

Preliminary

- ◆ CMOS Low Power Consumption
- ◆ PFM Controlled, Step-Up DC/DC Converter
- ◆ 5 Level Window Comparator
- ◆ Voltage Detector x 2 (Independent Power Supply)
- ◆ TSSOP-16 Package

■ Applications

- Battery Powered Equipment
- Various Portable Equipment

■ General Description

The XC651A series are step-up DC/DC converter and multi voltage detector IC s. CMOS processes and laser trimming technology provide high accuracy and low power consumption.

The XC651A comprises of a PFM controlled step-up DC/DC converter, a voltage detector with 4 x 5 level window comparators built-in, plus 2 other voltage detectors.

The step-up DC/DC converter's EN pin (chip enable) provides power consumption savings when the step-up operations are not operating (stand-by mode).

The series is available in a small TSSOP-16 package.

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■ Features

Independent power supply for each built-in block :

Each of the following built-in blocks is operated by a separate power supply :

PFM controlled, step-up DC/DC converter (PFM DC/DC)

5 level window comparator (MWVD)

Negative Logic : XC651A3 Series

Positive Logic : XC651A4 Series

Voltage detector 1 with built-in delay circuit (VD1)

Voltage detector 2 (VD2)

Highly accurate set-up voltage :

PFM controlled, step-up DC/DC converter : set-up voltage accuracy $\pm 2.5\%$

5 level window comparator : set-up voltage accuracy $\pm 2\%$

Voltage detectors 1, 2 : set-up voltage accuracy $\pm 2\%$

Set-up voltage range :

PFM controlled, step-up DC/DC converter : 2.0V to 3.0V (selectable in 0.1V steps)

5 level window comparator : 1.1V to 2.5V * (selectable in 0.1V steps)

Voltage detectors 1, 2 : 0.9V to 3.0V (selectable in 0.1V steps)

Operational voltage range :

0.9V to 6.0V

Small Package :

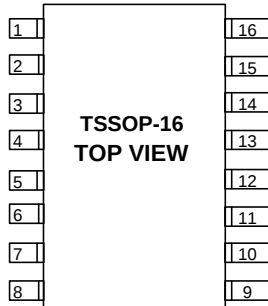
TSSOP-16

* Note : The set-up voltage of the 5 level window comparator cannot be freely set-up due to the limitations of the circuit.

Please also note that the set-up voltage range of MWVD1 is 1.0V to 1.8V.

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■ Pin Configuration

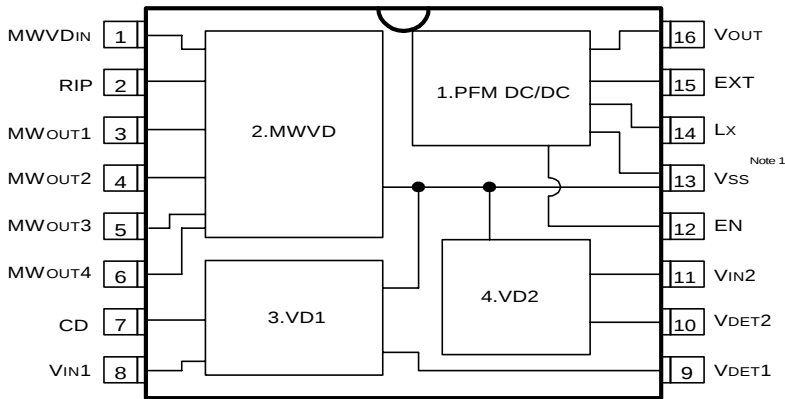


■ Pin Assignment

PIN NUMBER	PIN NAME	FUNCTION
1	MWVD IN	MWVD detect, MWVD current
2	RIP	MWVD ripple exclusion capacitor connection
3	MWOUT1	MWVD output 1
4	MWOUT2	MWVD output 2
5	MWOUT3	MWVD output 3
6	MWOUT4	MWVD output 4
7	CD	VD1 delay time set-up capacitor connection
8	VIN1	VD1 detect, VD1 current
9	VDET1	VD1 output
10	VDET2	VD2 output
11	VIN2	VD2 detect, VD2 current
12	EN	DC/DC enable
13	VSS	Ground pin (common)
14	Lx	DC/DC built-in transistor switch output
15	EXT	DC/DC external transistor drive output
16	VOUT	DC/DC output voltage monitor, DC/DC current

