



# AP4460

## Step-up DC-DC Converter with Power Path for Single Solar Cell

### 1. General Description

The AP4460 is a synchronous step-up DC-DC converter that can be operated by a single solar cell. It has a power management function which supplies power to an external system, charges super capacitors, or supplies power from the super capacitor to the system. The DC-DC converter is a hysteric comparator type and composed of an ultra-low power start-up circuit which starts from only 0.35 V. Because the power consumption is extremely low, the AP4460 can operate with low input power generated by a solar panel under indoor lighting. The input voltage of the DC-DC converter, i.e. output voltage of the solar cell is controlled by external resistors for the reference voltage of the IC. The best power efficiency can be obtained by adjusting this input level setting according to the characteristics of a connected solar cell. The AP4460 has a Power-Path Control switches for supplying power to the external system and charging a super capacitor. When the output voltage of DC-DC converter reaches a target voltage, the IC starts to charge a compact capacitor. After charging up to the target voltage of a compact capacitor, then the IC starts to supply power to the external system. Supplying power to the external system via capacitor makes it possible to operate high load external system even with a low input power. If the input power is surplus, the extra power is stored gradually in a super capacitor. The super capacitor automatically supplies power to the external system, if the power supply input is low. The AP4460 is suitable for sensor nodes of energy harvesting equipment.

### 2. Features

- Start-up with Ultra-low Input Voltage      0.35V(typ)
- Ultra-low Current Consumption (internal current consumption from storage element)      10nA
- Operating Temperature Range      -30 ~ 85°C
- Input Voltage from 0.14V
- DC-DC Output Voltage      2.5 ~ 4.0V
- Step up DC-DC Converter with Hysteric Comparator Control
- Synchronous Rectification by High-side Zero-cross Detection
- Built-in Output Control MOSFET
- Power Path Function that Automatically Supplies Power to External System from Storage Element (when input power is insufficient)
- DC-DC Operation Monitoring Function
- Supply power to External System Quickly without depending on Storage Element
- Efficiency      80% (When 0.5V and 1mA Input, 3V output)
- Package      24-pin QFN
- Applications
  - Power Supply Systems by Single Solar Cell
  - Portable Electronics
  - Sensor Nodes
  - Wearable Devices

<b>3. Table of Contents</b>
-----------------------------

1 . General Description .....	1
2 . Features.....	1
3 . Table of Contents.....	2
4 . Block Diagram.....	3
■ Block Diagram .....	3
5 . Ordering Guide .....	3
6 . Pin Configurations and Functions .....	4
■ Pin Configurations .....	4
■ Functions .....	4
7 . Absolute Maximum Ratings .....	5
8 . Recommended Operating Conditions .....	5
9 . Electrical Characteristics .....	6
10 . Functional Descriptions .....	8
10.1 Operation .....	8
10.2 Determine the control threshold of the DC-DC converter and power path.....	9
10.3 Timing Chart.....	11
10.4 Input/output Current Characteristic.....	13
11 . Recommended External Circuit .....	14
■ Recommended External Circuit .....	14
■ Recommended External Components.....	14
12 . Package .....	15
■ Outline Dimensions .....	15
■ Recommended Foot Print .....	15
■ Marking .....	16
11 . Revise History.....	17
IMPORTANT NOTICE .....	18

4. Block Diagram

■ Block Diagram

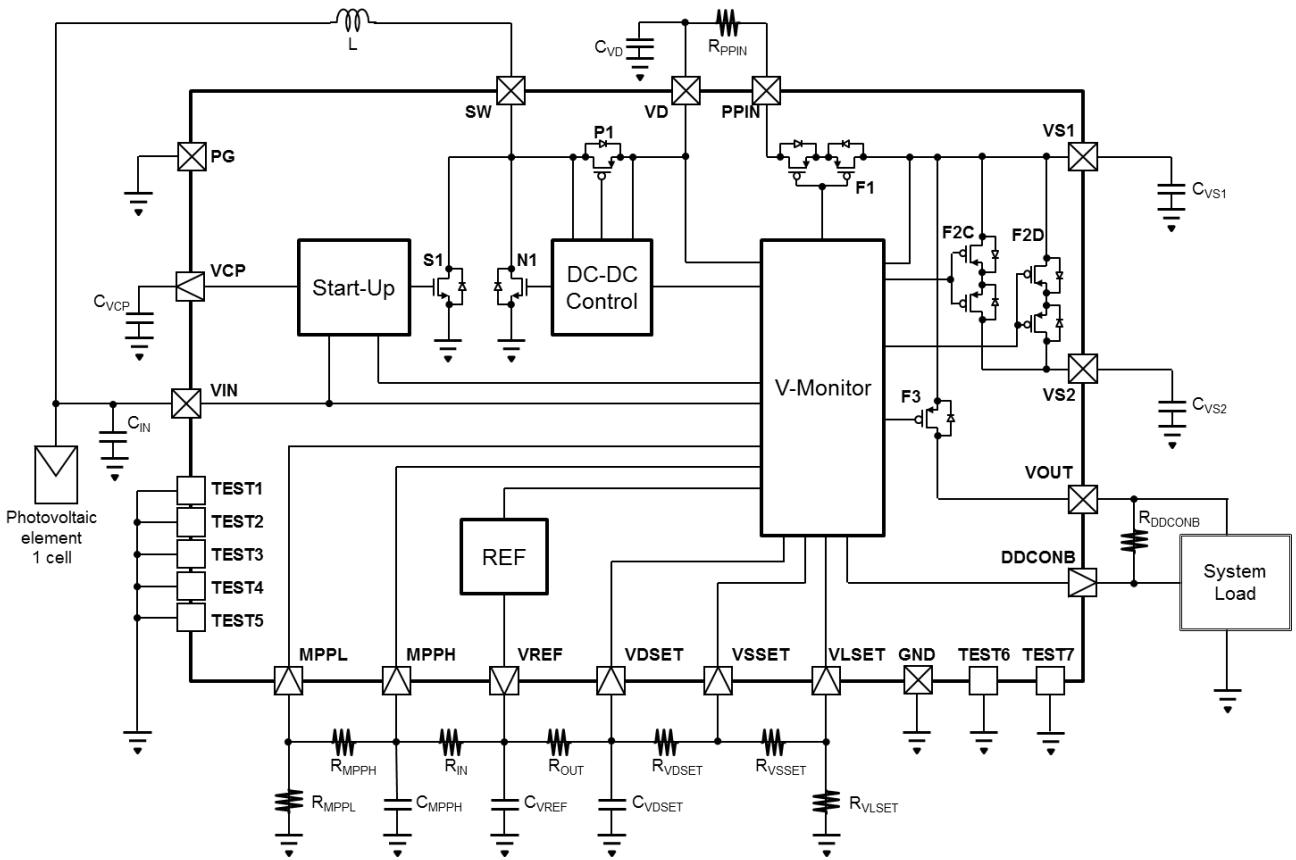


Figure 1. Block Diagram (Refer to 11. Recommended External Circuit as for external parts.)

5. Ordering Guide

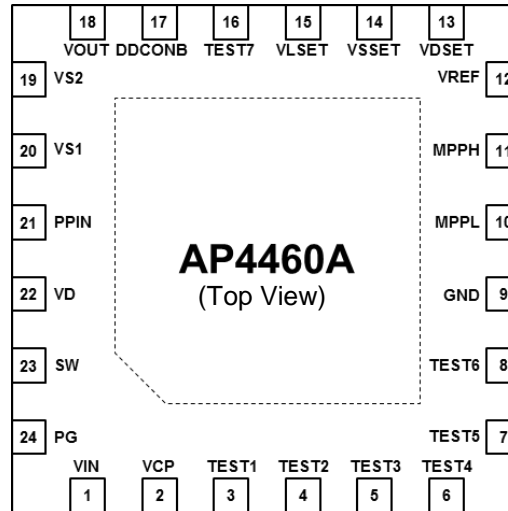
AP4460AEN

-30 ~ 85°C

24-pin QFN

## 6. Pin Configurations and Functions

### ■ Pin Configurations



Please connect exposed pad to GND or leave it OPEN.

