XCM410 Series

2 Channel Voltage Detector (Sense Pin separated from V_{DD})

■GENERAL DESCRIPTION

The XCM410 series is a multi combination module IC which comprises of two voltage detectors, XC6108 and XC6109 series. The two detectors inside are highly precise, low power consumption voltage detectors using laser trimming technology. The sense pin (V_{SEN}) for channel 1 (V_{OUT1}) is separated from power supply (V_{IN}) so that it allows this pin to monitor added power supply. This feature enables output to maintain the state of detection even when voltage of the monitored power supply drops to 0V. The output configuration is N-channel open-drain.

■APPLICATIONS

- ●Microprocessor reset circuitry
- ●Charge voltage monitors
- ●Memory battery back-up switch circuits
- ●Power failure detection circuits

■FEATURES

High Accuracy : ±2%(Detect Voltage≧1.5V)
: ±30mV(Detect Voltage＜1.5V)

Low Power Consumption : 1.7μA (TYP)
(V_{OUT1}=1.5V, V_{OUT2}=3.3V, V_{IN}=4.0V)

Detect Voltage Range : Channel1 (Sensing pin:V_{SEN}, Output pin:V_{OUT1})
0.8V～5.0V (0.1V increments)
: Channel2 (Sensing pin:V_{IN},Output pin: V_{OUT2})
1.1V～5.0V (0.1V increments)

Operating Voltage Range : 1.0V～6.0V

Detect Voltage Temperature Characteristics
: ±100ppm/℃(TYP.)

Output Configuration : N-channel open drain

Operating Temperature Range
: -40℃～85℃

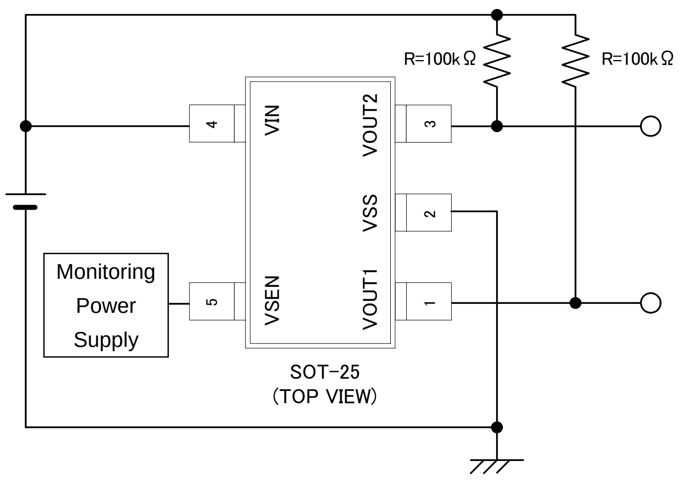
Built-In 2 Detect Voltage Circuit

Separated Sense Pin : Channel1 (Sensing pin:V_{SEN}, Output pin:V_{OUT1})

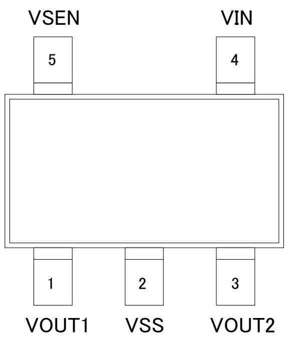
Package : SOT-25

Environmentally Friendly : EU RoHS Compliant, Pb Free

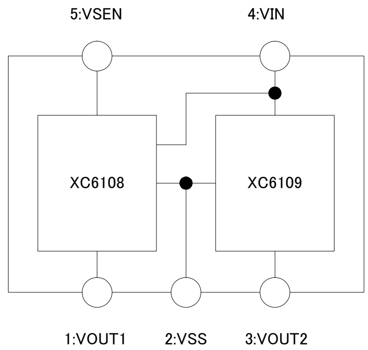
■TYPICAL APPLICATION CIRCUIT



■PIN CONFIGURATION



SOT-25
(TOP VIEW)



■PIN ASSIGNMENT

PIN	XCM410	FUNCTION	XC6108	XC6109
1	V_{OUT1}	Output 1	V_{OUT}	-
2	V_{SS}	Ground	V_{SS}	V_{SS}
3	V_{OUT2}	Output 2	-	V_{OUT}
4	V_{IN}	Input Voltage	V_{IN}	V_{IN}
5	V_{SEN}	Sense	V_{SEN}	-

■PRODUCT CLASSIFICATION

●Ordering Information

XCM410①②③④⑤⑥-⑦ (*1)

DESIGNATOR	DESCRIPTION	SYMBOL	DESCRIPTION
①②	Output Configuration	AA	V_{OUT1}/V_{OUT2} : N-ch open drain output
③④	Detect Voltage	01～	Sequential numbers for two voltage detect combinations V_{DF1} Detect Voltage Range : 0.8V ～ 5.0V (0.1V increments) V_{DF2} Detect Voltage Range : 1.1V ～ 5.0V (0.1V increments)
⑤⑥-⑦	Packages Taping Type (*2)	MR	SOT-25
		MR-G	SOT-25

(*1) The "-G" suffix indicates that the products are Halogen and Antimony free as well as being fully RoHS compliant.

