

Compound power supply IC with VD

NO.EA-196-130521

OUTLINE

RP902 Series are CMOS-based compound power supply IC with Voltage Detector (VD), Voltage Detector (VD), PWM/VFM Auto-switching Step-down DC/DC Converter with synchronous rectifier (DD1), PWM Step-down DC/DC Converter control type with synchronous rectifier (DD2) and PWM Step-up DC/DC Converter control type (DD3).

PWM/VFM Auto-switching Step-down DC/DC Converter control type with synchronous rectifier (DD1) has the adoption of the synchronous rectification method that the switching element is built-in. A highly effective step-up DC/DC converter can be composed only of the coil and the capacitor as external parts. The PWM/VFM auto-switching control method is for achieving highly effective at VFM mode.

PWM Step-down DC/DC Converter with synchronous rectifier (DD2) has the adoption of the synchronous rectification method that the switching element is built-in. A highly effective step-up DC/DC converter can be composed only of the coil and the capacitor as external parts.

PWM Step-up DC/DC Converter (DD3) has the asynchronous rectification method by NMOS switching element built-in. The step-up DC/DC converter can be composed only of the diode, the coil, the capacitors and resistances as external parts.

When a large output current is necessary, to control by the additional external NMOS is possible. When the output voltage is necessary to cut when it is off, to control additional external PMOS is possible.

As the protection circuits, the current limit circuits of DD1 and DD2 for limiting peak current of Lx at each clock cycle, and DD3 has the ratio limitation time function. This IC has also the built-in reset type protection function. When the limited condition is continue in certain time, the reset-start function is operated. The built-in low voltage detection circuit (UVLO) is operating for stopping the output to prevent the malfunction when a low voltage is detected.

As the soft-start circuits, the time of DD1, DD2 and DD3 is fixed. And DD1 and DD2 have the start-up order control function by the trimming.

DD1 and DD2 have the built-in feed-back resistance. The setting output voltage is fixed. It can set by the trimming in 0.1V step. DD3 has the feed-back resistance in externally. The setting output voltage can set between 5.0V and 11V.

Controlling the external pin, it is possible to changing the output voltage dramatically from 72.7% to 100%.

(The output voltage range is between 11V and 8.0V (72.7%) when the default output voltage is set to 11V by the external feed-back)

To using the trimming options, it is also possible to changing the output voltage dramatically from 57.8% to 100%. (The output voltage range is between 9V and 5.2V (57.8%) when the default output voltage is set to 9V by the external feed-back)

The Voltage Detector is monitoring the input voltage; the output is Nch open drain output. Power-on reset delay time is also included and it is possible to selected 50ms or 100ms by the trimming.

FEATURE

- Input Voltage Range 4.5V~5.5V
- Package QFN0404-20
- External components $C_{IN}=0.1\mu F$, $10\mu F$
 - $C_{OUT}=10\mu F$, $L=4.7\mu H$ (DD1)
 - $C_{OUT}=10\mu F$, $L=4.7\mu H$ (DD2)
 - $C_{OUT}=10\mu F*3$, $L=4.7\mu H$ (DD3)

■ PWM/VFM Auto-switching Step-down DC/DC Converter with synchronous rectifier (DD1)

- Output voltage range The output voltage in the range of 1.2V to 2.5V can be set by trim.
- Output Voltage accuracy..... $\pm 2.0\%$
- Oscillation Frequency Typ.1.35MHz
- Internal drive ON resistance Typ. Pch-0.5 Ω , Nch-0.25 Ω
- Soft-start function Typ. 1ms is fixed.
(The turning-on order with DD2 can be set by the trim.)
- Lx peak limit current function Typ.1.3A
- Output current Max.800mA
- Reset type protection function Typ.1ms

■ PWM Step-down DC/DC Converter with synchronous rectifier (DD2)

- Output voltage range The output voltage in the range of 1.2V to 3.3V can be set by trim.
- Output Voltage accuracy..... $\pm 2.0\%$
- Oscillation Frequency Typ.1.35MHz
- Internal drive ON resistance Typ. Pch-0.5 Ω , Nch-0.5 Ω
- Soft-start function Typ. 1ms is fixed.
(The turning-on order with DD1 can be set by the trim.)
- Lx peak limit current function Typ.1.0A
- Output current Max.500mA
- Reset type protection function Typ.1ms

■ PWM Step-up DC/DC Converter (DD3)

- Output voltage range The output voltage in the range of 5.0V to 11V can be set by the external resistances.
- Output Voltage accuracy..... $\pm 2.0\%$
- Oscillation Frequency Typ.1.35MHz
- Internal drive ON resistance Typ. Nch-0.4 Ω
- Soft-start function Typ. 10ms is fixed.
- Ratio limitation time function Typ.75%
- Output current Max.300mA(When internal FET is used)
- Reset type protection function Typ.1.5ms

