AC/DC Converter IC

PWM type DC/DC converter IC Included a Switching MOSFET

BM2PXX5F/BM2PXX6F/BM2PXX7F/BM2PXX8F Series

●General Description

The PWM type DC/DC converter (BM2PXXXF) for AC/DC provides an optimal system for all products that include an electrical outlet.

BM2PXXXF supports both isolated and non-isolated devices, enabling simpler design of various types of low-power electrical converters.

The built-in 650V HV starter circuit contributes to low-power consumption.

A higher degree of design freedom can be achieved with current detection resistors as external devices. Current is restricted in each cycle and excellent performance is demonstrated in bandwidth and transient response since current mode control is utilized. The switching frequency is 65 kHz. At light load, the switching frequency is reduced and high efficiency is achieved. A frequency hopping function that contributes to low EMI is also included on chip.

Design can be easily implemented because includes a 650V switching MOSFET.

●Features

- PWM frequency : 65kHz
- PWM current mode control
- Burst operation when load is light
- Frequency reduction function
- Built-in 650V starter circuit
- Built-in 650V switching MOSFET
- VCC pin Under-Voltage protection
- VCC pin Over-Voltage protection
- SOURCE pin Open Protection
- SOURCE pin Short Protection
- SOURCE pin Leading Edge Blanking function
- Per-cycle Over-Current Protection Circuit
- Soft start
- Secondary Over-Current Protection Circuit

●Basic specifications

■Operating Power Supply Voltage Range:

VCC	8.9V to 26.0V
DRAIN	to 650V

Normal Operating Current:

(BM2Px5xF) : 0.60mA (Typ.)
(BM2Px9xF) : 0.50mA (Typ.)

■Burst Operating Current: 0.30mA(Typ.)
■Oscillation Frequency: 65kHz(Typ.)
■Operating Temperature: - 40deg. to +105deg.
■MOSFET ON Resistance:

BM2Px5xF : 4.0Ω (Typ.)
BM2Px9xF : 8.5Ω (Typ.)

●Package

SOP8 5.00mm x 6.20mm x 1.71mm (Typ.) (Typ.) (TYP.) pitch 1.27mm (TYP.)



●Applications

For AC adapters and household appliances (vacuum cleaners, humidifiers, air cleaners, air conditioners, IH cooking heaters, rice cookers, etc.)

●Application Circuit

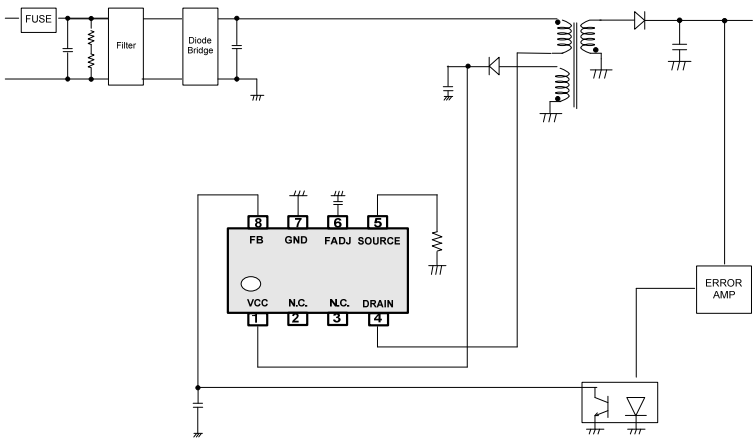


Figure 1. Application Circuit

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●Absolute Maximum Ratings（Ta=25°C）

Parameter	Symbol	Rating	Unit	Conditions
Maximum applied voltage 1	V_{max1}	-0.3 to 32.0	V	VCC
Maximum applied voltage 2	V_{max2}	-0.3 to 6.5	V	SOURCE, FB, FADJ
Maximum applied voltage 3	V_{max3}	650	V	DRAIN
Drain current pulse	I_{DP}	2.60	A	P_W=10us, Duty cycle=1% (BM2Px5xF)
Drain current pulse	I_{DP}	1.30	A	P_W=10us, Duty cycle=1% (BM2Px9xF)
Power dissipation	P_d	0.56	W	When implemented
Operating temperature range	T_{opr}	-40 to +105	°C	
MAX junction temperature	T_{jmax}	150	°C	
Storage temperature range	T_{str}	-55 to +150	°C	

(Note1) SOP8 : When mounted (on 70 mm × 70 mm, 1.6 mm thick, glass epoxy on single-layer substrate)
Derate by 4.563mW/°C when operating above T_a=25°C.