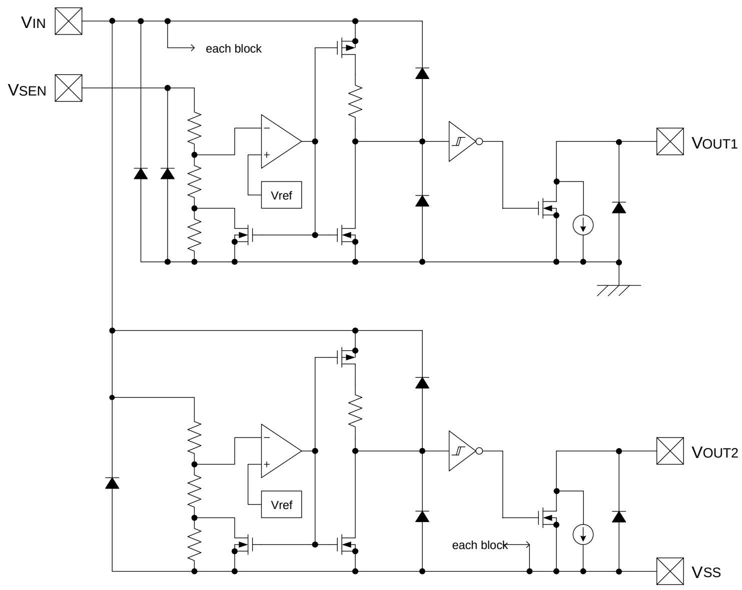
(*2) The device orientation is fixed in its embossed tape pocket. For reverse orientation, please contact your local Torex sales office or representative. (Standard orientation: ⑤R-⑦, Reverse orientation: ⑤L-⑦)

DESIGNATOR ③④ Detect Voltage

	V_{DF1}	V_{DF2}
01	1.5	3.3

*This series are semi-custom products. For other combinations, output voltages and etc., please ask Torex sales contacts.

■BLOCK DIAGRAM



■ABSOLUTE MAXIMUM RATINGS

PARAMETER		SYMBOL	RATINGS	UNITS
Input Voltage		V_{IN}	V_{SS}-0.3～7.0	V
Output Voltage	Nch Open Drain	V_{OUT1}	V_{SS}-0.3～7.0	V
	Nch Open Drain	V_{OUT2}	V_{SS}-0.3～7.0	
Sense Pin Voltage		V_{SEN}	V_{SS}-0.3～7.0	V
Output Current		I_{OUT1}	10	mA
		I_{OUT2}	10	mA
Power Dissipation	SOT-25	Pd	250	mW
Operating Temperature Range		Ta	-40～+85	^{o}C
Storage Temperature Range		Tstg	-55～+125	^{o}C

■ELECTRICAL CHARACTERISTICS

●XCM410AA Series

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	CIRCUIT
Operating Voltage (*1)	V_{IN}		1		6	V	-
Detect Voltage 1 (*2)	V_{DF1}		E-1			V	①
Detect Voltage 2 (*2)	V_{DF2}		E-1			V	②
Hysteresis Width 1	V_{HYS1}	V_{IN}=1.0～6.0V	V_{DF1} X0.02	V_{DF1} X0.05	V_{DF1} X0.08	V	①
Hysteresis Width 2	V_{HYS2}	$V_{DF2(T)}$=1.1～5.0V (*3)	V_{DF2} X0.02	V_{DF2} X0.05	V_{DF2} X0.08	V	②
Supply Current 1 (*4)	I_{SS1}	$V_{IN}=V_{DF2}\times0.9$ $V_{SEN}=V_{DF1}\times0.9$ $V_{DF2(T)}$=1.1V～1.9V $V_{DF2(T)}$=2.0V～3.9V $V_{DF2(T)}$=4.0V～5.0V		 1.4 1.5 1.6	 3.3 3.5 3.6	μA	③
Supply Current 2 (*4)	I_{SS2}	$V_{IN}=V_{DF2}\times1.1$ $V_{SEN}=V_{DF1}\times1.1$ $V_{DF2(T)}$=1.1V～1.9V $V_{DF2(T)}$=2.0V～3.9V $V_{DF2(T)}$=4.0V～5.0V		 1.8 2.0 3.1	 3.6 3.8 4.0	μA	③
Output Current 1	I_{OUT1}	V_{SEN}=0V V_{DS}=0.5V(N-ch) V_{IN}=1.0V V_{IN}=2.0V V_{IN}=3.0V V_{IN}=4.0V V_{IN}=5.0V V_{IN}=6.0V	 0.1 0.8 1.2 1.6 1.8 1.9	 0.7 1.6 2.0 2.3 2.4 2.5		mA	④
Output Current 2	I_{OUT2}	V_{DS}=0.5V(N-ch) V_{IN}=1.0V (*5) V_{IN}=2.0V (*6) V_{IN}=3.0V (*7) V_{IN}=4.0V (*8)	 0.1 0.8 1.2 1.6	 0.7 1.6 2.0 2.3		mA	⑤
N-ch Driver Leakage Current 1	I_{LEAK1}	V_{IN}=6.0V, V_{SEN}=6.0V, V_{OUT}=6.0V		0.2	0.4	μA	④
N-ch Driver Leakage Current 2	I_{LEAK2}	V_{IN}=6.0V V_{OUT}=6.0V		0.2	0.4	μA	④
Temperature Characteristics (*1)	$\Delta V_{DF}/\Delta Ta\cdot V_{DF}$	-40°C≦Ta≦85°C		±100		ppm/°C	①
Sense Resistance (*9)	R_{SEN}	V_{SEN}=5.0V V_{IN}=0V	E-2			MΩ	⑥
Detect Delay 1 (*10)	t_{DF1}	V_{IN}=6.0V		30	230	μs	⑦
Detect Delay 2 (*11)	t_{DF2}	V_{IN}=6.0V→1.0V		30	230	μs	⑧
Release Delay 1 (*12)	t_{DR1}	V_{IN}=6.0V		30	200	μs	⑦
Release Delay 2 (*13)	t_{DR2}	V_{IN}=1.0V→6.0V		30	200	μs	⑧