### ■ Functions

No.	Pin Name	I/O	Function	Condition
1	VIN	PWR	Power input pin	
2	VCP	O	Charge pump output pin	
3	TEST1	-	Test pin	Connect to GND.
4	TEST2	-	Test pin	Connect to GND.
5	TEST3	-	Test pin	Connect to GND.
6	TEST4	-	Test pin	Connect to GND.
7	TEST5	-	Test pin	Connect to GND.
8	TEST6	I	Test pin	Connect to GND.
9	GND	PWR	Ground pin	
10	MPPL	I	MPPL reference voltage input pin	
11	MPPH	I	MPPH reference voltage input pin	
12	VREF	O	Reference voltage output pin	
13	VDSET	I	VDSET reference voltage input pin	
14	VSSET	I	VSSET reference voltage input pin	
15	VLSET	I	VLSET reference voltage input pin	
16	TEST7	I	Test pin	Connect to GND.
17	DDCONB	O	DC-DC activation signal pin	Open Drain Outputs "L" if the voltage is over MPPH voltage during $V_{IN}$ is increasing. Outputs "H" if the voltage is less than MPPL voltage during $V_{IN}$ is decreasing.
18	VOUT	PWR	Power supply for external system pin	
19	VS2	PWR	Storage element connect pin 2	
20	VS1	PWR	Storage element connect pin 1	
21	PPIN	PWR	Power path input pin	
22	VD	PWR	DC-DC output pin	
23	SW	PWR	Coil connect pin	
24	PG	PWR	DC-DC Ground pin	

### 7. Absolute Maximum Ratings

Parameter	Symbol	min	max	Unit	Condition
Pin Voltage	$V_{IN}$	-0.3	6.5	V	
Operation Temperature	$T_a$	-30	85	°C	
Storage Temperature	$T_{STG}$	-40	150	°C	
Junction Temperature	$T_j$	-40	150	°C	
Power Dissipation	$P_D$	-	2.9	W	(Note 2)

Note 1. All voltages are with respect to GND, unless otherwise specified.

Note 2. 2-layer board is used. This is calculated as  $\theta_{JA}=42^{\circ}\text{C}/\text{W}$ . (Metal area of each layer should be more than 70%, Exposed Pad should be connected to GND)

WARNING: Operation at or beyond these limits may result in permanent damage to the device. Normal operation is not guaranteed at these extremes.

### 8. Recommended Operating Conditions

Parameter	Symbol	Condition	min	typ	max	Unit
Input Voltage (VIN pin)	$V_{VIN}$	$V_{VD}>V_{PORL}$ (after start-up)	0.14	-	$V_{VDTGT}$	V
MPPH Voltage	$V_{MPPH}$		0.16	-	0.8	V
MPPL Voltage	$V_{MPPL}$	$V_{MPPH}>V_{MPPL}$	0.14	-	0.7	V
Output Voltage	$V_{VDTGT}$		2.5	-	4.0	V
Power supplying threshold	$V_{VOUTEN}$		2.2	-	$0.94 \times V_{VDTGT}$	V
Stop power supply threshold	$V_{VOUTDIS}$		2.0	-	$0.90 \times V_{VSSET}$	V
Operation Temperature	$T_a$		-30	-	85	°C
Junction Temperature	$T_j$		-30	-	95	°C
Reference resistor 1	-	$R_{OUT}+R_{VDSET}+R_{VSSET}+R_{VLSET}$	3.6	4	4.4	MΩ
Reference resistor 2	-	$R_{IN}+R_{MPPH}+R_{MPPL}$	4.6	4	4.4	MΩ

<b>9. Electrical Characteristics</b>
--------------------------------------

(Ta=25°C, The external Circuit is as [Figure 13](#), unless otherwise specified.)

Parameter	Symbol	Condition	min	typ	max	Unit
<b>Start-up Circuit</b>						
Minimum input voltage to start-up operation	V <sub>INSTUP</sub>	T <sub>j</sub> ≥ 25°C	-	0.35	0.40	V
Stop start-up operation (When VD is increasing)	V <sub>PORH</sub>		1.8	1.9	2.0	V
Restart start-up operation (When VD is decreasing)	V <sub>PORL</sub>		1.7	1.8	1.9	V
<b>DC-DC Converter</b>						
V <sub>VDTGT</sub> voltage	V <sub>VDTGT</sub>		-	4 × V <sub>VDSET</sub>	-	V
V <sub>VDTGT</sub> voltage accuracy	-		-5	-	+5	%
V <sub>VDTGT</sub> hysteresis	V <sub>VDTGTHYS</sub>		0.01 × V <sub>VDTGT</sub>	0.03 × V <sub>VDTGT</sub>	0.05 × V <sub>VDTGT</sub>	V
High-side on resistance	R <sub>ONTOP</sub>		-	1.5	-	Ω
Low-side on resistance	R <sub>ONBOT</sub>		-	0.6	-	Ω
Low-side on Time	T <sub>ON</sub>	V <sub>VD</sub> =3.3V	2.3	4.5	6.8	μs
VD pin internal consumption current	I <sub>QVD</sub>	V <sub>VD</sub> =3.3V (When DC-DC converter is in skip state)	-	4.5	15	μA
<b>MPPT Circuit</b>						
Accuracy of V <sub>VIN</sub> to activate DC-DC (Include V <sub>OSMPP</sub> )	V <sub>MPPH</sub>	0.55V < set value < 0.8V	-5	0	+5	%
	V <sub>MPPH1</sub>	0.25V < set value	-7	0	+7	%
Accuracy of V <sub>VIN</sub> to be skip state (Include V <sub>OSMPP</sub> )	V <sub>MPPH1</sub>	0.40V < set value < 0.7V	-5	0	+5	%
	V <sub>MPPH1</sub>	0.25V < set value	-7	0	+7	%
<b>Power Path Switch</b>						
F1 switch ON resistance	R <sub>F1</sub>	VD > 2.5V, 20mA	-	2.5	5	Ω
F2 charge switch ON resistance	R <sub>F2C</sub>	VS1 > 2.5V, 2mA	-	200	300	Ω
F2 discharge switch ON resistance	R <sub>F2D</sub>	VS2 > 2.5V, 20mA	-	2	5	Ω
F3 switch ON resistance	R <sub>F3</sub>	VS1 > 2.5V, 20mA	-	2	5	Ω
F1 switch ON voltage	V <sub>F1ON</sub>	VD pin	-	V <sub>VDTGTH</sub>	-	V
F1 switch OFF voltage	V <sub>F1OFF</sub>	VD pin	-	V <sub>VDTGTH</sub> -V <sub>VDTGTHYS</sub>	-	V
F2 charge switch ON voltage (when charging)	V <sub>VS2CHG</sub>	VS1 pin	-	4 × V <sub>VSSET</sub> × 1.03	-	V
F2 charge switch OFF voltage (when charging)	V <sub>VS2HLD</sub>	VS1 pin	-	4 × V <sub>VSSET</sub> × 0.97	-	V
F2 discharge switch ON voltage (when discharging)	V <sub>VS2DCH</sub>	VS1 pin	-	4 × V <sub>VSSET</sub> × 0.94	-	V
F2 discharge switch OFF voltage (when discharging)	V <sub>VS2DIS</sub>	VS1 pin	-	4 × V <sub>VLSET</sub>	-	V
F3 switch ON voltage	V <sub>VOUTEN</sub>	VS1 pin	-	4 × V <sub>VSSET</sub>	-	V
F3 switch OFF voltage	V <sub>VOUTDIS</sub>	VS1 pin	-	4 × V <sub>VLSET</sub> × 0.97	-	V
F1, F2, F3 Control Voltage Accuracy	-	Include V <sub>VRFEF</sub> accuracy	-5	0	+5	%
<b>Reference Voltage</b>						
Reference Voltage Output	V <sub>VREF</sub>		1.187	1.236	1.285	V
<b>Current Consumption</b>						

Parameter	Symbol	Condition	min	typ	max	Unit
VS1, VS2, VOUT pin total current (Note 3)	-	$V_{VD} < V_{PORL}$	-	10	20	nA
Protect Function						
F2 discharge switch over current protection	$I_{F2CLIM}$	VS1 pin grounding	50	250	700	mA
F3 switch over current protection	$I_{F3CLIM}$	VOUT pin grounding	50	250	700	mA
VD over voltage protection	$V_{OV}$		4.2	4.45	4.7	V
VD over voltage protection hysteresis	$V_{OVHYS}$		0.35	0.45	0.55	V
Logic I/O						
DDCONB Output Voltage	$V_{OLDDCON}$	I load < 10 $\mu$ A	0	-	0.3	V
DDCONB Leakage Current	$I_{OHDDCON}$	$V_{DDCON} < 4V$	-	1	10	nA

Note 3. If there is no input power and  $V_{VD} < V_{PORL}$ , F1 becomes off and F2 and F3 become on. The internal current consumption of the IC is 10nA(typ) at this time.

