

## Low Voltage Detector

NO.EA-186-080328

### OUTLINE

The R3117 series are CMOS-based voltage detector ICs with high detector threshold accuracy and ultra-low supply current, which can be operated at an extremely low voltage and is used for system reset as an example.

Each of these ICs consists of a voltage reference unit, a comparator, resistors for detector threshold setting, an output driver and a hysteresis circuit. The detector threshold is fixed with high accuracy internally and does not require any adjustment. The tolerance of the detector threshold is  $\pm 15\text{mV}$  ( $-V_{\text{DET}} \leq 1.5\text{V}$ ) or  $\pm 1.0\%$  ( $1.5\text{V} < -V_{\text{DET}}$ ). Since the sense pin is separated from the VDD pin of the IC, therefore, even if the sense pin voltage becomes to 0V, the output voltage keeps its "L" level.

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

Three types of packages, SOT-23-5, SC-88(Under development), and DFN(PLP)1010-4 are available.

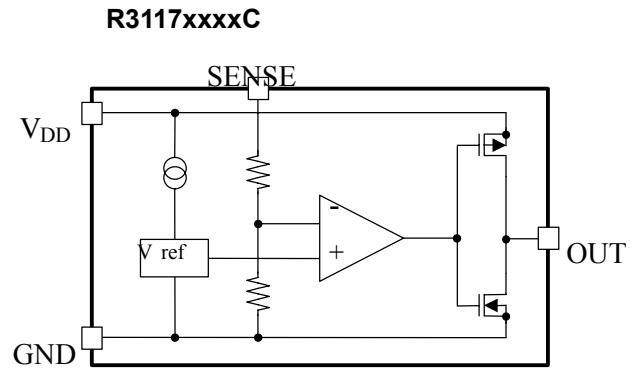
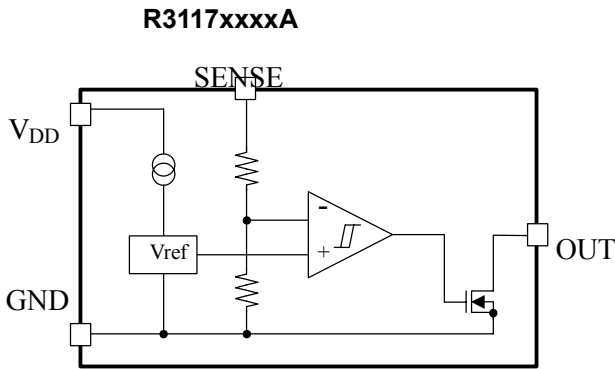
### FEATURES

- Ultra-low Supply Current ..... Typ.  $0.29\mu\text{A}$  (at  $V_{\text{DD}}=6.0\text{V}@T_{\text{a}}=25^{\circ}\text{C}$ )
- Operating Voltage ( $V_{\text{DD}}$  side) .....  $1.0\text{V}$  to  $6.0\text{V}@T_{\text{a}}=25^{\circ}\text{C}$
- Operating Temperature Range .....  $-40^{\circ}\text{C}$  to  $105^{\circ}\text{C}$
- Detector Threshold ..... Stepwise setting with a step of  $0.1\text{V}$  in the range of  $0.7\text{V}$  to  $5.0\text{V}$  is possible.
- High Accuracy Detector Threshold .....  $\pm 1.0\%$  (at  $T_{\text{opt}}=25^{\circ}\text{C}$ )
- Detector Threshold Temperature Coefficient ..... Typ.  $\pm 30\text{ppm}/^{\circ}\text{C}$
- Two Output Types ..... Nch Open Drain and CMOS
- Three Types of Packages ..... SOT-23-5, SC-88, DFN(PLP)1010-4