NOTE:
*1: $V_{OUT1}\cdot V_{OUT2}$: same characteristics.
*2: The detect voltage range for V_{DF1} (V_{OUT1}): 0.8V～5.0V.　The detect voltage range for V_{DF2} (V_{OUT2}): 1.1V～5.0V.
*3: The detect voltage for $V_{DF2(T)}$　(V_{OUT2}).
*4: Current flowing to the sense resistor is not included.
*5: $V_{DF2(T)}$>1.0V
*6: $V_{DF2(T)}$>2.0V
*7: $V_{DF2(T)}$>3.0V
*8: $V_{DF2(T)}$>4.0V
*9: Calculated from current value and voltage values at the both ends of the resistor.
*10: Time until $V_{SEN}=V_{DF1}$ reaches $V_{OUT1}=V_{IN}$x0.1 when V_{SEN} falls.
*11: Time until V_{IN}=VDF2 reaches V_{OUT2}=0.6V when V_{IN} falls.
*12: Time until $V_{SEN}=V_{DF1}+V_{HYS1}$ reaches $V_{OUT1}=V_{IN}$ when V_{SEN} rises.
*13: Time until $V_{IN}=V_{DF2}+V_{HYS2}$ reaches V_{OUT2}=5.4V when V_{IN} rises.

■VOLTAGE CHART

	E-1		E-2	
PARAMETER / NOMINAL DETECT VOLTAGE	DETECT VOLTAGE (*1) (V)		SENSE RESISTANCE (MΩ)	
$V_{DF1(T)}$, $V_{DF2(T)}$	V_{DF1}, V_{DF2}		R_{SEN}	
(V)	MIN.	MAX.	MIN.	TYP.
0.8	0.770	0.830	10	20
0.9	0.870	0.930		
1.0	0.970	1.030		
1.1	1.070	1.130		
1.2	1.170	1.230		
1.3	1.270	1.330		
1.4	1.370	1.430		
1.5	1.470	1.530		
1.6	1.568	1.632		
1.7	1.666	1.734		
1.8	1.764	1.836		
1.9	1.862	1.938		
2.0	1.960	2.040	13	24
2.1	2.058	2.142		
2.2	2.156	2.244		
2.3	2.254	2.346		
2.4	2.352	2.448		
2.5	2.450	2.550		
2.6	2.548	2.652		
2.7	2.646	2.754		
2.8	2.744	2.856		
2.9	2.842	2.958		
3.0	2.940	3.060		
3.1	3.038	3.162		
3.2	3.136	3.264		
3.3	3.234	3.366		
3.4	3.332	3.468		
3.5	3.430	3.570		
3.6	3.528	3.672		
3.7	3.626	3.774		
3.8	3.724	3.876		
3.9	3.822	3.978		
4.0	3.920	4.080	15	28
4.1	4.018	4.182		
4.2	4.116	4.284		
4.3	4.214	4.386		
4.4	4.312	4.488		
4.5	4.410	4.590		
4.6	4.508	4.692		
4.7	4.606	4.794		
4.8	4.704	4.896		
4.9	4.802	4.998		
5.0	4.900	5.100		

(*1) When $V_{DF1(T)}$, $V_{DF2(T)} \leqq 1.4V$, detect accuracy is ±30mV.
When $V_{DF1(T)}$, $V_{DF2(T)} \geqq 1.5V$, detect accuracy is ±2%.

■OPERATIONAL EXPLANATION

Figure1 is typical application circuit, and Fifure2 is timing chart of figure1.

