RICOH

Microprocessor power management with Watchdog Timer

OUTLINE

The R5104V Series are high voltage tolerance CMOS-based microprocessor power management ICs with high accuracy output voltage and detector threshold and with ultra low supply current. Each of these ICs consists of a voltage regulator, a voltage detector and a watchdog timer. Thus, the R5104V Series have the function of a power management for microprocessor, a monitor of the voltage of a power source and a microprocessor supervisor.

The built-in voltage regulator with an external driver transistor can supply Min.1A current to a system. Therefore these ICs are very suitable for various power supply systems for microprocessors. The output voltage is monitored by the voltage detector which is built-in these ICs.

The built-in voltage detector has an output delay function and the delay time can be set by an external capacitor (C_D).

The output voltage and the detector threshold voltage can be set individually for each IC by laser trimming.

Furthermore, when a microprocessor works incorrectly, the watchdog timer which checks over microprocessor generates reset signals intermittently to prevent a whole system from being malfunction.

The timeout periods for watchdog and reset can also be set individually by an external capacitor (C_{TW}).

There are two kinds of power down function: "A" version turns off the supervisor of clock input for the watchdog timer, while the "B" version turns off all the circuits and realizes the standby mode.

FEATURES

- Supply current .... Typ. 60μA (I_{OUT}=0mA)
- Standby Current (B version).......................... Typ. 0.1μA
- Output Voltage .... 3.3V to 5.0V
- Detector Threshold Voltage .... 2.8V to 4.0V
- Maximum Operating Input Voltage................. Max. 36V
- High Accuracy Output Voltage of Voltage Regulator and Detector Threshold ..... ±2.0%
- Built-in a watchdog timer
- Timeout period for watchdog and generating a reset signal can be set by an external capacitor
- Watchdog timer can be stopped individually by CE Pin
- Power-on Reset Delay Time can be set by an external capacitor
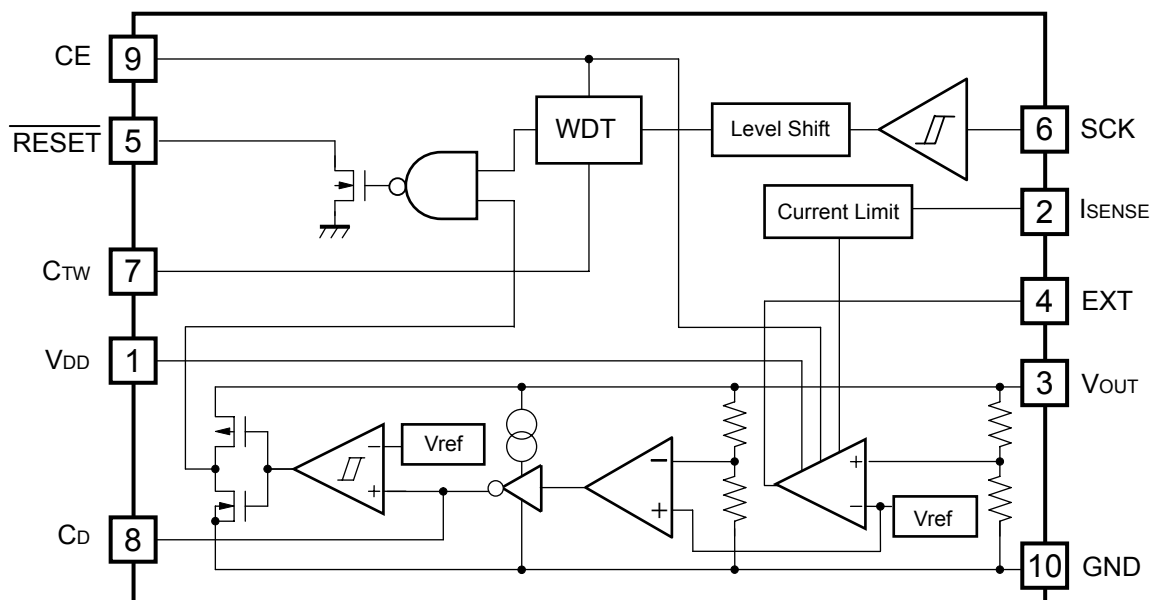- Package SSOP-10

APPLICATION

- Power source for microprocessors

BLOCK DIAGRAMS

R5104VxxxA
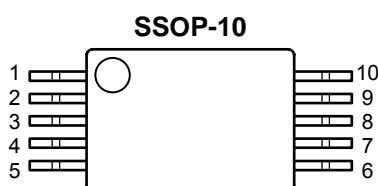

R5104VxxxB

RICOH
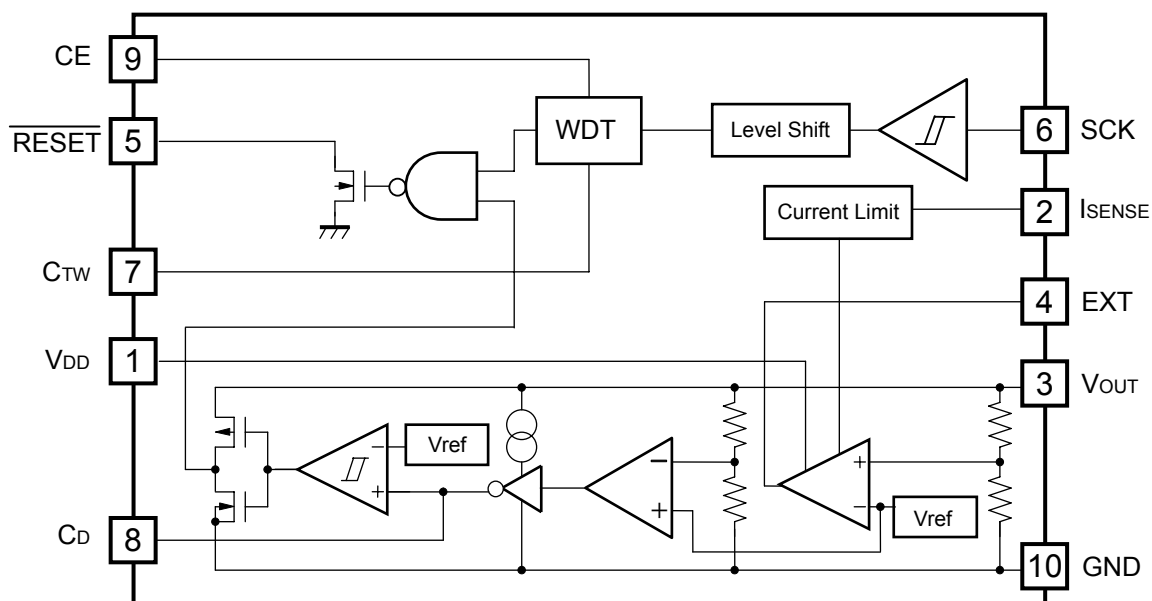
SELECTION GUIDE

The output voltage, the detector threshold, and the operation of the CE pin for the ICs can be selected at the users' request.

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R5104Vxxx∗-E2-KG	SSOP-10	2,000 pcs	Yes	Yes
xxx : The combination of output voltage and detector threshold for each channel can be designated by serial numbers. (For details, please refer to MARK INFORMATIONS.) ∗ : The operation of the CE pin are options as follows. (A) Watchdog timer off (B) Standby mode				

"-KG" of the product name shows that the product is for automotive (body system) use with the operating temperature of -40°C to 125°C.
Please contact our sales representative or distributor for details.

