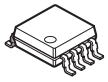
Battery Backup Switching IC

■ GENERAL DESCRIPTION

The NJU7287 is a battery backup system IC with three regulators, two voltage detectors, a battery switching system and their control circuit. It switches the regulator output from main power supply source to the backup battery when it detects main power supply drop and also has two voltage detection outputs.

The NJU7287 employs an exclusive sequence on the battery switching system which reduces the battery operation. Combining the special sequence and its low operating current, it is well-suited for battery backup systems of DSC, DVC and other portable devices. The NJU7287 is available in small and thin packages of 8-lead MSOP (TVSP) and 12-lead PCSP12-C3.

■ PACKAGE OUTLINE



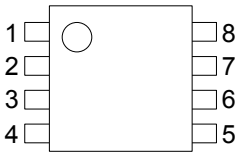
NJU7287xRB1
(MSOP8 (TVSP8))

■ FEATURES

- Low Quiescent Current :13μA max. / Normal operation
  :2.1μA max. / Backup
- Low Dropout Voltage :0.06V max. (I_{RO} =3mA) / REG1
  :0.3V max. (I_{OUT} =23mA) / REG2
  :0.06Vmax. (I_{CH}=3mA) / REG3
- 3ch(REG1, REG2, REG3) Output Voltage :±2.0%
- 2ch(CS, $\overline{\text{RESET}}$) Detection Voltage : ± 2.0%
- Exclusive Sequence
- Small Package NJU7287xRB1 : MSOP8 (TVSP8)*

*MEET JEDEC MO-187-DA / THIN TYPE

■ PIN CONFIGURATION



NJU7287xRB1

1.V_{SS}	**5. $\overline{\text{RESET}}$**
2.V_{CH}	**6.V_{OUT}**
3.V_{BAT}	**7.V_{IN}**
4.CS	**8.V_{RO}**

■ SELECTION GUIDE

Device Name	Output Voltage (V)			CS Voltage (V)		$\overline{\text{RESET}}$ Voltage (V)		Switch Voltage (V)
	V_{RO}	V_{OUT}	V_{CH}	$-V_{DET1}$	$+V_{DET1}$	$-V_{DET2}$	$+V_{DET2}$	V_{SW1}
NJU7287A	3.000	3.000	3.100	4.000	4.129	2.000	2.096	$+V_{DET1}\times0.85$

Caution: CS voltage should be set up so that switch voltage (V_{SW1}) may become more than $\overline{\text{RESET}}$ voltage ($-V_{DET2}$).
Note: The selection range is as follows.

V_{RO}, V_{OUT}, V_{CH} : 2.3 to 5.4V (0.1V Step)
$-V_{DET1}$:2.4 to 5.3V (0.1V Step)
$-V_{DET2}$:1.7 to 3.4V (0.1V Step)
V_{SW1} :$+V_{DET1}$X0.85

■ ABSOLUTE MAXIMAM RATINGS

(Ta=25˚C)

PARAMETER		SYMBOL	RATINGS	UNIT
Main Power Supply Input Voltage		V_{IN}	+10	V
Backup Power Supply Input Voltage		V_{BAT}	+10	V
Output Voltage of Voltage Regulator		V_{RO}, V_{OUT}, V_{CH}	V_{SS}-0.3 to V_{IN}+0.3	V
Output Voltage	CS Output Voltage	V_{CS}	V_{SS}-0.3 to +10	V
	$\overline{\text{RESET}}$ Output Voltage	V_{RESET}		V
Power Dissipation		P_D	320	mW
Operating Temperature		Topr	- 40 to +85	˚C
Storage Temperature		Tstg	- 40 to +125	˚C

■ ELECTRICAL CHARACTERISTICS

NJU7287A (C_{IN}=0.1µF, $C_{O(VOUT)}$=10µF, $C_{O(VRO)}$=10µF, $C_{O(VCH)}$=10µF, Ta=25˚C)