**10. Functional Descriptions**

**10.1 Operation**

The AP4460 is a synchronous step-up DC-DC converter that can be activated by a single solar cell. The IC has a power management function which supplies power to an external system, charges super capacitors, or controls the power path to supply power from the super capacitor to the external system. The AP4460 can be operated from 0.35V (typ) at the VIN pin. The start-up circuit is operated when  $V_{VIN}$  voltage reaches  $V_{INSTUP}$ . Then, the internal charge pump circuit boosts  $V_{VIN}$  voltage and charges the capacitor connected to the VCP pin ( $C_{VCP}$ ). When the VCP voltage reaches enough level, the internal start-up circuit switches the N-channel MOSFET transistor (S1) and charges the external capacitor connected to the VD pin ( $C_{VD}$ ). The start-up circuit is stopped when the VD voltage reaches  $V_{PORH}$  level, then the DC-DC converter starts the operation. When the VD voltage drops to the level less than  $V_{PORL}$ , the DC-DC converter stops and the start-up circuits is operated again.

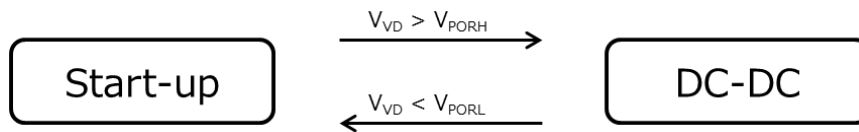


Figure 2. State transition of Start-up and DC-DC operation

The DC-DC converter activates the N-channel MOSFET transistor (N1) during  $T_{ON}$  period to charge the coil. After  $T_{ON}$  period, the energy stored in the coil is charged to the  $C_{VD}$  capacitor by a power switching of N1 transistor (becomes OFF) and the P1 transistor (becomes ON). The control circuits of the DC-DC sets the P1 transistor off when the SW voltage becomes less than the VD voltage, and then the N1 transistor turns on. The operation of DC-DC converter is controlled by three reference voltages such as VDSET, MPPL and MPPH voltages. The VDSET voltage controls the output voltage level ( $V_{VDTGT}$ ) of DC-DC converter. When the VD voltage reaches  $V_{VDTGT}$  level, the DC-DC converter stops the switching operation and enters 'Skip' state to save current consumption. When the VD voltage becomes less than  $V_{VDTGT} - V_{VDTGTHYS}$ , the DC-DC converter goes to 'Switching' state and boosts the VD voltage. The inputs of the MPPH pin and the MPPL pin ( $V_{MPPH}$  and  $V_{MPPL}$ ) control the input voltage of the DC-DC converter ( $V_{VIN}$ ) for effective voltage level of a solar cell. When the  $V_{VIN}$  voltage becomes less than  $V_{MPPTL}$  voltage, the DC-DC converter stops switching operation and goes to Skip state until  $V_{VIN}$  voltage reaches  $V_{MPPTH}$  voltage. By adjusting input levels of the MPPH pin and the MPPL pin ( $V_{MPPH}$  and  $V_{MPPL}$ ), the maximum output solar power can be efficiently generated.

The DDCONB (N-channel MOSFET open drain) pin outputs "L" when  $V_{VIN}$  voltage is in between  $V_{MPPL}$  and  $V_{MPPH}$ . The DC-DC converter has the over voltage protection function for the VD pin. When the VD voltage exceeds  $V_{OV}$  level, the DC-DC converter transitions to Skip state to prevent further voltage increase. When the VD voltage becomes lower than  $V_{OV} - V_{OVHYS}$ , the converter restarts switching operation.

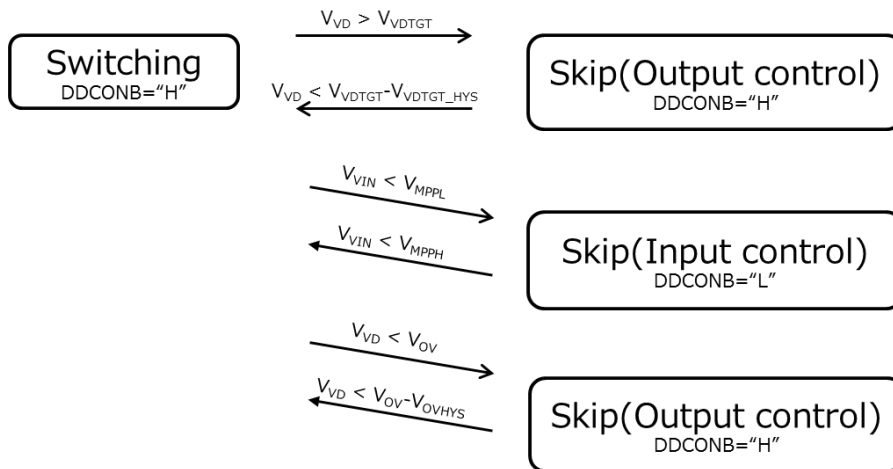


Figure 3. State Transition of DC-DC Operation



F1, F2 and F3 switches compose the Power Path function. The F1 switch is placed between the PPIN pin and the VS1 pin, F2 switch is placed between the VS1 pin and the VS2 pin and F3 switch is placed between the VS1 pin and the VOUT pin. The F1 switch is synchronized with DC-DC converter statement that is controlled by the VD condition. When the VD voltage reaches  $V_{VDTGT}$  by DC-DC converter, the F1 switch becomes ON state and the VD charge is transferred to VS1 to charge the external capacitor until VD voltage becomes less than  $V_{VDTGT} - V_{VDTGT\_HYS}$ . In other situations, the F1 switch is in OFF state to prevent reverse current flowing from the VS1 pin to the VD pin. When the VS1 voltage reaches  $V_{VOUTEN}$ , the F3 switch becomes ON state and the VOUT output is available for system loads. The F3 switch is turned OFF when the VS1 voltage becomes less than  $V_{VOUTDIS}$ . When the VS1 voltage reaches  $V_{VS2CHG}$ , the F2 switch changes to ON state and the VS1 charge is transferred to the capacitor connected to the VS2 pin until the VS1 voltage becomes  $V_{VS2HLD}$ . When VS1 voltage drops less than  $V_{VS2DCH}$ , the F2 switch also becomes ON state and the VS2 charge is transferred to the capacitor connected to the VS1 pin. If the VS1 voltage is below  $V_{VOUTDIS}$ , the F2 switch is turned OFF. Unnecessary power dissipation of the external system can be reduced by setting  $V_{VOUTDIS}$  higher than the lowest operation voltage of the external system connected to the VOUT pin. When the VD voltage becomes less than  $V_{VPORL}$ , the F2 and F3 switches become ON state. At this time, if the capacitor connected to the VS2 pin ( $C_{VS2}$ ) is charged enough, the power supply operation to the external system is continued. In case the VD voltage again reaches  $V_{VDTGT}$ , the F2 and F3 switches remain in ON state if the VS1 voltage is over  $V_{VOUTDIS} \times 1.03$ . If VS1 voltage is below  $V_{VOUTDIS}$ , the F2 and F3 switches change to OFF state.