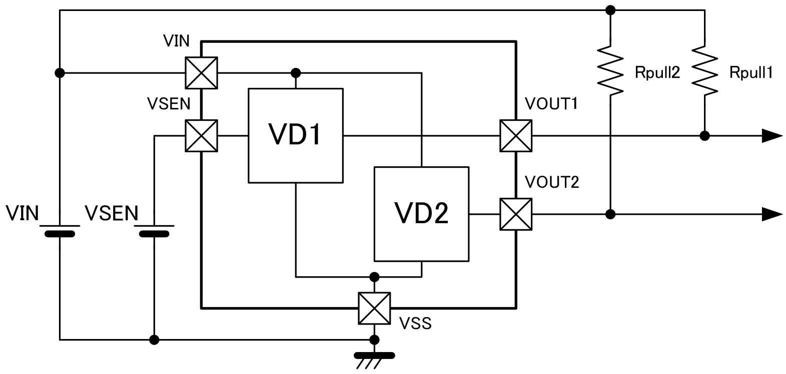


Figure 1: Typical application circuit example

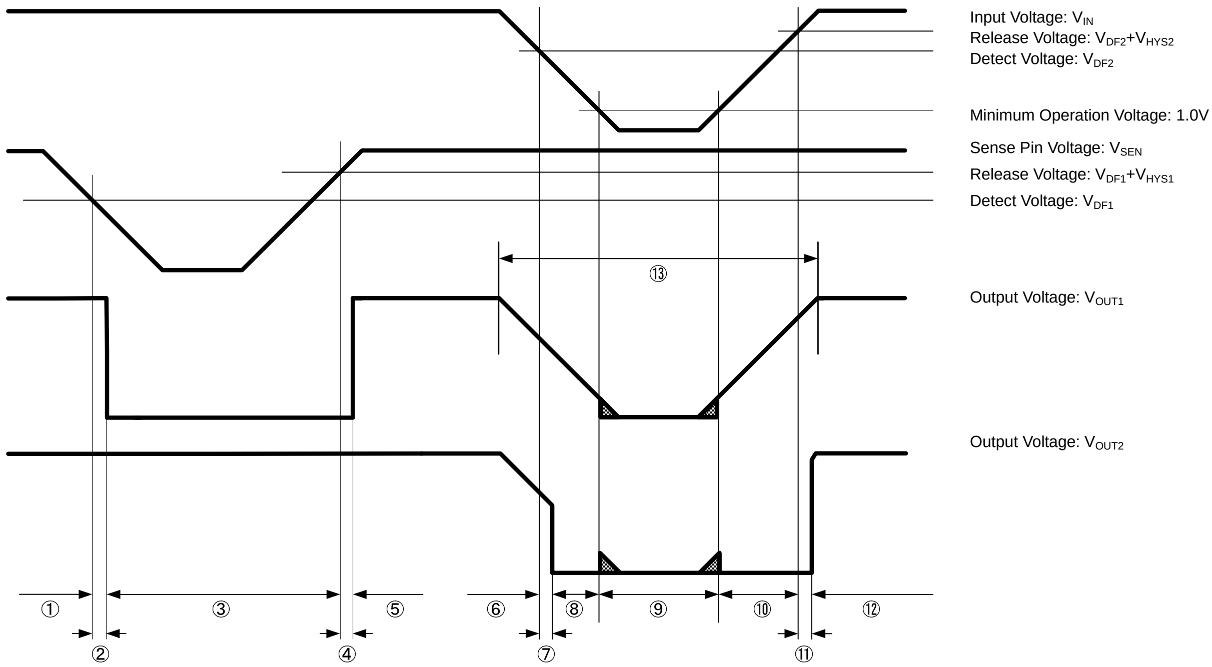


Figure 2: The timing chart of Figure 1

① As an early state, the V_{IN} power supply pin and the V_{SEN} sense pin are applied sufficiently high voltage (6.0V MAX.). While the sense pin voltage V_{SEN} starts dropping to the detect voltage V_{DF1} ($V_{SEN}>V_{DF1}$), the output voltage V_{OUT1} keeps high level (=V_{IN}).

* If a pull-up resistor of the N-ch open drain is connected to added power supply different from the input voltage pin, the high level will be a voltage value where the pull-up resistor is connected.

② When the sense pin voltage keeps dropping and becomes equal to the detect voltage ($V_{SEN}=V_{DF1}$), the output voltage changes into the low level ($\leqq V_{IN}\times 0.1$). The detect delay time t_{DF1} is defined as time which ranges from $V_{SEN}=V_{DF1}$ to the V_{OUT1} goes in low level.

③ The output voltage (V_{OUT1}) maintains low level while the sense pin voltage increases again to reach the release voltage ($V_{SEN}< V_{DF1}+V_{HYS1}$).

④ The release delay time t_{DR1} is defined as time which ranges from sense pin voltage reaches release voltage ($V_{SEN}\geqq V_{DF1}+V_{HYS1}$) to the V_{OUT1} goes in high level.

■OPERATIONAL EXPLANATION (Continued)

⑤ The output voltage V_{OUT1} maintains high level (=V_{IN}) while the sense pin voltage more than detect voltage (V_{SEN}>V_{DF1}).

⑥ The V_{IN} input voltage pin is applied sufficiently high voltage to the release voltage (V_{DF2}+V_{HYS2}). While the input pin voltage V_{IN} starts dropping to the detect voltage V_{DF2} (V_{IN} > V_{DF2}), the output voltage V_{OUT2} keeps high level (=V_{IN}).
* If a pull-up resistor of the N-ch open drain is connected to added power supply different from the input voltage pin, the high level will be a voltage value where the pull-up resistor is connected.