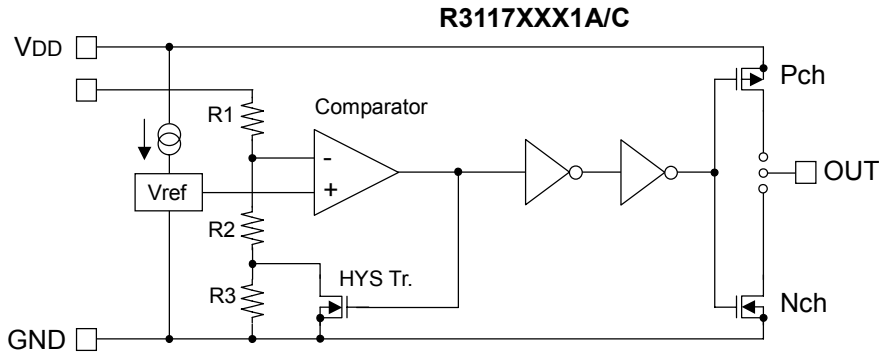
### APPLICATIONS

- CPU and Logic Circuit Reset
- Battery checker
- Level switcher
- Backup switcher
- Blackout detector

**BLOCK DIAGRAMS**

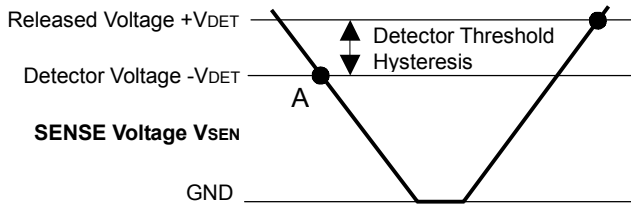


**TIMING CHART**

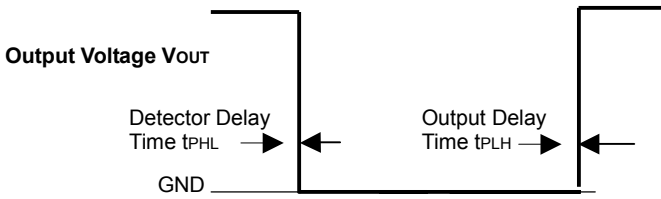


In the case of CMOS output voltage type, each drain of Nch transistor and Pch transistor is connected to the OUT pin.

In the case of Nch Open drain output type, the drain of Nch transistor is connected to the OUT pin. (OUT pin should be pulled up to VDD or an external power source).



Condition	1	2	3	
Comparator (-)Input				
Comparator Output	L	H	L	
HYS Tr.	OFF	ON	OFF	
Output Tr.	Nch	OFF	ON	OFF
	Pch	ON	OFF	ON



Timing Chart

$$\frac{R2+R3}{R1+R2+R3} \times VSEN$$

$$\frac{R2}{R1+R2} \times VSEN$$

**Description of the operating conditions:**

1. When the SENSE pin voltage is higher than the detector threshold voltage, the output voltage is equal to the VDD input voltage (in the case of Nch open-drain output type, the output voltage becomes equal to the pull-up voltage).
2. When the SENSE pin falls down to the detector threshold voltage (point A),  $V_{ref} \geq V_{sen} \times (R2+R3) / (R1+R2+R3)$  is true, then the output voltage will be reversed from "L" to "H", then the output voltage becomes "L".
3. When the SENSE pin becomes higher than released voltage (point B),  $V_{ref} \leq V_{sen} \times R2 / (R1+R2)$  is true, then the output voltage will be reversed from "H" to "L", then the output voltage becomes VDD input voltage (in the case of Nch open-drain output type, the output voltage becomes equal to the pull-up voltage).

The difference between the detector threshold voltage and released voltage is the hysteresis width.