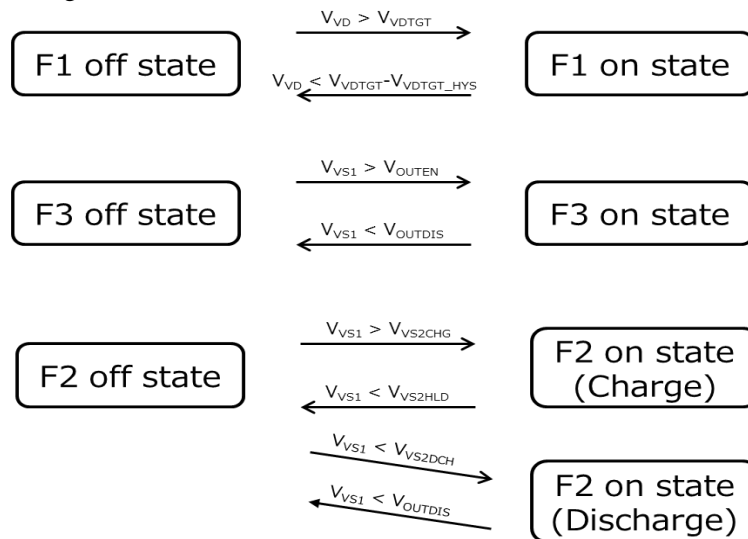


Figure 4. State Transition of the Power Path Switches

**10.2 Determine the control threshold of the DC-DC converter and power path**

Four resistors are needed to connect in series between the VREF pin and GND to determine the output target of the DC-DC converter ( $V_{VDTGT}$ ), the output start voltage of the VOUT pin and charge/discharge threshold of the super capacitor. The voltages between each resistor should be input to the VDSET pin, the VSSET pin and the VLSET pin. The control threshold of the DC-DC converter input voltage can be determined by connecting three resistors in series between the VREF pin and GND, and the voltages between each resistor should be input to the MPPH pin and the MPPL pin. The connection of resistors is shown in Figure 5.

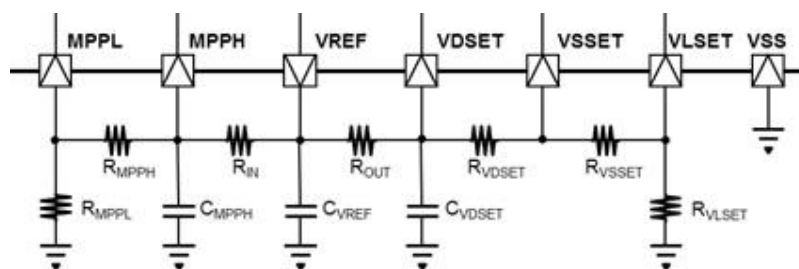


Figure 5. Resistor connection circuit

■ Determination of the control threshold voltage and external resistors

Table 1. Calculation of the control threshold voltage

Symbol	Calculation Formula
$V_{MPPL}$	$V_{REF} \times R_{MPPL} / (R_{MPPL} + R_{MPPH} + R_{IN})$
$V_{MPPH}$	$V_{REF} \times (R_{MPPL} + R_{MPPH}) / (R_{MPPL} + R_{MPPH} + R_{IN})$
$V_{VDSET}$	$V_{REF} \times (R_{VDSET} + R_{VSSET} + R_{VLSET}) / (R_{OUT} + R_{VDSET} + R_{VSSET} + R_{VLSET})$
$V_{VSSET}$	$V_{REF} \times (R_{VSSET} + R_{VLSET}) / (R_{OUT} + R_{VDSET} + R_{VSSET} + R_{VLSET})$
$V_{VLSET}$	$V_{REF} \times R_{VLSET} / (R_{OUT} + R_{VDSET} + R_{VSSET} + R_{VLSET})$

Note 4. Refer to 9. Electrical Characteristics as for  $V_{VDTGT}$ , F2 charge/discharge switch ON/OFF voltage and F3 switch ON voltage.

Table 2. Example settings of the external resistors,  $V_{MPPL}$  and  $V_{MPPH}$  (typ)

$V_{REF}$	$R_{MPPL}$	$R_{MPPH}$	$R_{IN}$	$V_{MPPL}$	$V_{MPPH}$
1.236V	1.6MΩ	0.2MΩ	2.4MΩ	0.471V	0.530V

Note 5.  $R_{MPPL} + R_{MPPH} + R_{IN}$  should be more than 3.6MΩ. Above setting is just an example, please choose appropriate numbers according to the input conditions.

Table 3. Example settings of  $V_{DSET}$ ,  $V_{SSET}$  and  $V_{LSET}$  (typ)

$V_{REF}$	$R_{OUT}$	$R_{VDSET}$	$R_{VSSET}$	$R_{VLSET}$	$V_{VDSET}$	$V_{VSSET}$	$V_{VLSET}$
1.236V	1.3MΩ	0.24MΩ	0.56MΩ	1.8MΩ	3.296 / 4 = 0.824V	2.992 / 4 = 0.748V	2.282 / 4 = 0.571 V

Note 6.  $R_{OUT} + R_{VDSET} + R_{VSSET} + R_{VLSET}$  should be more than 3.6MΩ. Above setting is just an example, please choose appropriate numbers according to the input conditions.