■ Block Diagrams

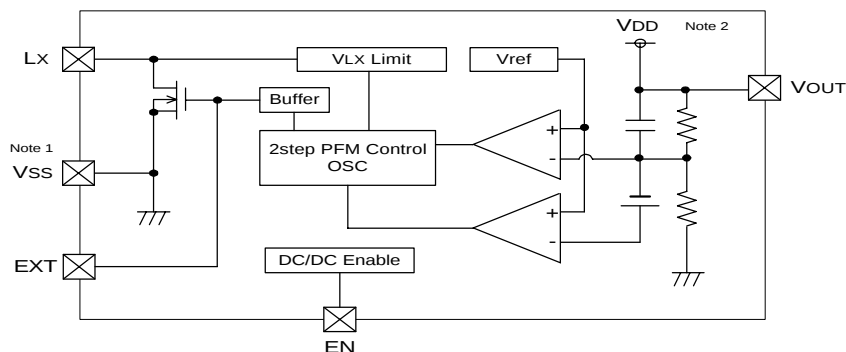
■ 1) Overall Composition



Note 1 : The VSS pin is common to each block.
Note 2 : The VDD pin is independent of each block.

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■ 2) PFM DC/DC

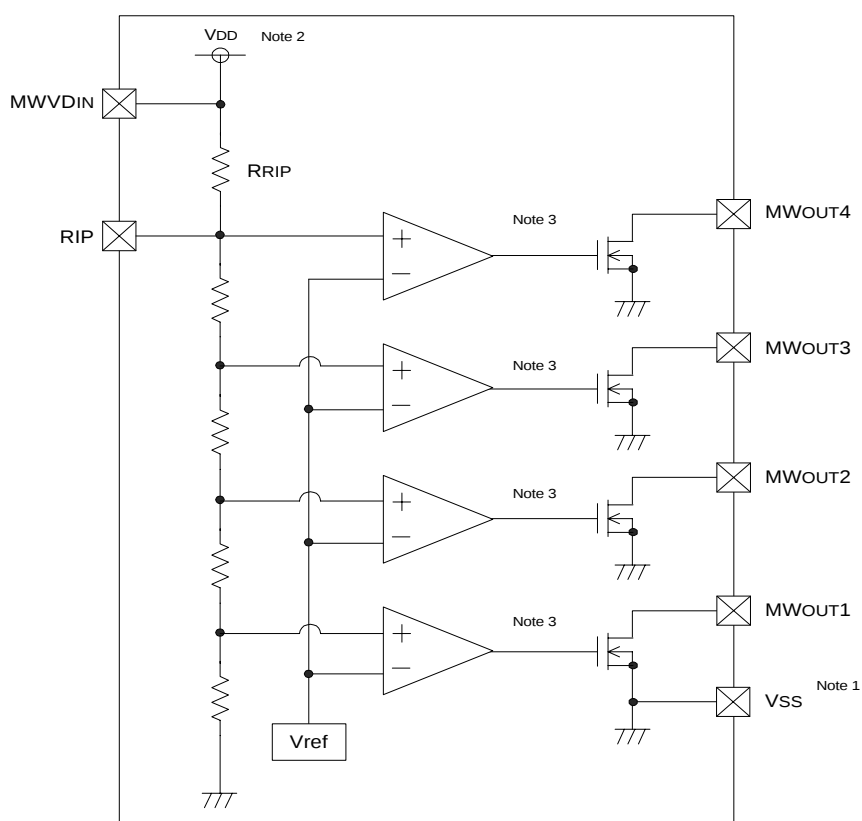


Note 1 : The Vss pin is common to each block.

Note 2 : VDD is independent for each block.

