-, V_{DD}-V_{SS}=0V	-	-	1.5	V	A
C_{OUT} Pin Nch ON Voltage	$V_{OL}1$	-	-	0.1	0.5	V	-
C_{OUT} Pin Pch ON Voltage	$V_{OH}1$	-	V_{DD}-0.1	V_{DD}-0.02	-	V	-
D_{OUT} Pin Nch ON Voltage	$V_{OL}2$	-	-	0.1	0.5	V	-
D_{OUT} Pin Pch ON Voltage	$V_{OH}2$	-	V_{DD}-0.1	V_{DD}-0.02	-	V	-
Current Consumption	I_{DD}	V_{DD}=3.9V, V-=0V	-	3.0	6.0	μA	L
Current Consumption at Stand-By	I_S	V_{DD}=2.0V	-	-	0.1	μA	L
Overcharge Detection Voltage	$V_{DET}1$	R1=100Ω	4.240	4.300	4.360	V	B
Overcharge Release Voltage	$V_{REL}1$	R1=100Ω	4.040	4.100	4.160	V	B
Overdischarge Detection Voltage	$V_{DET}2$	V-=0V, R1=100Ω	2.290	2.400	2.510	V	D
Overdischarge Release Voltage1	$V_{REL}2'$	V-≥V_{CHA}, R1=100Ω	2.290	2.400	2.510	V	D
Overdischarge Release Voltage2	$V_{REL}2'$	V-≤V_{CHA}, R1=100Ω	2.890	3.000	3.110	V	D
Discharging Overcurrent Detection Voltage	$V_{DET}3$	V_{DD}=3.6V, R2=1.0kΩ	0.115	0.150	0.185	V	F
Short Detection Voltage	V_{SHORT}	V_{DD}=3.6V	0.55	1.15	1.70	V	F
Charger Detection Threshold Voltage	V_{CHA}	-	-1.2	-0.7	-0.2	V	G

Note : *1 The test circuit symbols.

※ T_{OPR}=25℃

Item	Symbol	Measure Condition	Min.	Typ.	Max.	Unit	*1
Overcharge Detection Delay Time	$tV_{DET}1$	V_{DD}=3.6V→4.5V	0.001	0.08	0.20	s	B
Overdischarge Detection Delay Time	$tV_{DET}2$	V_{DD}=3.6V→2.0V	1	40	100	ms	D
Discharging Overcurrent Detection Delay Time	$tV_{DET}3$	V_{DD}=3.6V, V-=0V→1V	1	10	30	ms	F
Short Detection Delay Time	t_{SHORT}	V_{DD}=3.6V, V-=0V→3V	-	300	800	μs	F
Drain-Source Breakdown Voltage	BV_{DSS}	I_D=250μA, V_{GS}=0V	20	-	-	V	
Zero Gate Voltage Drain Current	I_{DSS}	V_{DS}=16V, V_{GS}=0V	-	-	1	μA	
Gate-Body Leakage Current	I_{GSS}	V_{DS}=0V, V_{GS}=±12V	-	-	0.1	μA	
Gate-Source Breakdown Voltage	BV_{GSO}	V_{DS}=0V, I_G=±250μA	±12	-	-	V	
Gate Threshold Voltage	$V_{GS(th)}$	V_{DS}=V_{GS}, I_D=250μA	0.4	-	0.9	V	
Static Source-Source ON-Resistance	$R_{SS(ON)}$	V_{GS}=10V, I_D=1A	-	42	50	mΩ	
		V_{GS}=4.5V, I_D=1A	-	50	60	mΩ	
		V_{GS}=3.9V, I_D=1A	-	51	61	mΩ	
		V_{GS}=2.5V, I_D=1A	-	62	76	mΩ	
Diode Forward Voltage	V_{SD}	I_S=1.7A, V_{GS}=0V	-	0.74	1.20	V	

Note : *1 The test circuit symbols.

*2 The parameter is guaranteed by design.