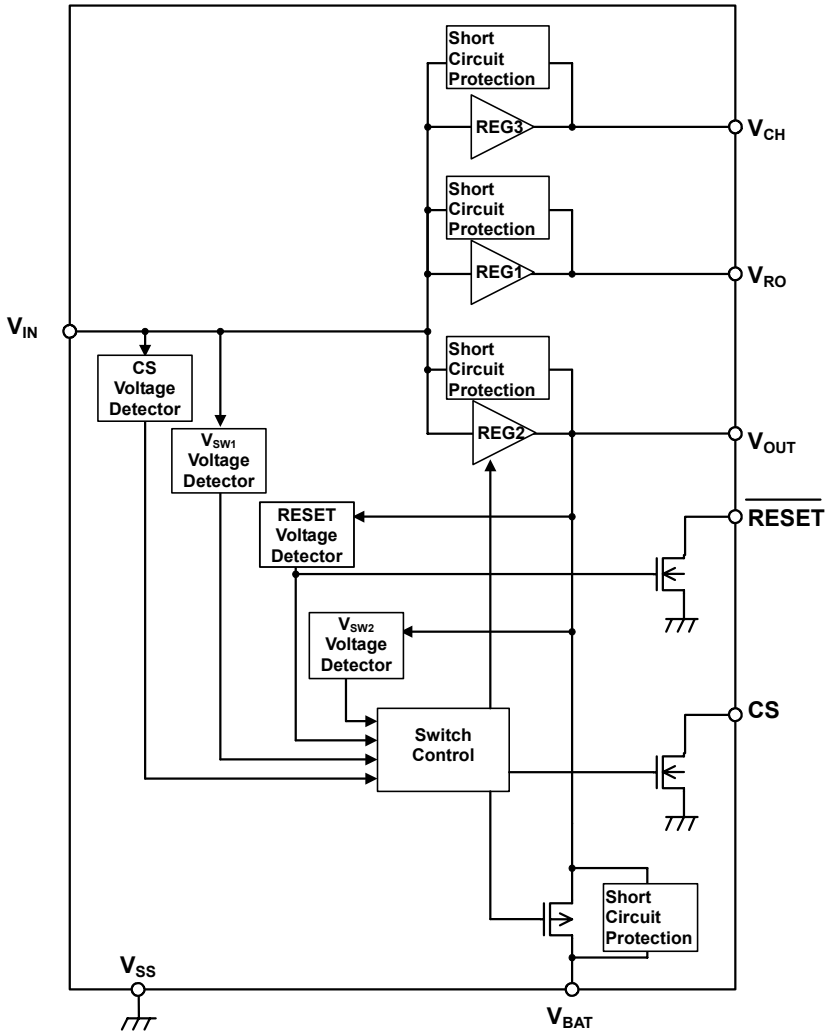
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Total						
Quiescent Current	I_{SS1}	V_{IN} =3.6V, No-Load	-	5.5	13	µA
	I_{BAT1}	V_{IN} =3.6V, V_{BAT}=3.0V, No-Load	-	-	0.1	µA
	I_{BAT2}	V_{IN}=OPEN,V_{BAT}=3.0V, No-Load	-	1.0	2.1	µA
Backup Power Supply Input Voltage	V_{BAT}		2.0	-	4.0	V
Voltage Regulator 1						
Output Voltage 1	V_{RO}	V_{IN}=7.2V, I_{RO}=3mA	2.94	3.00	3.06	V
Dropout Voltage 1	ΔV_{I-O1}	I_{RO}=3mA	-	30	60	mV
Load Regulation 1A	$\Delta V_{ROA}/\Delta I_{RO}$	V_{IN}=7.2V, I_{RO}=0.1 to 30mA	-	0.06	0.15	%/mA
Load Regulation 1B	$\Delta V_{ROB}/\Delta I_{RO}$	V_{IN}=3.6V, I_{RO}=0.1 to 30mA	-	0.06	0.15	%/mA
Line Regulation 1	$\Delta V_{RO}/\Delta V_N$	V_{IN}=4 to 9V, I_{RO}=3mA	-	-	0.2	%/V
Average Temperature Coefficient of Output Voltage 1	$\Delta V_{RO}/\Delta T$	Ta=0 to +85°C	-	±100	-	ppm/°C
Voltage Regulator 2						
Output Voltage 2	V_{OUT}	V_{IN}=7.2V, I_{OUT}=23mA	2.94	3.00	3.06	V
Dropout Voltage 2	ΔV_{I-O2}	I_{OUT}=23mA	-	150	300	mV
Load Regulation 2A	$\Delta V_{OUTA}/\Delta I_{OUT}$	V_{IN}=7.2V, I_{OUT}=0.1 to 60mA	-	0.04	0.10	%/mA
Load Regulation 2B	$\Delta V_{OUTB}/\Delta_{OUT}$	V_{IN}=3.6V, I_{OUT}=0.1 to 60mA	-	0.04	0.10	%/mA
Line Regulation 2	$\Delta V_{OUT}/\Delta V_N$	V_{IN}=4 to 9V, I_{OUT}=23mA	-	-	0.2	%/V
Average Temperature Coefficient of Output Voltage 2	$\Delta V_{OUT}/\Delta T$	Ta=0 to +85°C	-	±100	-	ppm/°C
Voltage Regulator 3						
Output Voltage 3	V_{OUT}	V_{IN}=7.2V, I_{OUT}=3mA	3.038	3.100	3.162	V
Dropout Voltage 3	ΔV_{I-O3}	I_{OUT}=3mA	-	30	60	mV
Load Regulation 3A	$\Delta V_{OUTA}/\Delta I_{OUT}$	V_{IN}=7.2V, I_{OUT}=0.1 to 30mA	-	0.06	0.15	%/mA
Load Regulation 3B	$\Delta V_{OUTB}/\Delta_{OUT}$	V_{IN}=3.6V, I_{OUT}=0.1 to 30mA	-	0.06	0.15	%/mA
Line Regulation 3	$\Delta V_{OUT}/\Delta V_N$	V_{IN}=4 to 9V, I_{OUT}=3mA	-	-	0.2	%/V
Average Temperature Coefficient of Output Voltage 3	$\Delta V_{OUT}/\Delta T$	Ta=0 to +85°C	-	±100	-	ppm/°C
CS Voltage Detector						
Detection Voltage 1	$-V_{DET1}$	V_{IN} Voltage Detection	3.920	4.000	4.080	V
Release Voltage 1	$+V_{DET1}$		4.030	4.129	4.228	V
Average Temperature Coefficient of Detection Voltage 1	$\Delta V_{DET1}/\Delta T$	Ta=0 to +85°C	-	±100	-	ppm/°C
Output Current 1	I_{SINK1}	V_{DS}=0.5V, V_{IN}=V_{BAT}=2.0V	1.50	2.30	-	mA
Leak Current 1	I_{LEAK1}	V_{DS}=9V, V_{IN}=9V	-	-	0.1	µA
Operation Voltage 1	V_{OPR1}	V_{IN} or V_{BAT}	1.7	-	9.0	V