⑦ When the input pin voltage keeps dropping and becomes equal to the detect voltage (V_{IN} = V_{DF2}), the output voltage changes into low level (≦V_{IN}×0.1). The detect delay time t_{DF2} is defined as time which ranges from V_{IN} =V_{DF} to the V_{OUT} goes in low level.

⑧ While the input pin voltage keeps below the detect voltage V_{DF2}, and 1.0V or more, the output voltage V_{OUT2} maintains low level.

⑨ While the input pin voltage drops to 1.0V or less and it increases again to 1.0V or more, the output voltage (V_{OUT2}) may not be able to maintain low level. Such an operation is called “Undefined Operation”, and the output voltage from the V_{OUT2} pin is called undefined operating voltage V_{UNS}.

⑩ While the input pin voltage increases from 1.0V to the release voltage level (V_{IN}<V_{DF2} +V_{HYS2}), the output voltage (V_{OUT2}) maintains low level.

⑪ The release delay time t_{DR2} is defined as time which ranges from the V_{IN} power supply voltage pin reaches release voltage (V_{IN}≧V_{DF2}+V_{HYS2}) to the V_{OUT2} goes in high level.

⑫ The output voltage V_{OUT2} maintains high level (=V_{IN}) while the power supply voltage more than detect voltage (V_{IN}>V_{DF2}).

⑬ If a pull-up resistor Rpull1 of the N-ch open drain is connected to power supply V_{IN}, output voltage V_{OUT1} becomes same to the input voltage V_{IN}. While the V_{IN} power supply voltage drops below 1.0V and increases again to 1.0V or more, the output voltage V_{OUT2} may not be able to maintain low level.

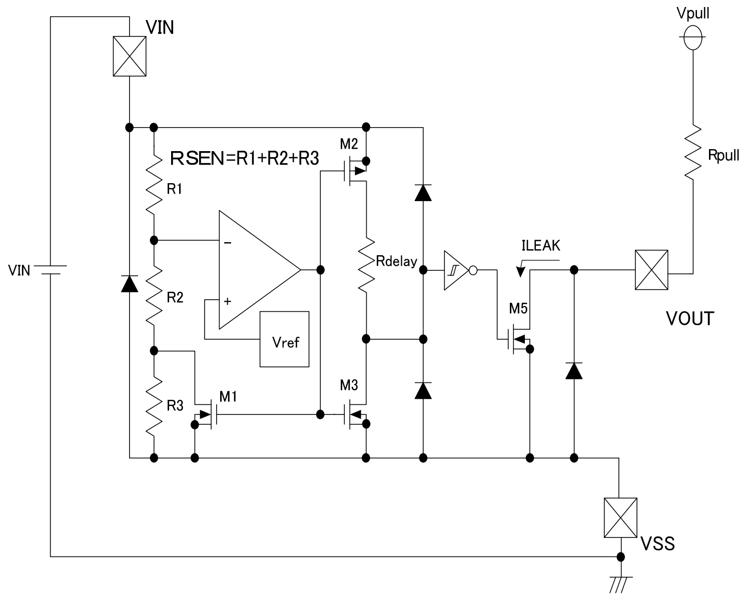
■NOTE ON USE

1. Use this IC within the stated maximum ratings. Operation beyond these limits may cause degrading or permanent damage to the device.
2. The power supply input pin voltage drops by the resistance between power supply and the V_{IN} pin, and by through current at operation of the IC. At this time, the IC may go into malfunction if the power supply input pin voltage falls below the minimum operating voltage range.
3. When the sense voltage is less than 1.0V, be sure to separate the V_{IN} pin and the sense pin, and to apply the voltage over 1.0V to the V_{IN} pin.
4. Note that a rapid and high fluctuation at the power supply input pin voltage may cause a wrong operation.
5. In N channel open drain output, V_{OUT} voltages at detect and release are determined by resistance of a pull-up resistor connected at the V_{OUT} pin. Please choose proper resistance values with referring to Figure 3;

During detection：V_{OUT}=Vpull / (1+Rpull / R_{ON})
Vpull：Pull-up voltage
R_{ON}(*1)：On-resistance of N channel driver M3 can be calculated as V_{DS} / I_{OUT1} from electrical characteristics,
For example, when (*2) R_{ON} = 0.5 / 0.8×10^{-3} = 625Ω（MIN.）at V_{IN}=2.0V, Vpull = 3.0V and V_{OUT} ≦0.1V at detect,
Rpull= (Vpull /V_{OUT}-1)×R_{ON}= (3 / 0.1-1)×625≒18ｋΩ
In this case, Rpull should be selected higher or equal to 18kΩ in order to keep the output voltage less than 0.1V during detection.

(*1) V_{IN} is smaller R_{ON} is bigger, be noted.
(*2) For calculation, minimum V_{IN} should be chosen among the input voltage range.

During releasing：V_{OUT} = Vpull / (1 + Rpull / R_{OFF})
Vpull：Pull-up voltage
R_{OFF}：On-resistance of N channel driver M3 is 15MΩ（MIN.）when the driver is off (as to V_{OUT} / I_{LEAK})
For example：when Vpull = 6.0V and V_{OUT} ≧ 5.99V,
Rpull = (Vpull / V_{OUT}-1)×Roff = (6/5.99-1)×15×10^6 ≒25 kΩ
In this case, Rpull should be selected smaller or equal to 25 kΩ in order to obtain output voltage higher than 5.99V during releasing.