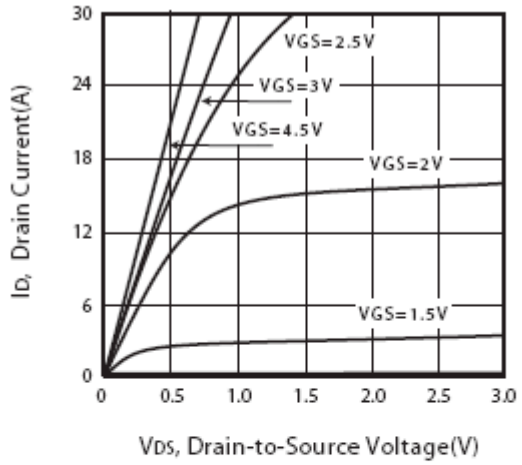


Figure 1. Output Characteristics

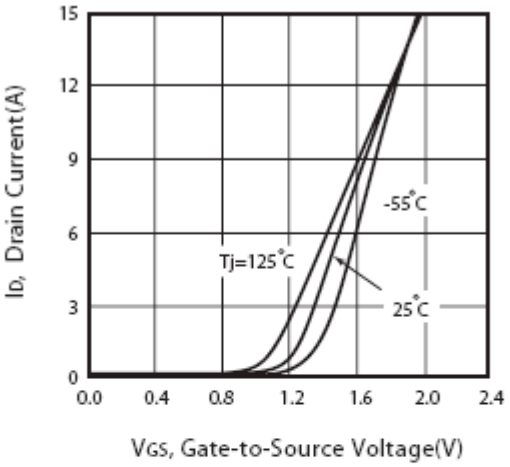


Figure 2. Transfer Characteristics

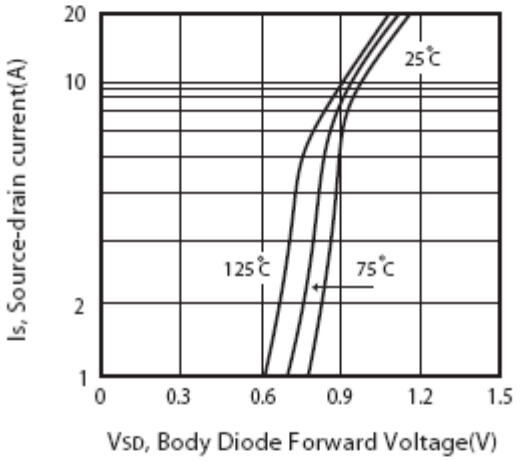


Figure 3. Body Diode Forward Voltage Variation with Source Current

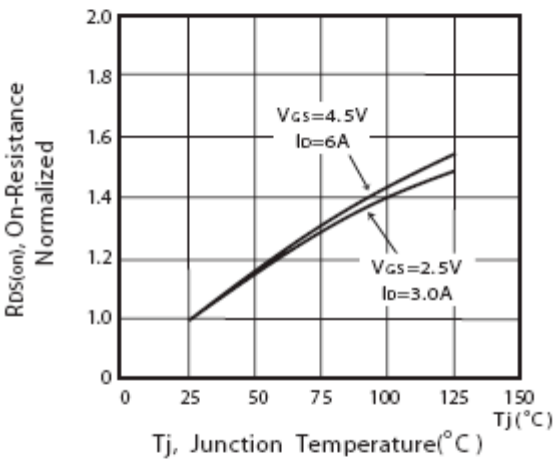


Figure 4. On-Resistance Variation with Drain Current and Temperature

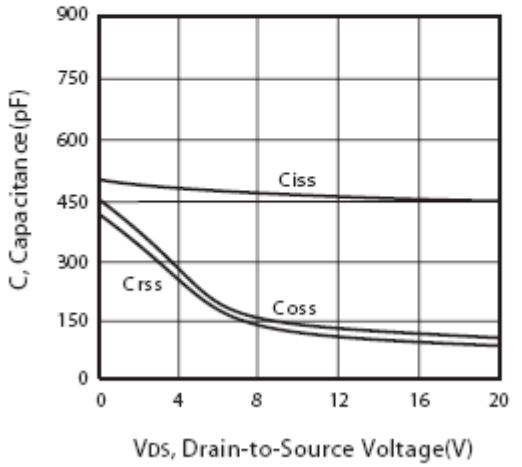


Figure 5. Capacitance

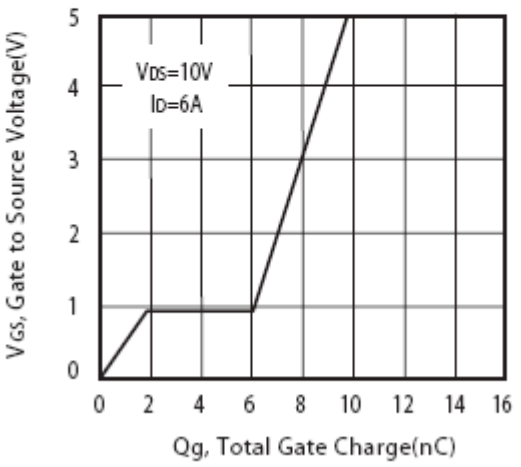
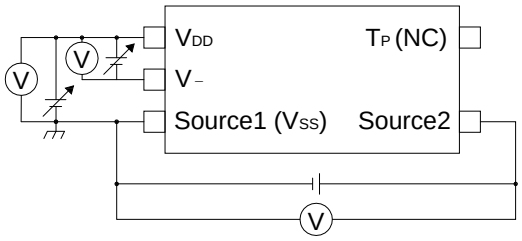


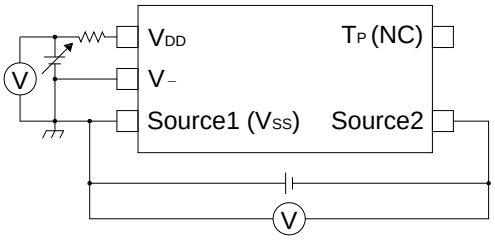
Figure 9. Gate Charge

■ Measuring Circuit

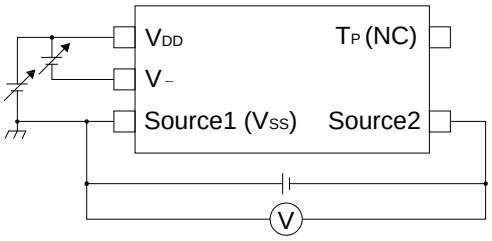
A.



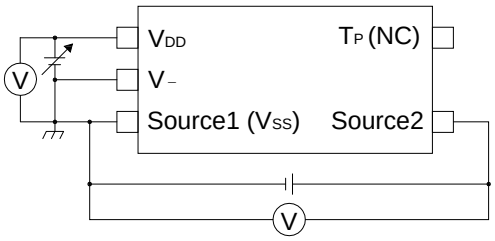
B.



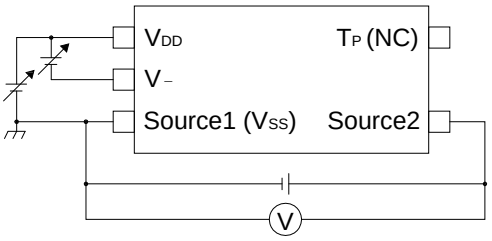
C.