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
$\overline{\text{RESET}}$ Voltage Detector						
Detection Voltage 2	$-V_{DET2}$	V_{OUT} Voltage Detection	1.960	2.000	2.040	V
Release Voltage 2	$+V_{DET2}$		2.046	2.096	2.146	V
Release Delay Time	T_{DELAY}		200	500	-	µs
Average Temperature Coefficient of Detection Voltage 2	$\Delta V_{DET2}/\Delta T$	Ta=0 to +85°C	-	±100	-	ppm/°C
Output Current 2	I_{SINK2}	V_{DS}=0.5V, V_{IN}=V_{BAT}=2.0V	1.50	2.30	-	mA
Leak Current 2	I_{LEAK2}	V_{DS}=9V, V_{IN}=9V	-	-	0.1	µA
Operation Voltage 2	V_{OPR2}	V_{IN} or V_{BAT}	1.7	-	9.0	V
Switch Control						
Switch Voltage	V_{SW1}	V_{BAT}=2.8V, V_{IN} Voltage Detection	$+V_{DET1}$ x 0.83	$+V_{DET1}$ x 0.85	$+V_{DET1}$ x 0.87	V
CS Output Inhibit Voltage	V_{SW2}	V_{BAT}=3.0V, V_{OUT} Voltage Detection	V_{OUT} x 0.93	V_{OUT} x 0.95	V_{OUT} x 0.97	V
V_{BAT} Switch Leak Current	I_{LEAK}	V_{IN}=3.6V, V_{BAT}=0V	-	-	0.1	µA
V_{BAT} Switch Resistance	R_{SW}	V_{IN}=OPEN, V_{BAT}=3.0V	-	30	60	Ω
Average Temperature Coefficient of Switch Voltage	$\Delta V_{SW1}/\Delta T$	Ta=0 to +85°C	-	±100	-	ppm/°C
Average Temperature Coefficient of CS Output Inhibit Voltage	$\Delta V_{SW2}/\Delta T$	Ta=0 to +85°C	-	±100	-	ppm/°C

