RICOH

VOLTAGE DETECTOR

R×5VL SERIES

OUTLINE

The R×5VL Series are voltage detector ICs with high detector threshold accuracy and ultra-low supply current by CMOS process. Each of these ICs consists of a voltage reference unit, a comparator, resistors for voltage detection, an output driver and a hysteresis circuit.

The detector threshold is fixed with high accuracy.

Two output Types, Nch open drain type and CMOS type, are available.

Three types of packages, TO-92, SOT-89 (Mini-power Mold), SOT-23-5 (Mini-mold), are available.

FEATURES

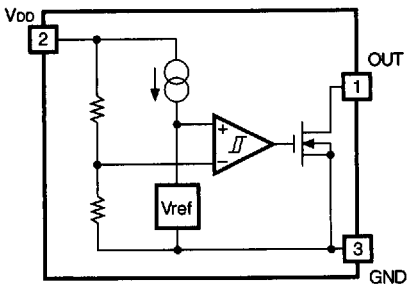
- Ultra-low Supply Current ..... TYP. 1.0μA (V_{DD}=3.0V)
- Broad Operating Voltage Range ..... 1.5V to 10.0V
- Detector Threshold ..... Stepwise setting with a step of 0.1V in the range of 2.0V to 6.0V is possible (refer to Selection Guide).
- High Accuracy Detector Threshold ..... ±2.5%
- Low Temperature-Drift Coefficient of Detector Threshold ..... TYP.±100ppm/°C
- Two Output Types ..... Nch Open Drain and CMOS
- Three Types of Packages ..... TO-92, SOT-89 (Mini-power Mold), SOT-23-5 (Mini-mold)

APPLICATIONS

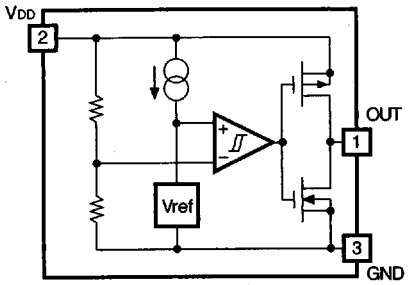
- CPU & Logic Circuit Reset
- Battery Checker
- Window Comparator
- Wave Shaping Circuit
- Battery Back-Up Circuit
- Power Failure Detector

BLOCK DIAGRAMS

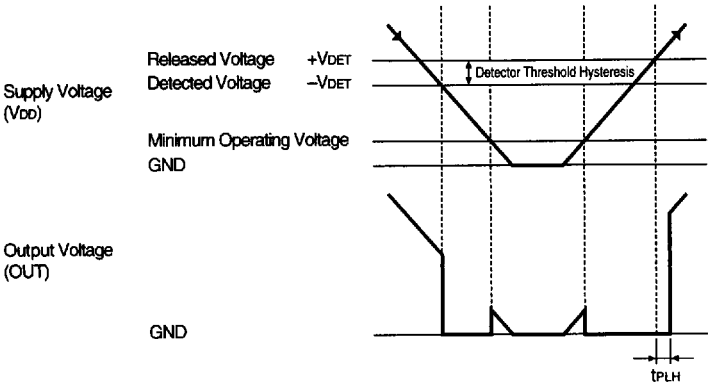
• **Nch Open Drain Output (R×5VL××A)**



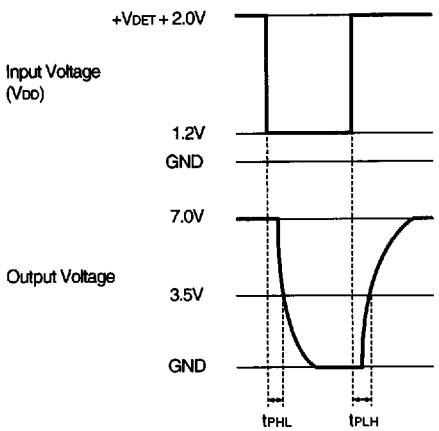
• **CMOS Output (R×5VL××C)**



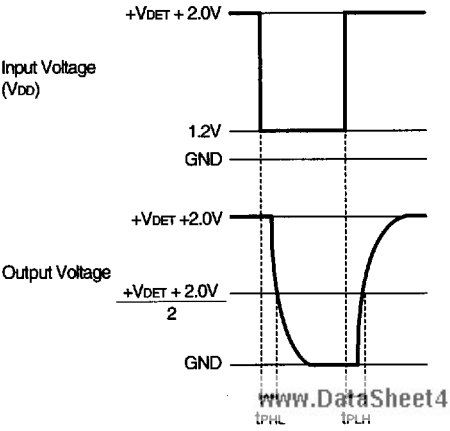
TIME CHART



DEFINITION OF OUTPUT DELAY TIME tPLH



Nch Open Drain Output



CMOS Output

Output Delay Time t_{PLH} is defined as follows:

1. In the case of Nch Open Drain Output:

   When the time at which a pulse voltage which increases from 1.2V to $+V_{DET}+2.0V$ is applied to V_{DD} is Time A, and the time at which the output reaches 3.5V under the conditions that the output pin (OUT) is pulled up to 7V by a resistor of 100kΩ is Time B, the time period from Time A through Time B.

2. In the case of CMOS Output:

   When the time at which a pulse voltage which increases from 1.2V to $+V_{DET}$ +2.0V is applied to V_{DD} is Time A, and the time at which the output voltage reaches the voltage of $(+V_{DET}+2.0V)/2$ is Time B, the time period from Time A through Time B.