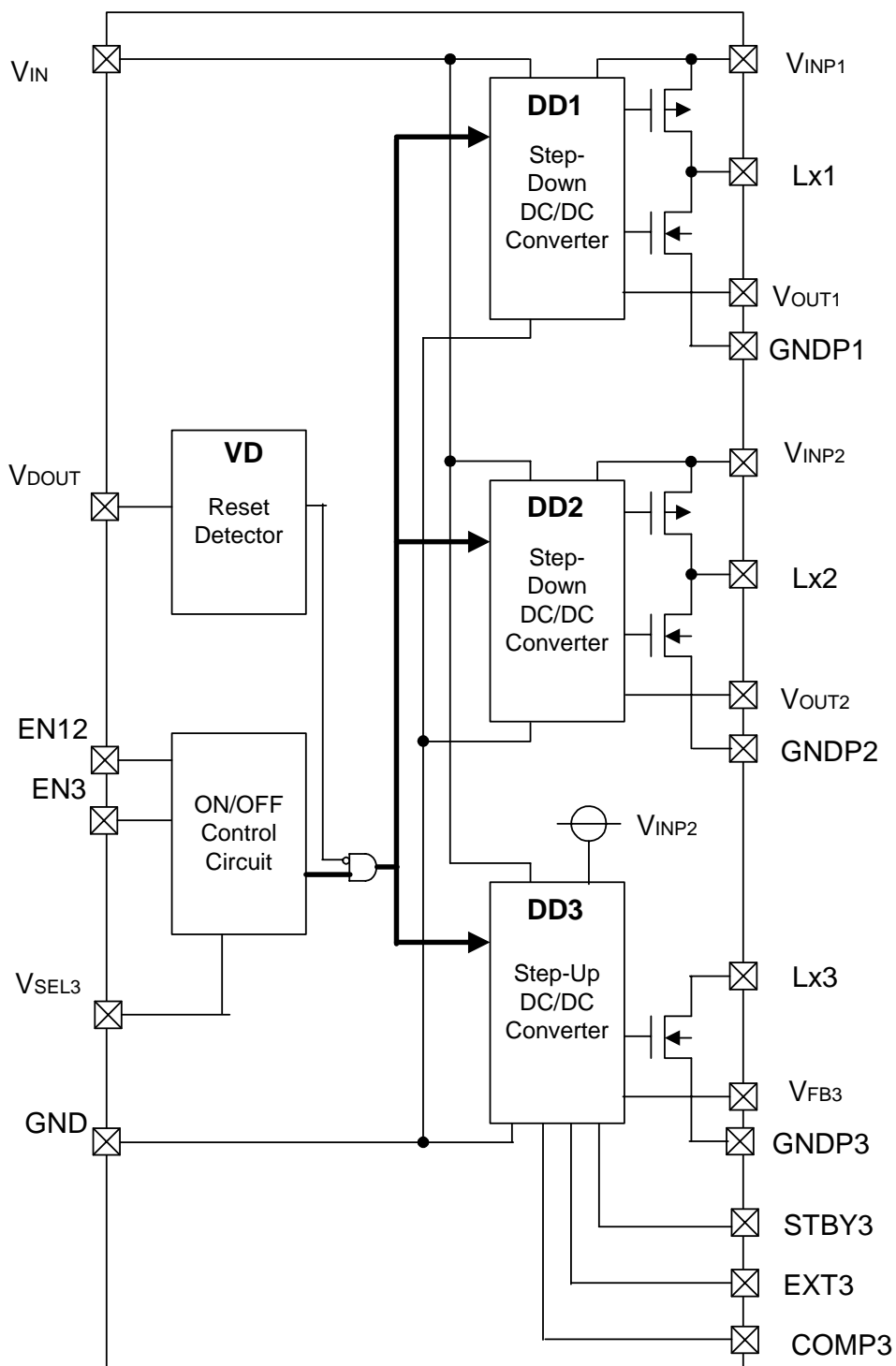
■ VD

- Voltage Detector Threshold voltage range..... The voltage detector threshold voltage in the range of 3.0V to 5.0V can be set by trim.
- Delay time for Release..... Typ.50ms or 100ms can be set by trim.

APPLICATION

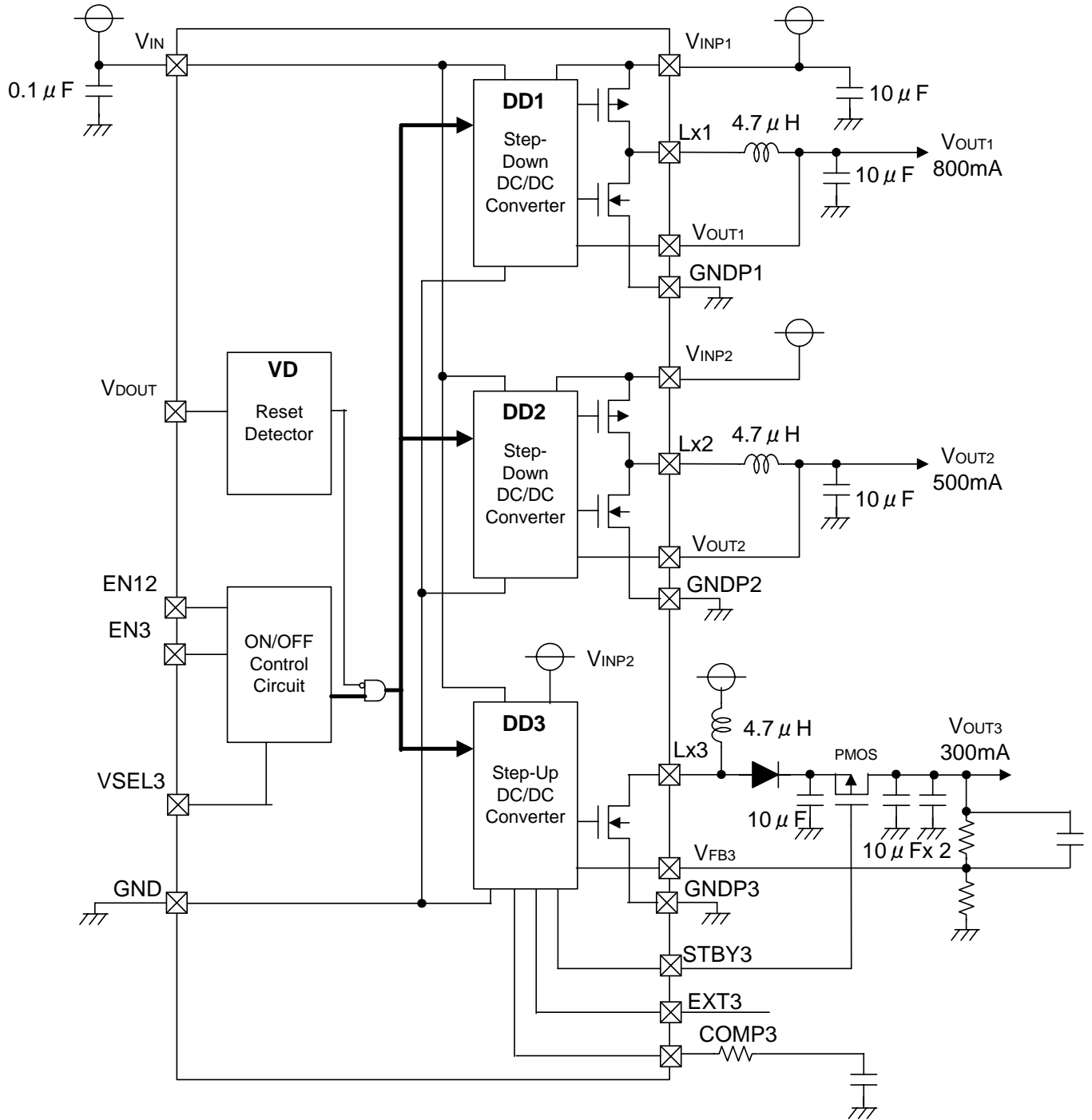
- Power source for digital home appliance such as DVD player.(both blue and red type LD)
- Power source for DVD-ROM/R/RW(both blue and red type LD) of note PC and desktop PC.