■ CAUTION ON USE

- Make a power supply line thick and short to reduce impedance. Particularly, V_{IN} line that flows output current needs to cautions.
- I_{RO} or I_{OUT} should be set 10µA or more to prevent the output voltage rises and a load regulation becomes unstable.
- Pay attention to overshoot of regulator to prevent exceed rating of IC and/or capacitors connected to the NJU7287.
- The output capacitors should surely connect between each output terminal, V_{IN}, V_{OUT}, V_{RO} and V_{SS}. Particularly, the output capacitor connected to the V_{OUT} terminal should use 10µF or more to avoid drop the output voltage when switch the V_{OUT} output from REG2 to V_{BAT}.
- External parts should connect as closer as possible to the NJU7287.
- The output capacitor should connect to the V_{OUT} terminal to prevent $\overline{\text{RESET}}$ voltage detector becomes active and sequence will switch to special sequence causing undershoot.
- If V_{IN} falls down to 0V, application circuit should design to falling time of V_{IN} is 10ms or more to prevent $\overline{\text{RESET}}$ output becomes "L".
- Power dissipation should not exceeded.

■ BLOCK DIAGRAM



■ FUNCTIONAL EXPLANATION OF BLOCK

1. Voltage regulator(REG1,REG2,REG3)
   - Each output voltage can select in 0.1V steps.
2. CS Voltage Detector
   - Monitors the V_{IN} (main power supply) terminal voltage, and detects a drop in the main power supply.
   - Detection result outputs to CS terminal (At the time of CS output inhibit voltage signal outputs)
     Detection voltage($-V_{DET1}$) ≥ V_{IN} : "L" Output
     Release voltage($+V_{DET1}$) ≤ V_{IN} : "H" Output
   - Power is supplied from both V_{IN} and V_{BAT}.
3. $\overline{\text{RESET}}$ Voltage Detector
   - Monitors the V_{OUT} terminal voltage.
   - Detection result is outputted to $\overline{\text{RESET}}$ terminal.
     Detection voltage($-V_{DET2}$) ≥ V_{OUT} : "L" Output
     Release voltage($+V_{DET2}$) ≤ V_{OUT} : "H" Output
   - Power is supplied from the V_{OUT} terminal. (If the V_{OUT} ≥ 1.0 V, normal logic is output.)
4. V_{SW1} Voltage Detector
   - Monitors the V_{IN} voltage.
   - The detection voltage (V_{SW1}) is determined by 85% of the CS detection voltage.
5. V_{SW2} Voltage Detector
   - Monitors the V_{OUT} voltage.
   - The CS output inhibit voltage (V_{SW2}) is determined by 95% of the REG2 output voltage.
   - The status of CS terminal :
     CS output inhibit voltage (V_{SW2}) ≥ V_{OUT} : fixed at "L" and CS release permission signal is stopped.
     CS output inhibit voltage (V_{SW2}) ≤ V_{OUT} : Outputs the CS detection result.
   - Provided that the V_{IN} terminal voltage is at least the CS detection voltage, the CS output is maintained at "H", even if the V_{OUT} terminal voltage is less than the V_{SW2} voltage.
6. Sequence explanation