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■ 3) MWVD



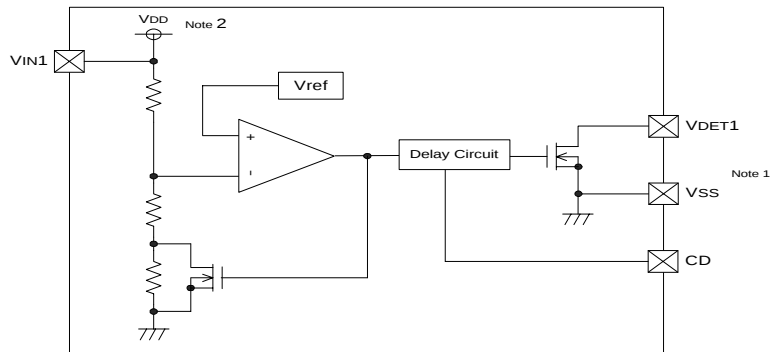
Note 1 : The Vss pin is common to each block.

Note 2 : VDD is independent for each block.

Note 3 : Applies to the XC6514 Series (Positive Logic) only.

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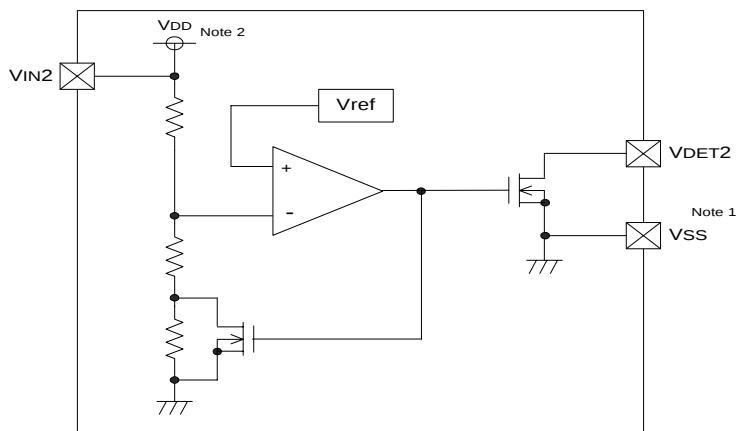
■ 4) VD 1



Note 1 : The Vss pin is common to each block.

Note 2: VDD is independent for each block.

■ 5) VD 2



Note 1 : The Vss pin is common to each block.

Note 2 : VDD is independent for each block.

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■ Absolute Maximum Ratings

Ta=25°C

PARAMETER	SYMBOL	CONDITIONS	UNITS
Output Voltage	V _{OUT}	9	V
Lx Pin Voltage	V _{LX}	9	V
Lx Pin Current	I _{LX}	400	mA
EXT Pin Voltage	V _{EXT}	-0.3 to V _{OUT} + 0.3	V
EXT Pin Current	I _{EXT}	± 50	mA
EN Input Voltage	V _{EN}	-0.3 to V _{OUT} + 0.3	V
MWVDIN Input Voltage	MWVD _{IN}	9	V
RIP Input Voltage	V _{RIP}	-0.3 to MWVD _{IN} + 0.3	V
MWOUT Output Voltage	V _{MWOUT}	9	V
MWOUT Output Current	I _{MWOUT}	50	mA
V _{IN} Input Voltage	V _{IN}	9	V
V _{DET} Output Voltage	V _{DET}	9	V
V _{DET} Output Current	I _{DET}	50	mA
CD Input Voltage	V _{CD}	-0.3 to V _{IN1} + 0.3	V
Continuous Total Power Dissipation	P _d	350	mW
Operating Ambient Temperature	T _{opr}	-30 to +80	°C
Storage Temperature	T _{stg}	-40 to +125	°C

■ Electrical Characteristics (XC651A4AA3VR)

(note that the above is a sample part number and that actual part numbers will differ)

