# ACE301

**High-precision Low Voltage Detector**

## Description

ACE301 is a series of high precision voltage detector with ultra low current consumption (500nA typ. at Vdd=3.0V). It can work at very low voltage, which makes it perfect for system reset.

ACE301 is composed of high precision voltage reference, comparator, output driver and resistor array. Internally preset detect voltage has a low temperature drift and requires no external trimming.

Two type of output, CMOS and N-channel open-drain are available.

## Features

- High-precision detection Voltage：±2%
- Detection Voltage：0.9V~6.0V (in 0.1V steps)
- Precise hysteresis：4% typ.
- Operating Voltage range：0.7V~10V
- Ultra-low current consumption：500nA typ. (at $V_{DD}$＝3.0V)
- Two Output forms: CMOS and N-channel open-drain

## Application

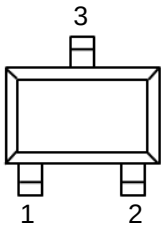
- Power monitor for portable equipment such as PDA, DSC, Mobile phone, Notebook, MP3
- CPU and Logic Circuit Reset
- Battery Checker
- Battery Back-up Circuit
- Power Failure Detector

## Absolute Maximum Ratings

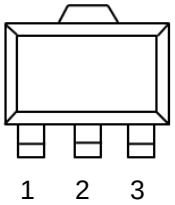
| Parameter | | Max | Unit |
|---|---|---|---|
| Input Voltage | | -0.3~10 | V |
| Output Voltage | | -0.3~12 | V |
| Maximum Output current | | 70 | mA |
| Maximum power dissipation | SOT-23-3 | 250 | mW |
| | SOT-23-5 | 250 | |
| | SOT-89-3 | 500 | |
| | TO-92 | 600 | |
| Ambient temperature | | -40~+85 | ℃ |
| Storage temperature | | -40~+150 | ℃ |

## Packaging Type

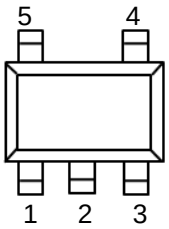
SOT-23-3



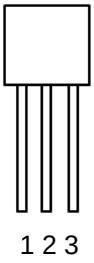

SOT-89-3




SOT-23-5




TO-92



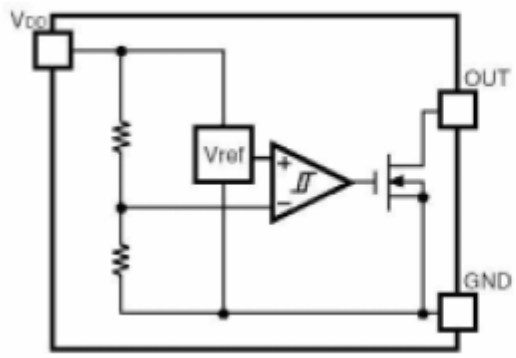

| SOT-23-3 | SOT-89-3 | SOT-23-5 | TO-92 | Description | Function |
|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | $V_{OUT}$ | Voltage detection output Pin |
| 3 | 2 | 2 | 2 | $V_{DD}$ | Voltage input Pin |
| 2 | 3 | 3 | 3 | $V_{SS}$ | GND Pin |
| | | 4 | | NC | No connection |
| | | 5 | | NC | No connection |

## Ordering information

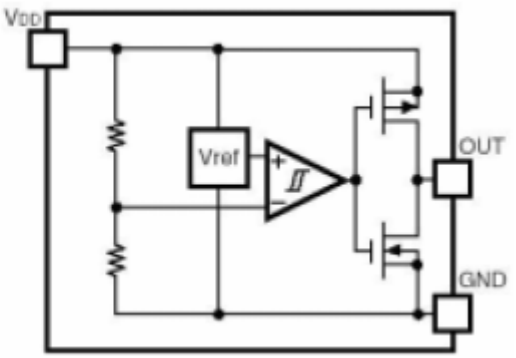
ACE301 X XX XX + H

- H: Halogen - free
- +: Pb - free
- XX: BM: SOT-23-3, BN: SOT-23-5, AM: SOT-89-3, EP: TO-92
- XX: Detector Voltage 0.9V ~ 6.0V
- X: Output type N: Nch / C: CMOS

## Block diagram




N channel open-drain




CMOS output

## Recommended Work Conditions

| Item | Min | Recommended | Max | Unit |
|---|---|---|---|---|
| Input Voltage | 0.7 | | 10 | V |
| Ambient temperature | -40 | 25 | 85 | ℃ |

## Electrical Characteristics:

ACE301C/N09XX + (0.9V) (Topt=25℃, Unless otherwise specified.)

| Symbol | Parameter | Conditions | Reference data | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| $-V_{DET}$ | Detector Threshold | | 0.882 | 0.9 | 0.918 | V |
| $V_{HYS}$ | Detector Threshold Hysteresis | | 0.018 | 0.036 | 0.054 | V |
| $I_{SS}$ | Current Consumption | $V_{DD}$=2.9V | | 1 | 2.5 | uA |
| $V_{DDH}$ | Maximum Operating Voltage | | | | 10 | V |
| $V_{DDL}$ | Minimum Operating Voltage | | | 0.5 | | V |
| $I_{OUT}$ | Output Current | Nch<br>$V_{DS}$=0.05V, $V_{DD}$=0.7V<br>$V_{DS}$=0.50V, $V_{DD}$=0.8V | 0.01<br>0.05 | 0.05<br>0.50 | | mA |
| | | Pch<br>$V_{DS}$=-2.1V, $V_{DD}$=4.50V | 1.0 | 2.0 | | mA |
| $T_{PLH}$ | Output Delay Time | | | | 20 | uS |

ACE301C/N27XX + (2.7V) (Topt=25℃, Unless otherwise specified.)

| Symbol | Parameter | Conditions | Reference data | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| $-V_{DET}$ | Detector Threshold | | 2.646 | 2.7 | 2.754 | V |
| $V_{HYS}$ | Detector Threshold Hysteresis | | 0.054 | 0.108 | 0.162 | V |
| $I_{SS}$ | Current Consumption | $V_{DD}$=4.7V | | 1 | 2.5 | uA |
| $V_{DDH}$ | Maximum Operating Voltage | | | | 10 | V |
| $V_{DDL}$ | Minimum Operating Voltage | | | 0.5 | | V |
| $I_{OUT}$ | Output Current | Nch $V_{DS}$=0.05V, $V_{DD}$=0.7V | 0.01 | 0.05 | | mA |
| | | Pch $V_{DS}$=-2.1V, $V_{DD}$=4.50V | 1.0 | 2.0 | | mA |
| $T_{PLH}$ | Output Delay Time | | | | 20 | uS |

ACE301C/N30XX + (3.0V) (Topt=25℃, Unless otherwise specified.)