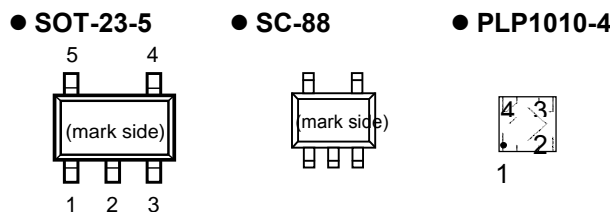
**SELECTION GUIDE**

The package type, the detector threshold, the output type and the taping type of R3117 Series can be designated at the users' request by specifying the part number as follows;

R3117XXXXX-XX-X ←Part Number  
 ↑↑↑↑ ↑ ↑  
 a b a'c d e

Code	Descriptions
a	Designation of Package Type; a=Q, a'=2: SC-88 a=N, a'=1: SOT-23-5      a=K, a'=1: DFN (PLP)1010-4
b	Setting Detector Threshold ( $-V_{DET}$ ); Stepwise setting with a step of 0.1V in the range of 0.7V to 5.0V is possible.
c	Designation of Output Type; A: Nch Open Drain(Output "L" at $V_{DD}=-V_{det}$ ) C: CMOS (Output "L" at $V_{DD}=-V_{det}$ )
d	Designation of Packing or Taping Type; Ex.SOT-23-5, SC-88, PLP1010-4: TR prescribed as standard directions. (Refer to Taping Specifications.) Antistatic bag for samples: C
e	F Pb-free solder plating

**PIN CONFIGURATION**



## PIN DESCRIPTION

● SOT-23-5

Pin No.	Symbol
1	OUT
2	V <sub>DD</sub>
3	GND
4	NC
5	SENSE

● SC-88

Pin No.	Symbol
1	V <sub>DD</sub>
2	NC
3	GND
4	SENSE
5	OUT

● DFN (PLP)1010-4

Pin No.	Symbol
1	OUT
2	SENSE
3	GND
4	V <sub>DD</sub>

In terms of NC pin of SC-88, connect it to the GND or use it as open.

## ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V <sub>DD</sub>	Supply Voltage	7.0	V
V <sub>SEN</sub>	SENSE Pin Voltage	7.0	V
V <sub>OUT</sub>	Output Voltage (CMOS): R3117xxxxC	V <sub>SS</sub> -0.3 to V <sub>DD</sub> +0.3	V
	Output Voltage (Nch): R3117xxxxA	V <sub>SS</sub> -0.3 to 7.0	
I <sub>OUT</sub>	Output Current	20	mA
P <sub>D</sub>	Power Dissipation 1(SOT23-5)*Note1	420	mW
P <sub>D</sub>	Power Dissipation 2(SC-88)*Note2	T.D.B.	mW
P <sub>D</sub>	Power Dissipation 3(PLP1010-4)*Note3	400	mW
T <sub>opt</sub>	Operating Temperature Range	-40 to +105	°C
T <sub>stg</sub>	Storage Temperature Range	-55 to +125	°C

\*Note 3: applied to PLP1010-4 at mounted on board

P<sub>D</sub> depends on conditions of mounting on board. This specification is based on the measurement at the condition below:

\*Measurement Conditions

Environment: Mounted on board (Wind velocity 0m/s)

Board Material: FR-4 (2-layer)

Board dimensions: 40mm x 40mm x t1.6mm

Copper Area: 50%

## ELECTRICAL CHARACTERISTICS

- **R3117xxxxA/C** Number written in Bold is applied to the temperature range from  $-40^{\circ}\text{C}$  to  $105^{\circ}\text{C}$   $T_{\text{opt}}=25^{\circ}\text{C}$