Set-Up Voltage

Ta=25°C

BLOCK	PARAMETER	SYMBOL	SET-UP VOLTAGE VALUE	UNITS
1. PFM DC/DC	output voltage	V _{OUT}	2.500	V
2. MWVD	MWOUT1 detect voltage	V _{DFMW1}	1.275	V
	MWOUT2 detect voltage	V _{DFMW2}	1.245	V
	MWOUT3 detect voltage	V _{DFMW3}	1.210	V
	MWOUT4 detect voltage	V _{DFMW4}	1.060	V
3. VD1	detect voltage 1	V _{DF1}	1.500	V
4. VD2	detect voltage 2	V _{DF2}	0.950	V

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1. PFM DC/DC

V_{OUT}=2.5V

T_a=25°C

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	CIRCUIT
Output Voltage	V _{OUT}	Ext. components connected	2.438	2.500	2.563	V	1
Operating Voltage	V _{IN}		-	-	6.0	V	-
Operating Start-Up Voltage	V _{ST}	Ext. components connected, I _{OUT} =1mA	-	0.8	0.9	V	1
Operating Hold Voltage	V _{HLD}	Ext. components connected, I _{OUT} =1mA	0.7	-	-	V	1
Supply Current 1	I _{DD1}	Output Voltage x 0.95 applied to V _{OUT}	-	35.0	56.9	μA	2
Supply Current 2	I _{DD2}	Output Voltage + 0.5V applied to V _{OUT}	-	2.5	5.0	μA	2
Lx Switch ON Resistance	R _{SWON}	Output Voltage x 0.95 applied to V _{OUT} , V _{LX} =0.4V	-	9.1	13.7	Ω	2
Lx Leak Current	I _{LXL}	No ext. components, V _{OUT} =V _{LX} =10V	-	-	1.0	μA	3
Lx Control Voltage	V _{LXLMT}	Output Voltage x 0.95 applied to V _{OUT} , Output Voltage applied to Lx, When the oscillator frequency is more than double	0.7	-	1.1	V	2
EXT H ON Resistance	R _{EXTH}	Output Voltage x 0.95 applied to V _{OUT} , V _{EXT} =V _{OUT} - 0.4V	-	140	210	Ω	2
EXT L ON Resistance	R _{EXTL}	Output Voltage x 0.95 applied to V _{OUT} , V _{EXT} =0.4V	-	140	210	Ω	2
Duty Ratio 1	DTY1	Output Voltage x 0.95 applied to V _{OUT} , EXT waveform measurement	70	75	80	%	2
Duty Ratio 2	DTY2	Ext. components connected, I _{OUT} =1mA, LX ON time measurement	-	62	-	%	1
Max Oscillator Frequency	MAXF _{OSC}	Output Voltage x 0.95 applied to V _{OUT} , EXT waveform measurement	85	100	115	kHz	2
Stand-by Current	I _{STB}	Output Voltage x 0.95 applied to V _{OUT} , V _{EN} =0V	-	0.2	1.0	μA	2
EN H Voltage	V _{ENH}	Output Voltage x 0.95 applied to V _{OUT} , EXT oscillation judgement	0.7	-	-	V	4
EN L Voltage	V _{ENL}	Output Voltage x 0.95 applied to V _{OUT} , EXT stopped judgement	-	-	0.2	V	4
EN H Current	I _{ENH}	Output Voltage x 0.95 applied to V _{OUT} , V _{EN} =V _{OUT}	-	-	0.25	μA	4
EN L Current	I _{ENL}	Output Voltage x 0.95 applied to V _{OUT} , V _{EN} =0V	-	-	- 0.25	μA	4
Efficiency (note 1)	EFFI	Ext. components connected	-	70	-	%	1

Conditions : Unless indicated, connect EN to V_{OUT}, V_{IN}=Output Voltage x 0.6, I_{OUT}=10mA

Note : 1. EFFI={ [(output voltage) x (output current)] / [(input voltage) x (input current)] } x 100

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2. MWVD (Positive Logic)