BLOCK DIAGRAM



* V_{DOUT} is Nch Open Drain Pin

REFERENCE CIRCUIT



- * Please set EXT3 pin as OPEN when the external NMOS is not necessary to use.
- * Please set Lx3 pin as OPEN when the external NMOS will be using.
- * Please set STBY3 pin as OPEN when the external PMOS is not necessary to use.

SELECTION GUIDE

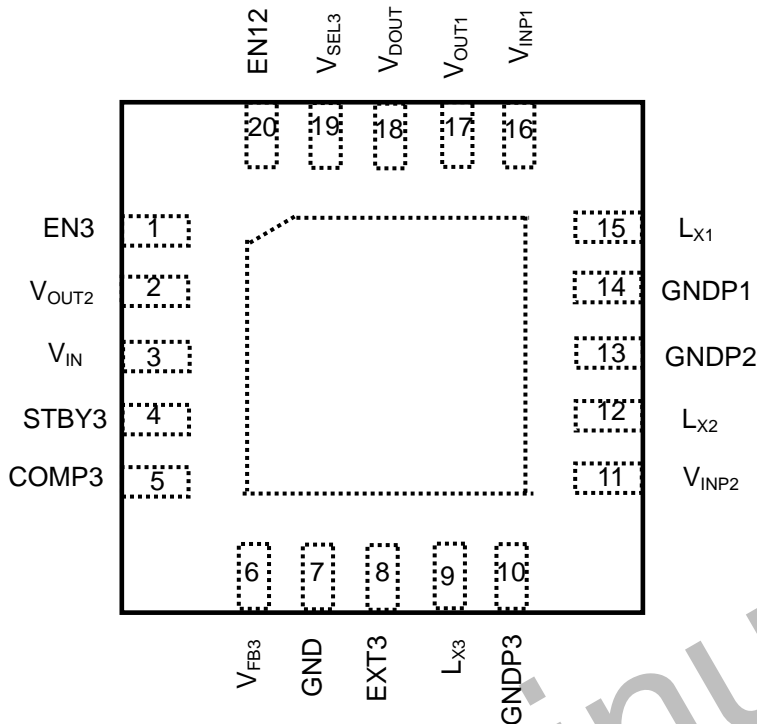
In the RP902 series, output voltage, function options, etc. can be selected at the with user's request. The selection can be made with designating the part number as shown below.

RP902K xx xx xx xx - x x - E2 ← Part Number
 ↑ ↑ ↑ ↑ ↑ ↑ ↑
 a b c d e f g

Code	Contents		
a	Designation of Package Type K: QFN0404-20		
b	Designation of DCDC1 output voltage. Designation is possible in the range from 1.2V to 2.5V with a step of 0.1V.		
c	Designation of DCDC2 output voltage. Designation is possible in the range from 1.2V to 3.3V with a step of 0.1V.		
d	Designation of DET detecting voltage. Designation is possible in the range from 3.0V to 5.0V with a step of 0.1V.		
e	Designation of function options1.		
		VFM/PWM alternative	Return delay time of VD
	A	VFM / PWM	100ms
	B	VFM / PWM	50ms
	C	PWM ONLY	100ms
f	Designation of function options2.		
		The start order	DCDC1,2 Power Good function (V _{DOUT} pin)
	A	DCDC1→2	100~72.7%
	B	DCDC1→2	100~72.7%
	C	DCDC1→2	100~57.8%
	D	DCDC1→2	100~57.8%
	E	DCDC1→2	100~55.6%
	F	DCDC1→2	100~55.6%
	G	DCDC2→1	100~72.7%
	H	DCDC2→1	100~72.7%
	J	DCDC2→1	100~57.8%
	K	DCDC2→1	100~57.8%
	L	DCDC2→1	100~55.6%
M	DCDC2→1	100~55.6%	
g	Designation of the taping type: (-E2 is the standard.)		

* As for V_{IN} voltage, V_{OUT1} voltage, and V_{OUT2} voltage normally stand up, if Power Good function is "yes", V_{DOUT} will be changed from "L" to "Hi-Z" after return delay time.

PACKAGE DIMENTIONS (QFN0404-20)



PIN DESCRIPTION

Pin No.	Symbol	Pin Description
1	EN3	Enable Pin for DD3 ("H" Active)
2	V_{OUT2}	Output Voltage Detective Pin 2
3	V_{IN}	Input Pin for Analog power supply
4	STBY3	External PMOS control Pin for DD3 (When EN3="L", STBY3="H")
5	COMP3	Phase compensation Pin for DD3
6	V_{FB3}	Output Voltage return Pin for DD3
7	GND	Ground Pin for Analog
8	EXT3	External NMOS control Pin for DD3
9	L_{X3}	L_X Switching Pin 3
10	GNDP3	Ground Pin 3
11	V_{INP2}	Input Pin for power supply 2
12	L_{X2}	L_X Switching Pin2
13	GNDP2	Ground Pin 2
14	GNDP1	Ground Pin 1
15	L_{X1}	L_X Switching Pin 1
16	V_{INP1}	Input Pin for power supply 1
17	V_{OUT1}	Output Voltage Detective Pin 1
18	V_{DOUT}	Output Pin (When detective mode; V_{DOUT} ="L", release mode; V_{DOUT} ="Hi-Z")
19	V_{SEL3}	Switching Output Voltage Pin for DD3
20	EN12	Enable Pin for DD1-2 ("H" Active)

* V_{IN} , V_{INP1} and V_{INP2} must be on the same voltage level.

* EN12, EN3 and V_{SEL3} should not be input opening.