| Symbol | Parameter | Conditions | Reference data | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| $-V_{DET}$ | Detector Threshold | | 2.94 | 3.0 | 3.06 | V |
| $V_{HYS}$ | Detector Threshold Hysteresis | | 0.060 | 0.12 | 0.18 | V |
| $I_{SS}$ | Current Consumption | $V_{DD}$=5.0V | | 1 | 2.5 | uA |
| $V_{DDH}$ | Maximum Operating Voltage | | | | 10 | V |
| $V_{DDL}$ | Minimum Operating Voltage | | | 0.5 | | V |
| $I_{OUT}$ | Output Current | Nch $V_{DS}$=0.05V, $V_{DD}$=0.7V | 0.01 | 0.05 | | mA |
| | | Pch $V_{DS}$=-2.1V, $V_{DD}$=4.50V | 1.0 | 2.0 | | mA |
| $T_{PLH}$ | Output Delay Time | | | | 20 | uS |

ACE301C/N34XX + (3.4V) (Topt=25℃, Unless otherwise specified.)

| Symbol | Parameter | Conditions | Reference data | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| $-V_{DET}$ | Detector Threshold | | 3.332 | 3.4 | 3.468 | V |
| $V_{HYS}$ | Detector Threshold Hysteresis | | 0.068 | 0.136 | 0.204 | V |
| $I_{SS}$ | Current Consumption | $V_{DD}$=5.0V | | 1 | 2.5 | uA |
| $V_{DDH}$ | Maximum Operating Voltage | | | | 10 | V |
| $V_{DDL}$ | Minimum Operating Voltage | | | 0.5 | | V |
| $I_{OUT}$ | Output Current | Nch $V_{DS}$=0.05V, $V_{DD}$=0.7V | 0.01 | 0.05 | | mA |
| | | Pch $V_{DS}$=-2.1V, $V_{DD}$=4.50V | 1.0 | 2.0 | | mA |
| $T_{PLH}$ | Output Delay Time | | | | 20 | uS |

ACE301C/N44XX + (4.4V) (Topt=25℃, Unless otherwise specified.)

| Symbol | Parameter | Conditions | Reference data | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| $-V_{DET}$ | Detector Threshold | | 4.312 | 4.4 | 4.488 | V |
| $V_{HYS}$ | Detector Threshold Hysteresis | | 0.088 | 0.176 | 0.264 | V |
| $I_{SS}$ | Current Consumption | $V_{DD}$=6.4V | | 1 | 2.5 | uA |
| $V_{DDH}$ | Maximum Operating Voltage | | | | 10 | V |
| $V_{DDL}$ | Minimum Operating Voltage | | | 0.5 | | V |
| $I_{OUT}$ | Output Current | Nch $V_{DS}$=0.05V, $V_{DD}$=0.7V | 0.01 | 0.05 | | mA |
| | | Pch $V_{DS}$=-2.1V, $V_{DD}$=8.0V | 1.5 | 3.0 | | mA |
| $T_{PLH}$ | Output Delay Time | | | | 20 | uS |

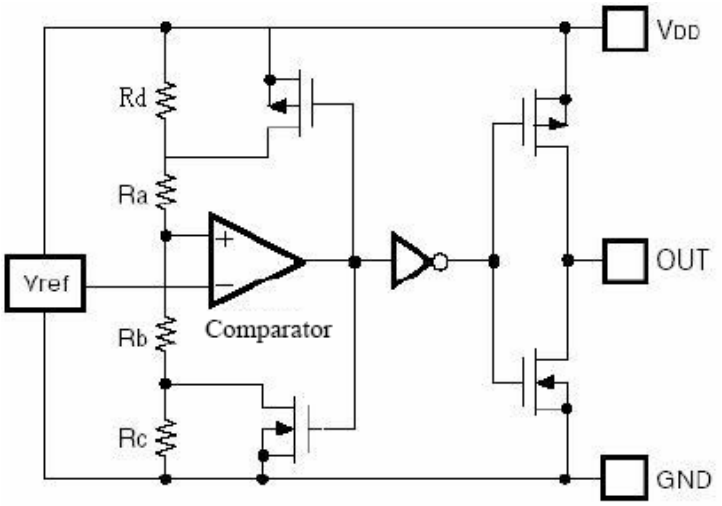
## Electrical Characteristics by Detector Threshold