Ta=25°C

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	CIRCUIT
MW OUT 1 Detect Voltage	VDFMW1		1.250	1.275	1.301	V	5
MW OUT 2 Detect Voltage	VDFMW2		1.220	1.245	1.270	V	5
MW OUT 3 Detect Voltage	VDFMW3		1.186	1.210	1.234	V	5
MW OUT 4 Detect Voltage	VDFMW4		1.039	1.060	1.081	V	5
MW OUT 1 Hysteresis Width	VHYSMW1	(Release Voltage=VDFMW1 + VHYSMW1)	4	10	-	mV	5
MW OUT 2 Hysteresis Width	VHYSMW2	(Release Voltage=VDFMW2 + VHYSMW2)	4	10	-	mV	5
MW OUT 3 Hysteresis Width	VHYSMW3	(Release Voltage=VDFMW3 + VHYSMW3)	4	10	-	mV	5
MW OUT 4 Hysteresis Width	VHYSMW4	(Release Voltage=VDFMW4 x (1 + VHYSMW4 / 100))	2	-	8	%	5
Supply Current	ISSMW	MWVD IN=2.0V	-	5.0	20.0	μA	6
Operating Voltage	MWVDIN		0.9	-	6.0	V	-
MW OUT 1 Output Current	IOUTMW1	Nch VDS=0.5V, MWVDIN=0.9V	0.18	1.8	-	mA	7
MW OUT 2 Output Current	IOUTMW2	Nch VDS=0.5V, MWVDIN=0.9V	0.18	1.8	-	mA	7
MW OUT 3 Output Current	IOUTMW3	Nch VDS=0.5V, MWVDIN=0.9V	0.18	1.8	-	mA	7
MW OUT 4 Output Current	IOUTMW4	Nch VDS=0.5V, MWVDIN=0.9V	0.18	1.8	-	mA	7
MW OUT 1 Delay Time	TDLYMW1	Release Voltage → Output Inversion, RIP open	-	-	0.4	msec	8
MW OUT 2 Delay Time	TDLYMW2	Release Voltage → Output Inversion, RIP open	-	-	0.4	msec	8
MW OUT 3 Delay Time	TDLYMW3	Release Voltage → Output Inversion, RIP open	-	-	0.4	msec	8
MW OUT 4 Delay Time	TDLYMW4	Release Voltage → Output Inversion, RIP open	-	-	0.4	msec	8
Ripple Rejection Resistance	RRIP	RIP=1V, MWVD IN=0V	250	500	1000	kΩ	9

Special Parameter : VDFMW1 ≥ VDFMW2 ≥ VDFMW3

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3. VD 1

V_{DF1}=1.5V

T_a=25°C

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	CIRCUIT
Detect Voltage VD1	V _{DF1}		1.470	1.500	1.530	V	5
Hysteresis Width VD1	V _{HYS1}	(Release Voltage=V _{DF1} x (1 + V _{HYS1} / 100))	2	-	8	%	5
Supply Current	I _{SS1}	V _{IN1} =2.0V	-	1.5	3.0	μA	6
Operating Voltage	V _{IN1}		0.7	-	6.0	V	-
Output Current V _{DET1}	I _{OUT1}	Nch V _{DS} =0.5V, V _{IN1} =0.9V	0.22	2.2	-	mA	7
V _{DET1} L → H Delay Time	T _{LH1}	CD=3.3 μF, V _{IN1} =V _{DF1} x 0.9 → V _{DF1} x 1.1	500	1000	2000	msec	8
V _{DET1} H → L Delay Time	T _{HL1}	CD=3.3 μF, V _{IN1} =V _{DF1} x 1.1 → V _{DF1} x 0.9	20	50	100	msec	8