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
$-V_{\text{DET}}$	Detector Threshold	$V_{\text{DD}}=1.0\text{V}$ to $6.0\text{V}$	Refer to the electrical characteristics by the detector threshold			V
$V_{\text{HYS}}$	Detector Threshold Hysteresis	$V_{\text{DD}}=1.0\text{V}$ to $6.0\text{V}$	Refer to the electrical characteristics by the detector threshold			V
$I_{\text{SS}}$	Supply Current(*Note1)	$\text{SENSE} = (-V_{\text{DET}}) - 0.1\text{V}$		0.31	<b>1.47</b>	$\mu\text{A}$
		$\text{SENSE} = (-V_{\text{DET}}) \times 1.1$		0.29	<b>1.25</b>	
$R_{\text{sen}}$	Sense resistor		Refer to the Electrical Characteristics by the detector threshold			$\text{M}\Omega$
$V_{\text{DD}}$	Operating Voltage	$-40^{\circ}\text{C} \leq T_{\text{opt}} \leq 105^{\circ}\text{C}$	<b>1.0</b>		<b>6.0</b>	V
$I_{\text{OUT}}$	Output Current (Driver Output Pin)	Nch	$V_{\text{DS}}=0.05\text{V}$ , $V_{\text{DD}}=0.55\text{V}$	<b>7</b>		mA
			$V_{\text{DS}}=0.50\text{V}$ , $V_{\text{DD}}=0.60\text{V}$	<b>0.020</b>		
		Pch*Note2	$V_{\text{DS}}=-2.1\text{V}$ , $V_{\text{DD}}=4.5\text{V}$	<b>0.650</b>		mA
$I_{\text{LEAK}}$	Nch Driver Leakage Current (Driver Output Pin)*Note 3	$V_{\text{DS}}=7.0\text{V}$ , $V_{\text{DD}}=6.0\text{V}$			<b>140</b>	nA
$V_{\text{DDL}}$	Minimum Operating Voltage*Note 4		<b>0.028</b>		<b>0.049</b>	V
$t_{\text{PHL}}$	Detector Output Delay Time	$V_{\text{DD}}=5\text{V}$ , $\text{SENSE}=6\text{V}$ to $0\text{V}$		40		$\mu\text{s}$
$t_{\text{PLH}}$	Release Output Delay Time	$V_{\text{DD}}=5\text{V}$ , $\text{SENSE}=0\text{V}$ to $6\text{V}$		80		$\mu\text{s}$
$\Delta -V_{\text{DET}}/\Delta T$	Detector Threshold Temperature Coefficient	$-40^{\circ}\text{C} \leq T_{\text{opt}} \leq 105^{\circ}\text{C}$		<b><math>\pm 30</math></b>		ppm/ $^{\circ}\text{C}$

The values in bold type are guaranteed by design, not mass production tested.

All limits are tested at  $T_a=25^{\circ}\text{C}$ .

\*Note 1: Consumption current through SENSE pin is not included.

\*Note 2: Applied to the CMOS output type.

\*Note 3: Applied to the Nch open drain output type.

\*Note 4: When the  $V_{\text{DD}}$  pin and SENSE pin are connected and the value shows the minimum supply voltage ( $V_{\text{DD}}$ ) when the output voltage at detector threshold can be maintained as 0.1V or less. (In case of Nch open drain type, pull-up resistor is 470k $\Omega$  and pull-up voltage is set at 5V for testing.)

## R3117X(Preliminary)

Electrical Characteristics by the Detector Threshold

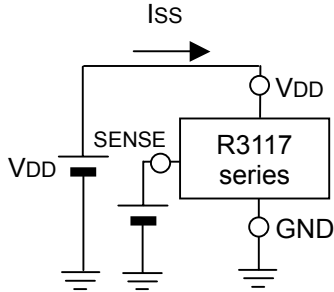
\*R3117x07xA/C ~ R3117x50xA/C

Values in Bold Type is applied in the temperature range from -40 Ta 105 [Ta=25 ]