PIN CONFIGURATION

SSOP-10

PIN DESCRIPTIONS

Pin No	Symbol	Pin Description
1	V_{DD}	Power supply Pin Clock
2	I_{SENSE}	Sense Pin for Current Limit of VR. Monitoring the dropout voltage generated at an external resistor between pin 1 and pin 2, if the dropout exceeds 0.3V (Typ.), the current limit works.
3	V_{OUT}	Output Pin for Voltage Regulator
4	EXT	External Transistor Drive Pin
5	$\overline{RESET}$	Output Pin for Reset signal of Watchdog timer and Voltage Detector. (Output Type is Nch Open Drain, Output "L" at detecting Detector Threshold and Watchdog Timer Reset.)
6	SCK	Clock Input Pin from Microprocessor
7	C_{TW}	External Capacitor Pin for Setting Reset and Watchdog Timeout Periods
8	C_D	External Capacitor Pin for Setting Delay Time of Voltage Detector
9	CE	Control Switch Pin for halting Watchdog timer (A version), or Chip Enable Pin (B version)
10	GND	Ground Pin

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ABSOLUTE MAXIMUM RATINGS

Symbol	Item		Rating	Unit
V_{DD}	Supply Voltage		-0.3 to 50	V
V_{PEAK}	Peak Input Voltage[*1]		60	V
V_{CD}	Output Voltage[*2]	Voltage of C_D Pin	$V_{SS} -0.3$ to 7.5	V
V_{CTW}		Voltage of C_{TW} Pin	$V_{SS} -0.3$ to 7.5	V
V_{OUT}		Voltage of V_{OUT} Pin	$V_{SS} -0.3$ to 7.5	V
V_{RESET}		Voltage of $\overline{RESET}$ Pin	$V_{SS} -0.3$ to 7.5	V
V_{CE}	Input Voltage	Voltage of CE Pin	$V_{SS} -0.3$ to $V_{IN}+0.3$	V
V_{ISENSE}		Voltage of I_{SENSE} Pin	$V_{SS} -0.3$ to $V_{IN}+0.3$	V
V_{SCK}		Voltage of SCK Pin	$V_{SS} -0.3$ to $V_{IN}+0.3$	V
I_{EXT}	Output Current	Current of EXT Pin	10	mA
I_{RESET}		Current of $\overline{RESET}$ Pin	20	mA
P_D	Power Dissipation (SSOP-10)[*3]		300	mW
T_{opt}	Operating Temperature Range		-40 to +125	°C
T_{stg}	Storage Temperature Range		-55 to +140	°C

∗1) duration time=200ms
∗2) Do not force any voltage more than supply voltage to C_D, C_{TW}, V_{OUT}, and $\overline{RESET}$ pins.
∗3) For Power Dissipation, please refer to PACKAGE INFORMATION.

ABSOLUTE MAXIMUM RATINGS
Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the life time and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings is not assured.

RECOMMENDED OPERATING CONDITIONS   (ELECTRICAL CHARACTERISTICS)
All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

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ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, V_{IN}=CE=V_{ISENSE}=12V, I_{OUT}=100mA, C_{CTW}=0.1μF, C_D=0.01μF)

● **R5104VxxxA (Overall)** Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{IN}	Operating Voltage				36	V
I_{SS}	Supply Current	I_{OUT}=0mA		60	100	μA
I_{off}	Supply Current (WDT inactive)	V_{IN}=12V, CE=0V		50	90	μA
V_{CEH}	CE Input Voltage"H"		2.0		V_{IN}+0.3	V
V_{CEL}	CE Input Voltage"L"		0		0.25	V

VR part

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage		×0.98		×1.02	V
I_{OUT}	Output Current(*1)	V_{IN}=12V	1.0			A
V_{DIF}	Dropout Voltage(*1)	I_{OUT}=300mA		50		mV
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation(*1)	V_{IN}=12V,1mA≤I_{OUT}≤1A		15	60	mV
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation(*1)	I_{OUT}=100mA V_{OUT}+1V≤V_{IN}≤36V		0.05	0.10	%/V
$\Delta V_{OUT}/\Delta T_{opt}$	Output Voltage Temperature Coefficient (*1)	-40°C≤T_{opt}≤125°C		±50		ppm/°C
I_{SINK1}	EXT Output Sink Current Limit	V_{IN}=12V, V_{OUT}=V_{OUT}-0.2V	9	14	20	mA
I_{SINK2}	EXT Output Sink Current Limit (Output short)	V_{IN}=12V, V_{OUT}=0V	0.20	0.50	0.85	mA
V_{ISENSE}	Current Limit Detector Threshold		0.23	0.30	0.37	V
RR	Ripple Rejection	V_{IN}=V_{OUT}+1V, f=1kHz, 500mVp-p		55		dB

*1) Depending on the capability of an external PNP transistor. Use an hFE with approximately 100 to 300. The output current does not always mean continuous current because of the limit of power dissipation of PNP transistor.

VD part

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
-V_{DET}	Detector Threshold		×0.98		×1.02	V
V_{HYS}	Hysteresis Range		(-V_{DET}) ×0.01	(-V_{DET}) ×0.02	(-V_{DET}) ×0.03	V
Δ-$V_{DET}/\Delta T_{opt}$	Detector Threshold Temperature Coefficient	-40°C≤T_{opt}≤125°C		±50		ppm/°C
V_{TCD}	C_D pin detector threshold		2.35	2.50	2.65	V
I_{CD}	Internal Current value for Delay Time Setting		0.12	0.30	0.47	μA
V_{INL}	Minimum Operating Voltage	V_{OUT} pin voltage			2.0	V

WDT part

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
t_{WD}	Watchdog Timeout period	C_{TW}=0.1μF	200	300	510	ms
t_{WR}	Reset Hold Time of WDT	C_{TW}=0.1μF	35	70	120	ms
V_{IHSCK}	SCK Input Voltage"H"		0.8×V_{OUT}		V_{DD}+0.3	V
V_{ILSCK}	SCK Input Voltage"L"		0		0.1	V
T_{SCKW}	SCK Input Pulse Width	-V_{DET}≥3.0V	500			ns
		-V_{DET}≤2.9V	5000			

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(Unless otherwise specified, V_{IN}=CE=V_{ISENSE} =12V, I_{OUT}=100mA, C_{CTW}=0.1μF, C_D=0.01μF)

● **R5104VxxxB (Overall)**   Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{IN}	Operating Voltage				36	V
I_{SS}	Supply Current	I_{OUT}=0mA		60	100	μA
I_{off}	Supply Current (Standby)	V_{IN}=12V, CE=0V		0.1	0.5	μA
V_{CEH}	CE Input Voltage"H"		2.0		V_{IN}+0.3	V
V_{CEL}	CE Input Voltage"L"		0		0.25	V

VR part

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage		×0.98		×1.02	V
I_{OUT}	Output Current(*Note 1)	V_{IN}=12V	1.0			A
V_{DIF}	Dropout Voltage(*Note 1)	I_{OUT}=300mA		50		mV
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation(*Note 1)	V_{IN}=12V ,1mA≤I_{OUT}≤1A		15	60	mV
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation(*Note 1)	I_{OUT}=100mA V_{OUT}+1V≤V_{IN}≤36V		0.05	0.10	%/V
$\Delta V_{OUT}/\Delta T_{opt}$	Output Voltage Temperature Coefficient (*Note 1)	-40°C≤T_{opt}≤125°C		±50		ppm/°C
I_{SINK1}	EXT Output Sink Current Limit	V_{IN}=12V, V_{OUT}=V_{OUT}-0.2V	9	14	20	mA
I_{SINK2}	EXT Output Sink Current Limit (Output short)	V_{IN}=12V, V_{OUT}=0V	0.20	0.50	0.85	mA
V_{ISENSE}	Current Limit Detector Threshold		0.23	0.30	0.37	V
RR	Ripple Rejection	V_{IN}=V_{OUT}+1V, f=1kHz, 500mVp-p		55		dB

*1) Depending on the capability of an external PNP transistor. Use an hFE with approximately 100 to 300. The output current does not always mean continuous current because of the limit of power dissipation of PNP transistor.