ABSOLUTE MAXIMUM RANGE

(GND 0V)

Item	Symbol	Ratings	Unit
V _{IN} pin voltage	V _{IN}	-0.3~6.5	V
V _{INP1} pin voltage	V _{INP1}	-0.3~6.5	V
V _{INP2} pin voltage	V _{INP2}	-0.3~6.5	V
EN12 pin voltage	V _{EN12}	-0.3~V _{IN} +0.3	V
EN3 pin voltage	V _{EN3}	-0.3~V _{IN} +0.3	V
V _{SEL3} pin voltage	V _{SEL3}	-0.3~V _{IN} +0.3	V
L _{X1} pin voltage	V _{LX1}	-0.3~V _{INP1} +0.3	V
L _{X1} pin current	I _{LX1}	1.0	A
L _{X2} pin voltage	V _{LX2}	-0.3~V _{INP2} +0.3	V
L _{X2} pin current	I _{LX2}	1.0	A
L _{X3} pin voltage	V _{LX3}	-0.3~15	V
L _{X3} pin current	I _{LX3}	1.0	A
V _{OUT1} pin voltage	V _{OUT1}	-0.3~V _{IN} +0.3	V
V _{OUT2} pin voltage	V _{OUT2}	-0.3~V _{IN} +0.3	V
V _{FB3} pin voltage	V _{FB3}	-0.3~V _{IN} +0.3	V
V _{DOUT} pin voltage	V _{DOUT}	-0.3~V _{IN} +0.3	V
Power Dissipation	P _D	1900	mW
Operation Temperature	T _{OPT}	-40~85	°C
Storage Temperature	T _{STG}	-55~125	°C

ABSOLUTE MAXIMUM RATINGS

Absolute Maximum ratings are threshold limit values that must not be exceeded ever 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 these limits.

ELECTRICAL CHARACTERISTICS

● RP902XXX

(Topt=25°C)

Symbol	Item	Condition	MIN.	TYP.	MAX.	Unit.
V_{IN}	Operation Input Voltage	$V_{INP1}=V_{INP2}=V_{IN}$	4.5		5.5	V
V_{INP1}	Operation Input Voltage	$V_{INP1}=V_{INP2}=V_{IN}$	4.5		5.5	V
V_{INP2}	Operation Input Voltage	$V_{INP1}=V_{INP2}=V_{IN}$	4.5		5.5	V
I_{STB}	Standby Current	$V_{IN}=5.5V, V_{EN12}=V_{EN3}=0V$		3.0	10	μA
I_{SS1}	Supply Current 1 (No Switching)	$V_{IN}=V_{EN12}=5.5V, V_{EN3}=0V$ $V_{OUT1}=V_{OUT2}=5.5V$		290		μA
I_{SS2}	Supply Current 2 (No Switching)	$V_{IN}=V_{EN12}=V_{EN3}=5.5V$ $V_{OUT1}=V_{OUT2}=V_{FB3}=5.5V$		350		μA
V_{EN12H}	EN12 Input Voltage "H"		1.9			V
V_{EN12L}	EN12 Input Voltage "L"				0.3	V
V_{EN3H}	EN3 Input Voltage "H"		1.9			V
V_{EN3L}	EN3 Input Voltage "L"				0.3	V
V_{SEL3H}	V_{SEL3} Input Voltage "H"		1.9			V
V_{SEL3L}	V_{SEL3} Input Voltage "L"				0.3	V
fosc	Oscillation Frequency		-20%	1.35	+20%	MHz

*Test circuit is "OPEN LOOP"

* $V_{IN}=V_{INP1}=V_{INP2}=V_{EN12}=V_{EN3}=5V, GND =GNDP1=GNDP2=GNDP3=0V$ unless otherwise noted.

● DD1

(Topt=25°C)

Symbol	Item	Condition	MIN.	TYP.	MAX.	Unit.
V_{OUT1}	Output Voltage	$I_{OUT1}=100mA, (CLOSED LOOP)$	-2.0%	1.2~2.5	+2.0%	V
$\Delta V_{OUT1}/\Delta T$	Output Voltage Temperature Coefficient	$-40^{\circ}C \leq T_{OPT} \leq 85^{\circ}C$		± 150		ppm/ $^{\circ}C$
$I_{LX1LEAKH}$	L_X1 Leak Current "H"	$V_{IN}=V_{LX1}=5.5V, V_{EN12}=V_{EN3}=0V$	-1	0	5	μA
$I_{LX1LEAKL}$	L_X1 Leak Current "L"	$V_{IN}=5.5V, V_{EN12}=V_{EN3}=V_{LX}=0V$	-5	0	1	μA
RONP1	Pch Transistor ON Resistance	$I_{LX1}=-100mA$		0.5		Ω
RONN1	Nch Transistor ON Resistance	$I_{LX1}=-100mA$		0.25		Ω
I_{LX1LIM}	L_X1 Limit Current		0.9	1.3		A
t_{PROT1}	Protection Delay Time			1.0		ms
t_{SS1}	Soft-Start Time			1		ms

*Test circuit is "OPEN LOOP"

* $V_{IN}=V_{INP1}=V_{INP2}=V_{EN12}=V_{EN3}=5V, GND =GNDP1=GNDP2=GNDP3=0V$ unless otherwise noted.

● DD2

(Topt=25°C)

Symbol	Item	Condition	MIN.	TYP.	MAX.	Unit.
V _{OUT2}	Output Voltage	I _{OUT2} =100mA _(CLOSED LOOP)	-2.0%	1.2~3.3	+2.0%	V
$\Delta V_{OUT2}/\Delta T$	Output Voltage Temperature Coefficient	-40°C ≤ T _{OPT} ≤ 85°C		±150		ppm/°C
I _{LX2LEAKH}	L _{X2} Leak Current "H"	V _{IN} =V _{LX2} =5.5V, V _{EN12} =V _{EN3} =0V	-1	0	5	μA
I _{LX2LEAKL}	L _{X2} Leak Current "L"	V _{IN} =5.5V, V _{EN12} =V _{EN3} =V _{LX2} =0V	-5	0	1	μA
RONP2	Pch Transistor ON Resistance	I _{LX2} =-100mA		0.5		Ω
RONN2	Nch Transistor ON Resistance	I _{LX2} =-100mA		0.5		Ω
I _{LX2LIM}	L _{X2} Limit Current		0.6	1.0		A
t _{PROT2}	Protection Delay Time			1.0		ms
t _{SS2}	Soft-Start Time			1		ms

*Test circuit is "OPEN LOOP"

*V_{IN}=V_{INP1}=V_{INP2}=V_{EN12}=V_{EN3}=5V, GND =GNPD1=GNPD2=GNPD3=0V unless otherwise noted.