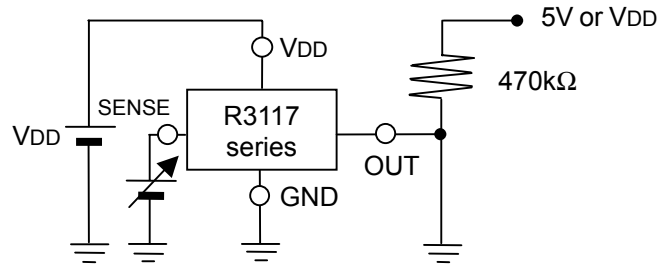
Product Code	Detector Threshold VDD 5.25V		Detector Threshold VDD 5.25V		Detector Threshold 5.25V < VDD		Detector Threshold 5.25V < VDD		Detector Threshold Hysteresis		Sense Resister	
	-VDET [V]		-VDET [V]		-VDET [V]		-VDET [V]		VHYS [V]		RSEN [M ]	
	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	TYP.
R3117x07xA/C	0.6850	0.7150	<b>0.6700</b>	<b>0.7300</b>	0.6758	0.7242	<b>0.5258</b>	<b>0.8742</b>	<b>0.028</b>	<b>0.049</b>	6	25
R3117x08xA/C	0.7850	0.8150	<b>0.7700</b>	<b>0.8300</b>	0.7758	0.8242	<b>0.6258</b>	<b>0.9742</b>	<b>0.032</b>	<b>0.056</b>		
R3117x09xA/C	0.8850	0.9150	<b>0.8700</b>	<b>0.9300</b>	0.8758	0.9242	<b>0.7258</b>	<b>1.0742</b>	<b>0.036</b>	<b>0.063</b>		
R3117x10xA/C	0.9850	1.0150	<b>0.9700</b>	<b>1.0300</b>	0.9758	1.0242	<b>0.8258</b>	<b>1.1742</b>	<b>0.040</b>	<b>0.070</b>		
R3117x11xA/C	1.0850	1.1150	<b>1.0700</b>	<b>1.1300</b>	1.0758	1.1242	<b>0.9258</b>	<b>1.2742</b>	<b>0.044</b>	<b>0.077</b>		
R3117x12xA/C	1.1850	1.2150	<b>1.1700</b>	<b>1.2300</b>	1.1758	1.2242	<b>1.0258</b>	<b>1.3742</b>	<b>0.048</b>	<b>0.084</b>		
R3117x13xA/C	1.2850	1.3150	<b>1.2700</b>	<b>1.3300</b>	1.2758	1.3242	<b>1.1258</b>	<b>1.4742</b>	<b>0.052</b>	<b>0.091</b>		
R3117x14xA/C	1.3850	1.4150	<b>1.3700</b>	<b>1.4300</b>	1.3758	1.4242	<b>1.2258</b>	<b>1.5742</b>	<b>0.056</b>	<b>0.098</b>		
R3117x15xA/C	1.4850	1.5150	<b>1.4700</b>	<b>1.5300</b>	1.4758	1.5242	<b>1.3258</b>	<b>1.6742</b>	<b>0.060</b>	<b>0.105</b>		
R3117x16xA/C	1.5840	1.6160	<b>1.5680</b>	<b>1.6320</b>	1.5742	1.6258	<b>1.5582</b>	<b>1.6418</b>	<b>0.064</b>	<b>0.112</b>		
R3117x17xA/C	1.6830	1.7170	<b>1.6660</b>	<b>1.7340</b>	1.6726	1.7274	<b>1.6556</b>	<b>1.7444</b>	<b>0.068</b>	<b>0.119</b>		
R3117x18xA/C	1.7820	1.8180	<b>1.7640</b>	<b>1.8360</b>	1.7710	1.8290	<b>1.7530</b>	<b>1.8470</b>	<b>0.072</b>	<b>0.126</b>		
R3117x19xA/C	1.8810	1.9190	<b>1.8620</b>	<b>1.9380</b>	1.8694	1.9306	<b>1.8504</b>	<b>1.9496</b>	<b>0.076</b>	<b>0.133</b>		