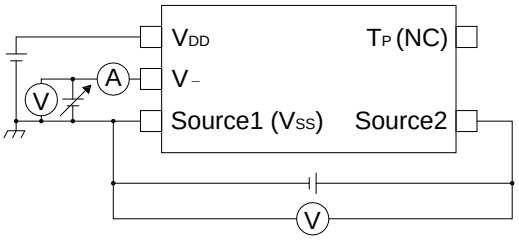
D.



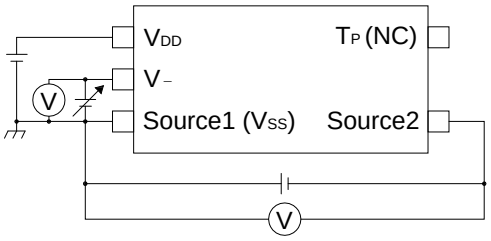
E.



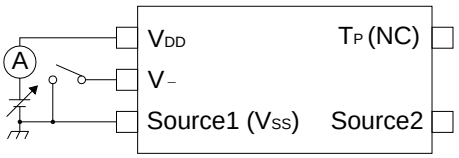
F.



G.



H.



■ Operation

1. Overcharge detector (VD1)

The VD1 monitors V_{DD} pin voltage during charge. In the state of charging the battery, it will detect the overcharge state of the battery if the V_{DD} terminal voltage becomes higher than the overcharge detection voltage(Typ. 4.300V). And then the C_{OUT} terminal turns to low level, so the internal charging control Nch MOSFET turns OFF and it forbids to charge the battery.

After detecting overcharge, it will release the overcharge state if the V_{DD} terminal voltage becomes lower than the overcharge release voltage(Typ.4.100V). And then the C_{OUT} terminal turns to high level, so the internal charging control Nch MOSFET turns ON, and it accepts to charge the battery.

When the V_{DD} terminal voltage is higher than the overcharge detection voltage, to disconnect the charger and connect the load, leave the C_{OUT} terminal low level, but it accepts to conduct load current via the paracitical body diode of the internal Nch MOSFET. And then if the V_{DD} terminal voltage becomes lower than the overcharge detection voltage, the C_{OUT} terminal turns to high level, so the internal Nch MOSFET turn ON, and it accepts to charge the battery.

The overcharge detection and release have delay time decided internally. When the V_{DD} terminal voltage becomes higher than the overcharge detection voltage, if the V_{DD} terminal voltage becomes lower than the overcharge detection voltage again within the overcharge detection delay time(Typ. 0.08s), it will not detect overcharge. And in the state of overcharge, when the V_{DD} terminal voltage becomes lower than the overcharge release voltage, if the V_{DD} terminal voltage backs higher than the overcharge release voltage again within the overcharge release delay time, it will not release overcharge.

The output driver stage of the C_{OUT} terminal includes a level shifter, so it will output the V_- terminal voltage as low level. The output type of the C_{OUT} terminal is CMOS output between V_{DD} and V_- terminal voltage.

2. Overdischarge detector (VD2)

The VD1 monitors V_{DD} pin voltage during discharge. In the state of discharging the battery, it will detect the overdischarge state of the battery if the V_{DD} terminal becomes lower than the overdischarge detection voltage (Typ. 2.400V). And then the D_{OUT} terminal turns to low level, so the internal discharging control Nch MOSFET turn OFF and it forbids to discharge the battery.

The overdischarge status will be released by two cases:

(1) When V- pin voltage is equal to or higher than the charger detection voltage (V_{CHA}) by charging and the V_{DD} pin voltage is higher than overdischarge detection voltage (Typ. 2.400V).

(2) When V- pin voltage is equal to or lower than the charger detection voltage (V_{CHA}) by charging and the V_{DD} pin voltage is higher than overdischarge release voltage (Typ. 3.000V).

When the battery voltage is about 0V, if the charger voltage is higher than the minimum operating voltage for 0V charging (Max. 1.5V), the C_{OUT} terminal outputs high level and it accepts to conduct charging current.

The overdischarge detection have delay time decided internally. When the V_{DD} terminal voltage becomes lower than the overdischarge detection voltage, if the V_{DD} terminal voltage becomes higher than the overdischarge detection voltage again within the overdischarge detection delay time (Typ. 40ms), it will not detect overdischarge. Moreover, the overdischarge release delay time exists, too.

All the circuits are stopped, and after the overdischarge is detected, it is assumed the state of the standby, and decreases the current (standby current) which IC consumes as much as possible. (When V_{DD}=2V, Max. 0.1uA).

The output type of the D_{OUT} terminal is CMOS output between V_{DD} and V_{SS} terminal voltage.