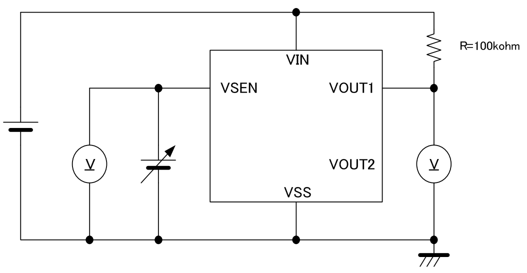


NOTE: Roff=V_{OUT}/I_{LEAK}

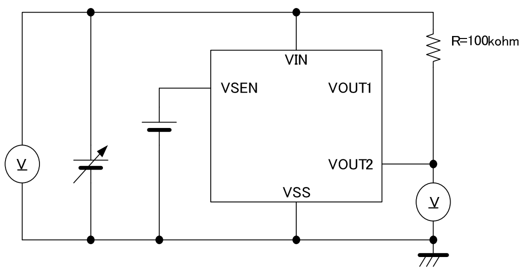
Figure 3: Test Circuit

■TEST CIRCUITS

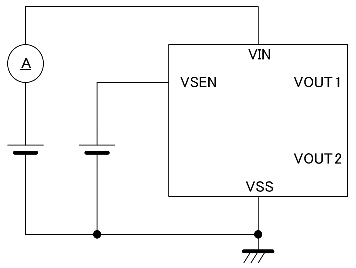
Circuit ①



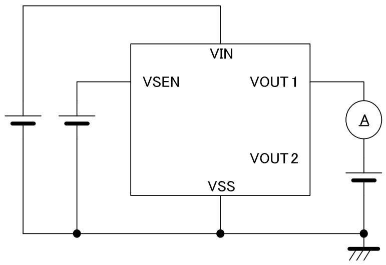
Circuit ②



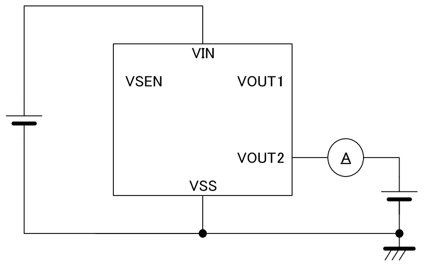
Circuit ③



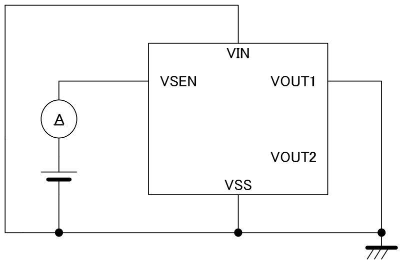
Circuit ④



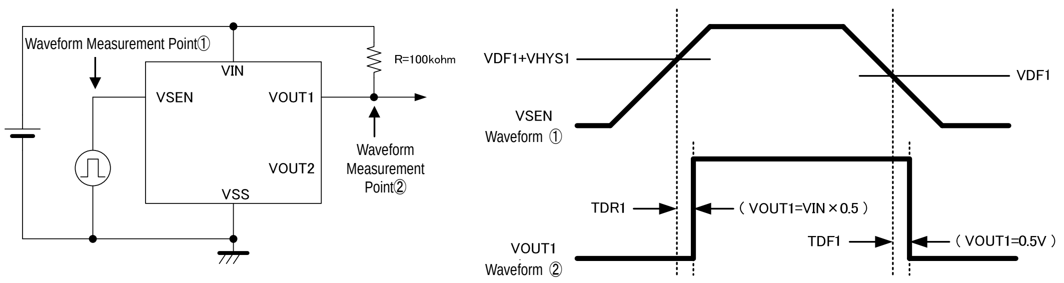
Circuit ⑤