● DD3

(Topt=25°C)

Symbol	Item	Condition	MIN.	TYP.	MAX.	Unit.
V _{FB3}	Output Return Voltage	I _{OUT3} =20mA _(CLOSED LOOP)	-2.0%		+2.0%	V
$\Delta V_{FB3}/\Delta T$	Output Voltage Temperature Coefficient	-40°C ≤ T _{OPT} ≤ 85°C		±150		ppm/°C
I _{SS3}	Supply Current	I _{SS2} -I _{SS1}		60		μA
I _{LX3LEAKH}	L _X Leak Current "H"	V _{IN} =V _{LX3} =5.5V, V _{EN12} =V _{EN3} =0V	-1	0	5	μA
RONN3	Nch Transistor ON Resistance	I _{LX3} =-100mA		0.4		Ω
t _{PROT3}	Protection Delay Time			1.5		ms
t _{SS3}	Soft-Start Time			10		ms
Maxduty	Maximum Duty Ratio			75		%

*Test circuit is "OPEN LOOP"

*V_{IN}=V_{INP1}=V_{INP2}=V_{EN12}=V_{EN3}=5V, GND =GNPD1=GNPD2=GNPD3=0V unless otherwise noted.

● VD

(Topt=25°C)

Symbol	Item	Condition	MIN.	TYP.	MAX.	Unit.
-V _{DET}	V _D Detector Threshold		-2.0%		+2.0%	V
$\Delta -V_{DET}/\Delta T$	V _D Detector Threshold Temperature Coefficient	-40°C ≤ T _{OPT} ≤ 85°C		±150		ppm/°C
V _{HYS}	Hysteresis Range			-V _{DET} × 0.05		V
T _{PLH}	Power-on Reset Delay Time			50		ms
I _{DOU_TL}	V _{DOU_T} "L" Output Current	V _{IN} =4.5V, V _{DOU_T} =0.1V	1	3.5	10	mA

*Test circuit is "OPEN LOOP"

*V_{IN}=V_{INP1}=V_{INP2}=V_{EN12}=V_{EN3}=5V, GND =GNPD1=GNPD2=GNPD3=0V unless otherwise noted.

■ The function of output voltage control for change in DD3

For the output voltage of DD3, it can be controlled by V_{SEL3} and EN3. The voltage to LD of the optical disk can be dynamically controlled. There are two control methods which are the 2 stage-switching of toggle control or the max 7 stage-switching. When the output voltage is changing, the soft-start function is operated to reduce the rash-current.

EN3 is the Enable pin of DD3 normally. It is possible to operate the step up in DD3 when it is "H" mode. The range of changing voltage can be set by two methods of the trimming options below.

① The method of changing output voltage in two stage (toggle control)

By starting up EN3 to control V_{SEL3} , the output voltage is able to control. The output is 100%(72.2% *1) when V_{SEL3} is "H level", and 72.7%(57.8% *1) when V_{SEL3} is "L level".

② The method of changing output voltage up to max7-stage.

EN3 is a pin shared with 1-Wire control function. It changes whenever the output voltage puts the pulse by putting the pulse in EN3 after EN3 is started up.

The control step of 1-wire is shown in the table below.

The value is shown in below table as 11V is set in 100% voltage in the 7-stage voltage control. If the output voltage will be excluding 11V in 100% voltage, selected by the external resistance, the output voltage is changing by the percentage ratio in the table below.

•Trimming option 1(default)

Stage	Ratio	V_{OUT3}	V_{FB3}	V_{SEL3} control
0	100.000%	11	1.00	(VSEL3="H")
1	95.455%	10.484	0.955	-
2	90.909%	10.012	0.909	-
3	86.364%	9.496	0.864	-
4	81.818%	8.980	0.818	-
5	77.273%	8.508	0.773	-
6	72.727%	7.992	0.727	(VSEL3="L")

By using the trimming option, the range of changing voltage can be selected between 100% and 57.8%. The value is shown in below table as 9V is set in 100% voltage in the 7-stage voltage control.

*1

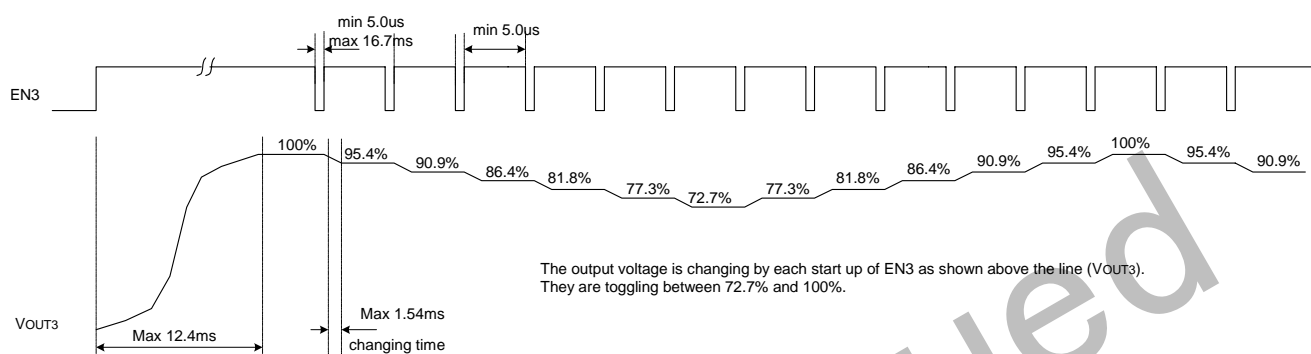
•Trimming Option 2

Stage	Ratio	V_{OUT3}	V_{FB3}	V_{SEL3} control
0	100.000%	9	1.00	-
1	95.444%	8.508	0.954	-
2	88.889%	8.016	0.888	-
3	83.333%	7.488	0.833	-
4	77.778%	6.996	0.778	-
5	72.222%	6.504	0.722	(VSEL3="H")
6	57.778%	5.203	0.578	(VSEL3="L")

For the trimming option1, the output voltage changing range controlled by $V_{SEL3}/EN3$ is shown as below.