VD part

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
-V_{DET}	Detector Threshold		×0.98		×1.02	V
V_{HYS}	Hysteresis Range		(-V_{DET}) ×0.01	(-V_{DET}) ×0.02	(-V_{DET}) ×0.03	V
Δ-$V_{DET}/\Delta T_{opt}$	Detector Threshold Temperature Coefficient	-40°C≤T_{opt}≤125°C		±50		ppm/°C
V_{TCD}	C_D pin detector threshold		2.35	2.50	2.65	V
I_{CD}	Internal Current value for Delay Time Setting		0.12	0.30	0.47	μA
V_{INL}	Minimum Operating Voltage	V_{OUT} pin Voltage			2.0	V

WDT part

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
t_{WD}	Watchdog Timeout period	C_{TW}=0.1μF	200	300	510	ms
t_{WR}	Reset Hold Time of WDT	C_{TW}=0.1μF	35	70	130	ms
V_{IHSCK}	SCK Input Voltage"H"		0.8×V_{OUT}		V_{DD}+0.3	V
V_{ILSCK}	SCK Input Voltage"L"		0		0.1	V
T_{SCKW}	SCK Input Pulse Width	-V_{DET}≥3.0V	500			ns
		-V_{DET}≤2.9V	5000			

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(Unless otherwise specified, V_{IN}=CE=V_{ISENSE} =12V, I_{OUT}=100mA, C_{CTW}=0.1μF, C_D=0.01μF)

● **R5104V007A (Overall)**   **Topt=25°C**

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{IN}	Operating Voltage				36	V
I_{SS}	Supply Current	I_{OUT}=0mA		45	80	μA
Ioff	Supply Current (WDT inactive)	V_{IN}=12V, CE=0V		45	80	μA
V_{CEH}	CE Input Voltage"H"		2.0		V_{IN}+0.3	V
V_{CEL}	CE Input Voltage"L"		0.00		0.25	V

VR part

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage		×0.98		×1.02	V
I_{OUT}	Output Current(*1)	V_{IN}=12V	1.0			A
V_{DIF}	Dropout Voltage(*1)	I_{OUT}=300mA		50		mV
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation(*1)	V_{IN}=12V ,1mA≤I_{OUT}≤1A		15	60	mV
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation(*1)	I_{OUT}=100mA V_{OUT}+1V≤V_{IN}≤36V		0.05	0.10	%/V
$\Delta V_{OUT}/\Delta T_{opt}$	Output Voltage Temperature Coefficient (*1)	-40°C≤T_{opt}≤125°C		±50		ppm/°C
I_{SINK1}	EXT Output Sink Current Limit	V_{IN}=12V, V_{OUT}=V_{OUT}-0.2V	9	14	20	mA
I_{SINK2}	EXT Output Sink Current Limit (Output short)	V_{IN}=12V, V_{OUT}=0V	0.20	0.50	0.85	mA
V_{ISENSE}	Current Limit Detector Threshold		0.23	0.30	0.37	V
RR	Ripple Rejection	V_{IN}=V_{OUT}+1V, f=1kHz, 500mVp-p		55		dB

*1) Depending on the capability of an external PNP transistor. Use an hFE with approximately 100 to 300. The output current does not always mean continuous current because of the limit of power dissipation of PNP transistor.

VD part

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
-V_{DET}	Detector Threshold		×0.98		×1.02	V
V_{HYS}	Hysteresis Range		(-V_{DET}) ×0.01	(-V_{DET}) ×0.02	(-V_{DET}) ×0.03	V
Δ-$V_{DET}/\Delta T_{opt}$	Detector Threshold Temperature Coefficient	-40°C≤T_{opt}≤125°C		±50		ppm/°C
V_{TCD}	C_D pin detector threshold		2.35	2.50	2.65	V
I_{CD}	Internal Current value for Delay Time Setting		0.12	0.30	0.47	μA
V_{INL}	Minimum Operating Voltage	V_{OUT} pin Voltage			2.0	V

WDT part

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
t_{WD}	Watchdog Timeout period	C_{TW}=0.1μF	200	300	510	ms
t_{WR}	Reset Hold Time of WDT	C_{TW}=0.1μF	35	70	130	ms
V_{IHSCK}	SCK Input Voltage"H"		0.8×V_{OUT}		V_{DD}+0.3	V
V_{ILSCK}	SCK Input Voltage"L"		0.0		0.1	V
T_{SCKW}	SCK Input Pulse Width	-V_{DET}≥3.0V	500			ns
		-V_{DET}≤2.9V	5000			