| Part Number | Detector Threshold | | | Detector Threshold Hysteresis | | | Supply Current1 | | | Supply Current2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | -Vdet[V] | | | Vhys[V] | | | Iss1[uA] | | | Iss2[uA] | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. | Condition | Typ. | Max. | Condition | Typ. | Max. |
| ACE301X09XX+ | 0.882 | 0.900 | 0.918 | 0.018 | 0.036 | 0.054 | Vdd= (-Vdet)+0.1V | 0.5 | 1.0 | Vdd= (-Vdet)+2V | 1.0 | 2.5 |
| ACE301X10XX+ | 0.980 | 1.000 | 1.020 | 0.020 | 0.040 | 0.060 | | | | | | |
| ACE301X11XX+ | 1.078 | 1.100 | 1.122 | 0.022 | 0.044 | 0.066 | | | | | | |
| ACE301X12XX+ | 1.176 | 1.200 | 1.224 | 0.024 | 0.048 | 0.072 | | | | | | |
| ACE301X13XX+ | 1.274 | 1.300 | 1.326 | 0.026 | 0.052 | 0.078 | | | | | | |
| ACE301X14XX+ | 1.372 | 1.400 | 1.428 | 0.028 | 0.056 | 0.084 | | | | | | |
| ACE301X15XX+ | 1.470 | 1.500 | 1.530 | 0.030 | 0.060 | 0.090 | | | | | | |
| ACE301X16XX+ | 1.568 | 1.600 | 1.632 | 0.032 | 0.064 | 0.096 | | | | | | |
| ACE301X17XX+ | 1.666 | 1.700 | 1.734 | 0.034 | 0.068 | 0.102 | | | | | | |
| ACE301X18XX+ | 1.764 | 1.800 | 1.836 | 0.036 | 0.072 | 0.108 | | | | | | |
| ACE301X19XX+ | 1.862 | 1.900 | 1.938 | 0.038 | 0.076 | 0.114 | | | | | | |
| ACE301X20XX+ | 1.960 | 2.000 | 2.040 | 0.040 | 0.080 | 0.120 | | | | | 0.5 | 2.5 |
| ACE301X21XX+ | 2.058 | 2.100 | 2.142 | 0.042 | 0.084 | 0.126 | | | | | | |
| ACE301X22XX+ | 2.156 | 2.200 | 2.244 | 0.044 | 0.088 | 0.132 | | | | | | |
| ACE301X23XX+ | 2.254 | 2.300 | 2.346 | 0.046 | 0.092 | 0.138 | | | | | | |
| ACE301X24XX+ | 2.352 | 2.400 | 2.448 | 0.048 | 0.096 | 0.144 | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| ACE301X25XX+ | 2.450 | 2.500 | 2.550 | 0.050 | 0.100 | 0.150 |
| ACE301X26XX+ | 2.548 | 2.600 | 2.652 | 0.052 | 0.104 | 0.156 |
| ACE301X27XX+ | 2.646 | 2.700 | 2.754 | 0.054 | 0.108 | 0.162 |
| ACE301X28XX+ | 2.744 | 2.800 | 2.856 | 0.056 | 0.112 | 0.168 |
| ACE301X29XX+ | 2.842 | 2.900 | 2.958 | 0.058 | 0.116 | 0.174 |
| ACE301X30XX+ | 2.940 | 3.000 | 3.060 | 0.060 | 0.120 | 0.180 |
| ACE301X31XX+ | 3.038 | 3.100 | 3.162 | 0.062 | 0.124 | 0.186 |
| ACE301X32XX+ | 3.136 | 3.200 | 3.264 | 0.064 | 0.128 | 0.192 |
| ACE301X33XX+ | 3.234 | 3.300 | 3.366 | 0.066 | 0.132 | 0.198 |
| ACE301X34XX+ | 3.332 | 3.400 | 3.468 | 0.068 | 0.136 | 0.204 |
| ACE301X35XX+ | 3.430 | 3.500 | 3.570 | 0.070 | 0.140 | 0.210 |
| ACE301X36XX+ | 3.528 | 3.600 | 3.672 | 0.072 | 0.144 | 0.216 |
| ACE301X37XX+ | 3.626 | 3.700 | 3.774 | 0.074 | 0.148 | 0.222 |
| ACE301X38XX+ | 3.724 | 3.800 | 3.876 | 0.076 | 0.152 | 0.228 |
| ACE301X39XX+ | 3.822 | 3.900 | 3.978 | 0.078 | 0.156 | 0.234 |
| ACE301X40XX+ | 3.920 | 4.000 | 4.080 | 0.080 | 0.160 | 0.240 |
| ACE301X41XX+ | 4.018 | 4.100 | 4.182 | 0.082 | 0.164 | 0.246 |
| ACE301X42XX+ | 4.116 | 4.200 | 4.284 | 0.084 | 0.168 | 0.252 |
| ACE301X43XX+ | 4.214 | 4.300 | 4.386 | 0.086 | 0.172 | 0.258 |
| ACE301X44XX+ | 4.312 | 4.400 | 4.488 | 0.088 | 0.176 | 0.264 |
| ACE301X45XX+ | 4.410 | 4.500 | 4.590 | 0.090 | 0.180 | 0.270 |
| ACE301X46XX+ | 4.508 | 4.600 | 4.692 | 0.092 | 0.184 | 0.276 |
| ACE301X47XX+ | 4.606 | 4.700 | 4.794 | 0.094 | 0.188 | 0.282 |
| ACE301X48XX+ | 4.704 | 4.800 | 4.896 | 0.096 | 0.192 | 0.288 |
| ACE301X49XX+ | 4.802 | 4.900 | 4.998 | 0.098 | 0.196 | 0.294 |
| ACE301X50XX+ | 4.900 | 5.000 | 5.100 | 0.100 | 0.200 | 0.300 |
| ACE301X51XX+ | 4.998 | 5.100 | 5.202 | 0.102 | 0.204 | 0.306 |
| ACE301X52XX+ | 5.096 | 5.200 | 5.304 | 0.104 | 0.208 | 0.312 |
| ACE301X53XX+ | 5.194 | 5.300 | 5.406 | 0.106 | 0.212 | 0.318 |
| ACE301X54XX+ | 5.292 | 5.400 | 5.508 | 0.108 | 0.216 | 0.324 |
| ACE301X55XX+ | 5.390 | 5.500 | 5.610 | 0.110 | 0.220 | 0.330 |
| ACE301X56XX+ | 5.488 | 5.600 | 5.712 | 0.112 | 0.224 | 0.336 |
| ACE301X57XX+ | 5.586 | 5.700 | 5.814 | 0.114 | 0.228 | 0.342 |
| ACE301X58XX+ | 5.684 | 5.800 | 5.916 | 0.116 | 0.232 | 0.348 |
| ACE301X59XX+ | 5.782 | 5.900 | 6.018 | 0.118 | 0.236 | 0.354 |
| ACE301X60XX+ | 5.880 | 6.000 | 6.120 | 0.120 | 0.240 | 0.360 |

| Output Current1 | | | Output Current2 | | | | Output Delay Time | Minimum Operation Voltage | | Detector Threshold Temperature Coefficient | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Iout1[mA] | | | Iout2[mA] | | | | $T_{PLH}$[us] | $V_{DDL}$[V] | | $\Delta$-$V_{DET}$/$\Delta$Tppm/℃ | |
| Condition | Min. | Typ. | Condition | | Min. | Typ. | Max. | Typ. | Max. | Condition | Typ. |
| NCH, $V_{DS}$=0.05V, $V_{DD}$=0.7V | 0.01 | 0.05 | NCH, $V_{DS}$=0.5V | Vdd=0.85V | 0.1 | 0.5 | 20 | 0.5 | 0.7 | -40℃~85℃ | 100 |
| | | | | Vdd=1.0V | 0.2 | 1.0 | | | | | |
| | | | | $V_{DD}$=1.5V | 1.0 | 2.0 | | | | | |

## Function description



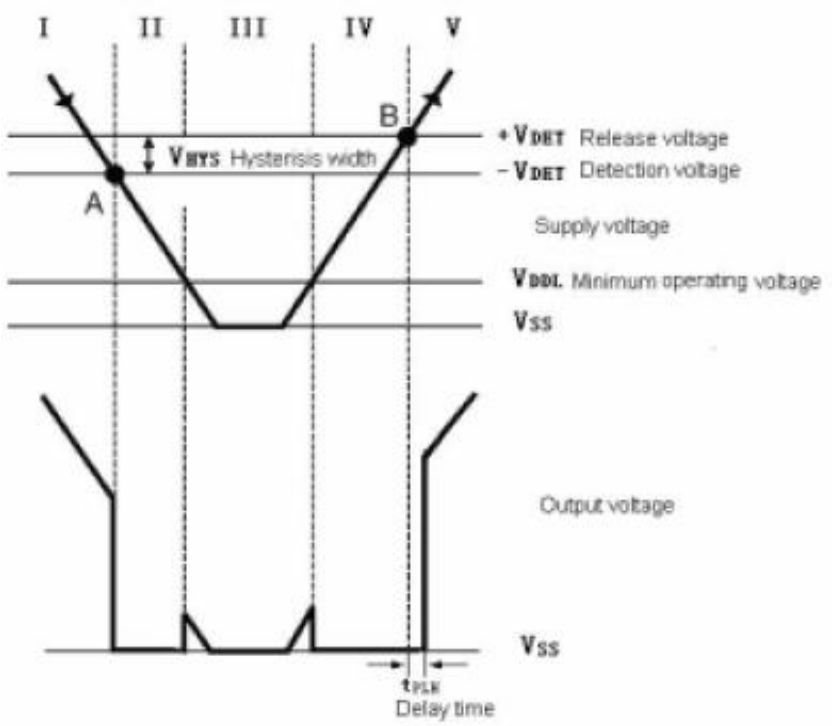

High precision low temperature co-efficiency reference voltage is applied to the negative input of a comparator. Input voltage, divided by resistor array of Ra Rb and Rc, is applied to the positive input of the comparator. Output of the comparator controls a pair of NMOS and PMOS switches, generating the hysteresis. Output of the comparator passes a series of buffer to drive the output CMOS pair.