R3117x20xA/C	1.9800	2.0200	<b>1.9600</b>	<b>2.0400</b>	1.9678	2.0322	<b>1.9478</b>	<b>2.0522</b>	<b>0.080</b>	<b>0.140</b>		
R3117x21xA/C	2.0790	2.1210	<b>2.0580</b>	<b>2.1420</b>	2.0661	2.1339	<b>2.0451</b>	<b>2.1549</b>	<b>0.084</b>	<b>0.147</b>		
R3117x22xA/C	2.1780	2.2220	<b>2.1560</b>	<b>2.2440</b>	2.1645	2.2355	<b>2.1425</b>	<b>2.2575</b>	<b>0.088</b>	<b>0.154</b>		
R3117x23xA/C	2.2770	2.3230	<b>2.2540</b>	<b>2.3460</b>	2.2629	2.3371	<b>2.2399</b>	<b>2.3601</b>	<b>0.092</b>	<b>0.161</b>		
R3117x24xA/C	2.3760	2.4240	<b>2.3520</b>	<b>2.4480</b>	2.3613	2.4387	<b>2.3373</b>	<b>2.4627</b>	<b>0.096</b>	<b>0.168</b>		
R3117x25xA/C	2.4750	2.5250	<b>2.4500</b>	<b>2.5500</b>	2.4597	2.5403	<b>2.4347</b>	<b>2.5653</b>	<b>0.100</b>	<b>0.175</b>		
R3117x26xA/C	2.5740	2.6260	<b>2.5480</b>	<b>2.6520</b>	2.5581	2.6419	<b>2.5321</b>	<b>2.6679</b>	<b>0.104</b>	<b>0.182</b>		
R3117x27xA/C	2.6730	2.7270	<b>2.6460</b>	<b>2.7540</b>	2.6565	2.7435	<b>2.6295</b>	<b>2.7705</b>	<b>0.108</b>	<b>0.189</b>		
R3117x28xA/C	2.7720	2.8280	<b>2.7440</b>	<b>2.8560</b>	2.7549	2.8451	<b>2.7269</b>	<b>2.8731</b>	<b>0.112</b>	<b>0.196</b>		
R3117x29xA/C	2.8710	2.9290	<b>2.8420</b>	<b>2.9580</b>	2.8533	2.9467	<b>2.8243</b>	<b>2.9757</b>	<b>0.116</b>	<b>0.203</b>		
R3117x30xA/C	2.9700	3.0300	<b>2.9400</b>	<b>3.0600</b>	2.9517	3.0483	<b>2.9217</b>	<b>3.0783</b>	<b>0.120</b>	<b>0.210</b>		
R3117x31xA/C	3.0690	3.1310	<b>3.0380</b>	<b>3.1620</b>	3.0500	3.1500	<b>3.0190</b>	<b>3.1810</b>	<b>0.124</b>	<b>0.217</b>		
R3117x32xA/C	3.1680	3.2320	<b>3.1360</b>	<b>3.2640</b>	3.1484	3.2516	<b>3.1164</b>	<b>3.2836</b>	<b>0.128</b>	<b>0.224</b>		
R3117x33xA/C	3.2670	3.3330	<b>3.2340</b>	<b>3.3660</b>	3.2468	3.3532	<b>3.2138</b>	<b>3.3862</b>	<b>0.132</b>	<b>0.231</b>		
R3117x34xA/C	3.3660	3.4340	<b>3.3320</b>	<b>3.4680</b>	3.3452	3.4548	<b>3.3112</b>	<b>3.4888</b>	<b>0.136</b>	<b>0.238</b>		