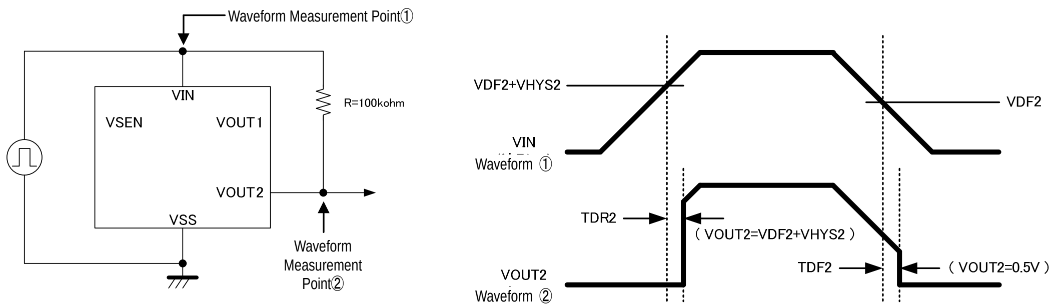
Circuit ⑥



Circuit ⑦

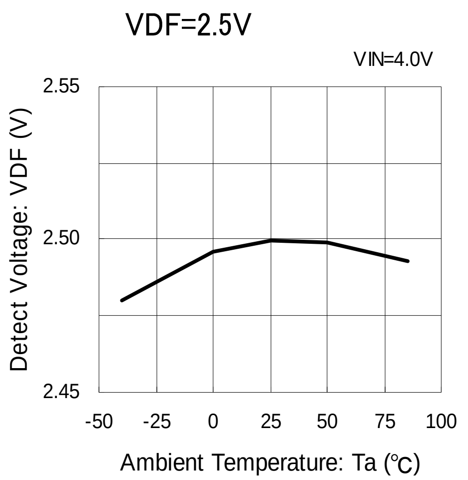


Circuit ⑧

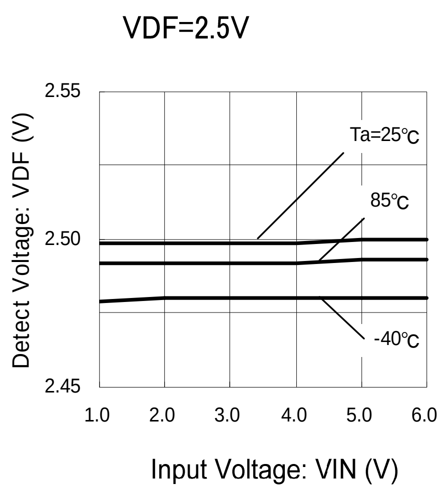


■TYPICAL PERFORMANCE CHARACTERISTICS

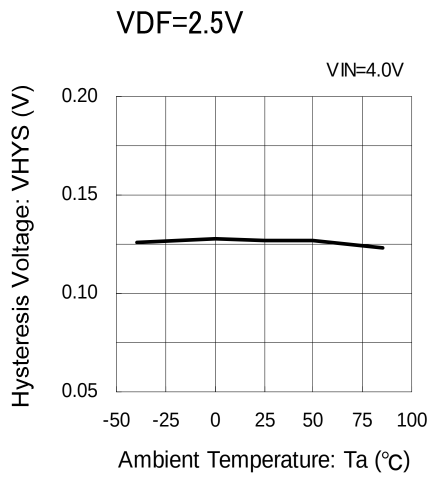
(1)Detect Voltage vs. Ambient Temperature



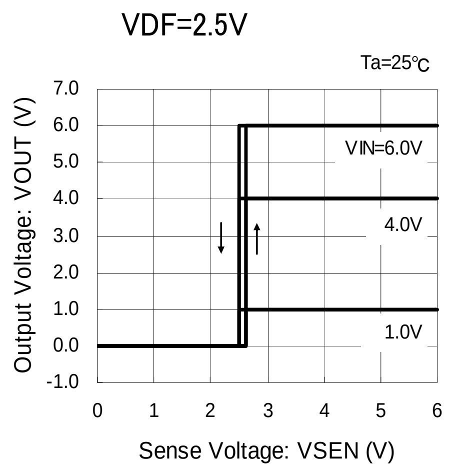
(2)Detect Voltage vs. Input Voltage



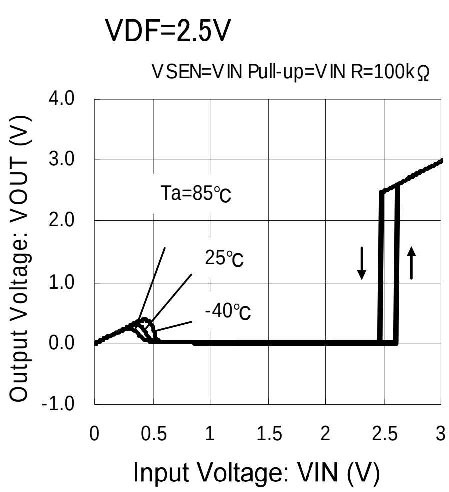
(3)Hysteresis Voltage vs. Ambient Temperature