$+V_{DET}$, $-V_{DET}$, $V_{HYS}$ can be calculated as follows:

$-V_{DET} = V_{REF}*(1+Ra/(Rb+Rc))$

$+V_{DET} = V_{REF}*(1+(Ra+Rb)/Rb) = V_{REF}*(1+(Ra+Rc)/Rb)$

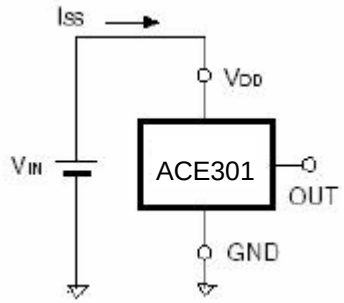
$V_{HYS} = +V_{DET}-(-V_{DET}) = V_{REF}*(Ra+Rb+Rc)(1/Rb-1/(Rb+Rc))$



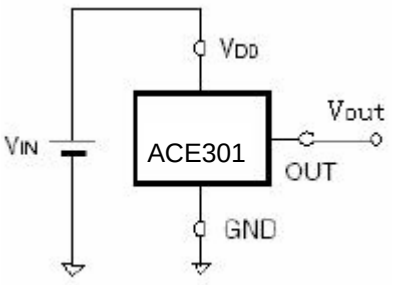

| No. | Operation status | Output status |
|---|---|---|
| I | $V_{DD}$>-$V_{DET}$ | Output voltage is equal to the supply voltage |
| II | $V_{DD}$ drops below – $V_{DET}$ | Output voltage equals to GNP level |
| III | $V_{DD}$ drops further below $V_{DDL}$ | Output voltage is undefined |
| IV | $V_{DD}$ rises above $V_{DDL}$ | Output voltage equals to GNP level |
| V | $V_{DD}$ rises above + $V_{DET}$ | Output voltage equals to supply voltage, $V_{HYS}$=(+$V_{DET}$)-(-$V_{DET}$) |

## Test circuits

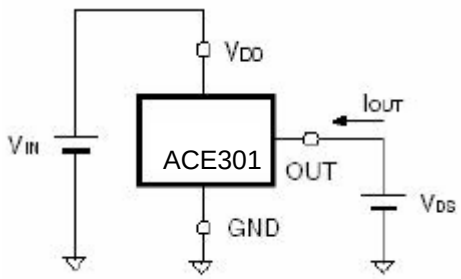
(1) Supply current test circuit



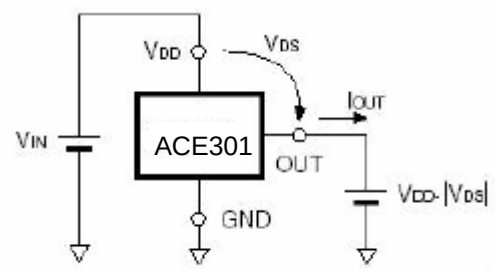

(2) Detector threshold test circuit



(3) NCH Drive Output Current Test Circuit



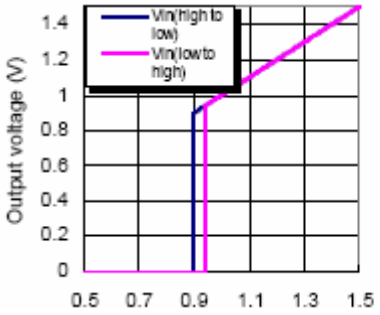

(4) PCH Drive Output Current Test Circuit



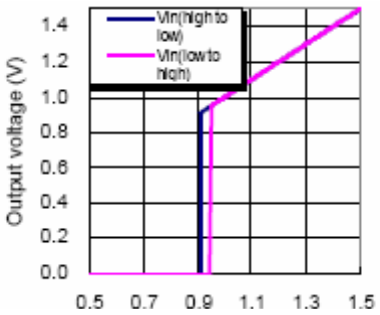

## Typical Performance Characteristics

(1) Output voltage VS. Input Voltage

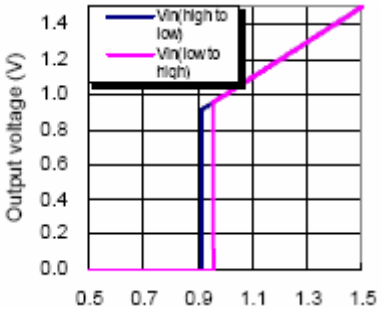
Detector threshold=0.9V (-40℃)



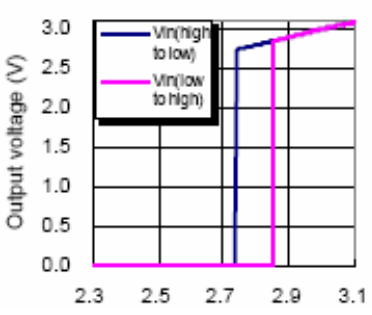

Detector threshold=0.9V (25℃)



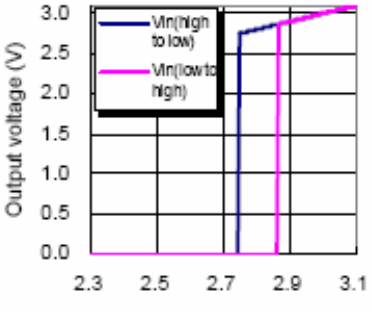

Detector threshold=0.9V (70℃)



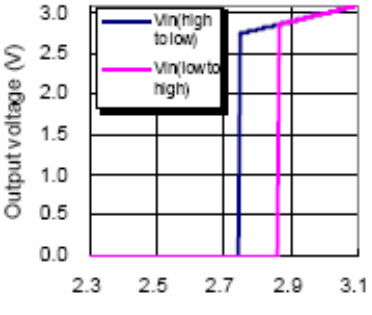

Detector threshold=2.7V (-40℃)



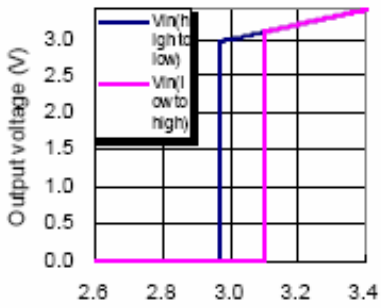

Detector threshold=2.7V (25℃)



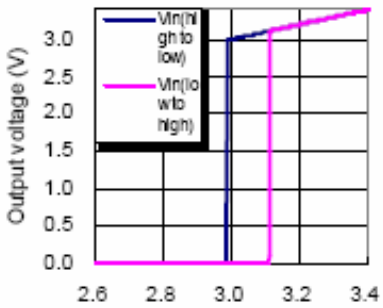

Detector threshold=2.7V (70℃)



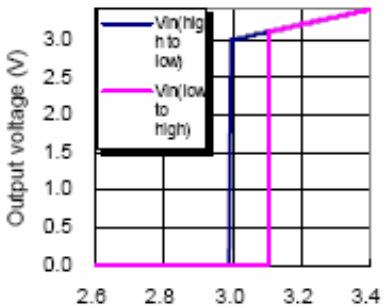
Detector threshold=3.0V (-40℃)