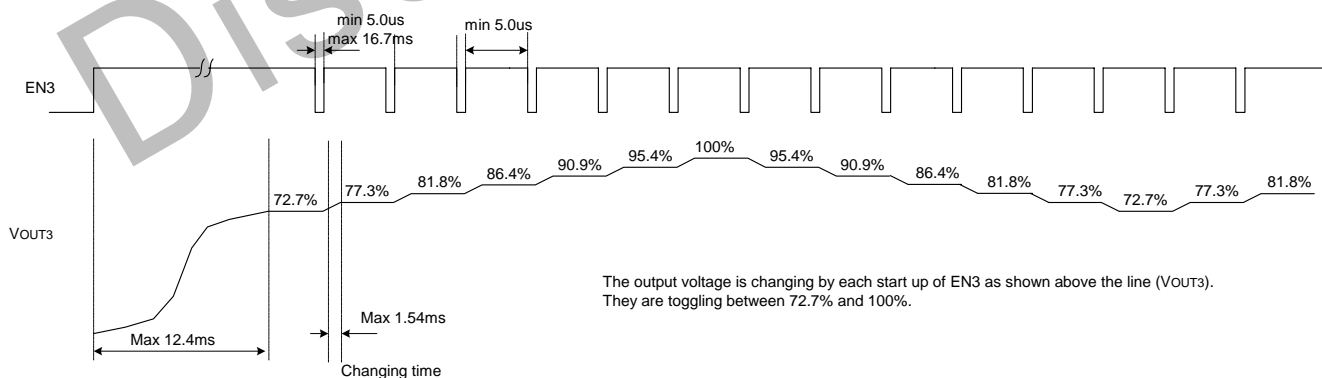
■ Set $V_{SEL3}="H"$ and then start EN3 up.

When V_{SEL3} is "H", the voltage ratio is 100%. When V_{SEL3} is set in "H" and then EN3 is started up, it operates as follows. The voltage decreases from 100% when the pulse is entered by EN3. When the sixth-pulse was entered, the voltage ratio is set to the lowest 72.2%. After the voltage ratio is 72.2%, the voltage is increasing from 72.2% up to 100% again if keeping putting the pulse in.



■ Set $V_{SEL3}="L"$ and then start EN3 up

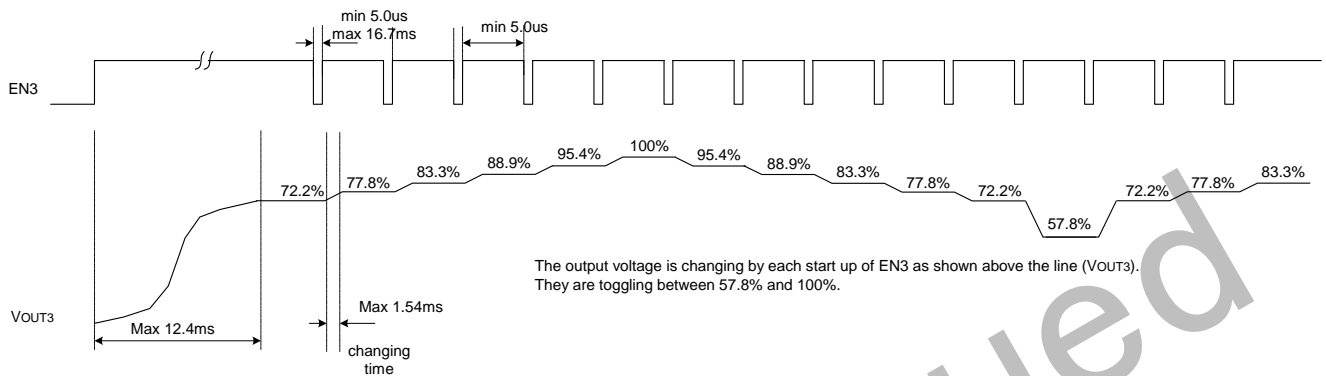
When V_{SEL3} is "L", the voltage ratio is 72.2%. When V_{SEL3} is set in "L" and then EN3 is started up, it operates as follows. The voltage is increasing from 72.2% when the pulse is entered by EN3. When the sixth-pulse was entered, the voltage ratio is set to the maximum 100%. After the voltage ratio is 100%, the voltage is decreasing from 100% down to 72.2% again if keeping putting the pulse in.



For the trimming option2, the output voltage changing range controlled by $V_{SEL3}/EN3$ is shown as below.

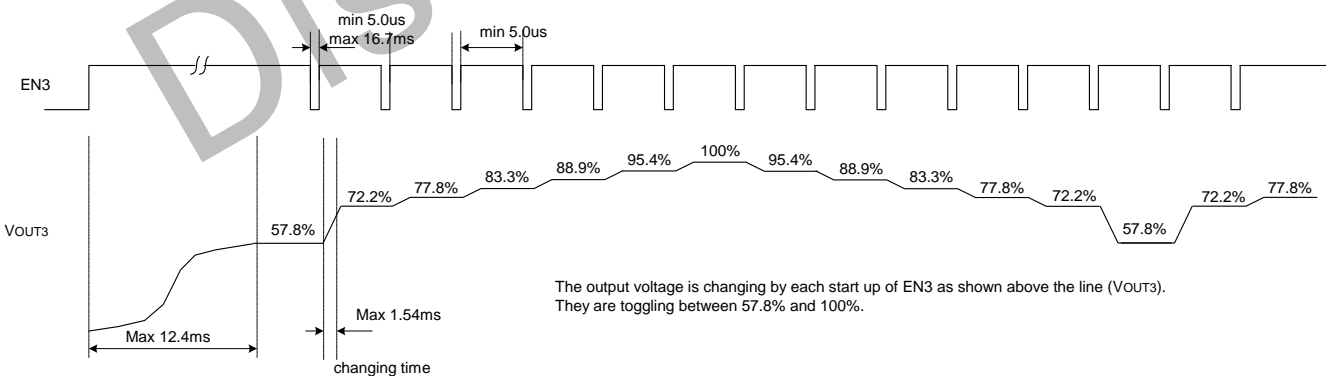
■ Set $V_{SEL3}="H"$ and then start EN3 up

When V_{SEL3} is "H", the voltage ratio is 72.2%. When V_{SEL3} is set in "H" and then EN3 is started up, it operates as follows. The voltage is increasing from 72.2% when the pulse is entered by EN3. When the fifth-pulse was entered, the voltage ratio is set to the maximum 100%. After the voltage ratio is 100%, the voltage is decreasing from 100% down to 72.2% again if keeping putting the pulse in.