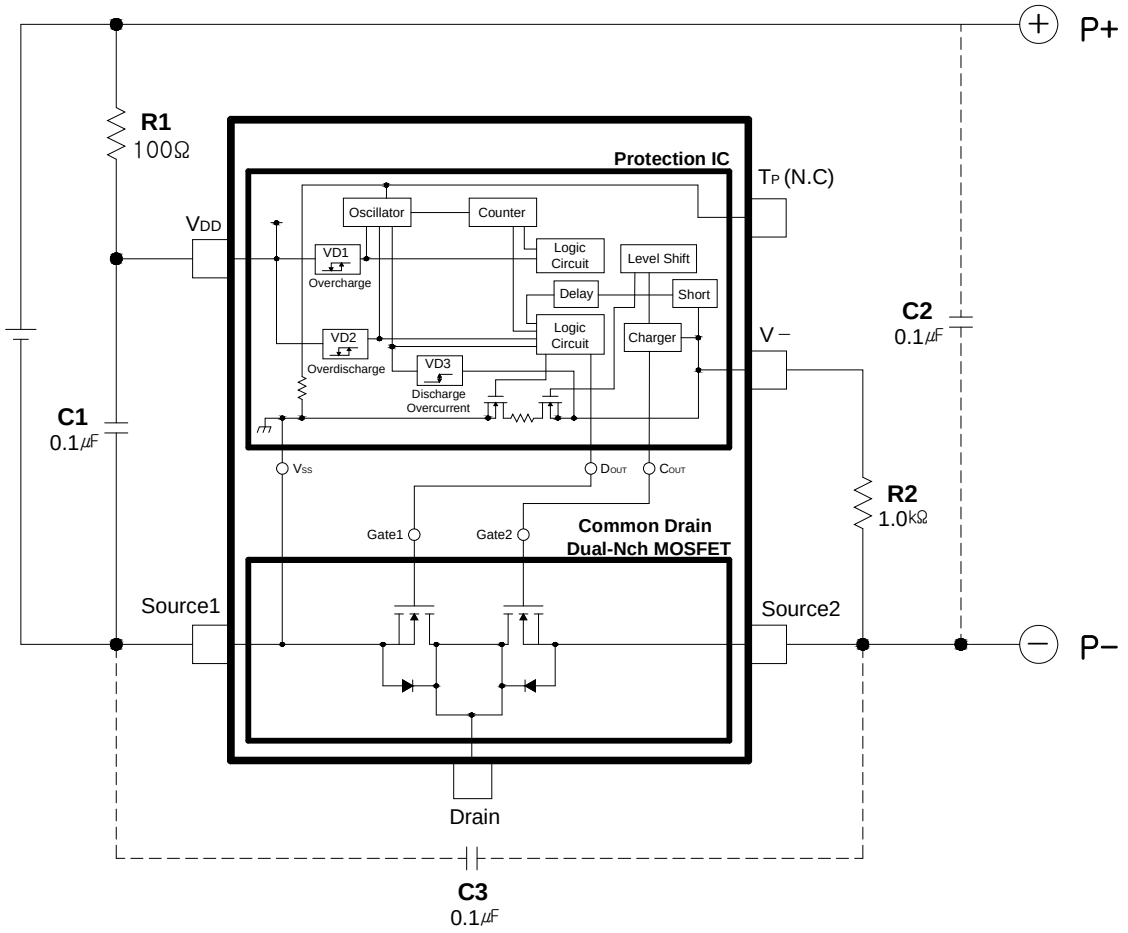
3. Discharge overcurrent detector, Short detector (VD3, Short Detector)

In the state of chargable and dischargabe, VD3 monitors the voltage level of V_- pin. If the V_- terminal voltage becomes higher than the discharging overcurrent detection voltage (Typ. 0.150V) by short of loads, etc., it will detect discharging overcurrent state. If the V_- terminal voltage becomes higher then short detection voltage (Typ. 1.15V), it will detect discharging overcurrent state, too. And then the D_{OUT} terminal outputs low level, so the internal discharging control Nch MOSFET turns OFF, and it protects from large current discharging.

The discharging overcurrent detection has delay time decided internally. When the V_- terminal voltage becomes higher than the discharging overcurrent detection voltage, if the V_- terminal voltage becomes lower than the discharging overcurrent detection voltage within the discharging overcurrent detection delay time (Typ. 10ms), it will not detect discharging overcurrent. Morever, the discharging overcurrent release delay time exists, too.

The short detection delay time (Typ. 300us) decided internally exists, too.

■ Application Circuit (Example)