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TIMING CHART

R5104VxxxA

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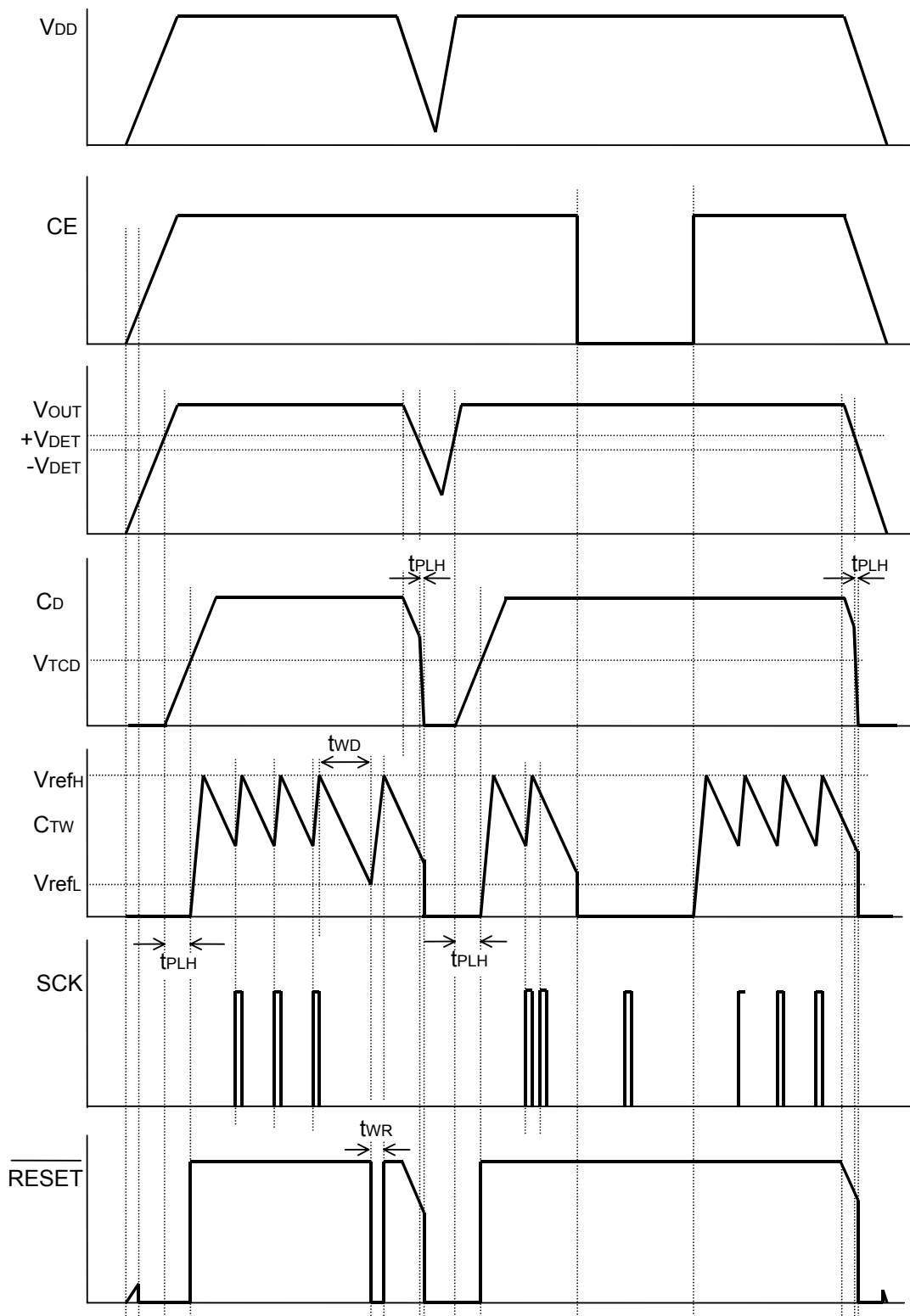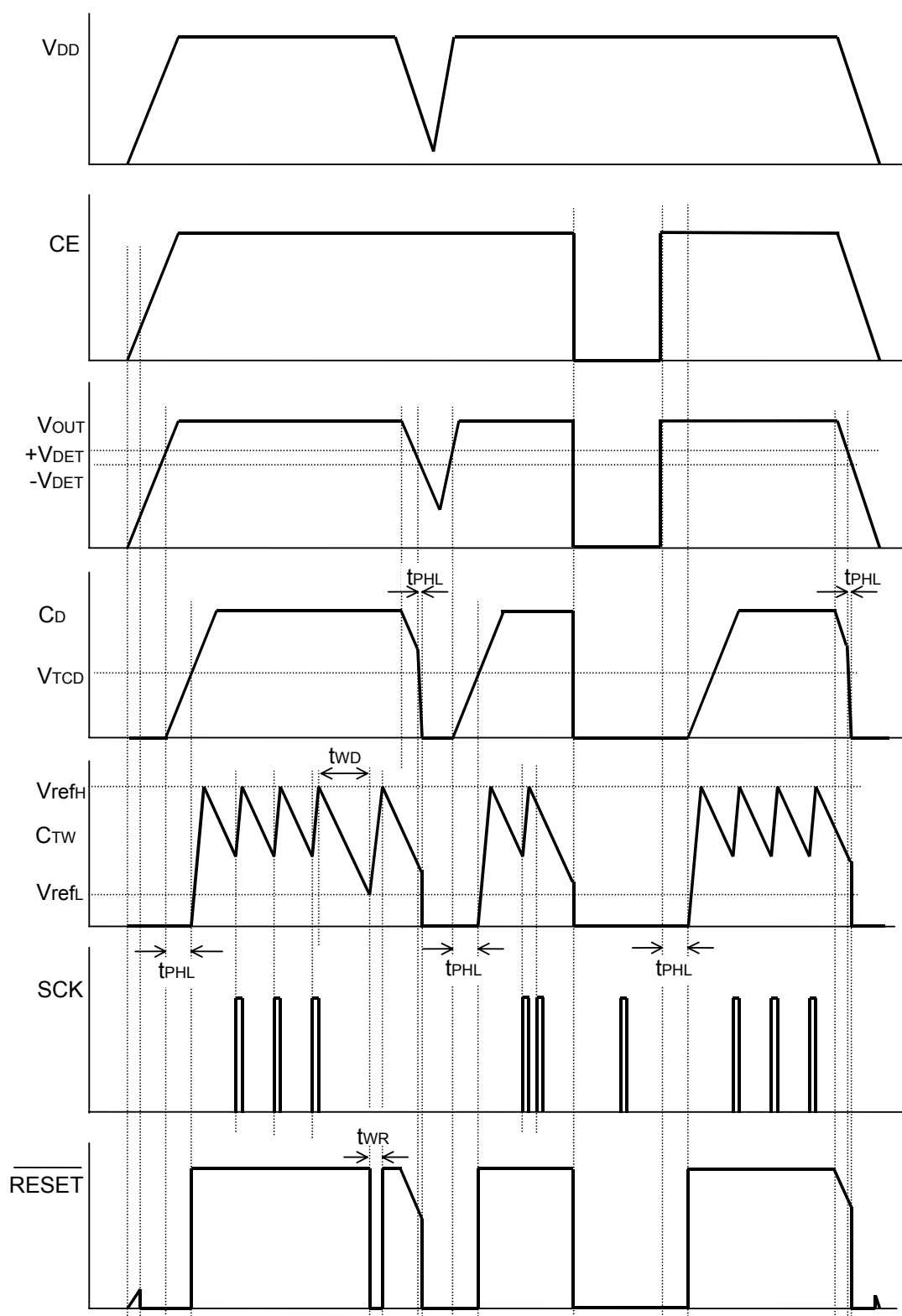
R5104VxxxB

OPERATION

R5104VxxxA (Watchdog Timer On/Off type)

    The R5104VxxxA have the function that turns off the clock input of the watchdog timer. When the watchdog timer is enabled (CE="H"), the output of the internal regulator and SCK input pulse are supervised, while the watchdog timer is disabled (CE="L"), only the regulator is supervised.

R5104VxxxB (Standby Function)

    Since the standby function is included in the R5104VxxxB, the consumption current of the system can be reduced. The supply current at the standby mode is very small, typically 0.1μA.

Output Delay Time Setting of the built-in voltage detector

    The released delay time from reset of the voltage detector (t_{PLH}) can be calculated with the external capacitor value C_D and the next formula.

      $t_{PLH} = V_{TCD} \times C_D/I_{CD}$ (S)

    On the other hand, output delay time for detecting voltage (t_{PHL}) is not specified, the time depends on the capacitance value of C_D.

TYPICAL APPLICATION

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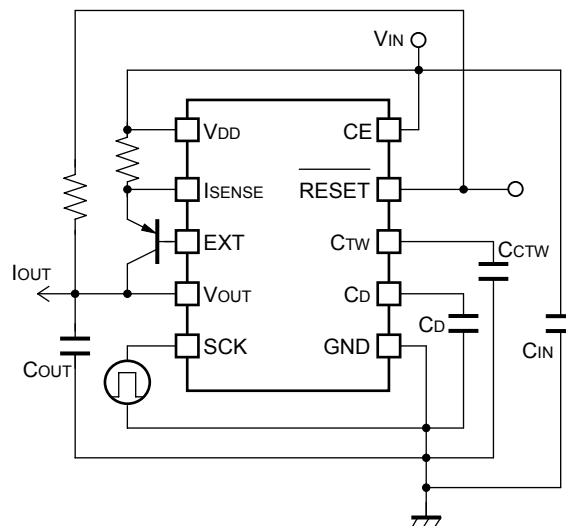
TEST CIRCUITS

Standard Test Circuit
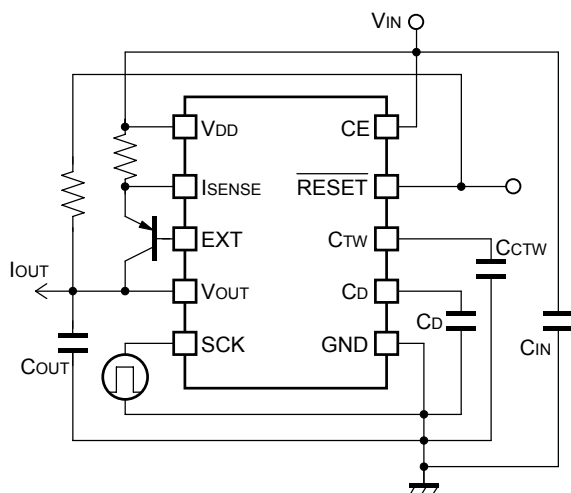
Supply Current Test Circuit
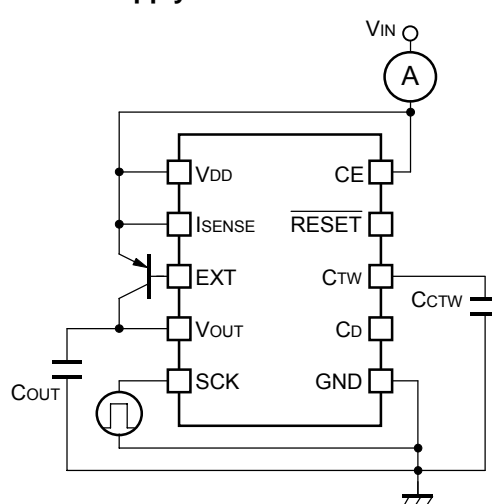
Standby Current Test Circuit
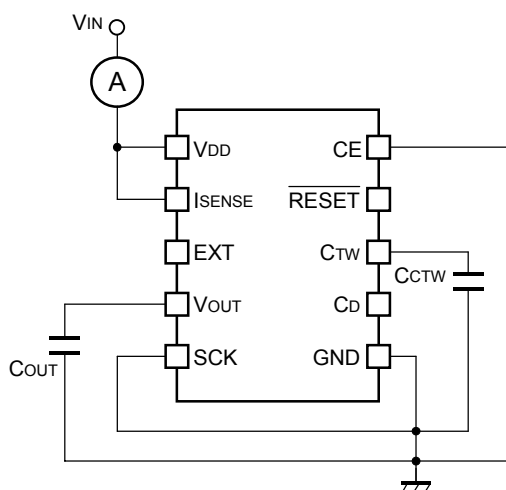
EXT Sink Current Test Circuit
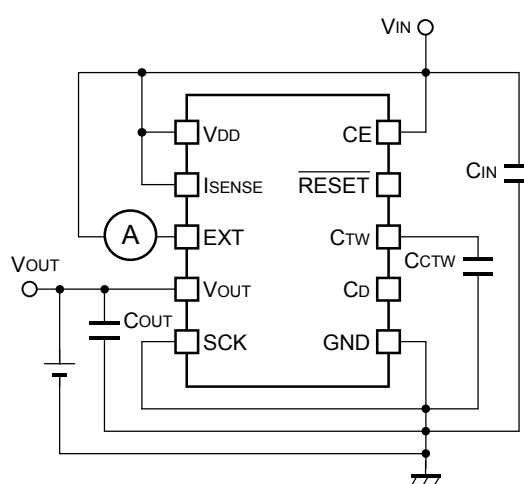
Ripple Rejection Test Circuit