SELECTION GUIDE

The package type,the detector threshold,the output type,the packing type,and the taping type of R×5VL series can be designating at the user's request by specifying the part number as follows:

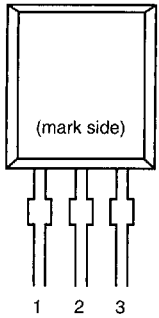
R×5VL××××-×× ← Part Number
↑ ↑ ↑↑ ↑
a b cd e

Code	Contents
a	Designation of Package Type: E: TO-92 H: SOT-89 (Mini-power Mold) N: SOT-23-5 (Mini-mold)
b	Setting Detector Threshold ($-V_{DET}$): Stepwise setting with a step of 0.1V in the range of 2.0V to 6.0V is possible.
c	Designation of Output Type: A: Nch Open Drain C: CMOS
d	Designation of Packing Type: A: Taping C: Antistatic bag for TO-92 and samples
e	Designation of Taping Type: Ex. TO-92: RF, RR, TZ SOT-89: T1, T2 SOT-23-5: TR, TL (refer to Taping Specifications) "TZ", "T1" and "TR" are prescribed as a standard.

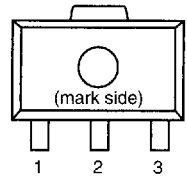
For example, the product with Package Type SOT-89, Detector Threshold 3.5V, Output Type Nch Open Drain and Taping Type T1, is designated by Part Number RH5VL35AA-T1.

PIN CONFIGURATION

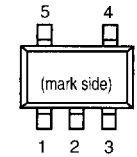
• TO-92



• SOT-89



• SOT-23-5



PIN DESCRIPTION

• TO-92

Pin No	Symbol
1	OUT
2	VDD
3	GND

• SOT-89

Pin No	Symbol
1	OUT
2	VDD
3	GND

• SOT-23-5

Pin No	Symbol
1	OUT
2	VDD
3	GND
4	NC
5	NC

ABSOLUTE MAXIMUM RATINGS

Topt=25°C

Symbol	Item	Rating		Unit
V_{DD}	Supply Voltage	12		V
V_{OUT}	Output Voltage	CMOS	V_{SS}–0.3 to V_{DD}+0.3	V
		Nch	V_{SS}–0.3 to 12	
I_{OUT}	Output Current	70		mA
P_{D1}	Power Dissipation 1 (NOTE1)	300		mW
P_{D2}	Power Dissipation 2 (NOTE2)	150		mW
Topt	Operating Temperature Range	–30 to +80		°C
Tstg	Storage Temperature Range	–55 to +125		°C
Tsolder	Lead Temperature (Soldering)	260°C,10s		

(NOTE 1) applied to SOT-89 and TO-92
(NOTE 2) applied to SOT-23-5

ABSOLUTE MAXIMUM RATINGS

Absolute Maximum ratings are threshold limit values that must not be exceeded even for an instant under any conditions. Moreover, such values for any two items must not be reached simultaneously. Operation above these absolute maximum ratings may cause degradation or permanent damage to the device. These are stress ratings only and do not necessarily imply functional operation below these limits.

ELECTRICAL CHARACTERISTICS

• R×5VL20C

Topt=25°C

Symbol	Item	Conditions		MIN.	TYP.	MAX.	Unit
$-V_{DET}$	Detector Threshold			1.950	2.000	2.050	V
V_{HYS}	Detector Threshold Hysteresis			0.060	0.100	0.140	V
I_{SS}	Supply Current	V_{DD}=1.90V			0.90	2.70	µA
		V_{DD}=4.00V			1.10	3.30	
		V_{DD}=10.0V			1.70	5.10	
V_{DD}	Operating Voltage			1.50		10.0	V
I_{OUT}	Output Current	Nch	V_{DS}=0.5V V_{DD}=1.5V	0.25	0.50		mA
		Pch	V_{DS}=−2.1V V_{DD}=4.5V	1.00	2.00		mA
t_{PLH}	Output Delay Time					100	µs
$\frac{\Delta -V_{DET}}{\Delta Topt}$	Detector Threshold Temperature Coefficient	−30°C≤Topt≤80°C			±100		ppm/°C

• R×5VL27C

Topt=25°C

Symbol	Item	Conditions		MIN.	TYP.	MAX.	Unit
$-V_{DET}$	Detector Threshold			2.633	2.700	2.767	V
V_{HYS}	Detector Threshold Hysteresis			0.081	0.135	0.189	V
I_{SS}	Supply Current	V_{DD}=2.60V			0.90	2.70	µA
		V_{DD}=4.70V			1.10	3.30	
		V_{DD}=10.0V			1.70	5.10	
V_{DD}	Operating Voltage			1.50		10.0	V
I_{OUT}	Output Current	Nch	V_{DS}=0.5V V_{DD}=1.5V	0.25	0.50		mA
		Nch	V_{DS}=0.5V V_{DD}=2.0V	1.50	3.00		mA
		Pch	V_{DS}=−2.1V V_{DD}=4.5V	1.00	2.00		mA
t_{PLH}	Output Delay Time					100	µs
$\frac{\Delta -V_{DET}}{\Delta Topt}$	Detector Threshold Temperature Coefficient	−30°C≤Topt≤80°C			±100		ppm/°C