4. VD 2

V_{DF2}=0.95V

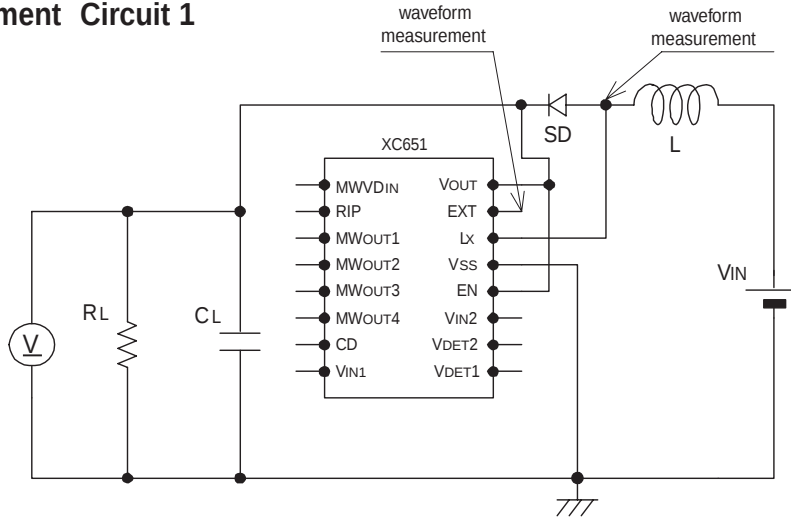
T_a=25°C

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	CIRCUIT
Detect Voltage VD2	V _{DF2}		0.931	0.950	0.969	V	5
Hysteresis Width VD2	V _{HYS2}	(Release Voltage=V _{DF2} x (1 + V _{HYS2} / 100))	2	-	8	%	5
Supply Current	I _{SS2}	V _{IN2} =2.0V	-	1.5	3.0	μA	6
Operating Voltage	V _{IN2}		0.7	-	6.0	V	-
Output Current V _{DET2}	I _{OUT2}	Nch V _{DS} =0.5V, V _{IN2} =0.9V	0.18	1.8	-	mA	7
Delay Time V _{DET2}	T _{DLY2}	Release Voltage → Output Inversion	-	-	0.2	msec	8

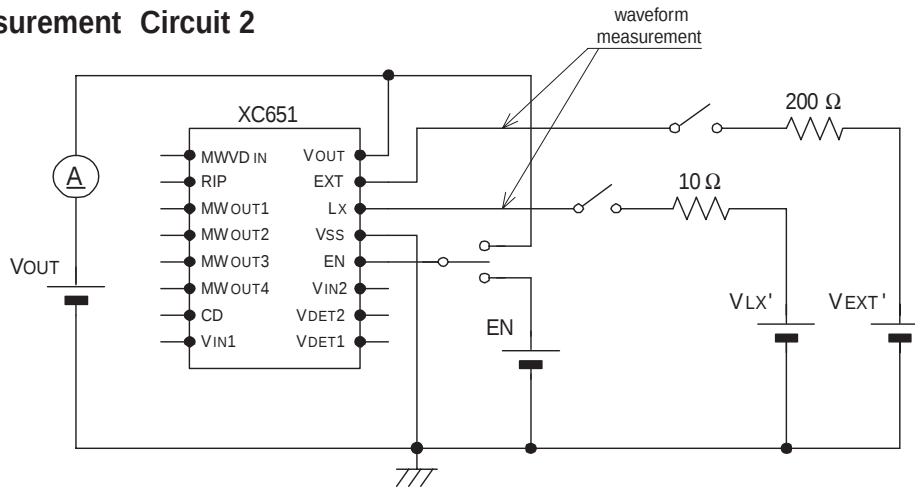
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Measurement Circuits