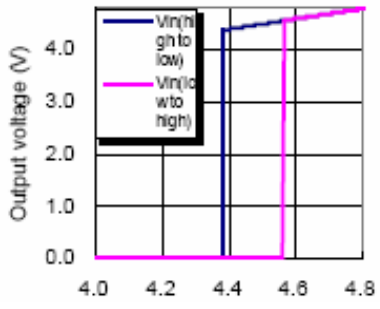

Detector threshold=3.0V (25℃)



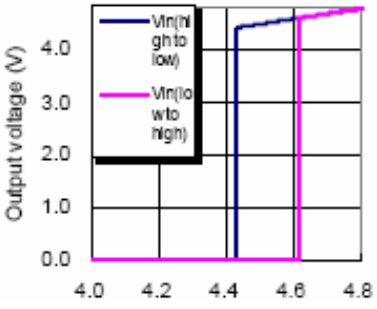

Detector threshold=3.0V (70℃)



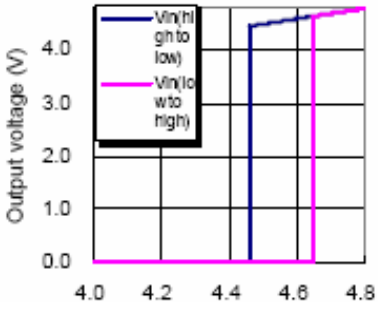

Detector threshold=4.4V (-40℃)




Detector threshold=4.4V (25℃)

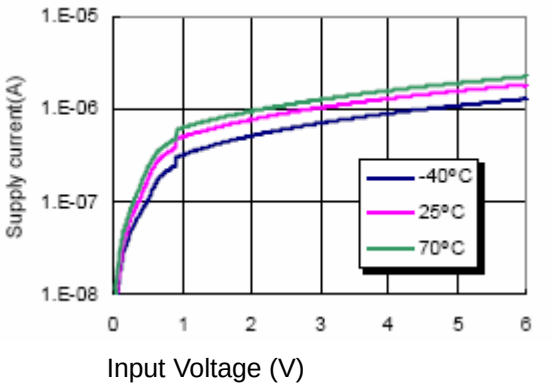



Detector threshold=4.4V (70℃)