• **R×5VL36C**

Topt=25°C

Symbol	Item	Conditions		MIN.	TYP.	MAX.	Unit
$-V_{DET}$	Detector Threshold			3.510	3.600	3.690	V
V_{HYS}	Detector Threshold Hysteresis			0.108	0.180	0.252	V
I_{SS}	Supply Current	V_{DD}=3.47V			1.00	3.00	µA
		V_{DD}=5.60V			1.20	3.60	
		V_{DD}=10.0V			1.70	5.10	
V_{DD}	Operating Voltage			1.50		10.0	V
I_{OUT}	Output Current	Nch	V_{DS}=0.5V V_{DD}=1.5V	0.25	0.50		mA
		Nch	V_{DS}=0.5V V_{DD}=3.0V	3.00	5.00		mA
		Pch	V_{DS}=−2.1V V_{DD}=4.5V	1.00	2.00		mA
t_{PLH}	Output Delay Time					100	µs
$\frac{\Delta -V_{DET}}{\Delta Topt}$	Detector Threshold Temperature Coefficient	−30°C≤Topt≤80°C			±100		ppm/°C

• **R×5VL45C**

Topt=25°C

Symbol	Item	Conditions		MIN.	TYP.	MAX.	Unit
$-V_{DET}$	Detector Threshold			4.388	4.500	4.612	V
V_{HYS}	Detector Threshold Hysteresis			0.135	0.225	0.315	V
I_{SS}	Supply Current	V_{DD}=4.34V			1.10	3.30	µA
		V_{DD}=6.50V			1.30	3.90	
		V_{DD}=10.0V			1.70	5.10	
V_{DD}	Operating Voltage			1.50		10.0	V
I_{OUT}	Output Current	Nch	V_{DS}=0.5V V_{DD}=1.5V	0.25	0.50		mA
		Nch	V_{DS}=0.5V V_{DD}=4.0V	4.00	6.00		mA
		Pch	V_{DS}=−2.1V V_{DD}=8.0V	1.50	3.00		mA
t_{PLH}	Output Delay Time					100	µs
$\frac{\Delta -V_{DET}}{\Delta Topt}$	Detector Threshold Temperature Coefficient	−30°C≤Topt≤80°C			±100		ppm/°C

• R×5VL54C

Topt=25°C

Symbol	Item	Conditions		MIN.	TYP.	MAX.	Unit
$-V_{DET}$	Detector Threshold			5.265	5.400	5.535	V
V_{HYS}	Detector Threshold Hysteresis			0.162	0.270	0.378	V
I_{SS}	Supply Current	V_{DD}=5.20V			1.20	3.60	μA
		V_{DD}=7.40V			1.40	4.20	
		V_{DD}=10.0V			1.70	5.10	
V_{DD}	Operating Voltage			1.50		10.0	V
I_{OUT}	Output Current	Nch	V_{DS}=0.5V V_{DD}=1.5V	0.25	0.50		mA
		Nch	V_{DS}=0.5V V_{DD}=5.0V	5.00	7.00		mA
		Pch	V_{DS}=−2.1V V_{DD}=8.0V	1.50	3.00		mA
t_{PLH}	Output Delay Time					100	μs
$\frac{\Delta -V_{DET}}{\Delta Topt}$	Detector Threshold Temperature Coefficient	−30°C≤Topt≤80°C			±100		ppm/°C

ELECTRICAL CHARACTERISTICS BY DETECTOR THRESHOLD

• **R×5VL××A**

Part Number	Detector Threshold			Detector Threshold Hysteresis		SupplyCurrent 1			Supply Current 2			Supply Current 3		
	–VDET(V)			VHYS(V)		Iss(μA)			Iss(μA)			Iss(μA)		
	MIN.	TYP.	MAX.	MIN.	MAX.	Conditions	TYP.	MAX.	Conditions	TYP.	MAX.	Conditions	TYP.	MAX.
R×5VL20A	1.950	2.000	2.050											
R×5VL21A	2.048	2.100	2.152											
R×5VL22A	2.145	2.200	2.255											
R×5VL23A	2.243	2.300	2.357											
R×5VL24A	2.340	2.400	2.460			VDD= (–VDET) –0.10V	0.9	2.7		1.1	3.3			
R×5VL25A	2.438	2.500	2.562											
R×5VL26A	2.535	2.600	2.665											
R×5VL27A	2.633	2.700	2.767											
R×5VL28A	2.730	2.800	2.870											
R×5VL29A	2.828	2.900	2.972											
R×5VL30A	2.925	3.000	3.075											
R×5VL31A	3.023	3.100	3.177											
R×5VL32A	3.120	3.200	3.280											
R×5VL33A	3.218	3.300	3.382											
R×5VL34A	3.315	3.400	3.485			VDD= (–VDET) –0.13V	1.0	3.0		1.2	3.6			
R×5VL35A	3.413	3.500	3.587											
R×5VL36A	3.510	3.600	3.690											
R×5VL37A	3.608	3.700	3.792											
R×5VL38A	3.705	3.800	3.895											
R×5VL39A	3.803	3.900	3.997	(–VDET) ×3%	(–VDET) ×7%				VDD= (–VDET) +2.0V			VDD= 10V	1.7	5.1
R×5VL40A	3.900	4.000	4.100											
R×5VL41A	3.998	4.100	4.202											
R×5VL42A	4.095	4.200	4.305											
R×5VL43A	4.193	4.300	4.407			VDD= (–VDET) –0.16V	1.1	3.3		1.3	3.9			
R×5VL44A	4.290	4.400	4.510											
R×5VL45A	4.388	4.500	4.612											
R×5VL46A	4.485	4.600	4.715											
R×5VL47A	4.583	4.700	4.817											
R×5VL48A	4.680	4.800	4.920											
R×5VL49A	4.778	4.900	5.022											
R×5VL50A	4.875	5.000	5.125											
R×5VL51A	4.973	5.100	5.227											
R×5VL52A	5.070	5.200	5.330											
R×5VL53A	5.168	5.300	5.432			VDD= (–VDET) –0.20V	1.2	3.6		1.4	4.2			
R×5VL54A	5.265	5.400	5.535											
R×5VL55A	5.363	5.500	5.637											
R×5VL56A	5.460	5.600	5.740											
R×5VL57A	5.558	5.700	5.842											
R×5VL58A	5.655	5.800	5.945											
R×5VL59A	5.753	5.900	6.047											
R×5VL60A	5.850	6.000	6.150											