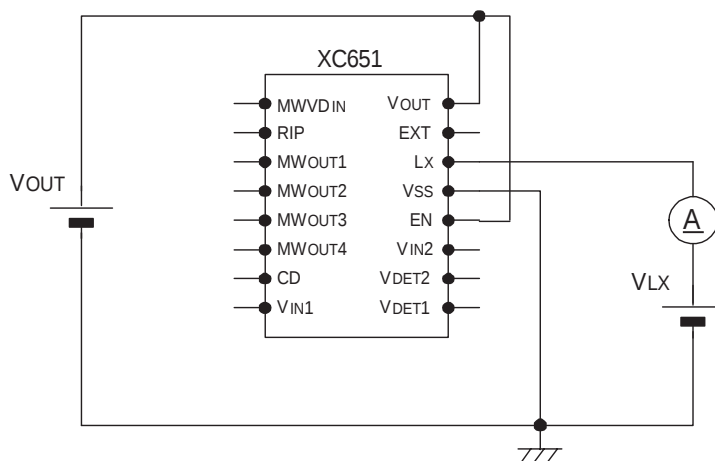
Measurement Circuit 1



Measurement Circuit 2

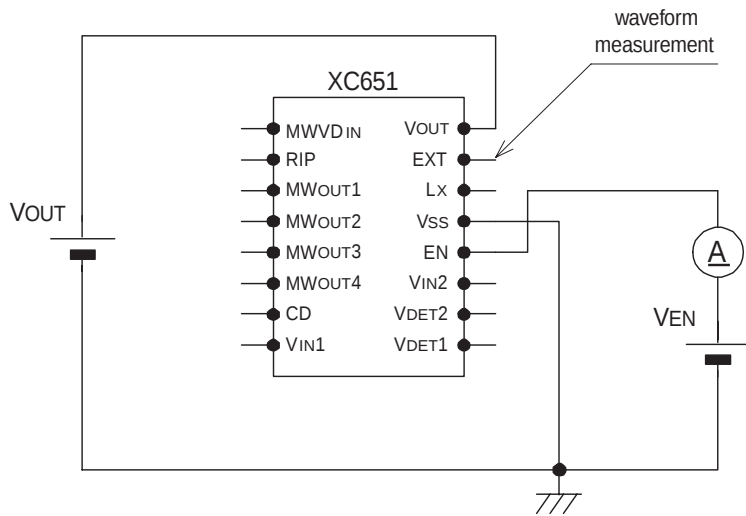


Measurement Circuit 3

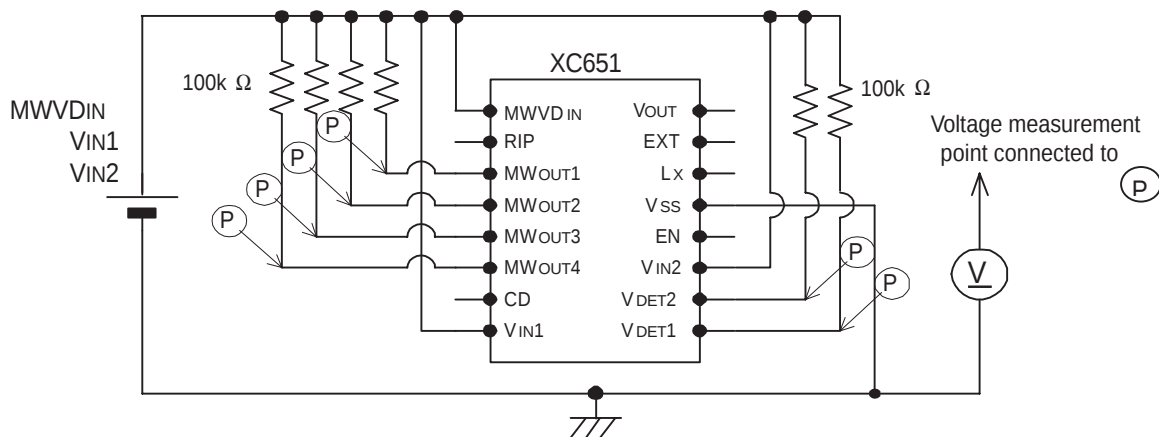


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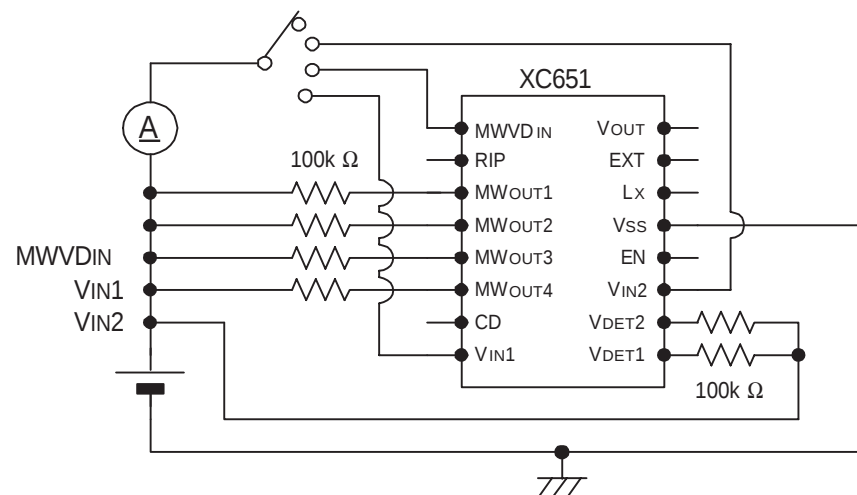
Measurement Circuit 4