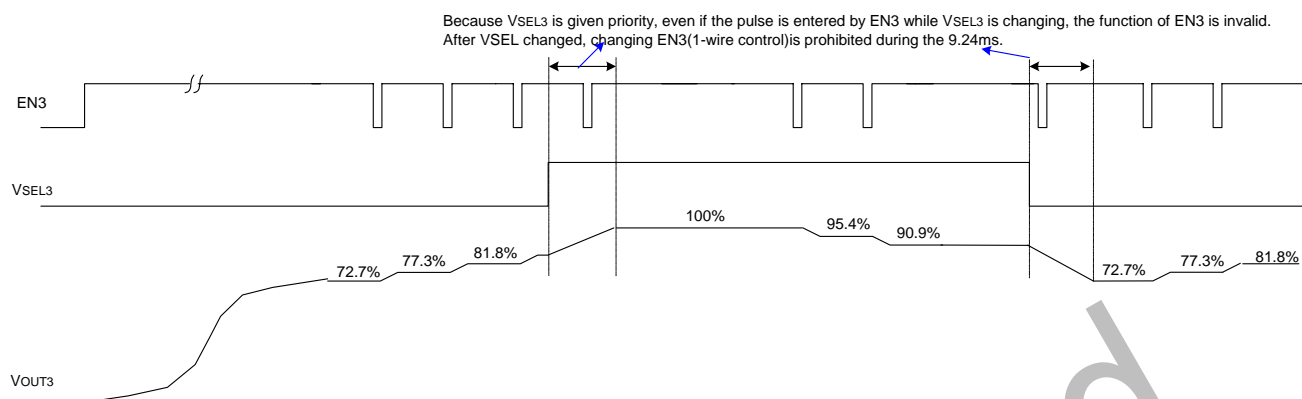
■ Set $V_{SEL3}="L"$ and then start EN3 up

When V_{SEL3} is "L", the voltage ratio is 58.8%. When V_{SEL3} is set in "L" and then EN3 is started up, it operates as follows. The voltage is increasing from 58.8% when the pulse is entered by EN3. When the sixth-pulse was entered, the voltage ratio is set to the maximum 100%. After the voltage ratio is 100%, the voltage is decreasing from 100% down to 58.8% again if keeping putting the pulse in.



■ When V_{SEL3} is changed at HIGH of EN3

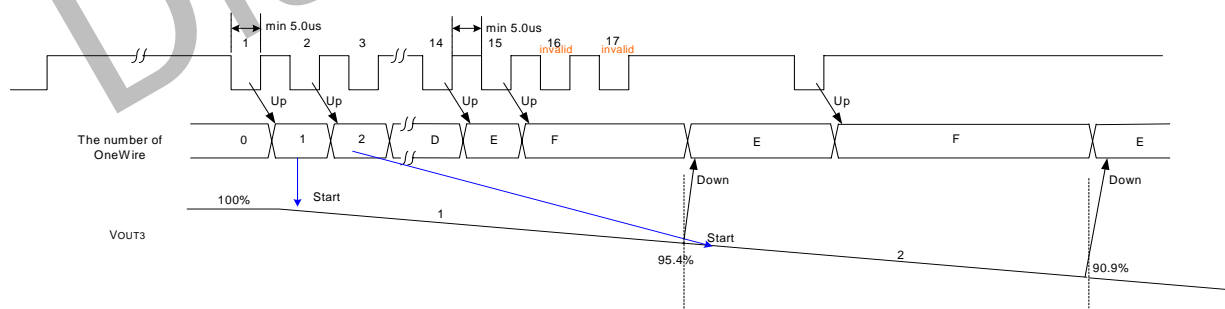
Because changing V_{SEL3} is given priority, EN3 pulse is invalid while V_{SEL3} is changing.
 When V_{SEL3} changed to "H", the output voltage is set in 100%, V_{SEL3} changed to "L", it is set in 72.2%.



(The diagram shown above is the function explanation of the trimming option 1. The function is the same as the trimming option 1 and 2)

■ About the 1-wire control pulse of EN3

Even if the output voltage hasn't changed completely yet, it is able to enter the 15 times pulses in continuously by EN3 if it is more than $5.0\mu s$ in between pulses. It is disregarded even if more than 15 times entered. Because V_{SEL3} is given priority, even if the EN3 is changing while V_{SEL3} is changing, the function of EN3 is invalid.



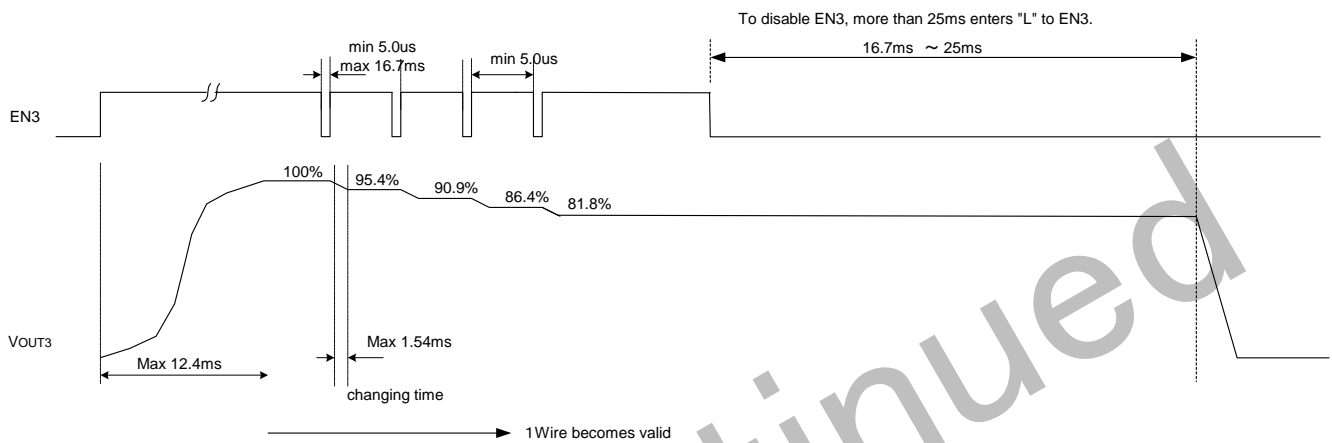
(The diagram shown above is the function explanation of the trimming option 1. The function is the same as the trimming option 1 and 2)

■ About the Soft-start-control of the output voltage

The soft-start-control function of DD3 is operating for reducing the rash-current due to the output voltage control by EN3 or V_{SEL3} .