R3117x35xA/C	3.4650	3.5350	<b>3.4300</b>	<b>3.5700</b>	3.4436	3.5564	<b>3.4086</b>	<b>3.5914</b>	<b>0.140</b>	<b>0.245</b>		
R3117x36xA/C	3.5640	3.6360	<b>3.5280</b>	<b>3.6720</b>	3.5420	3.6580	<b>3.5060</b>	<b>3.6940</b>	<b>0.144</b>	<b>0.252</b>		
R3117x37xA/C	3.6630	3.7370	<b>3.6260</b>	<b>3.7740</b>	3.6404	3.7596	<b>3.6034</b>	<b>3.7966</b>	<b>0.148</b>	<b>0.259</b>		
R3117x38xA/C	3.7620	3.8380	<b>3.7240</b>	<b>3.8760</b>	3.7388	3.8612	<b>3.7008</b>	<b>3.8992</b>	<b>0.152</b>	<b>0.266</b>		
R3117x39xA/C	3.8610	3.9390	<b>3.8220</b>	<b>3.9780</b>	3.8372	3.9628	<b>3.7982</b>	<b>4.0018</b>	<b>0.156</b>	<b>0.273</b>		
R3117x40xA/C	3.9600	4.0400	<b>3.9200</b>	<b>4.0800</b>	3.9356	4.0644	<b>3.8956</b>	<b>4.1044</b>	<b>0.160</b>	<b>0.280</b>		
R3117x41xA/C	4.0590	4.1410	<b>4.0180</b>	<b>4.1820</b>	4.0339	4.1661	<b>3.9929</b>	<b>4.2071</b>	<b>0.164</b>	<b>0.287</b>		
R3117x42xA/C	4.1580	4.2420	<b>4.1160</b>	<b>4.2840</b>	4.1323	4.2677	<b>4.0903</b>	<b>4.3097</b>	<b>0.168</b>	<b>0.294</b>		
R3117x43xA/C	4.2570	4.3430	<b>4.2140</b>	<b>4.3860</b>	4.2307	4.3693	<b>4.1877</b>	<b>4.4123</b>	<b>0.172</b>	<b>0.301</b>		
R3117x44xA/C	4.3560	4.4440	<b>4.3120</b>	<b>4.4880</b>	4.3291	4.4709	<b>4.2851</b>	<b>4.5149</b>	<b>0.176</b>	<b>0.308</b>		
R3117x45xA/C	4.4550	4.5450	<b>4.4100</b>	<b>4.5900</b>	4.4275	4.5725	<b>4.3825</b>	<b>4.6175</b>	<b>0.180</b>	<b>0.315</b>		
R3117x46xA/C	4.5540	4.6460	<b>4.5080</b>	<b>4.6920</b>	4.5259	4.6741	<b>4.4799</b>	<b>4.7201</b>	<b>0.184</b>	<b>0.322</b>		
R3117x47xA/C	4.6530	4.7470	<b>4.6060</b>	<b>4.7940</b>	4.6243	4.7757	<b>4.5773</b>	<b>4.8227</b>	<b>0.188</b>	<b>0.329</b>		
R3117x48xA/C	4.7520	4.8480	<b>4.7040</b>	<b>4.8960</b>	4.7227	4.8773	<b>4.6747</b>	<b>4.9253</b>	<b>0.192</b>	<b>0.336</b>		
R3117x49xA/C	4.8510	4.9490	<b>4.8020</b>	<b>4.9980</b>	4.8211	4.9789	<b>4.7721</b>	<b>5.0279</b>	<b>0.196</b>	<b>0.343</b>		
R3117x50xA/C	4.9500	5.0500	<b>4.9000</b>	<b>5.1000</b>	4.9195	5.0805	<b>4.8695</b>	<b>5.1305</b>	<b>0.200</b>	<b>0.350</b>		
											10	