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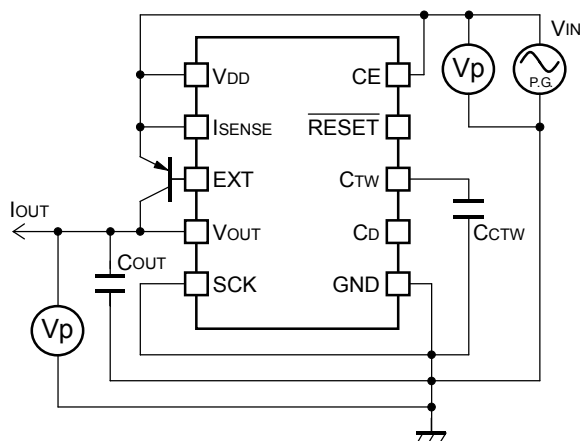
TYPICAL CHARACTERISTICS

(Unless otherwise provided, $V_{IN}=V_{ISENSE}=CE=12V$, $C_{IN}=0.1\mu F$, $C_{OUT}=10\mu F$, $C_{TW}=0.1\mu F$, $C_D=10\mu F$, Topt=25°C)

1) Output Voltage vs. Output Current

5.0V

I_{SENSE} Resistance=0Ω

3.3V

I_{SENSE} Resistance=0Ω

5.0V

I_{SENSE} Resistance=1Ω

3.3V

I_{SENSE} Resistance=1Ω
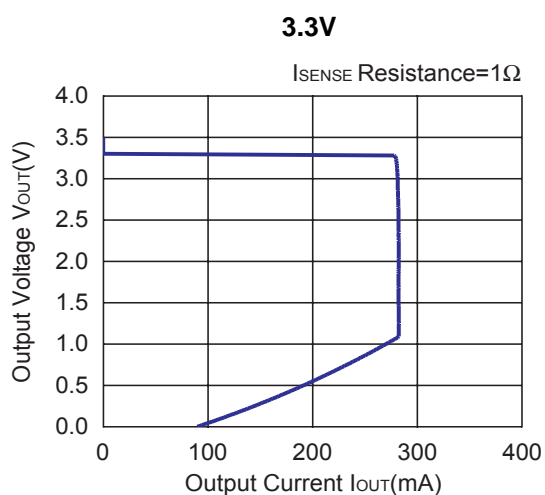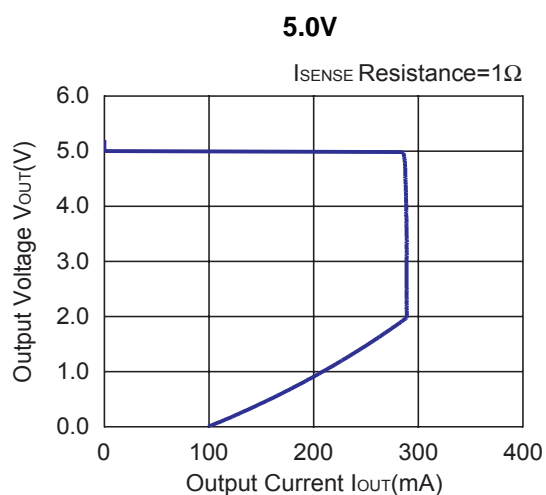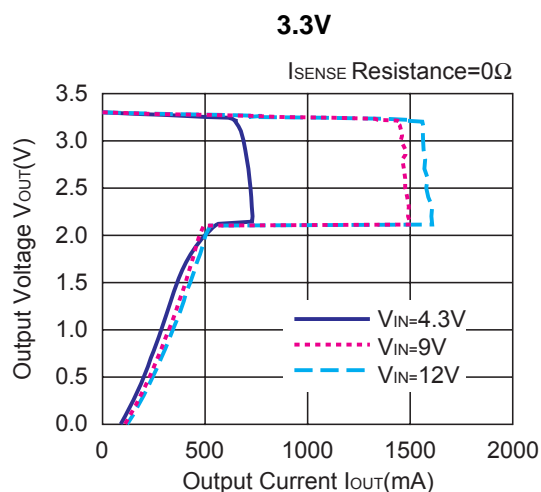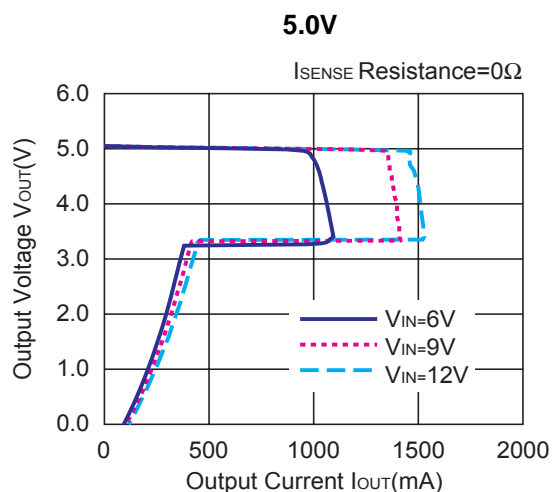
2) Output Voltage vs. Input Voltage

5.0V

$I_{OUT}=100mA$

3.3V

$I_{OUT}=100mA$

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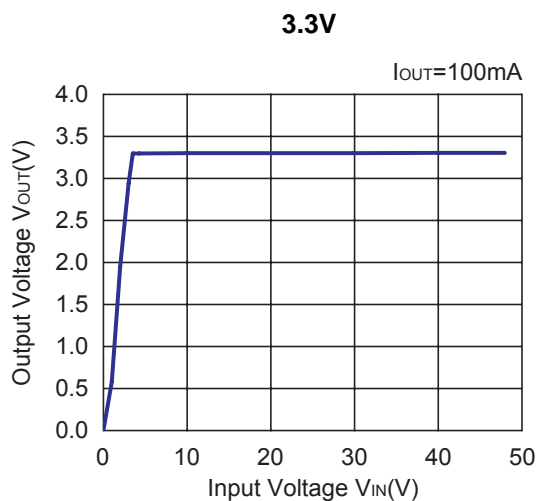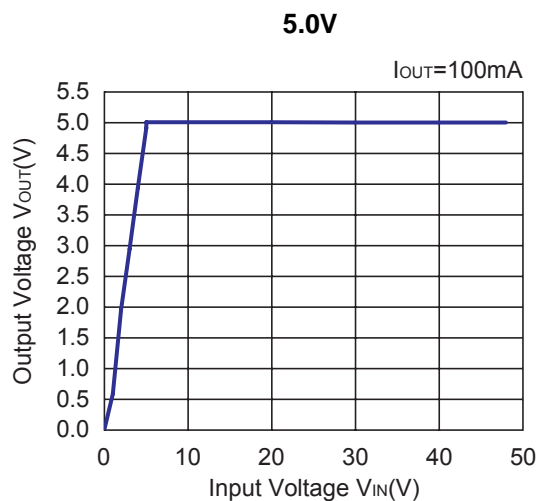
3) Output Voltage vs. Temperature