   Special sequence
   - Period from when the V_{IN} voltage rises from 0V until the CS output becomes "H".
   - When the V_{OUT} voltage falls, and the $\overline{\text{RESET}}$ output becomes "L" level.
   - During the period of a special sequence, the V_{OUT} output is fixed at REG2.

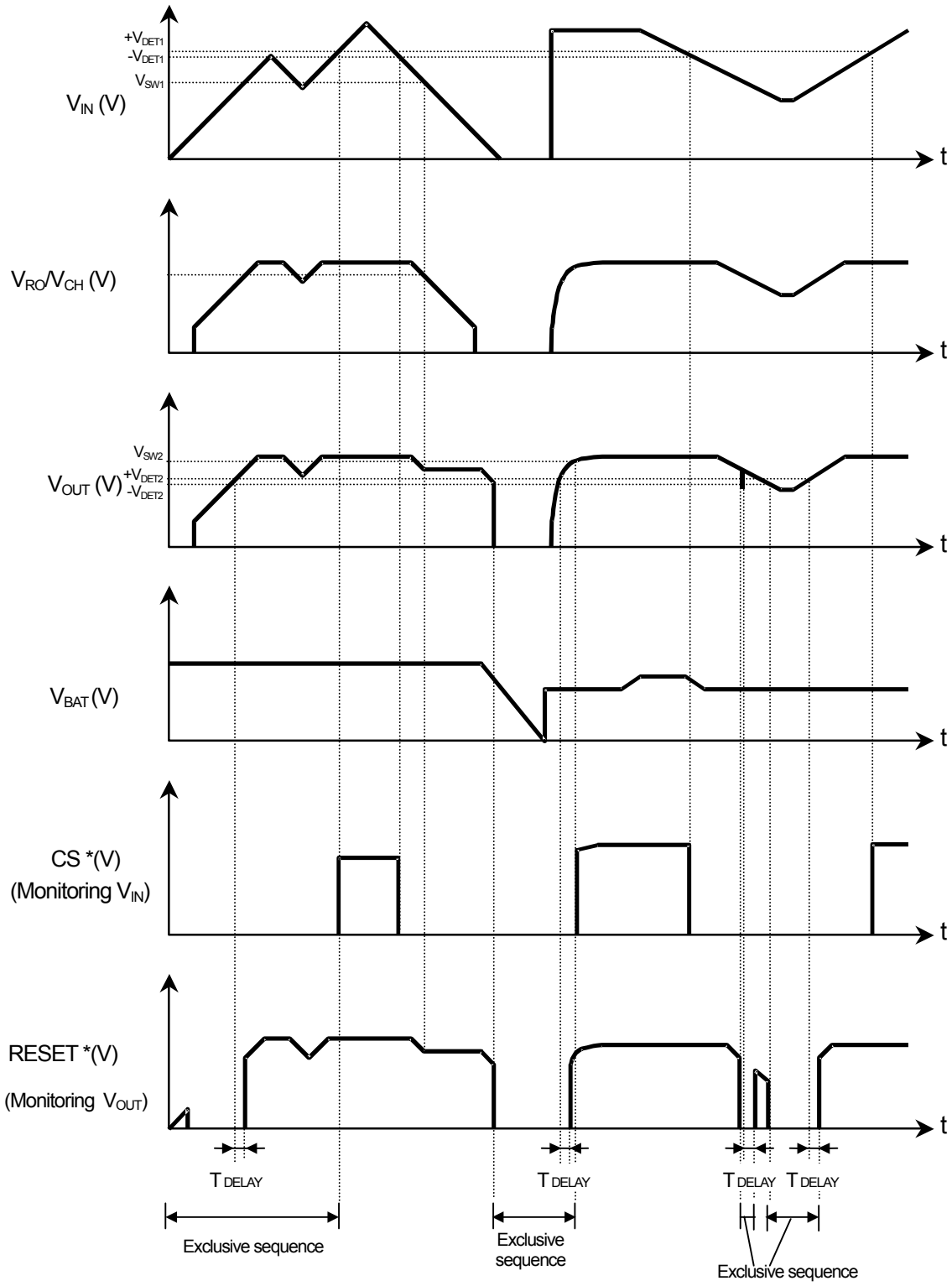
   Normal sequence
   - The period from when the V_{IN} voltage rises and the CS output becomes "H" level, and then the V_{OUT} voltage falls, and the $\overline{\text{RESET}}$ output becomes "L" level.
   - During the period of the normal sequence, the detection result from the V_{SW1} detection circuit which monitors the V_{IN} voltage causes the V_{OUT} output to switch over to REG2 or V_{BAT}.