**TEST CIRCUITS**

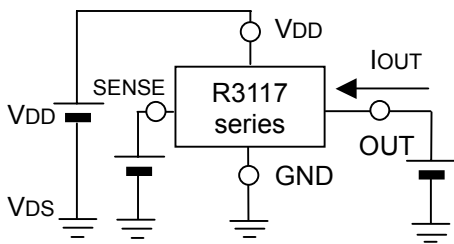
Supply Current Test Circuit



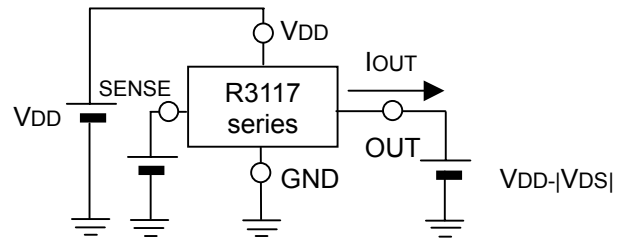
Output Voltage Test Circuit  
(CMOS type : without Pull-Up)



Nch Driver Output Current Test Circuit

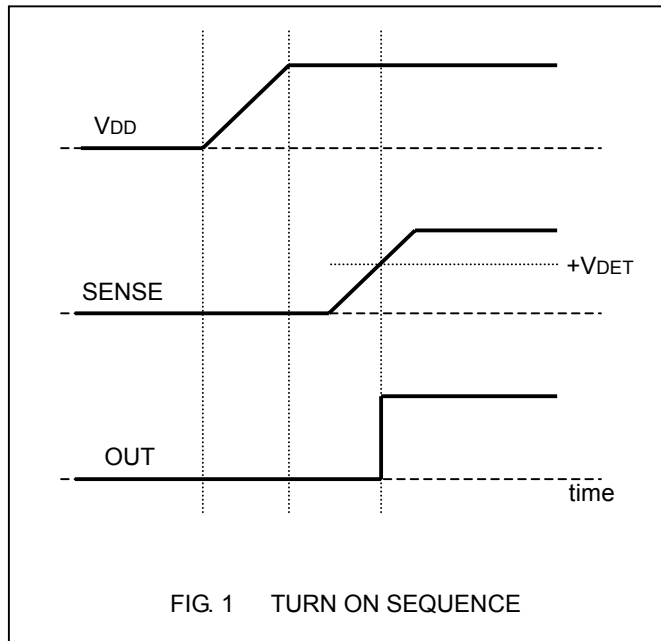


Pch Driver Output Current Test Circuit (Only applied to CMOS Output type)



TECHNICAL NOTES

The R3117xxxxA/C Series supervise the voltage of the SENSE pin. VDD pin and SENSE pin can be used at the same voltage level. Likewise, VDD pin and SENSE pin can be used at the different voltage level. If the VDD pin and SENSE pin are used at different voltage level, regarding the start-up sequence, force the voltage level to VDD pin prior to the SENSE pin. If the SENSE pin voltage is equal or more than the released voltage (+VDET), OUT pin becomes "H". Besides, a voltage beyond VDD pin is also acceptable to SENSE pin. Concerning the R3117xxxxA series (Nch open drain output type), OUT pin must be pulled-up with an external resistor.



To monitor the voltage more than 5.0V, divider resistors can be applied to the SENSE pin. In this usage, some error range will be generated to the detector threshold voltage caused by the internal resistor R<sub>IC</sub> (Fig. 3) of the IC. Supposed that the detector threshold voltage is described as V<sub>s</sub>, the next equation will be true.

$$V_s = (-V_{DET}) \times (1 + R_a/R_b) + (-V_{DET}) \times (R_a/R_{IC})$$

The error range is  $(-V_{DET}) \times R_a/R_{IC}$  (Fig. 3) and to make it small, choosing the low detector threshold voltage type and set the resistance values R<sub>a</sub>, R<sub>b</sub> as R<sub>IC</sub> >> R<sub>a</sub>. Refer to the electrical characteristics table to see the R<sub>IC</sub> value.

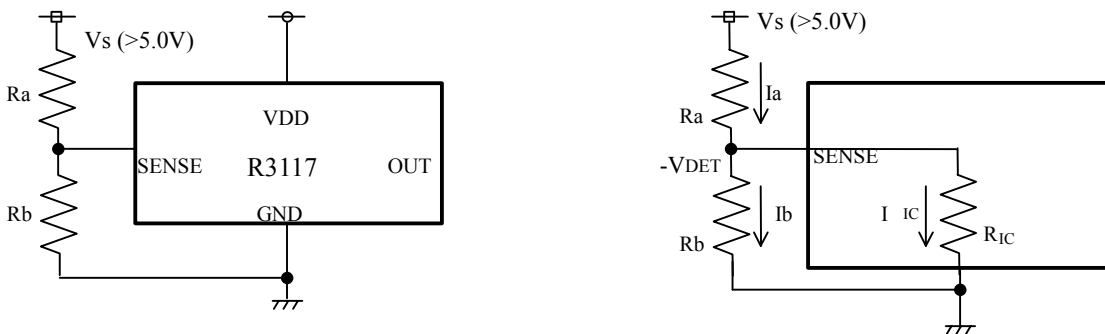


FIG. 2