5.0V

I_{OUT}=100mA

Output Voltage V_{OUT}(V) vs. Temperature T_{opt}(°C)

3.3V

I_{OUT}=100mA

Output Voltage V_{OUT}(V) vs. Temperature T_{opt}(°C)
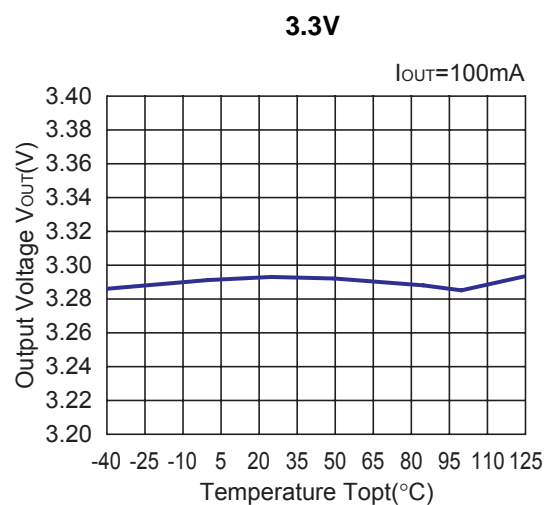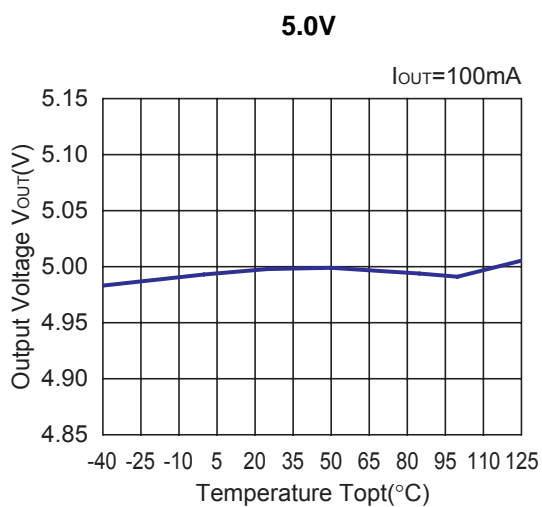
4) Base Current Limit vs. Output Voltage

5.0V

V_{IN}=12V

Output Voltage V_{OUT}(V) vs. EXT Output Current I_{SINK}(mA)

3.3V

V_{IN}=12V

Output Voltage V_{OUT}(V) vs. EXT Output Current I_{SINK}(mA)
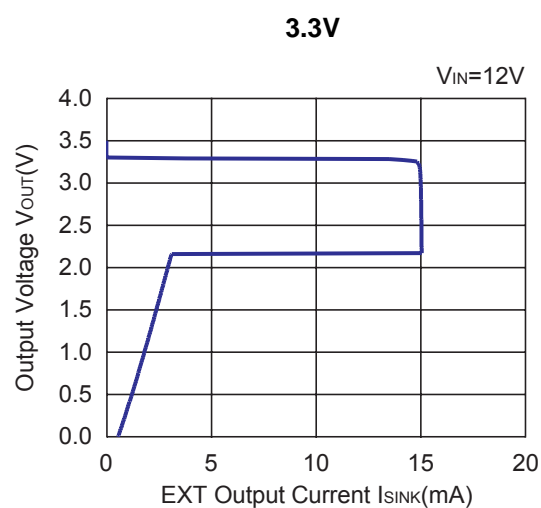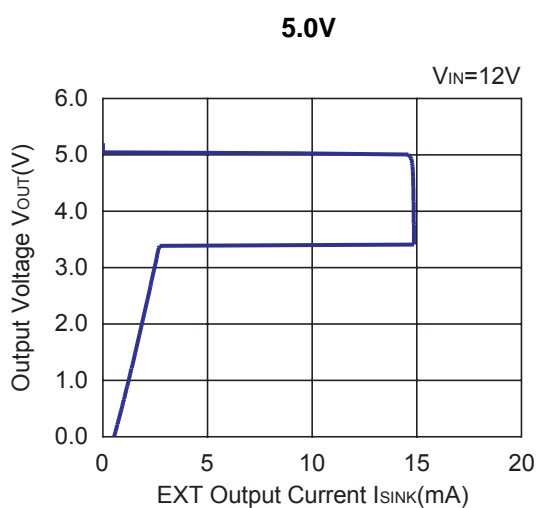
5) Ripple Rejection vs. Frequency

V_{IN}=V_{OUT}+1V,500mVp-p

Ripple Rejeciton RR(dB) vs. Frequency f(kHz)

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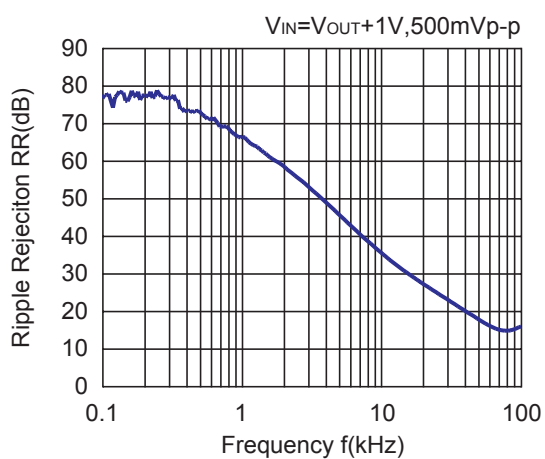
6) Input Transient Response

5.0V

3.3V
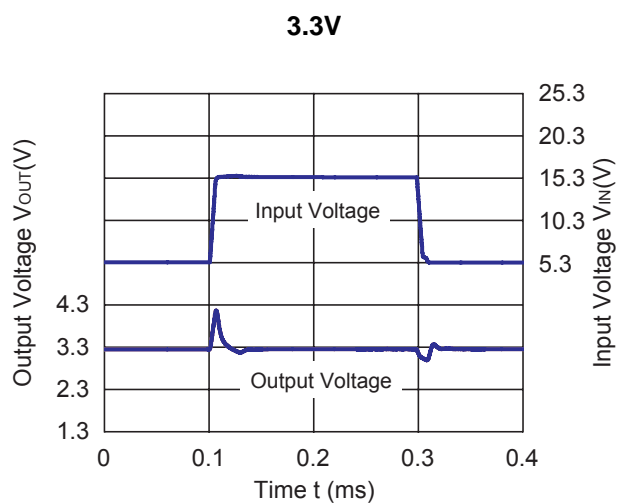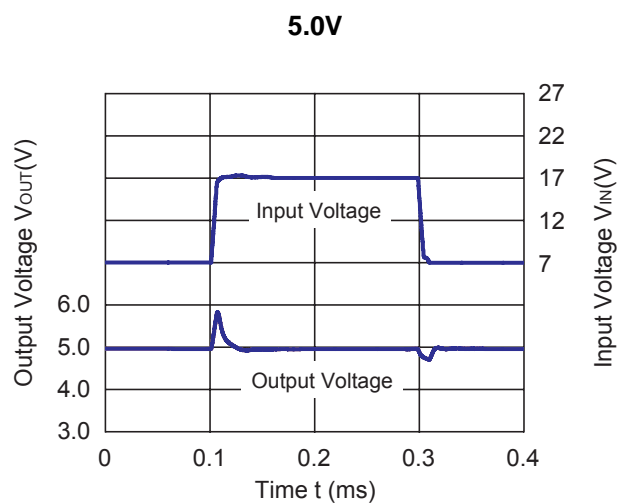
7) Load Transient Response