Terminal voltage	REG2 operation state	V_{OUT} output	State of operation
0V to V_{IN} < "$+V_{DET1}$"	ON	REG2	Special sequence
V_{IN} > "V_{SW1}"	ON	REG2	Normal sequence
V_{IN} ≤ "V_{SW1}"	OFF	V_{BAT} - ΔVT1	Normal sequence
V_{OUT} > "$-V_{DET2}$"	ON	REG2	Special sequence

ΔVT1 indicates V_{DS} of the switch transistor between V_{BAT} and V_{OUT}.

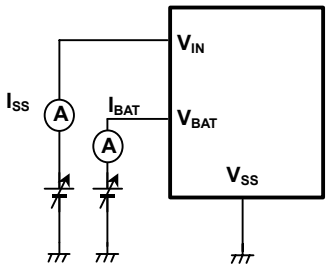
Note : It takes a maximum of several hundred μsec for REG2 to go from OFF to ON. During this period, it is possible that V_{OUT} may become high impedance, so it is necessary to connect a capacitor of at least 10 μF to the V_{OUT} terminal to prevent the voltage from falling.

■ TIMING CHART



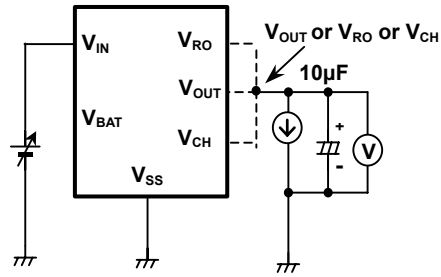
■ TEST CIRCUIT

1.



To Measure I_{BAT2}, apply 6V to V_{IN}, 3V to V_{BAT} and then leave V_{IN} open and measure I_{BAT2}.

2.



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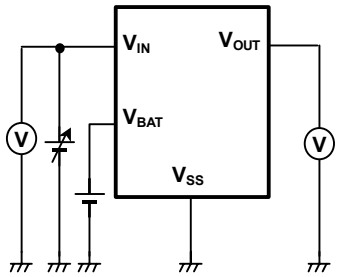
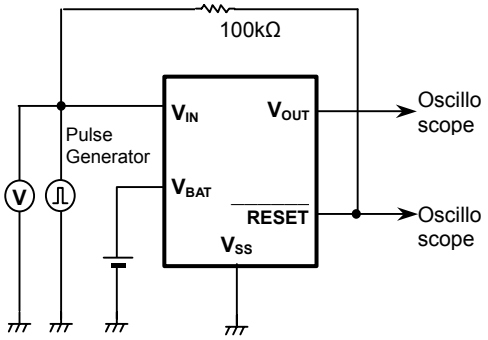


Measure the value after applying 6V to V_{IN}.

4.