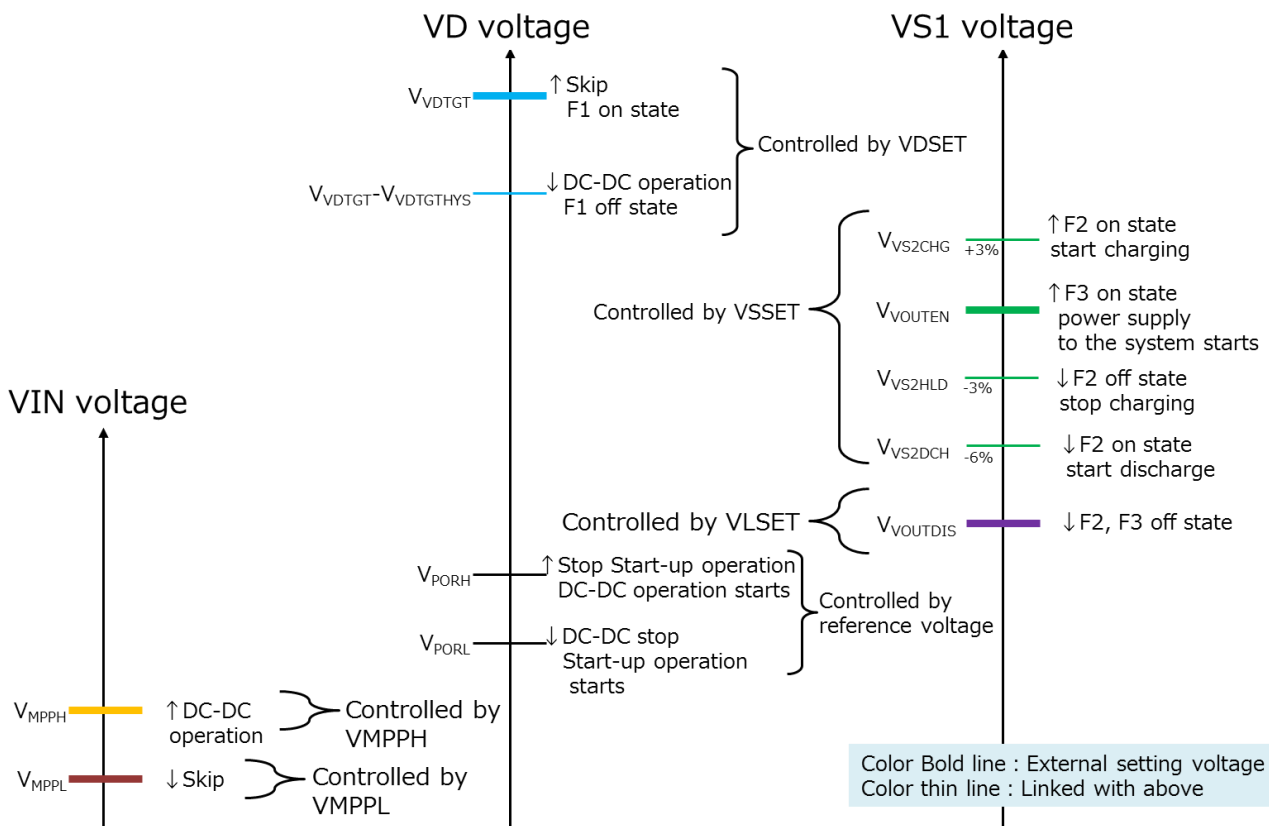


Figure 6. Control Threshold Voltages

### 10.3 Timing Chart

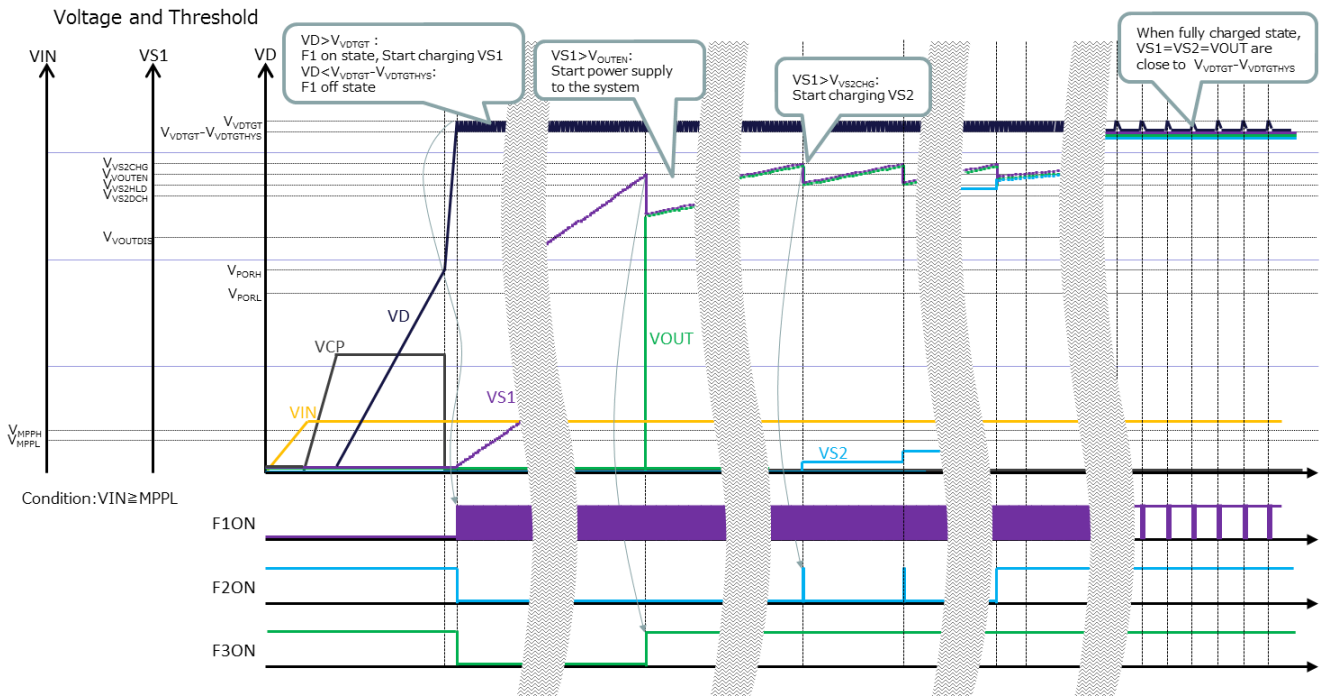


Figure 7. Timing Chart 1: from Start-up to Charge (No Initial Charging)

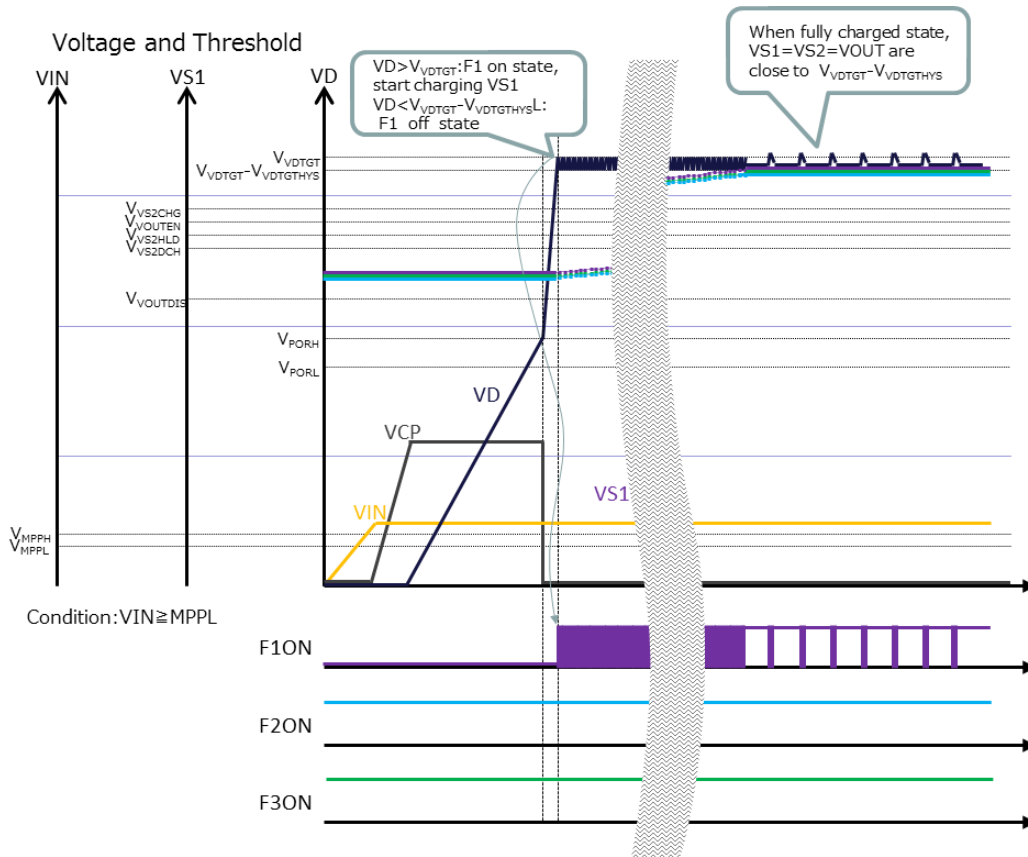


Figure 8. Timing Chart 2: from Start-up to Charge (With Initial Charging)