Topt=25°C

Output Current 1			Output Current 2			Output Delay Time	Operating Voltage		Detector Threshold Tempco.	
IOUT(mA)			IOUT(mA)			tPLH (μs)	VDD(V)		Δ-VDET/ΔTopt (ppm/°C)	
Conditions	MIN.	TYP.	Conditions	MIN.	TYP.	MAX.	MIN.	MAX.	Conditions	TYP.
Nch VDS=0.5V VDD=1.5V	0.25	0.50	—	—	—	100	1.5	10	-30°C≤Topt≤80°C	±100
			Nch VDS=0.5V VDD=2.0V	1.5	3.0					
			Nch VDS=0.5V VDD=3.0V	3.0	5.0					
			Nch VDS=0.5V VDD=4.0V	4.0	6.0					
			Nch VDS=0.5V VDD=5.0V	5.0	7.0					

• **R×5VL××C**

Part Number	Detector Threshold			Detector Threshold Hysteresis		SupplyCurrent 1			Supply Current 2			Supply Current 3		
	–VDET(V)			VHYS(V)		Iss(μA)			Iss(μA)			Iss(μA)		
	MIN.	TYP.	MAX.	MIN.	MAX.	Conditions	TYP.	MAX.	Conditions	TYP.	MAX.	Conditions	TYP.	MAX.
R×5VL20C	1.950	2.000	2.050	(–VDET) ×3%	(–VDET) ×7%	VDD= (–VDET) –0.10V	0.9	2.7	VDD= (–VDET) +2.0V	1.1	3.3	VDD= 10V	1.7	5.1
R×5VL21C	2.048	2.100	2.152											
R×5VL22C	2.145	2.200	2.255											
R×5VL23C	2.243	2.300	2.357											
R×5VL24C	2.340	2.400	2.460											
R×5VL25C	2.438	2.500	2.562											
R×5VL26C	2.535	2.600	2.665											
R×5VL27C	2.633	2.700	2.767											
R×5VL28C	2.730	2.800	2.870											
R×5VL29C	2.828	2.900	2.972											
R×5VL30C	2.925	3.000	3.075			VDD= (–VDET) –0.13V	1.0	3.0		1.2	3.6			
R×5VL31C	3.023	3.100	3.177											
R×5VL32C	3.120	3.200	3.280											
R×5VL33C	3.218	3.300	3.382											
R×5VL34C	3.315	3.400	3.485											
R×5VL35C	3.413	3.500	3.587											
R×5VL36C	3.510	3.600	3.690											
R×5VL37C	3.608	3.700	3.792											
R×5VL38C	3.705	3.800	3.895											
R×5VL39C	3.803	3.900	3.997											
R×5VL40C	3.900	4.000	4.100			VDD= (–VDET) –0.16V	1.1	3.3		1.3	3.9			
R×5VL41C	3.998	4.100	4.202											
R×5VL42C	4.095	4.200	4.305											
R×5VL43C	4.193	4.300	4.407											
R×5VL44C	4.290	4.400	4.510											
R×5VL45C	4.388	4.500	4.612											
R×5VL46C	4.485	4.600	4.715											
R×5VL47C	4.583	4.700	4.817											
R×5VL48C	4.680	4.800	4.920											
R×5VL49C	4.778	4.900	5.022											
R×5VL50C	4.875	5.000	5.125			VDD= (–VDET) –0.20V	1.2	3.6		1.4	4.2			
R×5VL51C	4.973	5.100	5.227											
R×5VL52C	5.070	5.200	5.330											
R×5VL53C	5.168	5.300	5.432											
R×5VL54C	5.265	5.400	5.535											
R×5VL55C	5.363	5.500	5.637											
R×5VL56C	5.460	5.600	5.740											
R×5VL57C	5.558	5.700	5.842											
R×5VL58C	5.655	5.800	5.945											
R×5VL59C	5.753	5.900	6.047											
R×5VL60C	5.850	6.000	6.150											

Topt=25°C

Output Current 1			Output Current 2			Output Current 3			Output Delay Time	Operating Voltage		Detector Threshold Tempco.	
IOUT(mA)			IOUT(mA)			IOUT(mA)			tPLH (μs)	VDD(V)		Δ-VDET/ΔTopt (ppm/°C)	
Conditions	MIN.	TYP.	Conditions	MIN.	TYP.	Conditions	MIN.	TYP.	MAX.	MIN.	MAX.	Conditions	TYP.
Nch VDS=0.5V VDD=0.5V	0.25	0.50	—	—	—	Pch VDS=-2.1V VDD=4.5V	1.0	2.0	100	1.5	10	-30°C≤Topt≤80°C	±100
			Nch VDS=0.5V VDD=2.0V	1.5	3.0								
			Nch VDS=0.5V VDD=3.0V	3.0	5.0								
			Nch VDS=0.5V VDD=4.0V	4.0	6.0	Pch VDS=-2.1V VDD=8.0V	1.5	3.0					
			Nch VDS=0.5V VDD=5.0V	5.0	7.0								

OPERATION

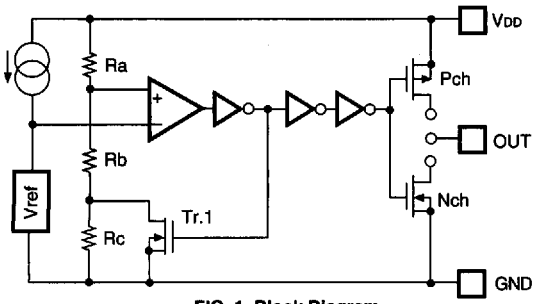


FIG. 1 Block Diagram

- In R×5VL××A, Nch Tr. drain is connected to OUT pin.
- In R×5VL××C, Nch Tr. drain and Pch Tr. drain are connected to OUT pin.