5.0V

3.3V
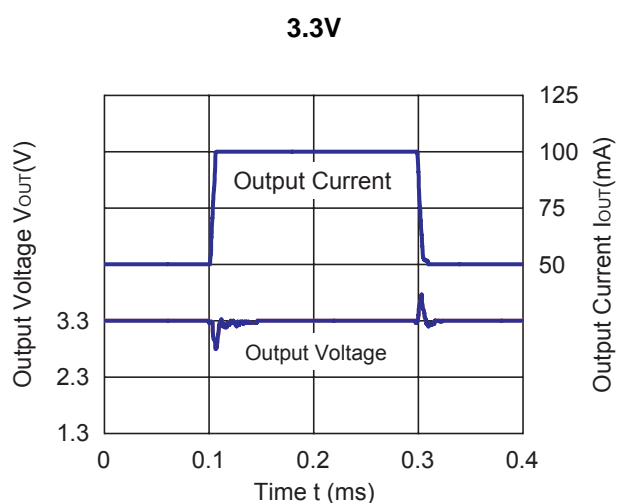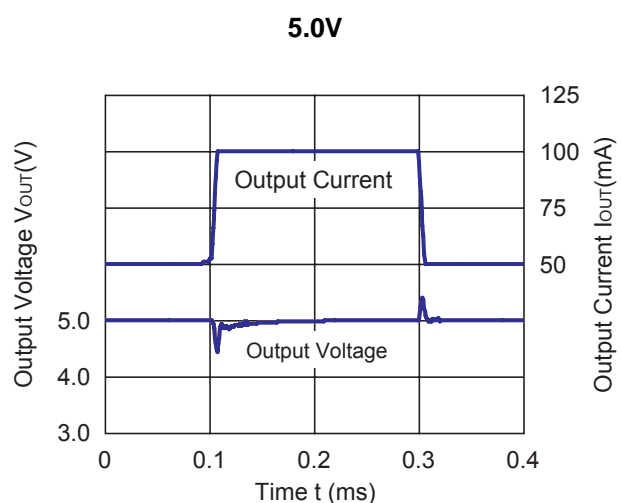
8) Detector Threshold vs. Temperature

4.0V

2.8V

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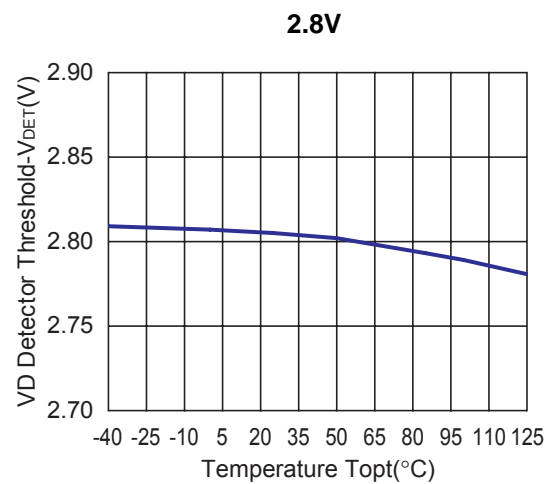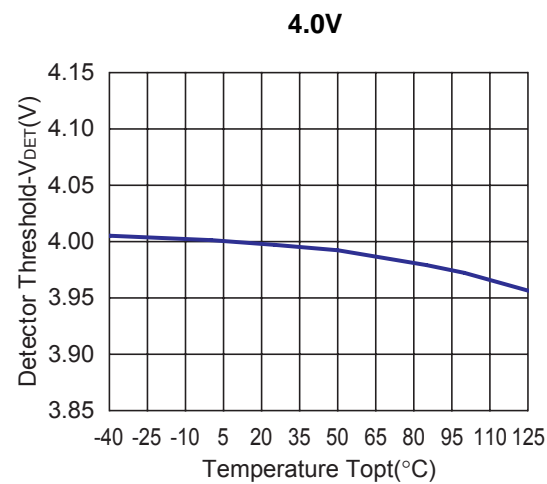
9) Output Voltage vs. Output Current
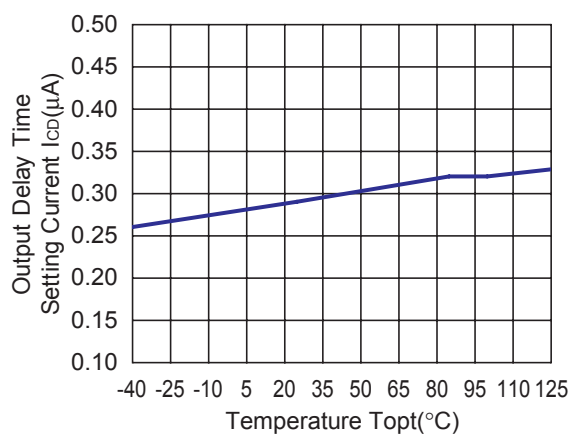
10) C_D Pin Threshold vs. Temperature
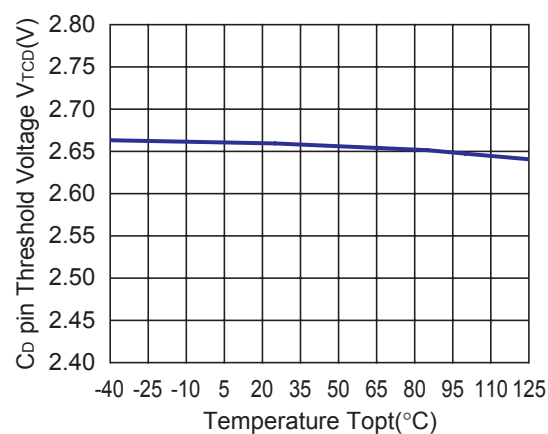
11) C_D Pin External Capacitance vs. Delay Time
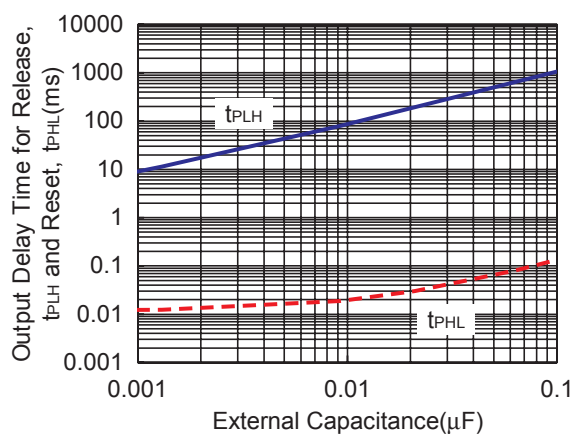
12) WDT monitoring Time vs. Temperature
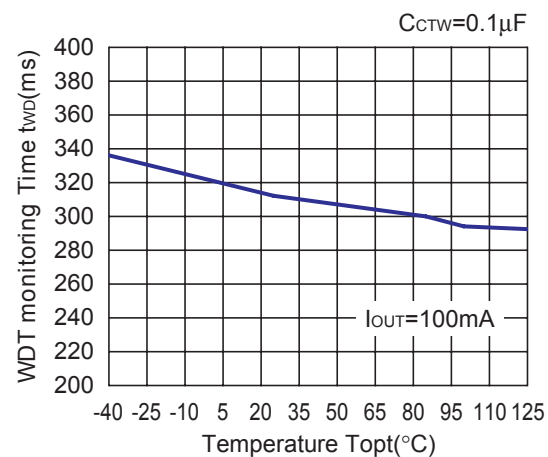
13) WDT Reset Time vs. Temperature
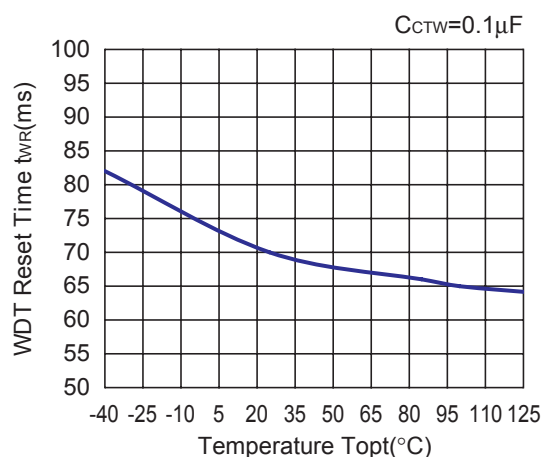
14) External Capacitance vs. WDT monitoring/Reset Time
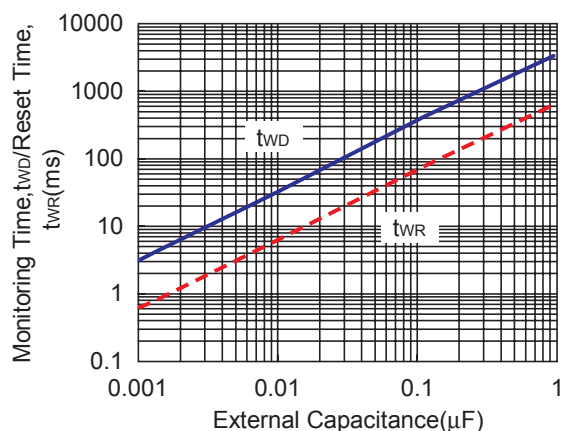
15) Supply Current vs. Temperature