※ Application Hint

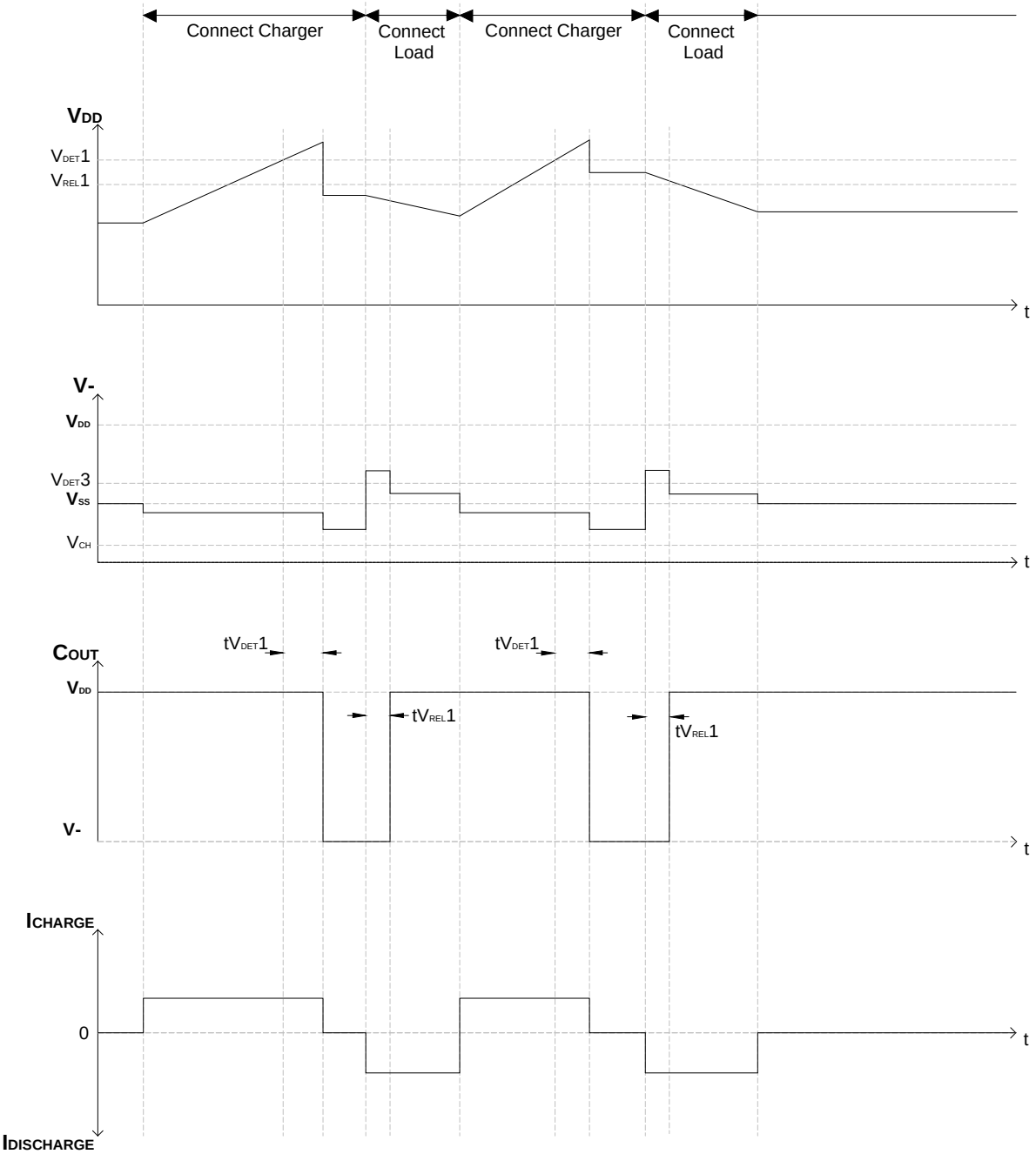
R1 and C1 stabilize a supply voltage ripple. However, the detection voltage rises by the current of penetration in IC of the voltage detection when R1 is enlarged, so the value of R1 is adjusted to 100Ω or less. Moreover, adjust the value of C1 to 0.01uF or more to do the stability operation, please.

R1 and R2 resistors are current limit resistance if a charger is connected reversibly or a highvoltage charger that exceeds the absolute maximum rating is connected. R1 and R2 may cause a power consumption will be over rating of power dissipation, therefore the `R1+R2` should be more than 1kohm. Moreover, if R2 is too enlarged, the charger connection release cannot be occasionally done after the overdischarge is detected, so adjust the value of R2 to 5kohm or less, please.

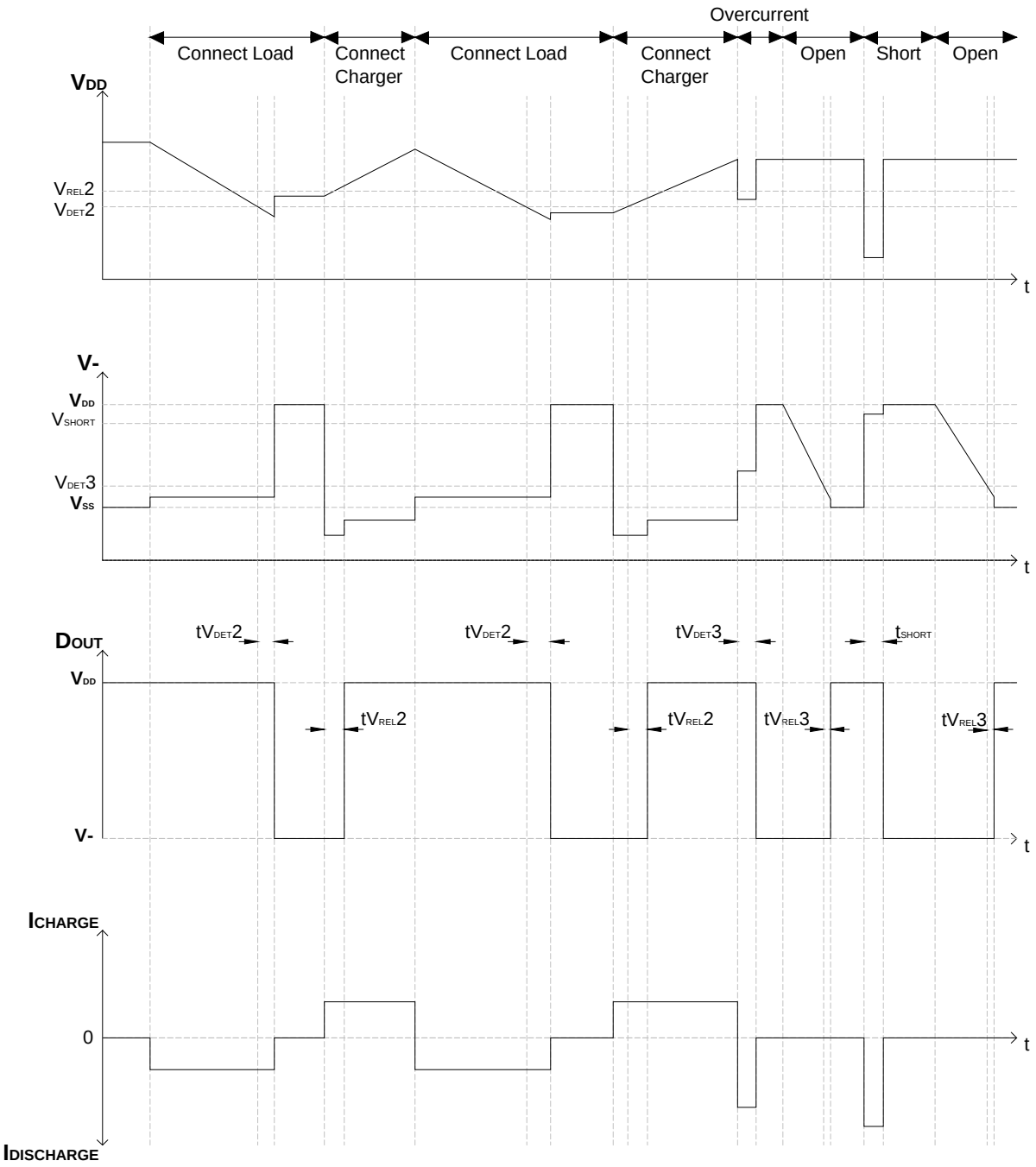
C2 and C3 capacitors have effect that the system stability about voltage ripple or imported noise. After check characteristics, decide that these capacitors should be inserted or not, where should be inserted, and capacitance value, please.