Caution: Operating the IC over the absolute maximum ratings may damage the IC. The damage can either be a short circuit between pins or an open circuit between pins and the internal circuitry. Therefore, it is important to consider circuit protection measures, such as adding a fuse, in case the IC is operated over the absolute maximum ratings.

●Operating Conditions（Ta=25°C）

Parameter	Symbol	Rating	Unit	Conditions
Power supply voltage range 1	V_{CC}	8.9 to 26.0	V	VCC pin voltage
Power supply voltage range 2	V_{DRAIN}	650	V	DRAIN pin voltage

●Electrical Characteristics of MOSFET (unless otherwise noted, Ta = 25°C, VCC = 15V)

Parameter	Symbol	Specifications			Unit	Conditions
		Min	Typ	Max		
[MOSFET Block]						
Between drain and source voltage	$V_{(BR)DDS}$	650	-	-	V	I_D=1mA / V_{GS}=0V
Drain leak current	I_{DSS}	-	-	100	uA	V_{DS}=650V / V_{GS}=0V
On resistance	$R_{DS(ON)}$	-	4.0	5.5	Ω	I_D=0.25A / V_{GS}=10V (BM2Px5xF)
On resistance	$R_{DS(ON)}$	-	8.5	12.0	Ω	I_D=0.25A / V_{GS}=10V (BM2Px9xF)

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●**Electrical Characteristics (unless otherwise noted, Ta = 25°C, VCC = 15 V)**