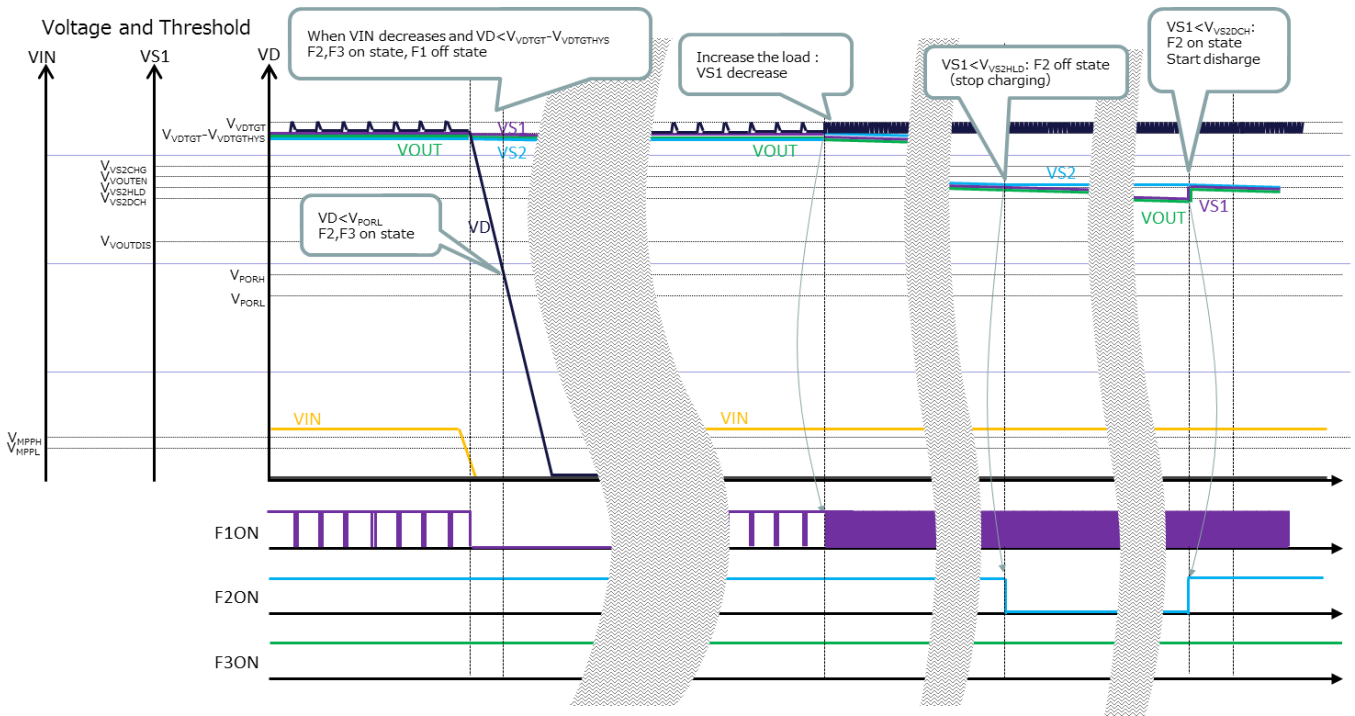


Figure 9. Timing Chart 3: (Left) VIN decrease, (Right) Load increase

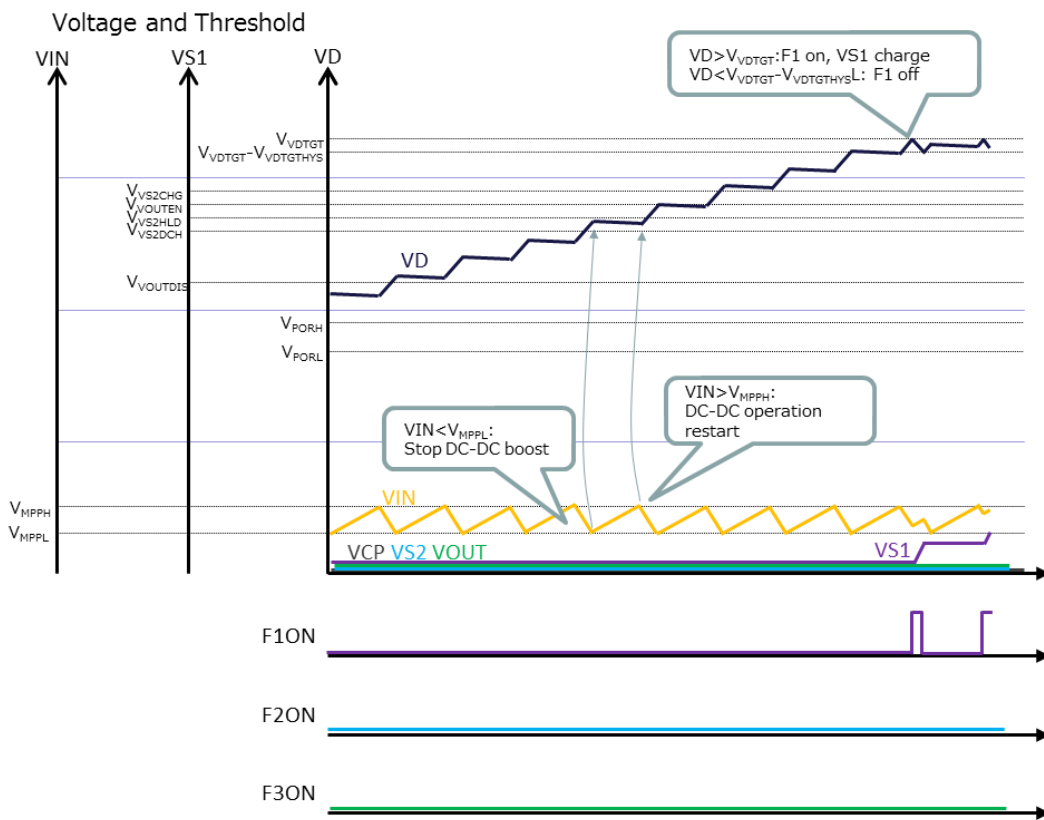


Figure 10. Timing Chart 4: Control VIN voltage

10.4 Input/output Current Characteristic

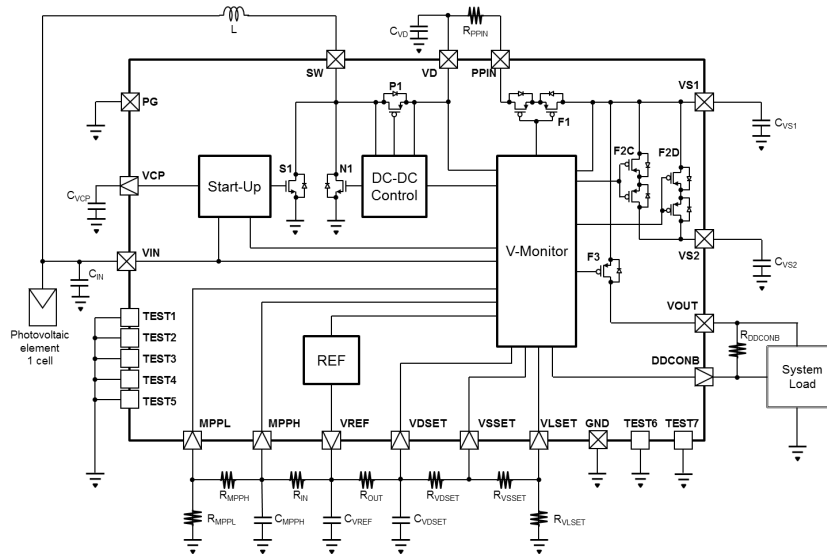


Figure 11. Circuit Example

Internal current consumption of each pin is shown in Figure 12.