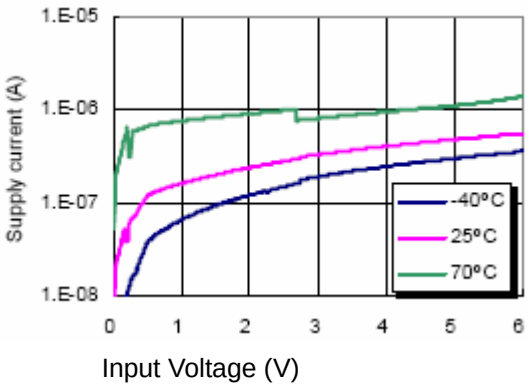



(2) Supply current VS. Input Voltage

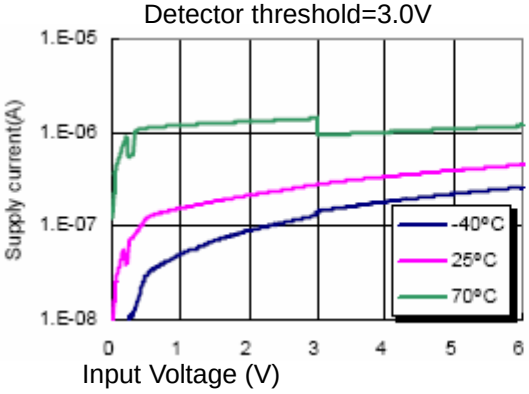
Detector threshold=0.9V



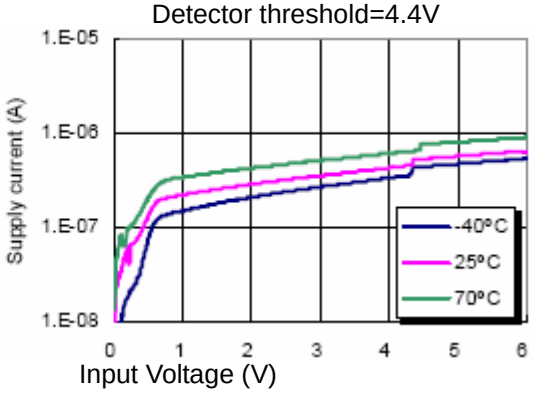

Detector threshold=2.7V



Detector threshold=3.0V

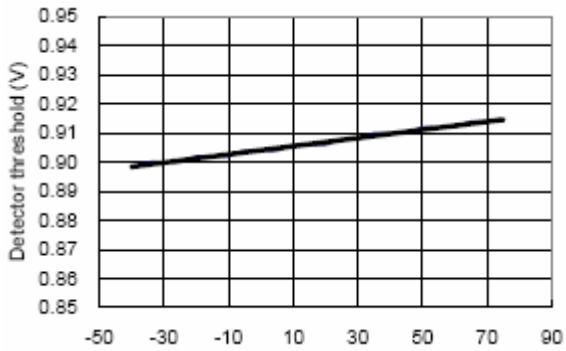



Detector threshold=4.4V

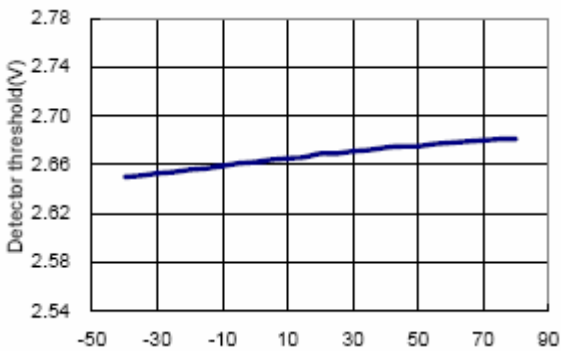



(3) Detector Threshold Hysteresis VS. Temperature

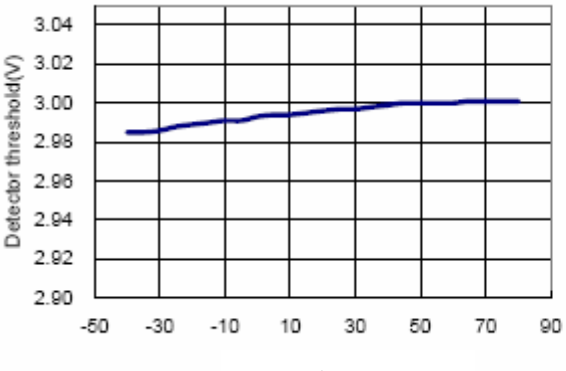
Detector threshold=0.9V



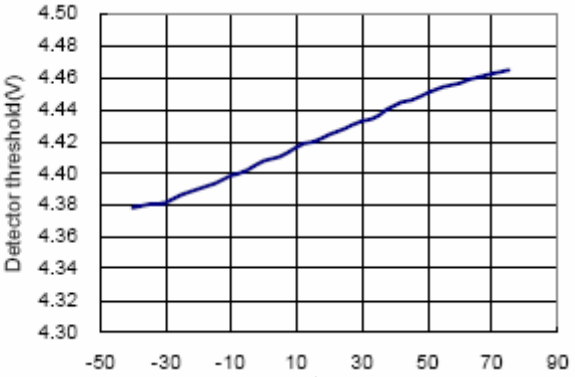

Detector threshold=2.7V




Detector threshold=3.0V

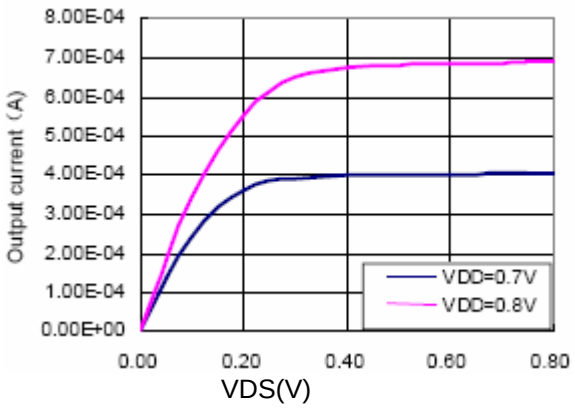



Detector threshold=4.4V

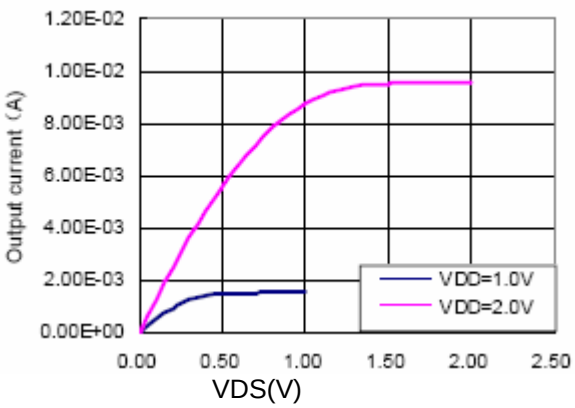


(4) Nch Driver Output Current VS. $V_{DS}$

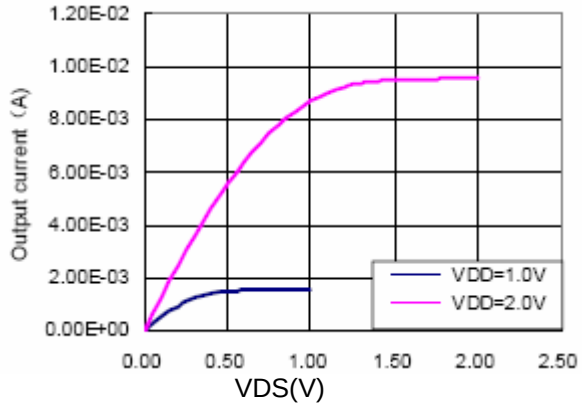
ACE301C09XX+