Operation Diagram

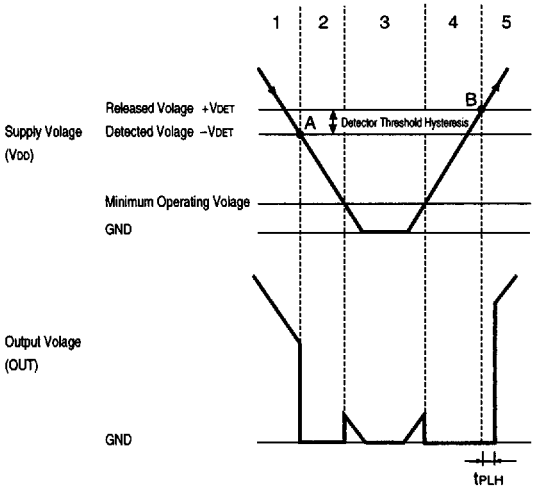


FIG. 2 Operation Diagram

Step		Step 1	Step 2	Step 3	Step 4	Step 5
Comparator(+)Pin Input Voltage		I	II	II	II	I
Comparator Output		H	L	Indefinite	L	H
Tr. 1		OFF	ON	Indefinite	ON	OFF
Output Tr.	Pch	ON	OFF	Indefinite	OFF	ON
	Nch	OFF	ON	Indefinite	ON	OFF

I. $\frac{Rb + Rc}{Ra + Rb + Rc} \cdot V_{DD}$

II. $\frac{Rb}{Ra + Rb} \cdot V_{DD}$

Step 1. Output Voltage is equal to Power Source Voltage (VDD).

Step 2. When Input Voltage to Comparator reaches the state of Vref ≥ VDD·(Rb+Rc)/(Ra+Rb+Rc)at Point A (Detected Voltage –VDET), the output of Comparator is reserved, so that Output Voltage becomes GND.

Step 3. In the case of CMOS Output, Output Voltage becomes unstable when Supply Voltage (VDD) is smaller than Minimum Operating Voltage. In the case of Nch Open Drain Output, a pulled-up voltage is output.

Step 4. Output Voltage becomes equal to GND.

Step 5. When Input Voltage to Comparator reaches the state of Vref≤VDD·(Rb)/(Ra+Rb) at Point B (Released Voltage +VDET), the output of Comparator is reserved, so that Output Voltage becomes equal to Supply Voltage (VDD)

TEST CIRCUITS

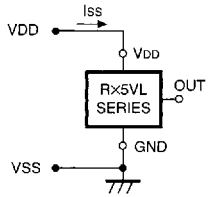


FIG. 3 Supply Current Test Circuit

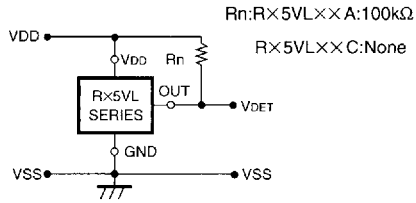


FIG. 4 Detector Threshold Test Circuit

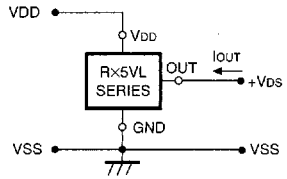


FIG. 5 Nch Driver Output Current Test Circuit

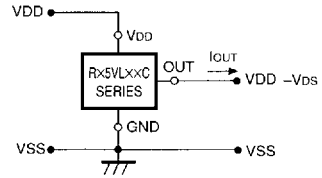


FIG. 6 Pch Driver Output Current Test Circuit

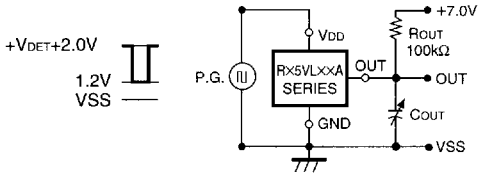
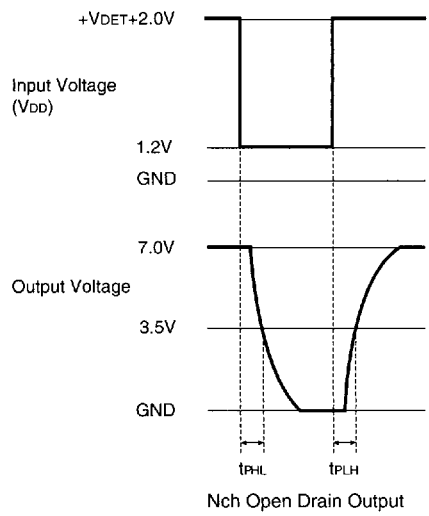
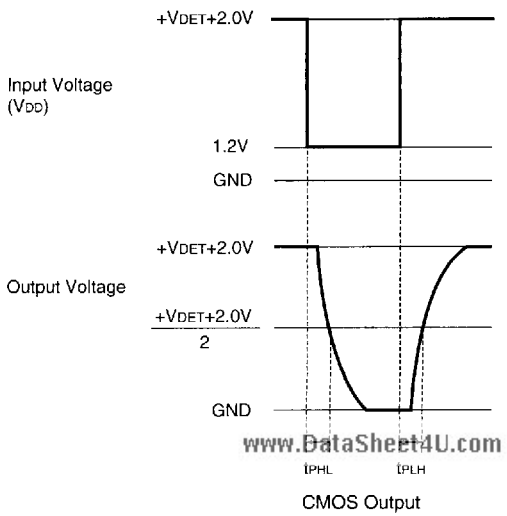