■ Timing Chart

1. Overcharge operations

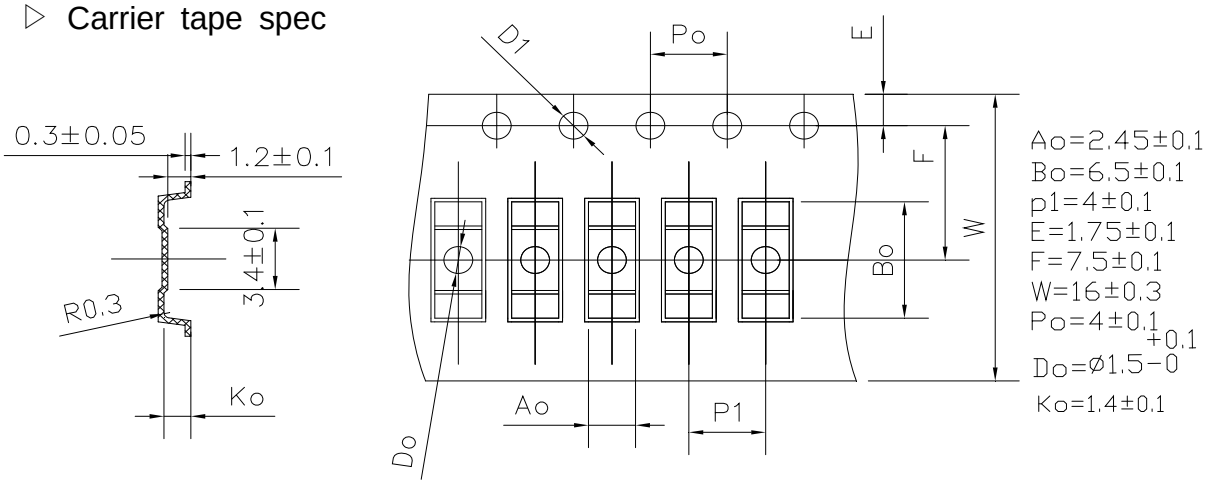


2. Overdischarge, Discharging Overcurrent and Short operations

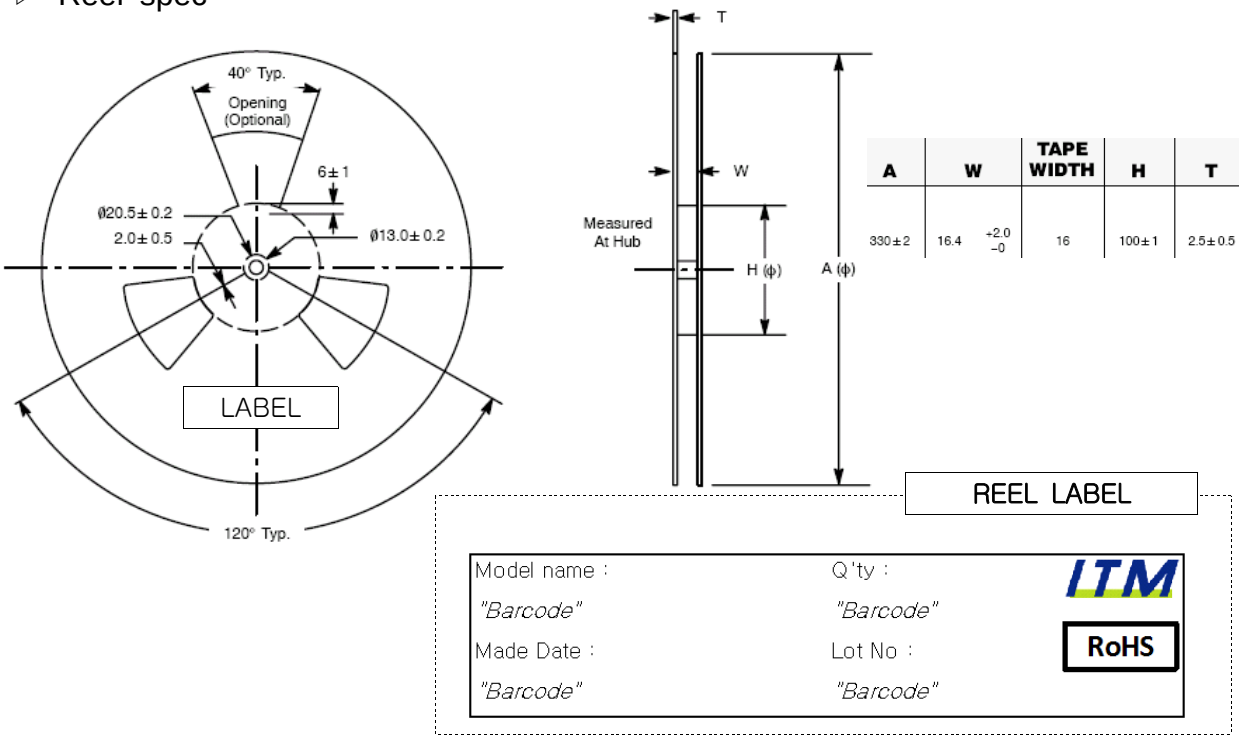


■ Packing spec

▷ Carrier tape spec



▷ Reel spec



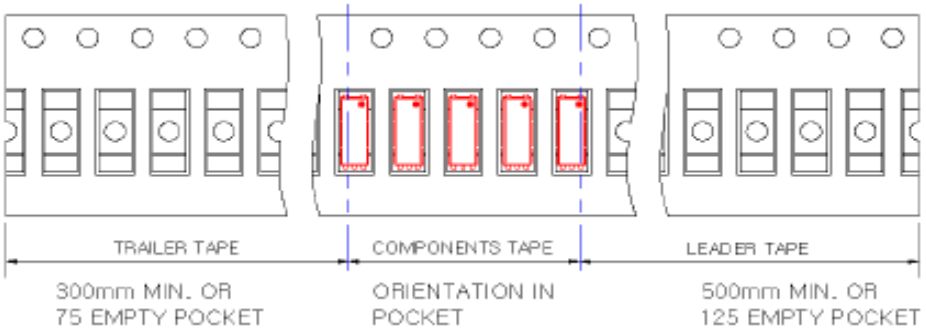
A	W		TAPE WIDTH	H	T