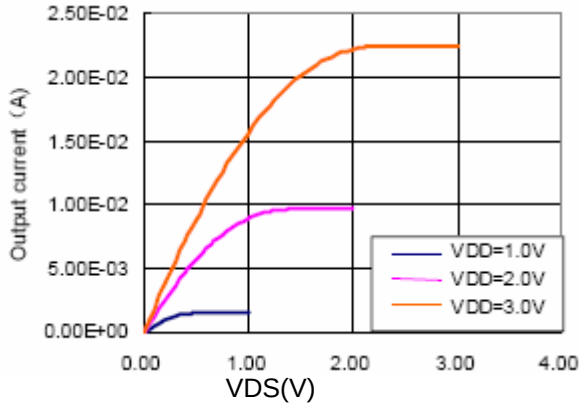

ACE301C27XX+




ACE301C30XX+

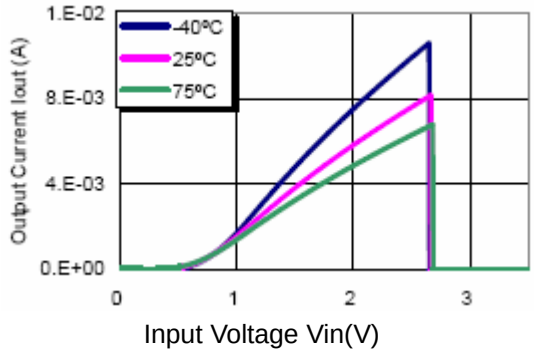



ACE301C44XX+

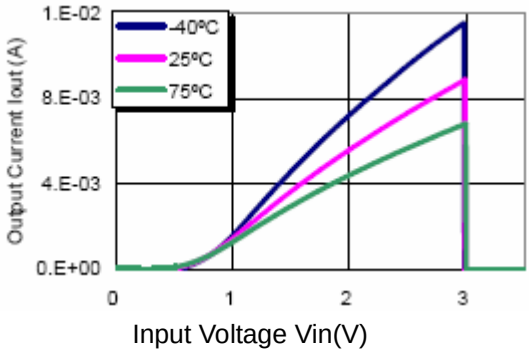



(5) Nch Driver Output Current VS. Input Voltage

Detector threshold=2.7V

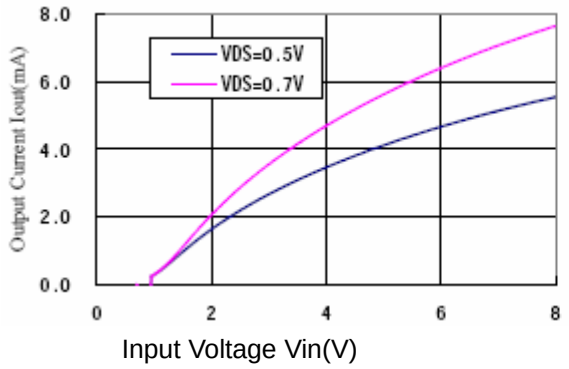



Detector threshold=3.0V

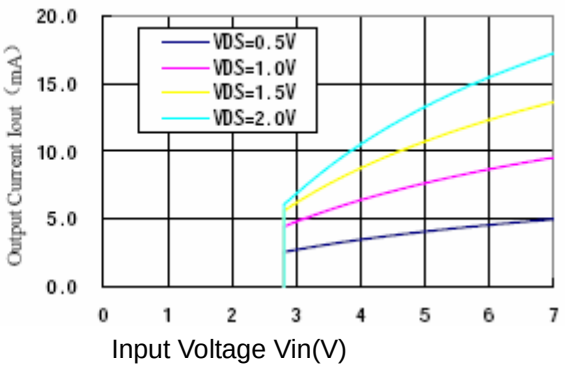


(6) PCH Driver Output Current VS. Input Current

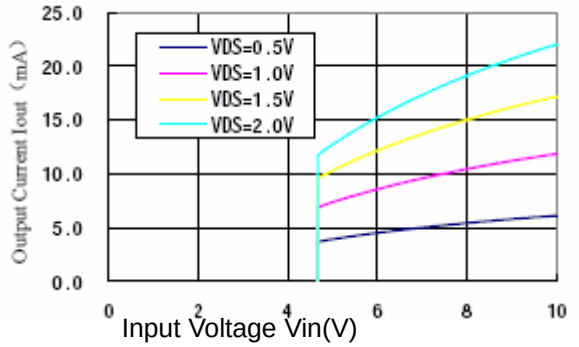
Detector threshold=0.9V



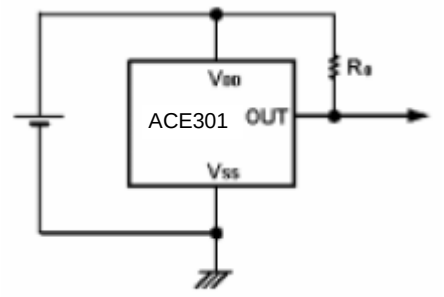

Detector threshold=2.7V




Detector threshold=4.4V




## Typical applications

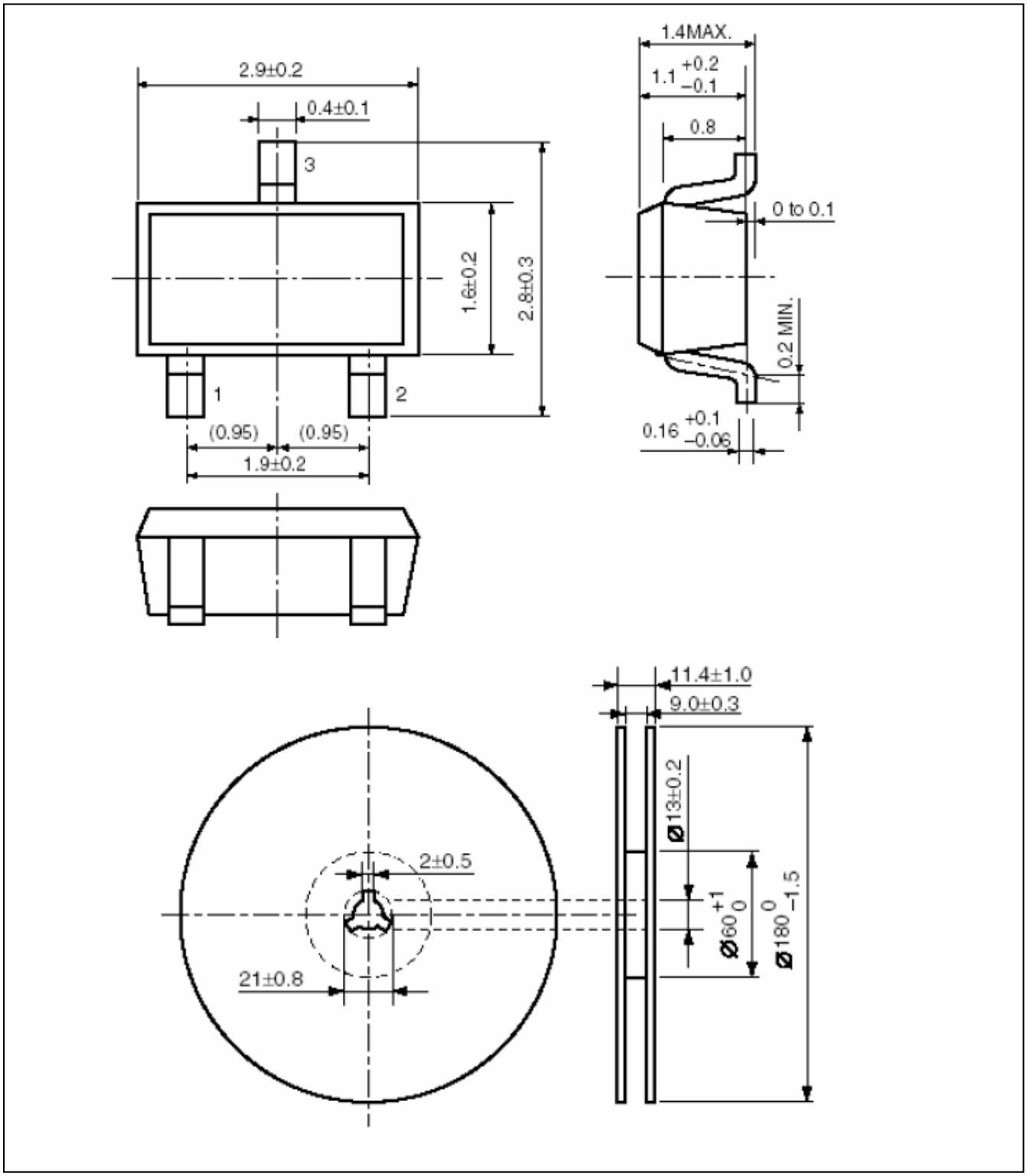



Note:

1. R0 is unnecessary for CMOS output products.
2. The value of R0 need to be selected in different application, Typical value is 470kΩ.