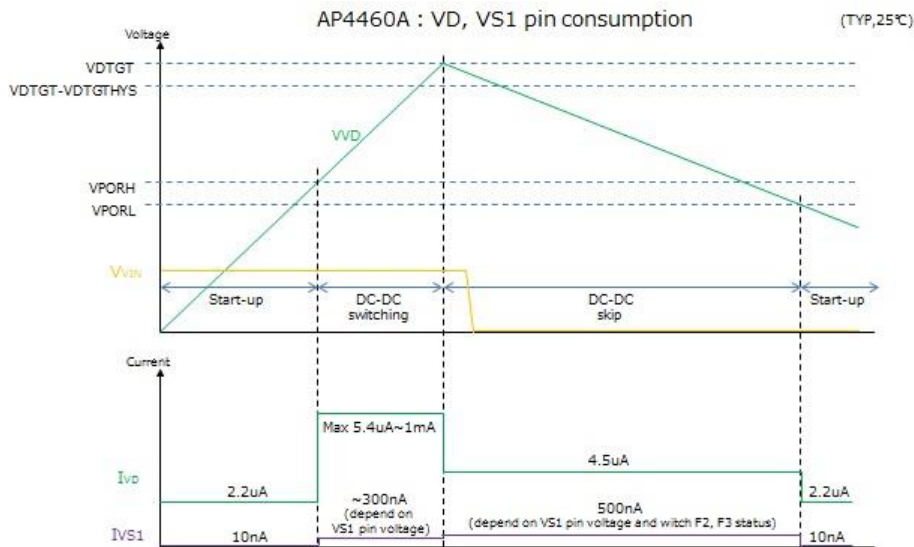


Figure 12. The consumption for VD and VS1 pin

- In the case of Start-up:  
VD pin current ( $I_{VD}$ , inflow into VD pin) is about 2.2uA and VS1 pin current ( $I_{VS1}$ , inflow into VS1 pin) is about 10nA before  $V_{VD}$  reaches to  $V_{PORH}$  voltage. (In case of  $V_{VD} < V_{PORL}$ , F2 switch= ON, the total internal consumption of VS1 and VS2 pins is 10nA.)
- In the case of DC-DC switching:  
After  $V_{VD}$  reaches to  $V_{PORH}$ , until  $V_{VD}$  drops to  $V_{PORL}$ ,  $I_{VD}$  is 5.4uA~1mA depends on switching period and  $V_{VD}$  voltage.
- In the case of DC-DC skip (intermittent action):  
After  $V_{VD}$  reaches to  $V_{TGT}$ , internal current consumption is about 4.7uA.  $I_{VS1}$  consumption is determined by VS1 pin voltage and internal resistor. (Maximum  $I_{VS1}$  is 500nA when VS1 voltage= 4V) After  $V_{VD}$  reaches to  $V_{TGT}$ , until  $V_{VD}$  drops to  $V_{VDTGT}-V_{VDTGTHYS}$ , switch F1= OFF, the adverse current (from VS1 pin to VD pin) is not occurred. When  $V_{VD}$  reaches  $V_{PORL}$ ,  $I_{VD}$  is about 2.2uA and  $I_{VS1}$  is about 10nA.

## 11. Recommended External Circuit

### ■ Recommended External Circuit

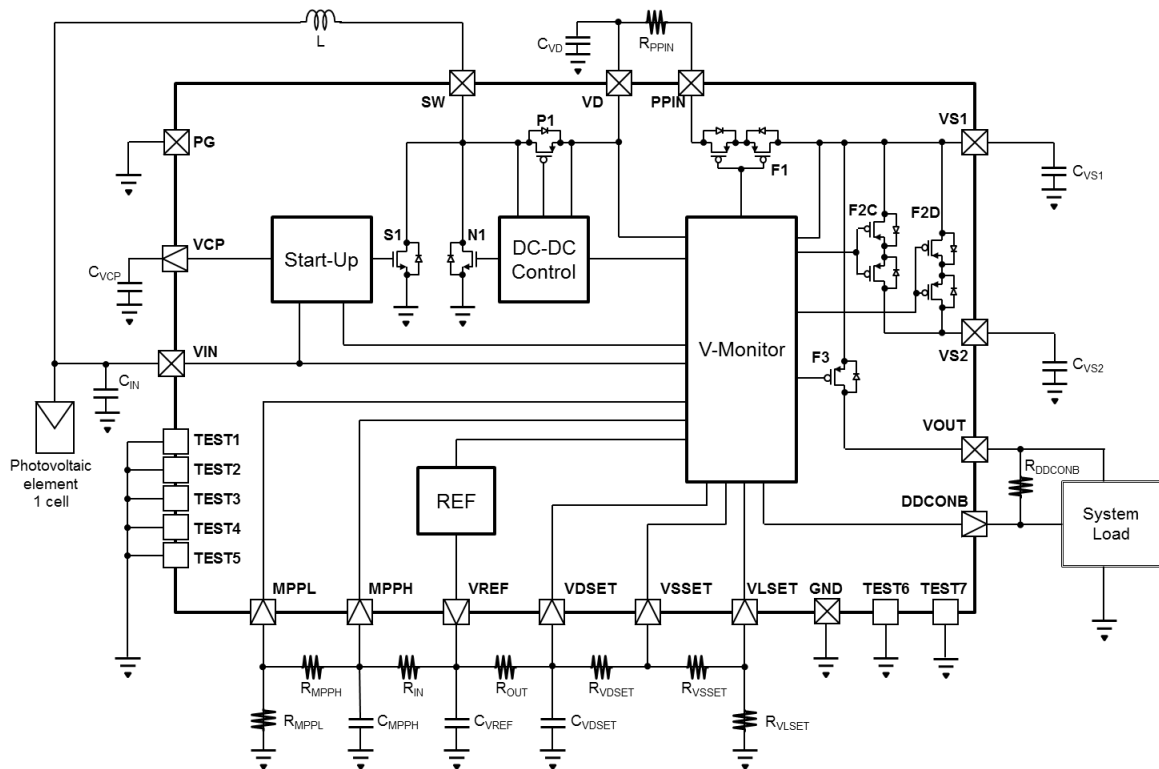


Figure 13. Recommended External Circuit

### ■ Recommended External Components

Item	Symbol	Value	Parts No.	Note
VIN capacitor	$C_{IN}$	10 $\mu$ F		Ceramic (Note 7)
VCP capacitor	$C_{VCP}$	100pF		Ceramic
VD capacitor	$C_{VD}$	33 $\mu$ F		Ceramic
PPIN resistor	$R_{PPIN}$	330 $\Omega$		
VS1 capacitor	$C_{VS1}$	470 $\mu$ F		
VS2 capacitor	$C_{VS2}$	-		(Note 8)
VREF capacitor	$C_{VREF}$	1nF		Ceramic
VDSET capacitor	$C_{VDSET}$	100pF		Ceramic
MPPH capacitor	$C_{MPPH}$	100pF		Ceramic
Output control resistor	$R_{OUT}$	1.3M $\Omega$		(Note 9)
VDSET resistor	$R_{VDSET}$	0.24M $\Omega$		3.296V (Note 9)
VSSSET resistor	$R_{VSSSET}$	0.56M $\Omega$		2.992V (Note 9)
VLSET resistor	$R_{VLSET}$	1.8M $\Omega$		2.282V (Note 9)
Input control resistor	$R_{IN}$	2.4M $\Omega$		(Note 9)
MPPH resistor	$R_{MPPH}$	0.2M $\Omega$		0.530V (Note 9)
MPPL resistor	$R_{MPPL}$	1.6M $\Omega$		0.471V (Note 9)
DDCONB resistor	$R_{DDCONB}$	33M $\Omega$		100nA
Coil	L	22 $\mu$ H	VLF403215MT-220M(TDK) or VLF302510MT-220M(TDK)	

Note 7. The capacitance of the  $C_{IN}$  depends on the solar cell. Please choose the suitable value.