330±2	16.4	+2.0 −0	16	100±1	2.5±0.5

REEL LABEL

Model name :	Q'ty :
"Barcode"	*"Barcode"*
Made Date :	Lot No :
"Barcode"	*"Barcode"*

ITM
RoHS

▷ Taping spec



▷ OUTER BOX PACKING SPECIFICATION

OUT BOX LABEL

ITM Semiconductor Co., LTD

Model No :
'Barcode'

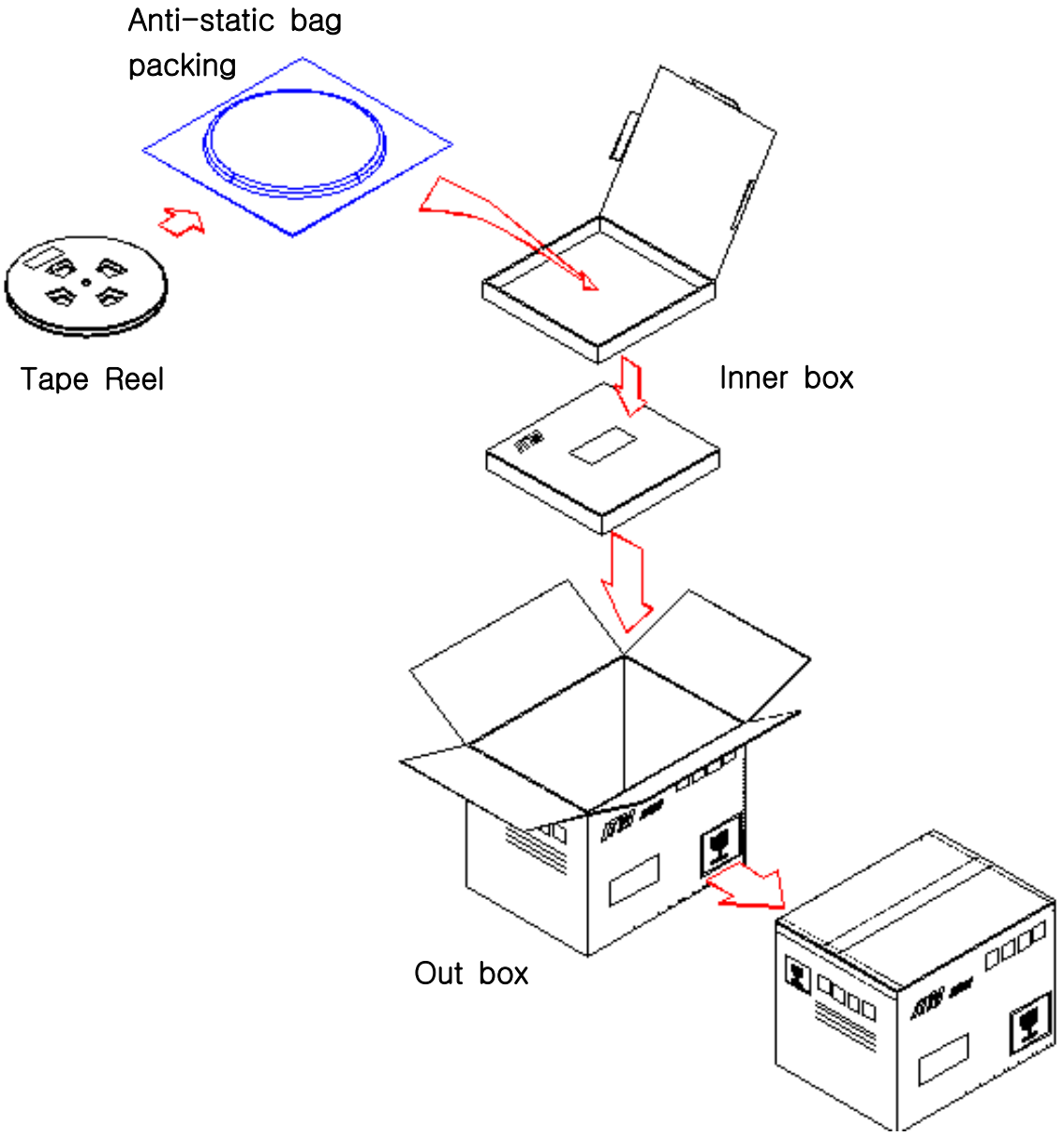
Q'ty :
'Barcode'