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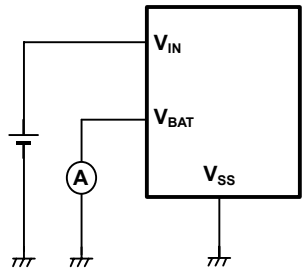

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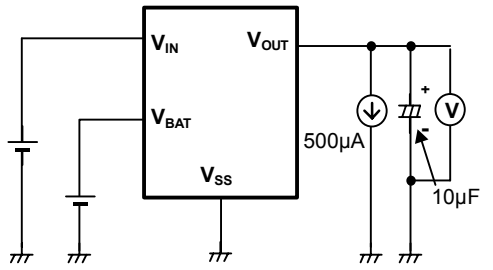
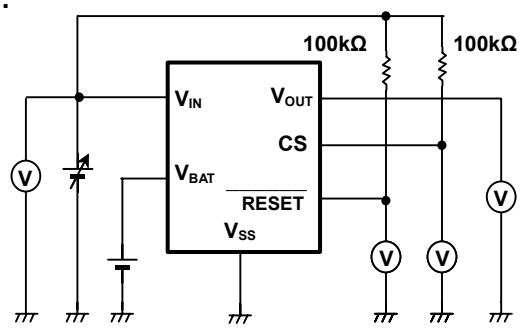


Leave V_{IN} open and measure the value after applying 6V to V_{IN}.

7.



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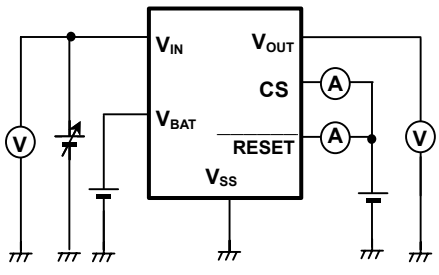
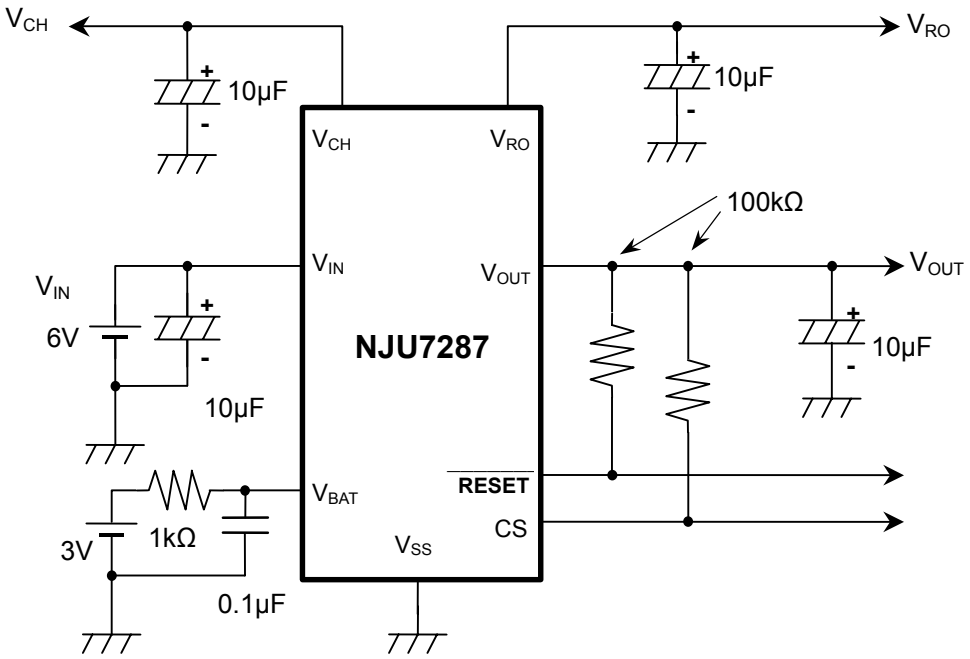