FIG. 7 Output Delay Time Test Circuit

In Output Delay Time Test Circuit in FIG.7, it's Output Voltage Fall Times (t_{PHL}) and Rise Times (t_{PLH}) are defined as shown below.



Nch Open Drain Output

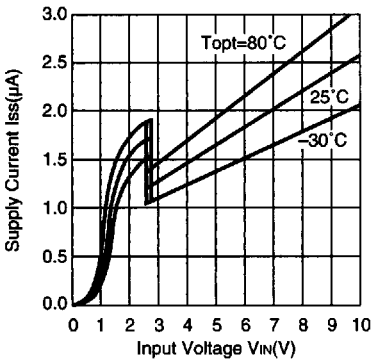


CMOS Output

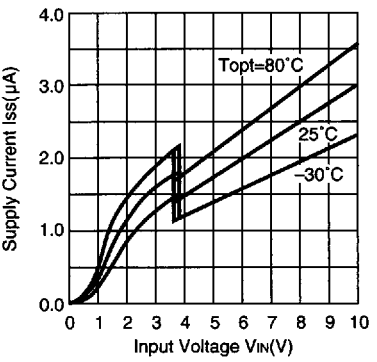
TYPICAL CHARACTERISTICS

1) Supply Current vs. Input Voltage

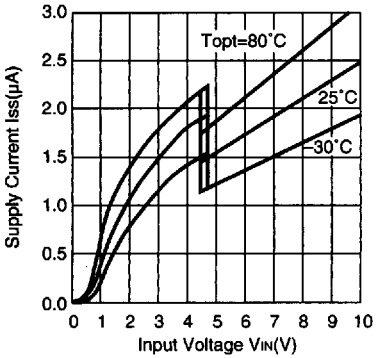
R×5VL27C



R×5VL36C

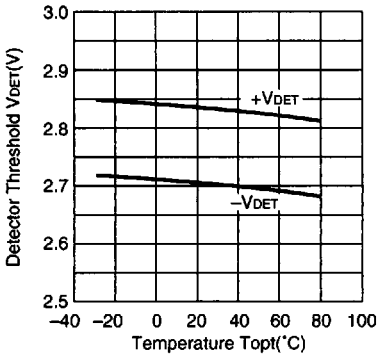


R×5VL45C

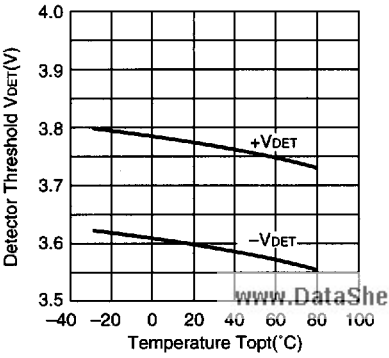


2) Detector Threshold vs. Temperature

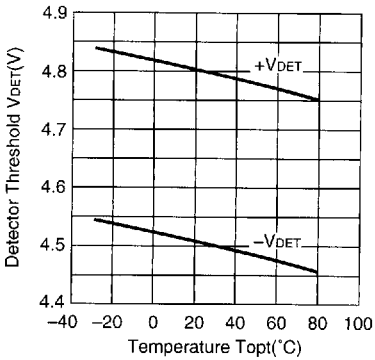
R×5VL27C



R×5VL36C

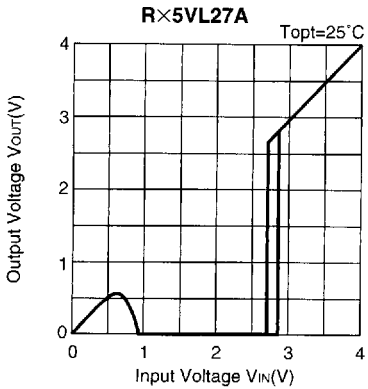


R×5VL45C