Ship Date :
'Barcode'

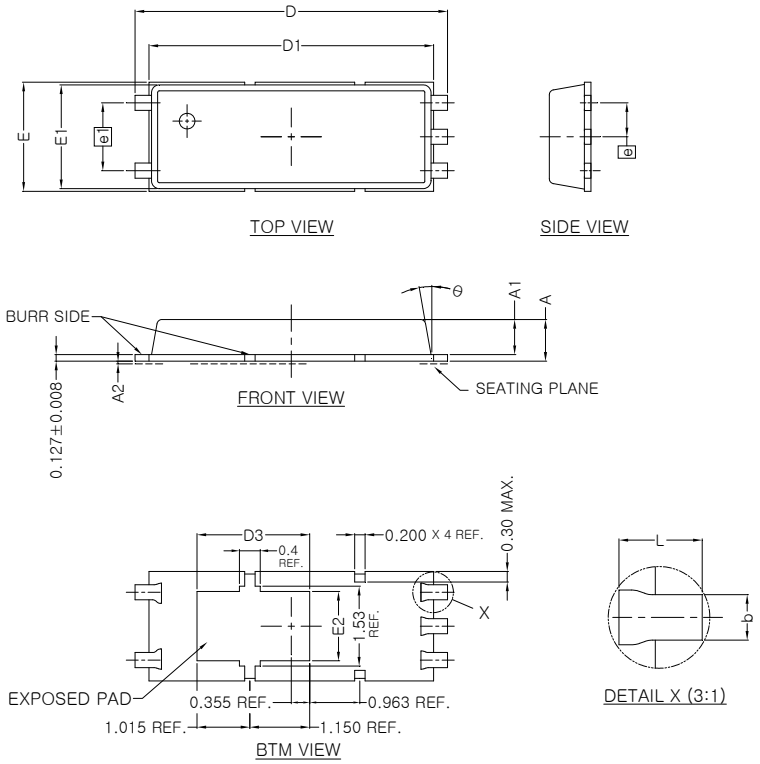
Halogen free

Lot No :
'Barcode'

RoHS



■ Package Description

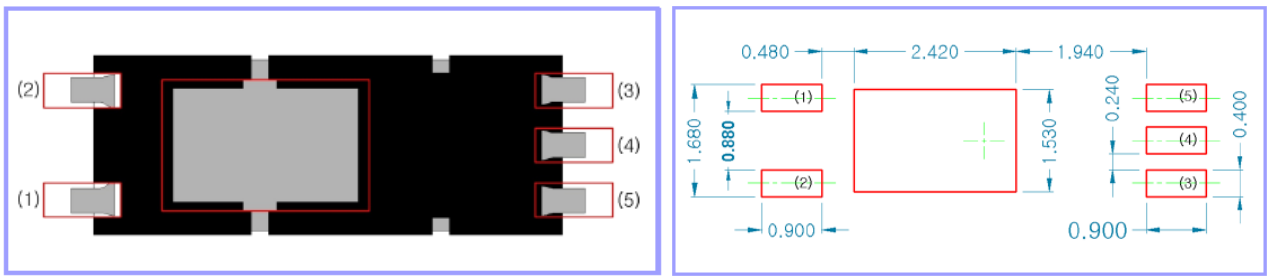


SYMBOL	DIMENSIONS			NOTE
	MIN.	NOM.	MAX.	
A	0.750	0.800	0.850	
A1	0.623	0.673	0.723	
A2	–	–	0.050	
D	5.900	6.000	6.100	
D1	5.320	5.370	5.420	
D3	2.220 REF.			
E	2.000	2.100	2.200	
E1	1.950	2.000	2.050	
E2	1.330 REF.			
θ	–	–	10 °	
e	0.650 BSC			
e1	1.300 BSC			
L	0.350	–	–	
b	0.255	0.300	0.390	

NOTE

1. LEAD BURR : VERTICAL MAX 0.025
   HORIZONTAL MAX 0.025
   BURR SIDE : ALL TOP SIDE
2. MOLD BURR & FLASH : PACKAGE OUT LINE BURR MAX 0.100
   EXPOSED PAD FLASH MAX 0.200
3. PACKAGE WARPAGE MAX 0.025
4. LEAD AND EXPOSED PAD PLATING : PURE TIN
   THICKNESS> 7.62~25.4um

■ Recommend Land Pattern (time shorar)



■ Marking Contents