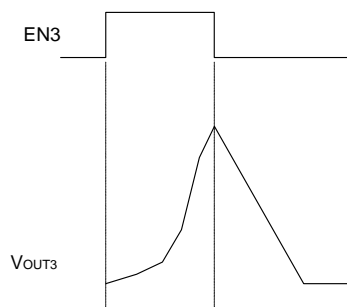
DD3 starts up by EN3 but during the time of standing DD3 up, the 1-Wire control is invalid. After EN3 is started up (max12.4ms), 1-Wire control becomes valid.

When 25ms or more enters "L" to EN3, EN3 becomes disabling and then DD3 doesn't function.



(The diagram shown above is the function explanation of the trimming option 1. The function is the same as the trimming option 1 and 2)

When "L" by EN3 is entered without completing the start-up of DD3 after EN3 is started up that "L" signal is recognized as noise, in this case, EN3 is disabled in 1-clock cycle.



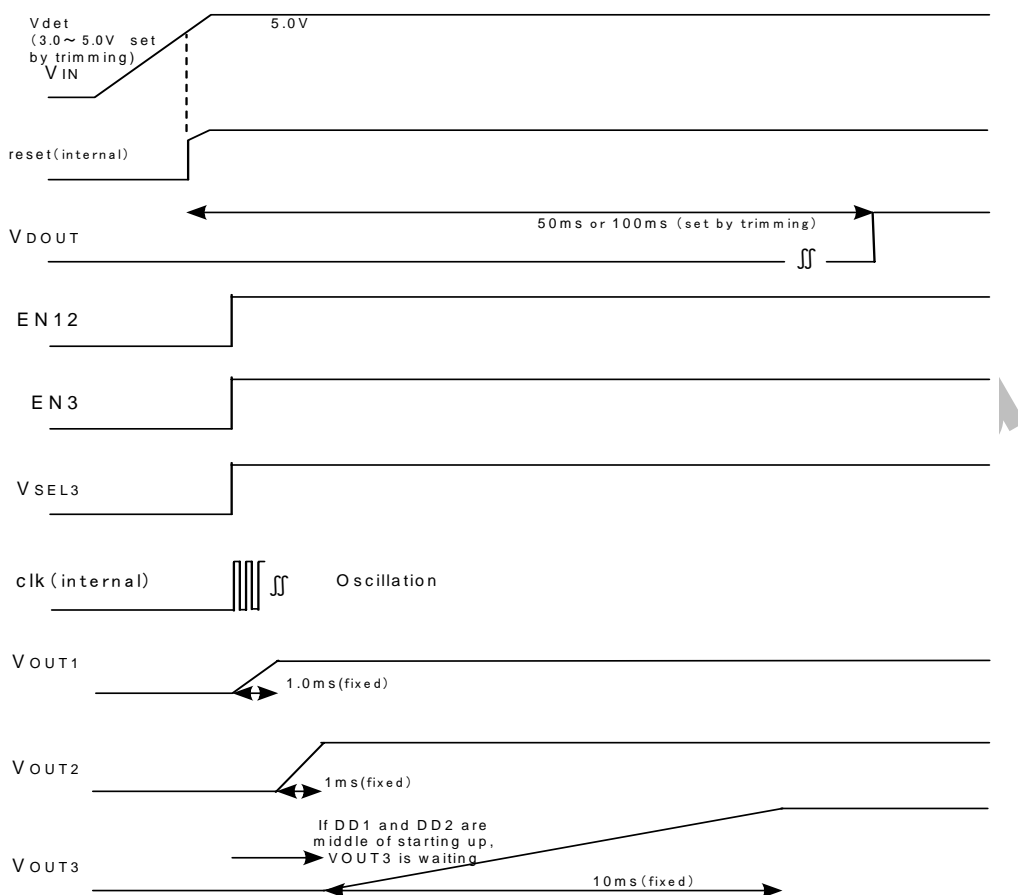
(The diagram shown above is the function explanation of the trimming option 1. The function is the same as the trimming option 1 and 2)

■ The start-up sequence function and the timing chart

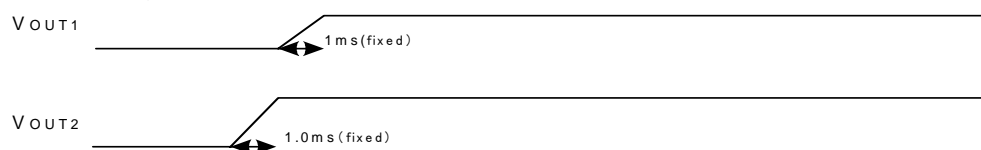
For starting up of DD1, DD2 and DD3, there is the sequence function of starting up, including the soft-start function. A possible sequences order to use as follows;

DD1→DD2 →DD3 or DD2→DD1→DD3.

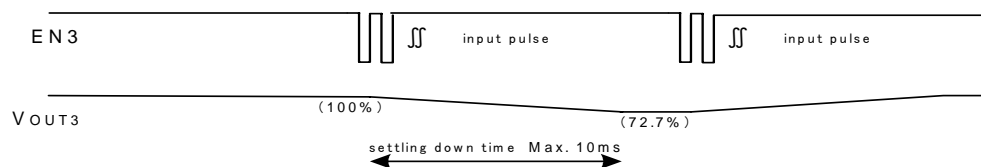
This sequence order is set by the trimming option when shipping them.



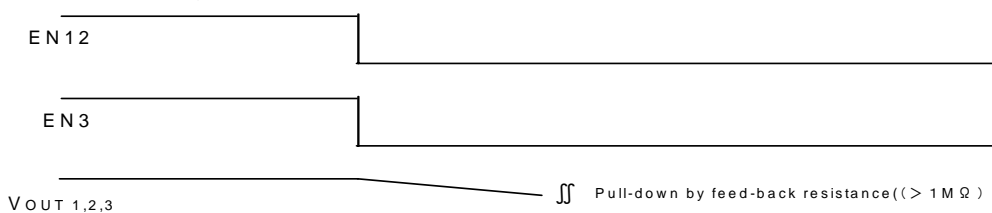
The trimming options



changable output of DD3



About disabling





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