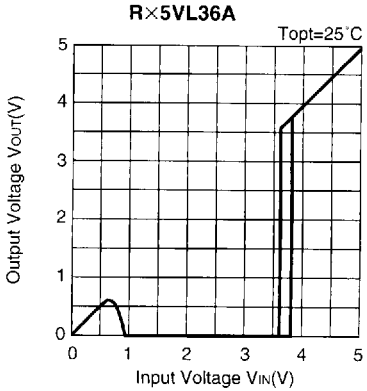


3) Output Voltage vs. Input Voltage

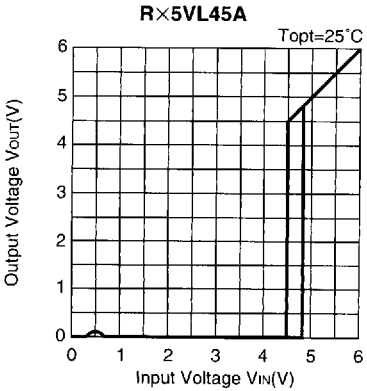
R×5VL27A



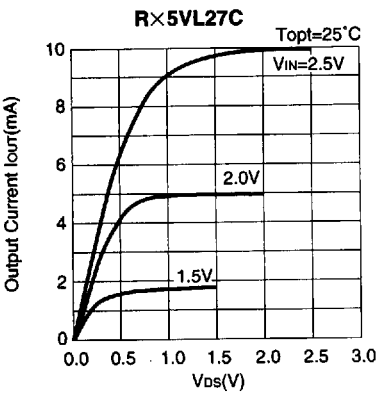
R×5VL36A

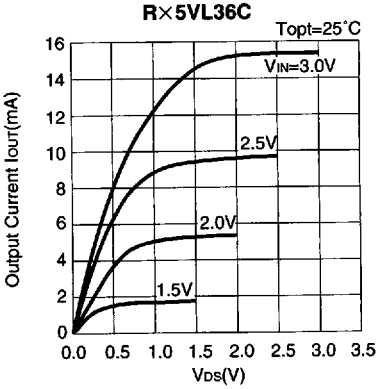


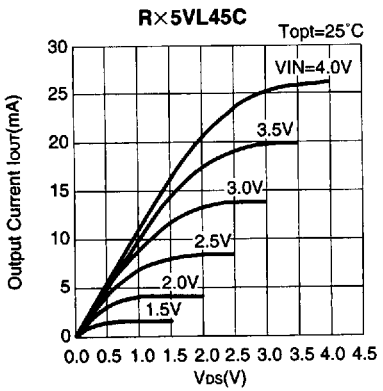
R×5VL45A



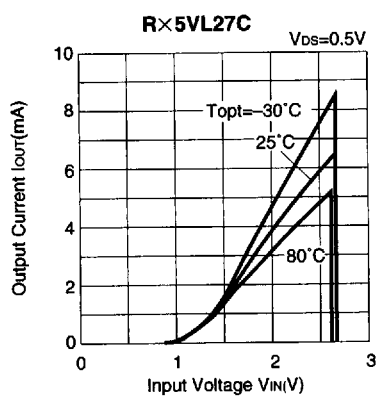
4) Nch Driver Output Current vs. V_{DS}

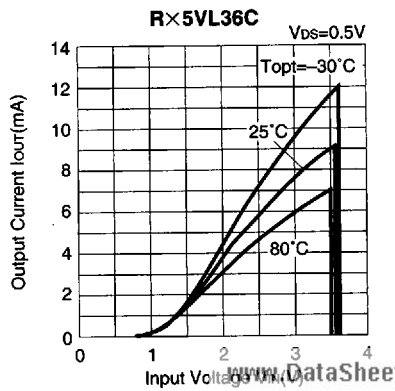


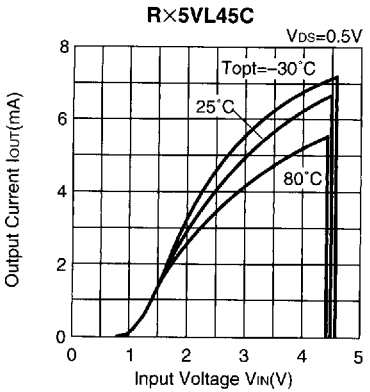




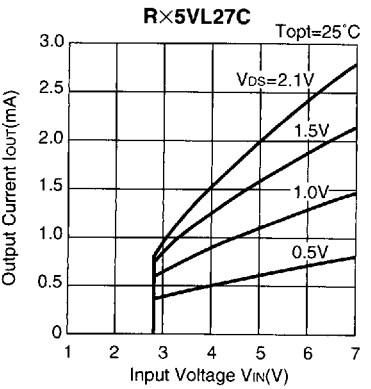
5) Nch Driver Output Current vs. Input Voltage

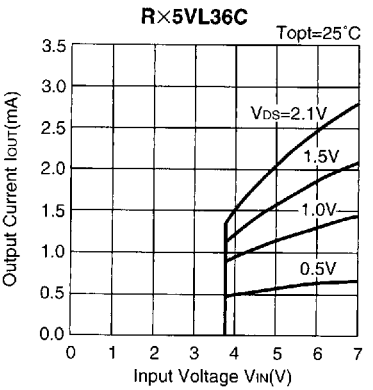


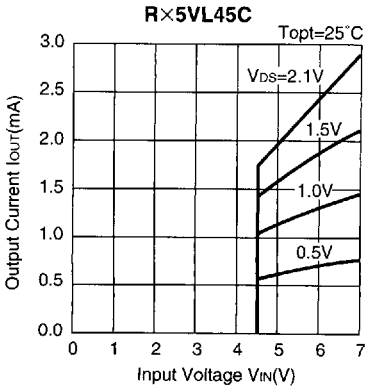




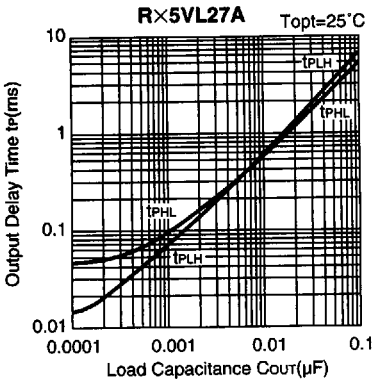
6) Pch Driver Output Current vs. Input Voltage