I_{OUT}=0mA
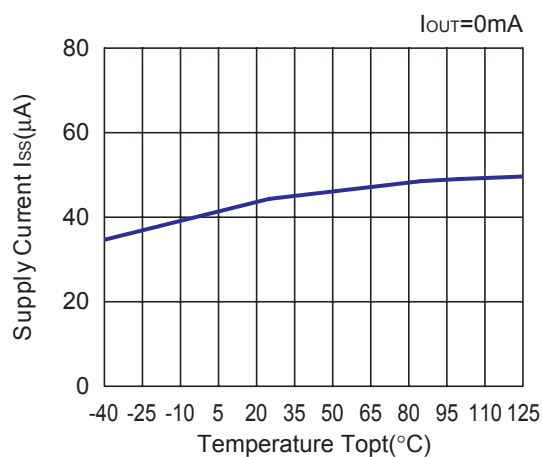
16) Supply Current vs. Input Voltage

5.0V

I_{OUT}=0mA
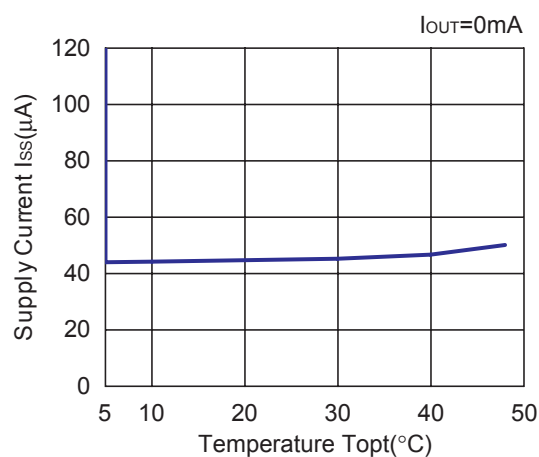
17) Current limit detector threshold vs. Temperature

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

-V_{DET}=3.4V

V_{OUT}=3.4V
3.0V
2.5V
2.0V

19) Nch Driver Output Current vs. V_{GS}

-V_{DET}=3.4V,$\overline{RESET}$=0.05V

-40°C
25°C
85°C
125°C

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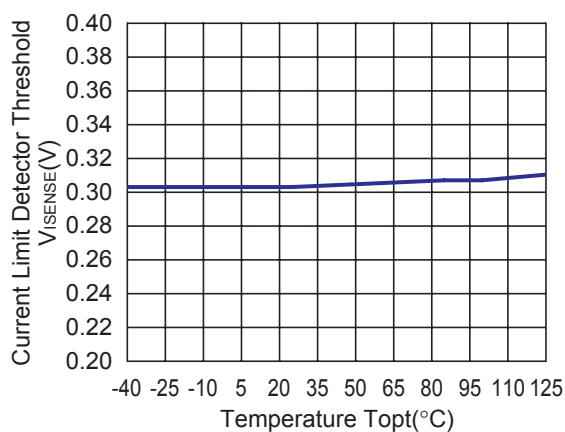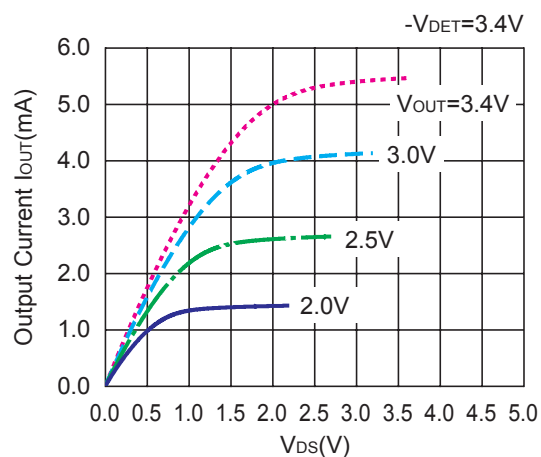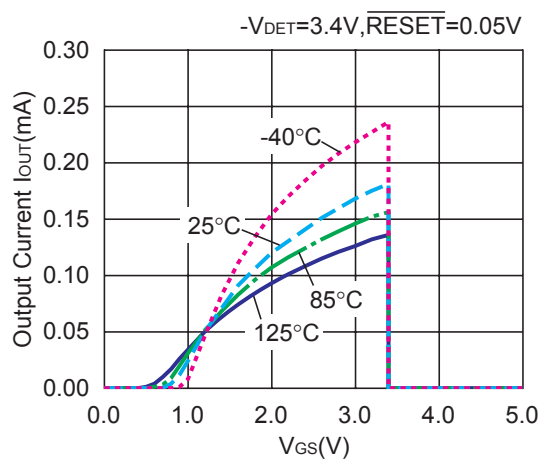
TECHNICAL NOTES

The phase compensation is made with the phase compensation circuit in the IC and the ESR of the output capacitor to make the operation stable. Therefore connect a 10μF or more value capacitor between V_{OUT} and GND. The ESR range of the output capacitor should be approximately 1Ω to 10Ω.

The fluctuation and the noise of the supply voltage, or a drastic change of the output voltage by the load transition of the regulator might be the reason of the mis-operation of the watchdog timer. If the SCK input pulse frequency is beyond 10kHz, or if the capacitance value of C_{TW} pin is large, the watchdog timer is easily affected by the fluctuation or noise of the supply voltage, or the fluctuation of the regulator output voltage, and it may cause an unstable operation.

If V_{IN} (supply voltage) may swing momentary, the regulator output is also swings. If the output of the voltage regulator becomes lower than detector voltage threshold, the built-in detector may generate the reset signal.

Built-in over-current limit works as monitoring the sink current of EXT pin and limits the current. Considering the over-current of the corrector current caused by short of EXT pin and GND externally, set a resistor between EXT pin and the base of the external driver transistor to limit the base current.

Use a 100pF or more value capacitor for C_{TW} pin.

Use a 10pF or more capacitor for C_D pin. A capacitor must be connected to C_D pin to use R5104VxxxA.

To avoid the mis-operation, during watchdog timer monitoring time, there is some ignoring time against clock pulse. Therefore, during the ignoring time, input clock pulse (rising edge trigger) is ignored. The ignoring time $V_{REF}2H$ is approximately as follows:

The time interval for C_{TW} pin voltage from $V_{REF}2H$ to $V_{REF}2H-(V_{REF}2H-V_{REF}2L)/4$

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