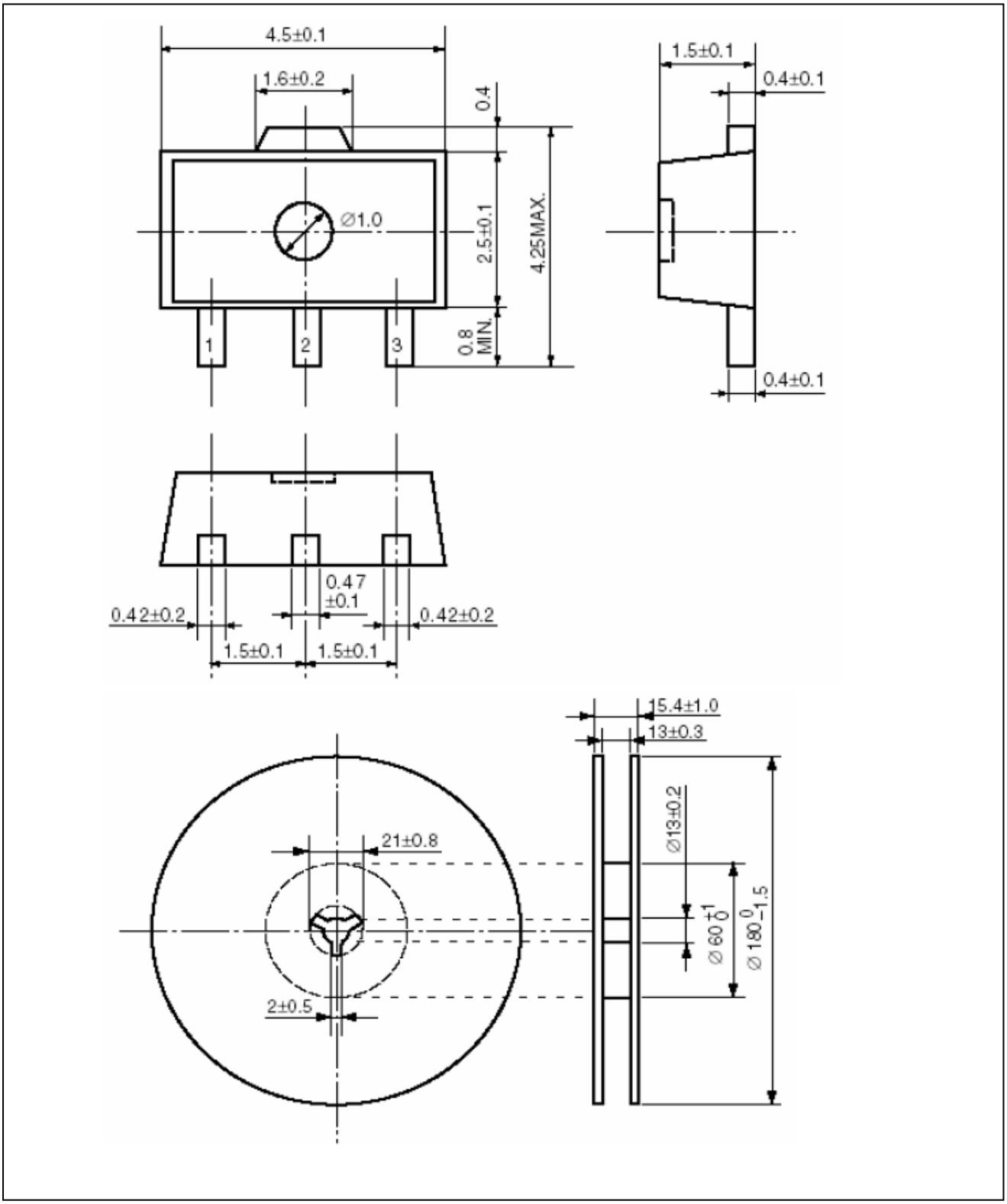
## Packing Information

### SOT-23-3



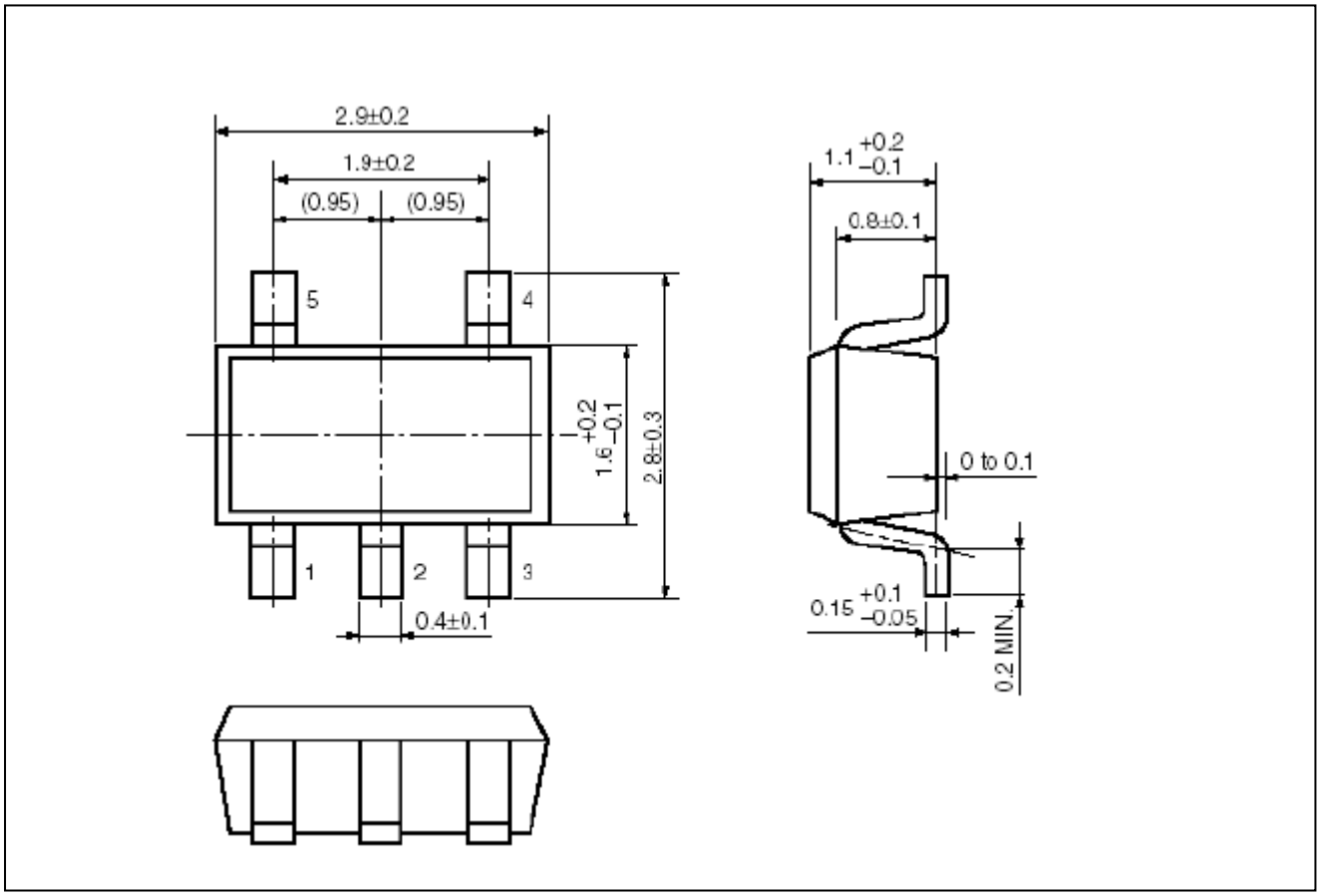
## Packing Information

### SOT-89-3



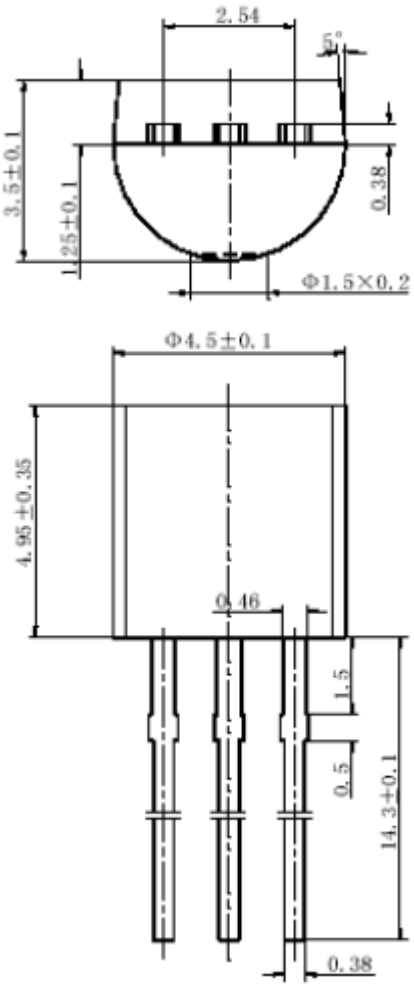
## Packing Information

### SOT-23-5



## Packing Information

### TO-92



Notes

ACE does not assume any responsibility for use as critical components in life support devices or systems without the express written approval of the president and general counsel of ACE Electronics Co., LTD. As sued herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and shoes failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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