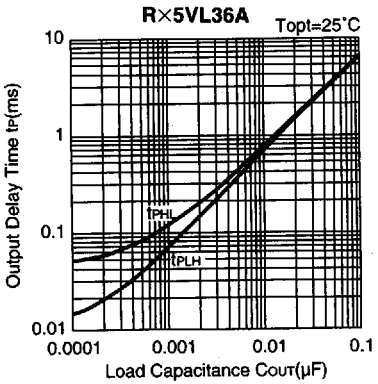


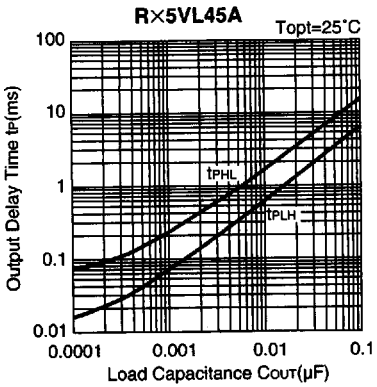




7) Output Delay Time vs. Load Capacitance



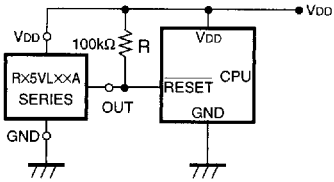




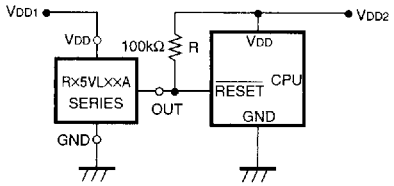
TYPICAL APPLICATION

• **R×5VL××A CPU Reset Circuit (Nch Open Drain Output)**

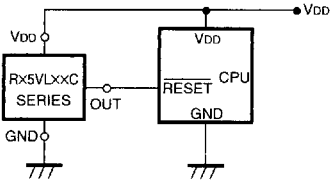
(1) Input Voltage to R×5VL××A is the same as the input voltage to CPU.



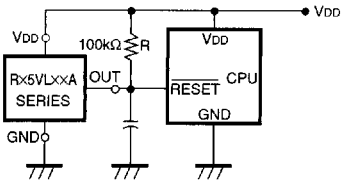
(2) Input Voltage to R×5VL××A is different from the input voltage to CPU.



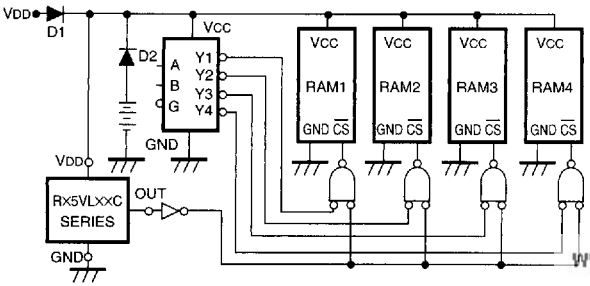
• **R×5VL××C CPU Reset Circuit (CMOS Output)**



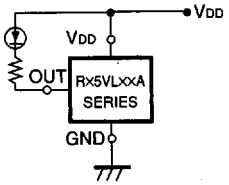
• **R×5VL××A Output delay Time Circuit**



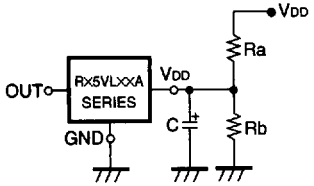
• **Memory Back-up Circuit**



• **Voltage Level Indicator Circuit (lighted when the power runs out)**
(Nch Open Drain Output)



• **Detector Threshold Changing Circuit**
(Nch Open Drain Output)

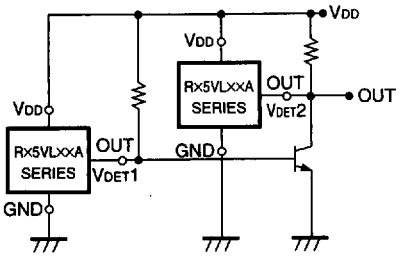


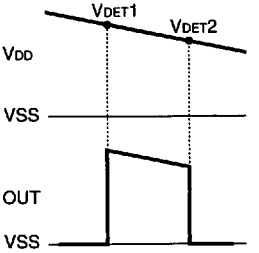
$$\text{Changed Detector Threshold} = \frac{Ra + Rb}{Rb} \cdot (-V_{DET})$$

$$\text{Hysteresis Voltage} = \frac{Ra + Rb}{Rb} \cdot V_{HYS}$$

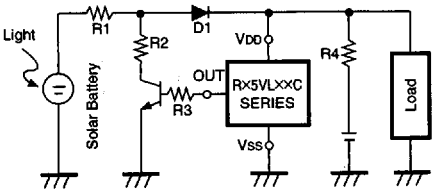
(Note) Please note that when the value of Ra becomes excessively large, the detector threshold detected may differ from the value calculated by use of the above formula.

• **Window Comparator Circuit**
(Nch Open Drain Output)





• **Excessive Charge Preventing Circuit**



APPLICATION HINTS

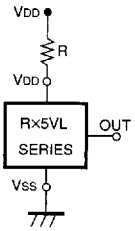


FIG.8

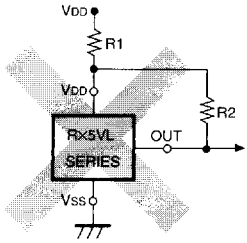


FIG.9

1. When R×5VL××C (CMOS Output) is used in FIG. 8, this IC may oscillate by the through-type current at the detection when impedance is connected between Power Source VDD and R×5VL VDD Pin. When R×5VL××A (Nch Open Drain Output) is used in FIG. 8, and R becomes excessively large, Detector Threshold may be varied because of the voltage drop of the supply current in the IC itself.
2. The connection as shown in FIG. 9 may cause the oscillation in both R×5VL××C (CMOS Output) and R×5VL××A (Nch Open Drain Output).