Measurement Circuit 5

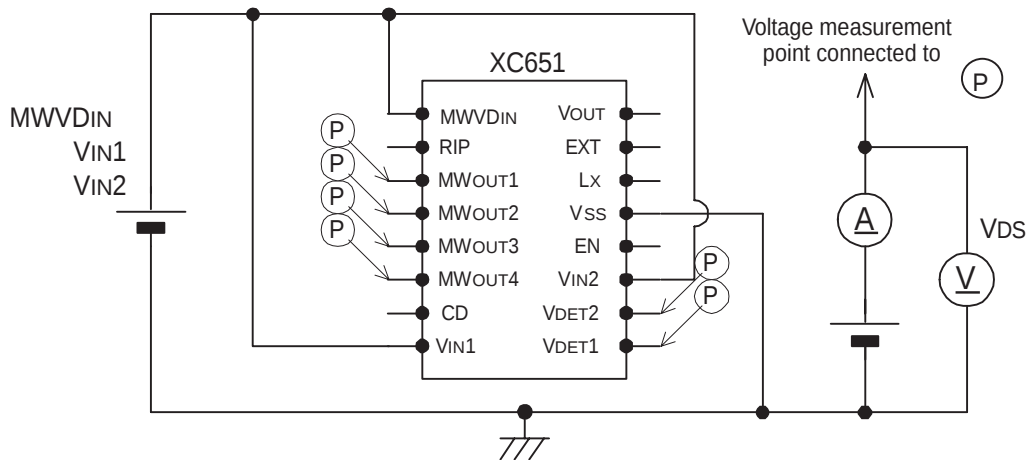


Measurement Circuit 6

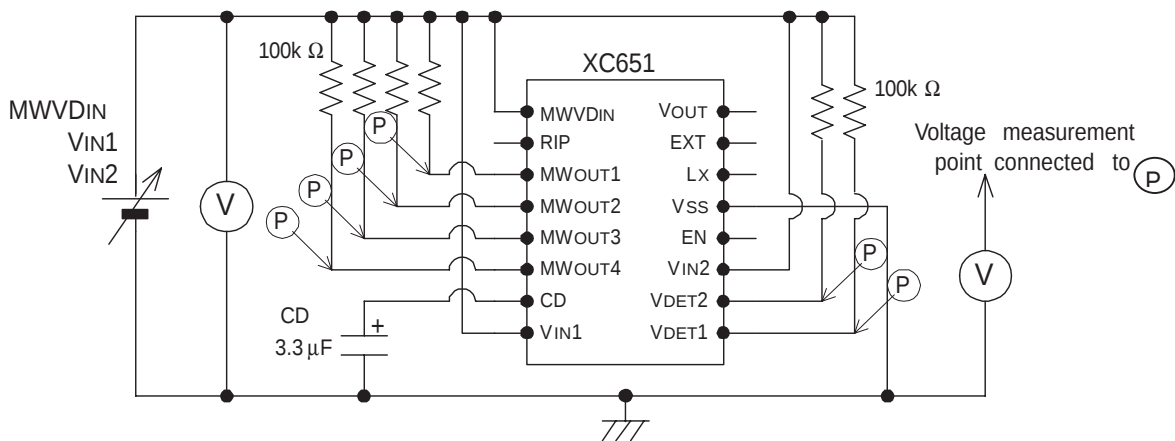


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Measurement Circuit 7



Measurement Circuit 8



Measurement Circuit 9