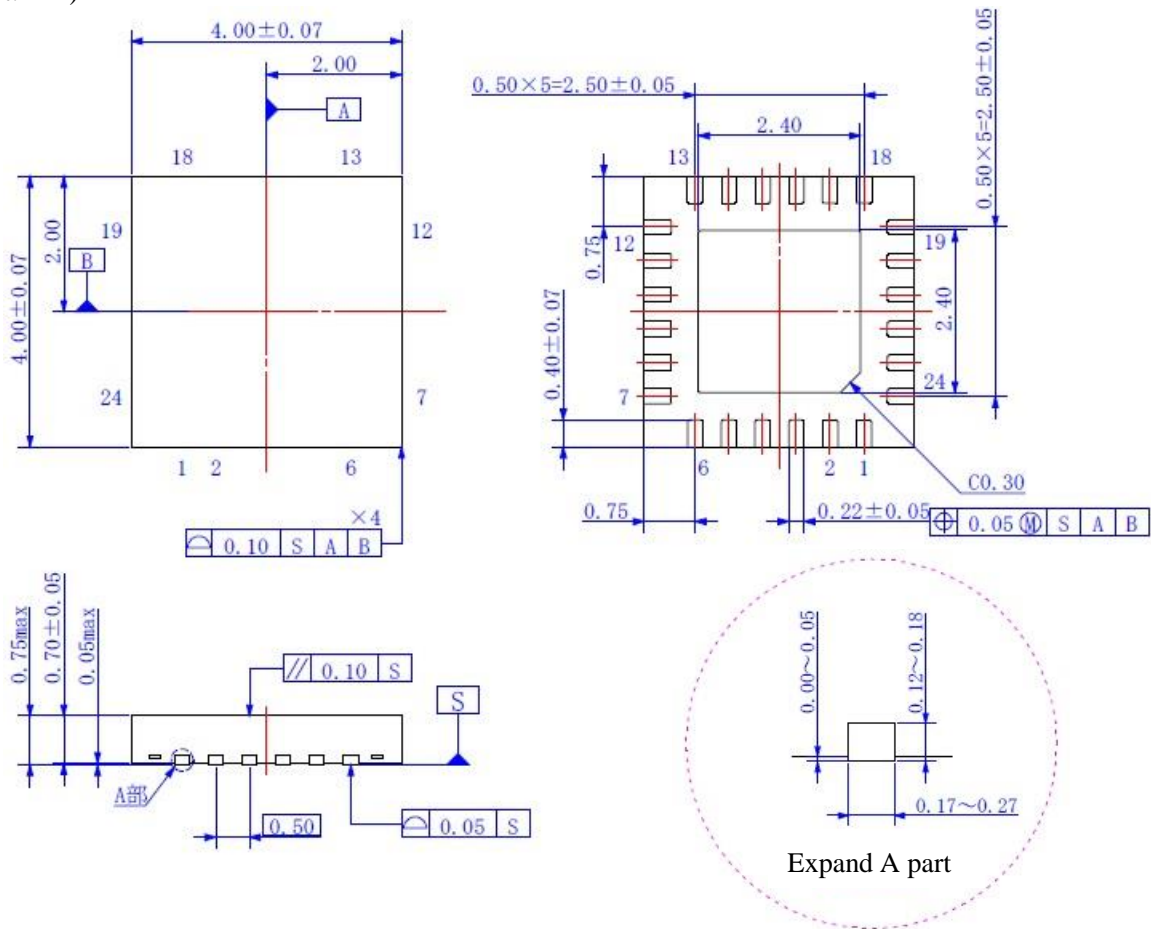
Note 8. A super capacitor or a rechargeable battery is usable.

Note 9. Refer to 10.2 for settings of the control threshold voltage and resistors.

12. Package

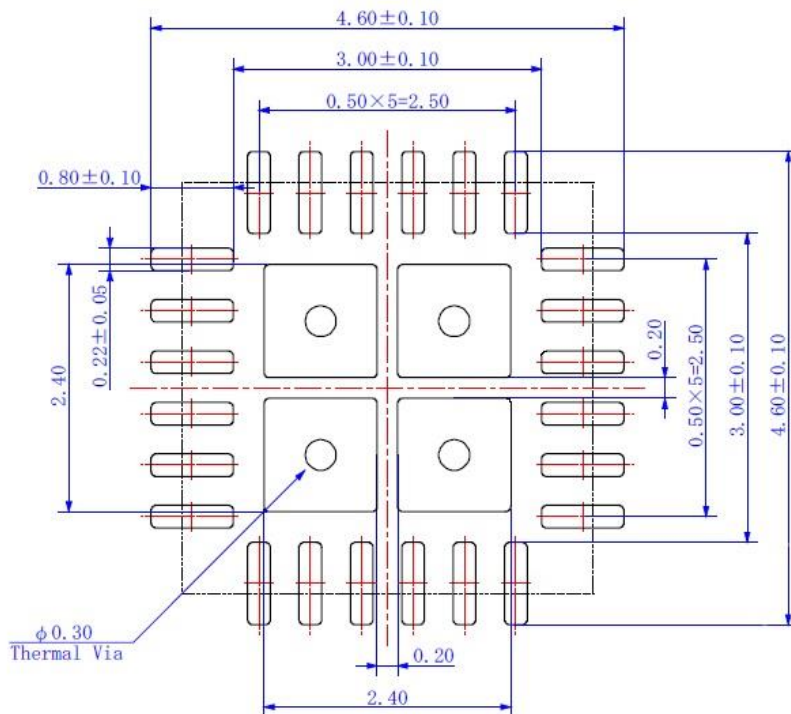
■ Outline Dimensions

(Unit: mm)

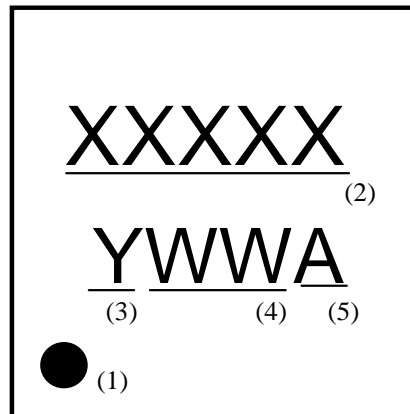


■ Recommended Foot Print

(Unit : mm)



■ **Marking**



- (1) 1pin Indication
- (2) Market Code : 4460A
- (3) Year Code (last 1 digit)
- (4) Week Code
- (5) Management Code



**11 . Revise History**

Date (YY/MM/DD)	Revision	Page	Contents
14/12/09	00	-	First edition
15/04/16	01	10	Table 2. error correction

**IMPORTANT NOTICE**

0. Asahi Kasei Microdevices Corporation (“AKM”) reserves the right to make changes to the information contained in this document without notice. When you consider any use or application of AKM product stipulated in this document (“Product”), please make inquiries the sales office of AKM or authorized distributors as to current status of the Products.
1. All information included in this document are provided only to illustrate the operation and application examples of AKM Products. AKM neither makes warranties or representations with respect to the accuracy or completeness of the information contained in this document nor grants any license to any intellectual property rights or any other rights of AKM or any third party with respect to the information in this document. You are fully responsible for use of such information contained in this document in your product design or applications. **AKM ASSUMES NO LIABILITY FOR ANY LOSSES INCURRED BY YOU OR THIRD PARTIES ARISING FROM THE USE OF SUCH INFORMATION IN YOUR PRODUCT DESIGN OR APPLICATIONS.**
2. The Product is neither intended nor warranted for use in equipment or systems that require extraordinarily high levels of quality and/or reliability and/or a malfunction or failure of which may cause loss of human life, bodily injury, serious property damage or serious public impact, including but not limited to, equipment used in nuclear facilities, equipment used in the aerospace industry, medical equipment, equipment used for automobiles, trains, ships and other transportation, traffic signaling equipment, equipment used to control combustions or explosions, safety devices, elevators and escalators, devices related to electric power, and equipment used in finance-related fields. Do not use Product for the above use unless specifically agreed by AKM in writing.
3. Though AKM works continually to improve the Product’s quality and reliability, you are responsible for complying with safety standards and for providing adequate designs and safeguards for your hardware, software and systems which minimize risk and avoid situations in which a malfunction or failure of the Product could cause loss of human life, bodily injury or damage to property, including data loss or corruption.
4. Do not use or otherwise make available the Product or related technology or any information contained in this document for any military purposes, including without limitation, for the design, development, use, stockpiling or manufacturing of nuclear, chemical, or biological weapons or missile technology products (mass destruction weapons). When exporting the Products or related technology or any information contained in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations. The Products and related technology may not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations.
5. Please contact AKM sales representative for details as to environmental matters such as the RoHS compatibility of the Product. Please use the Product in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. AKM assumes no liability for damages or losses occurring as a result of noncompliance with applicable laws and regulations.
6. Resale of the Product with provisions different from the statement and/or technical features set forth in this document shall immediately void any warranty granted by AKM for the Product and shall not create or extend in any manner whatsoever, any liability of AKM.
7. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written consent of AKM.