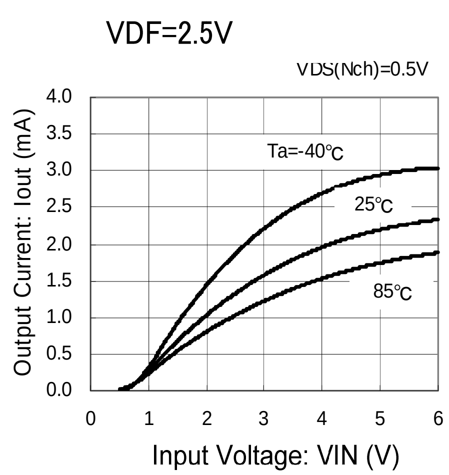
(4)Output Voltage vs. Sense Voltage



(5)Output Voltage vs. Input Voltage

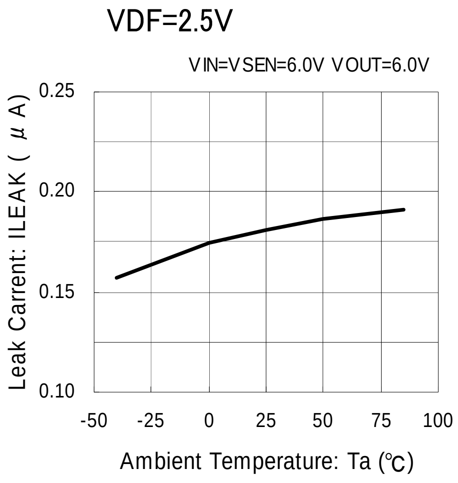


(6)Output Current vs. Input Voltage

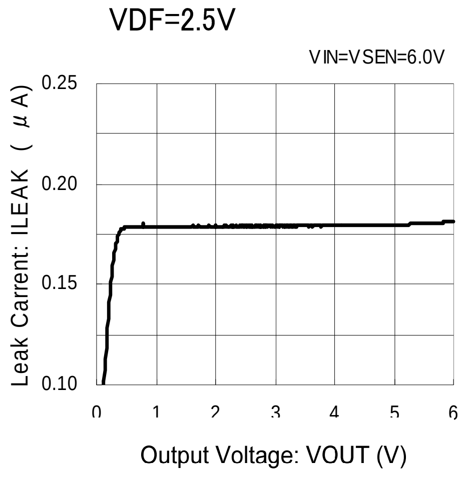


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(7)Leak Current vs. Ambient Temperature

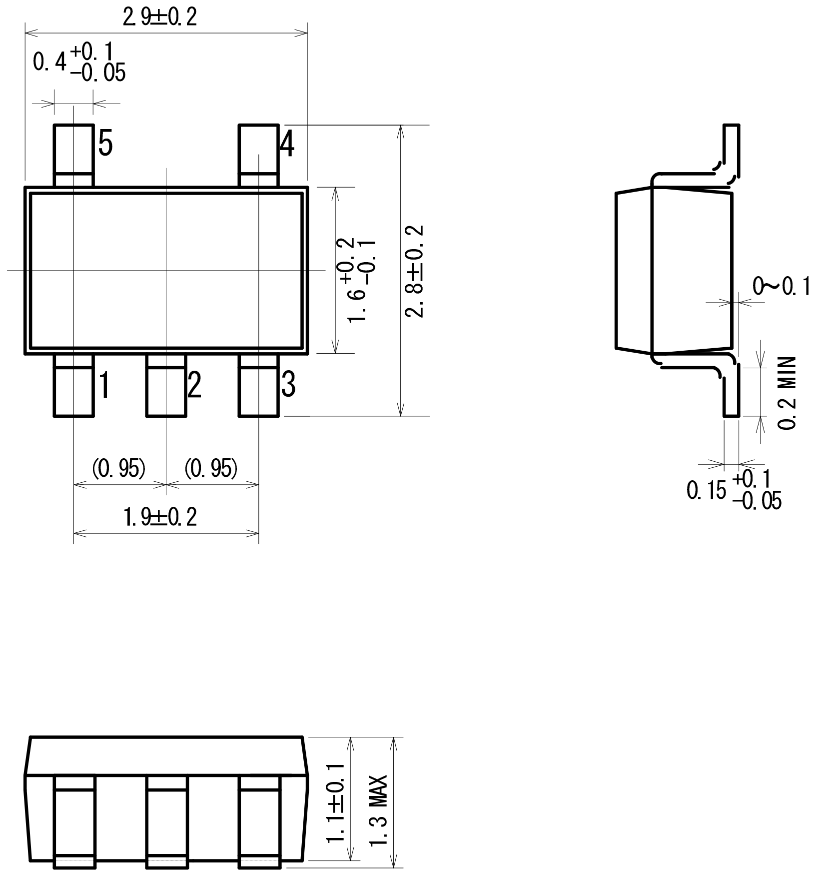


(8)Leak Current vs. Output Voltage



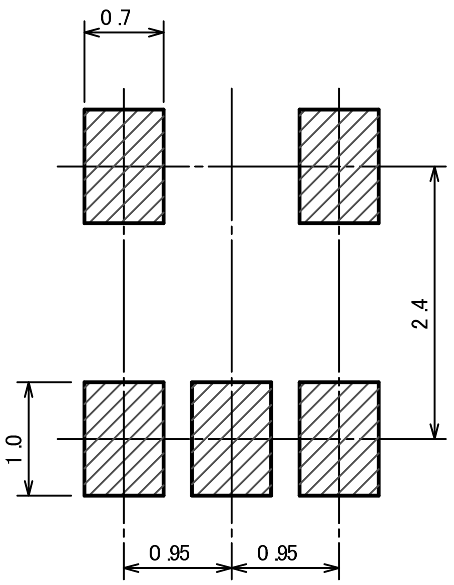
■PACKAGING INFORMATION

●SOT-25



*The side of pins are not gilded, but nickel is used:　Sn 5～15μm

●SOT-25 Reference Pattern Layout



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3. Please ensure suitable shipping controls (including fail-safe designs and aging protection) are in force for equipment employing products listed in this datasheet.
4. The products in this datasheet are not developed, designed, or approved for use with such equipment whose failure of malfunction can be reasonably expected to directly endanger the life of, or cause significant injury to, the user.
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