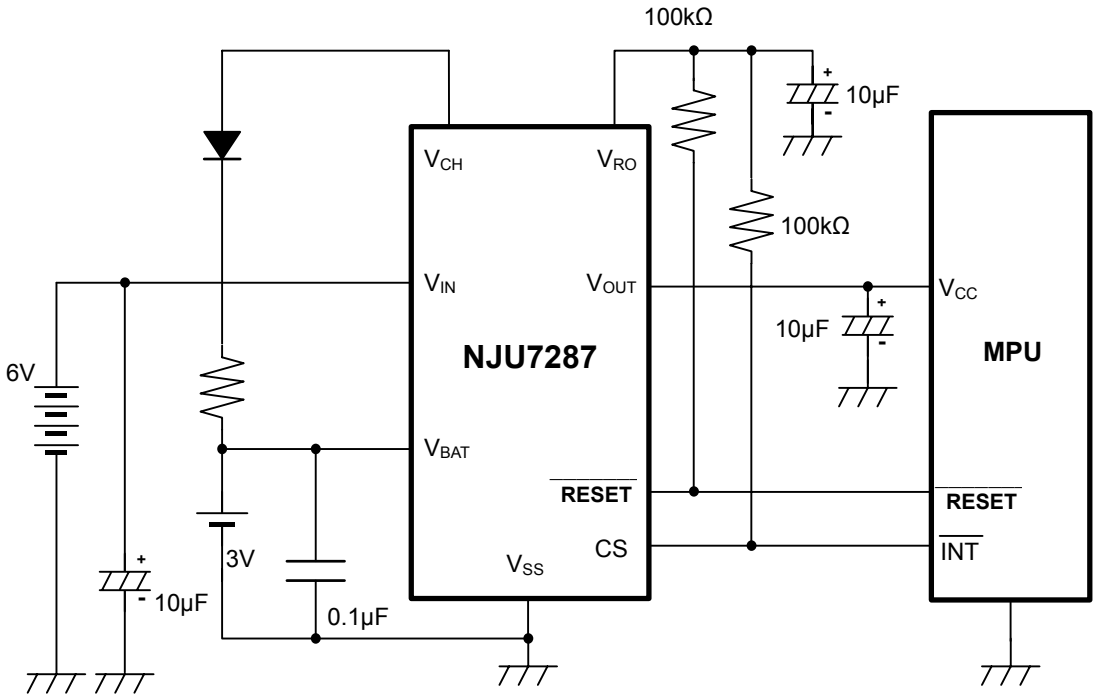
■ **CORRESPOND TABLE OF TEST CIRCUIT**

TEST PARTNER	TEST CIRCUIT NUMBER
Quiescent Current	1
Back up power supply Input Voltage	6
Output Voltage 1	2
Dropout Voltage 1	2
Load Regulation 1A	2
Load Regulation 1B	2
Line Regulation 1	2
Average Temperature Coefficient of Output Voltage 1	2
Output Voltage 2	2
Dropout Voltage 2	2
Load Regulation 2A	2
Load Regulation 2B	2
Line Regulation 2	2
Average Temperature Coefficient of Output Voltage 2	2
Output Voltage 3	2
Dropout Voltage 3	2
Load Regulation 3A	2
Load Regulation 3B	2
Line Regulation 3	2
Average Temperature Coefficient of Output Voltage 3	2
Detection Voltage 1	7
Release Voltage 1	7
Average Temperature Coefficient of Detection Voltage1	7
Output Current 1	8
Leak Current 1	8
Operation Voltage 1	7
Detection Voltage 2	7
Release Voltage 2	7
Release Delay Time	4
Average Temperature Coefficient of Detection Voltage 2	7
Output Current 2	8
Leak Current 2	8
Operation Voltage 2	7
Switch Voltage	3
V_{BAT} Switch Leak Current	5
V_{BAT} Switch Resistance	6
Average Tempereture Coefficient of Switch Voltage	3

■ TYPICAL APPLICATIONS



When the rechargeable battery is used as the backup battery.



The backup battery can be flating –recharged by using voltage regulator 3 (REG3).

[CAUTION]
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