Parameter	Symbol	Specifications			Unit	Conditions
		Min	Typ	Max		
[Circuit Current]						
Circuit current (ON) 1	I_{ON1}	410	600	790	μA	FB=2.0(at pulse operation) BM2Px5xF
Circuit current (ON) 1	I_{ON1}	350	500	650	μA	FB=2.0(at pulse operation) BM2Px9xF
Circuit current (ON) 2	I_{ON2}	200	300	400	μA	FB=0.0V(at burst operation)
[VCC Protection Function]						
VCC UVLO voltage 1	V_{UVLO1}	12.50	13.50	14.50	V	VCC rise
VCC UVLO voltage 2	V_{UVLO2}	7.50	8.20	8.90	V	VCC fall
VCC UVLO hysteresis	V_{UVLO3}	-	5.30	-	V	$V_{UVLO3}= V_{UVLO1}- V_{UVLO2}$
VCC OVP voltage 1	V_{OVP1}	26.0	27.5	29.0	V	VCC rise
VCC OVP voltage 2	V_{OVP2}	-	23.5	-	V	BM2Pxx6F/BM2Pxx8F VCC fall
VCC OVP hysteresis	V_{OVP3}	-	4.0	-	V	BM2Pxx6F/BM2Pxx8F
Latch released VCC voltage	V_{LATCH}	-	V_{UVLO2}-0.5	-	V	
VCC recharge start voltage	V_{CHG1}	7.70	8.70	9.70	V	
VCC recharge stop voltage	V_{CHG2}	12.00	13.00	14.00	V	
Latch mask time	t_{LATCH}	50	100	150	us	
Thermal shut down temperature1	T_{SD1}	120	145	-	°C	Control IC, temp rise
Thermal shut down temperature2	T_{SD2}	-	115	-	°C	Control IC, temp fall
[PWM Type DCDC Driver Block]						
Oscillation frequency 1	F_{SW1}	60	65	70	KHz	FB=2.00V
Oscillation frequency 2	F_{SW2}	20	25	30	KHz	FB=0.30V
Frequency hopping width 1	F_{DEL1}	-	4.0	-	KHz	FB=2.0V
Hopping fluctuation frequency	F_{CH}	75	125	175	Hz	
FADJ source current	I_{BST}	0.80	1.00	1.20	uA	FADJ=0.0V
FADJ comparator voltage	V_{BST}	1.13	1.20	1.27	V	
FADJ max burst frequency	F_{BST}	-	0.833	-	KHz	CFADJ=1000pF
Soft start time 1	t_{SS1}	0.30	0.50	0.70	ms	
Soft start time 2	t_{SS2}	0.60	1.00	1.40	ms	
Soft start time 3	t_{SS3}	1.20	2.00	2.80	ms	
Soft start time 4	t_{SS4}	3.20	4.00	4.80	ms	
Maximum duty	D_{max}	68.0	75.0	82.0	%	
Minimum ON pulse	T_{min}	150	400	650	ns	
FB pin pull-up resistance	R_{FB}	23	30	37	kΩ	
ΔFB / ΔSOURCE gain	Gain	-	4.00	-	V/V	
FB burst voltage 1	V_{BST1}	0.220	0.280	0.340	V	FB fall
FB burst voltage 2	V_{BST2}	0.260	0.320	0.380	V	FB rise
FB burst hysteresis	V_{BST3}	-	0.04	-	V	$V_{BST3}= V_{BST2}- V_{BST1}$
FB voltage of starting frequency reduction mode	V_{DLT}	1.100	1.250	1.400	V	
FB OLP voltage 1a	V_{FOLP1A}	2.60	2.80	3.00	V	Overload is detected (FB rise)
FB OLP voltage 1b	V_{FOLP1B}	-	2.60	-	V	Overload is detected (FB fall)
FB OLP ON time	T_{FOLP1}	80	128	176	ms	
FB OLP OFF time	T_{FOLP2}	332	512	692	ms	BM2Pxx5F/BM2Pxx6F
[Over Current Detection Block]						
Over-current detection voltage	V_{SOURCE}	0.375	0.400	0.425	V	Ton=0us
Over-current detection voltage SS1	V_{S_SS1}	-	0.100	-	V	0[ms] to Tss1 [ms]
Over-current detection voltage SS2	V_{S_SS2}	-	0.150	-	V	TSS1 [ms] to TSS2 [ms]
Over-current detection voltage SS3	V_{S_SS3}	-	0.200	-	V	TSS2 [ms] to TSS3 [ms]
Over-current detection voltage SS4	V_{S_SS4}	-	0.300	-	V	TSS3 [ms] to TSS4 [ms]
Leading edge blanking time	t_{LEB}	-	250	-	ns	
Over current detection AC voltage compensation factor	K_{SOURCE}	12	20	28	mV/us	
SOURCE pin short protection voltage	V_{SHT}	0.020	0.050	0.080	V	
SOURCE pin short protection time	$T_{SOURCESHT}$	1.80	3.00	4.20	us	
[Start Circuit Block]						
Start current 1	I_{START1}	0.100	0.500	1.000	mA	VCC= 0V
Start current 2	I_{START2}	1.000	3.000	6.000	mA	VCC=10V
OFF current	I_{START3}	-	10	20	uA	Inflow current from Drain pin after UVLO is released and when MOSFET is OFF
Start current switching voltage	V_{SC}	0.800	1.500	2.100	V	

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●Pin Descriptions

Table 1. Pin Description

NO.	Pin Name	I/O	Function	ESD Diode	
				VCC	GND
1	VCC	I	Power supply input pin	-	✔
2	N.C.	-	-	-	-
3	N.C.	-	-	-	-
4	DRAIN	I/O	MOSFET DRAIN pin	-	-
5	SOURCE	I/O	MOSFET SOURCE pin	✔	✔
6	FADJ	I	MAX Burst Frequency setting pin	✔	✔
7	GND	I/O	GND pin	✔	-
8	FB	I	Feedback signal input pin	✔	✔

●I/O Equivalent Circuit Diagram

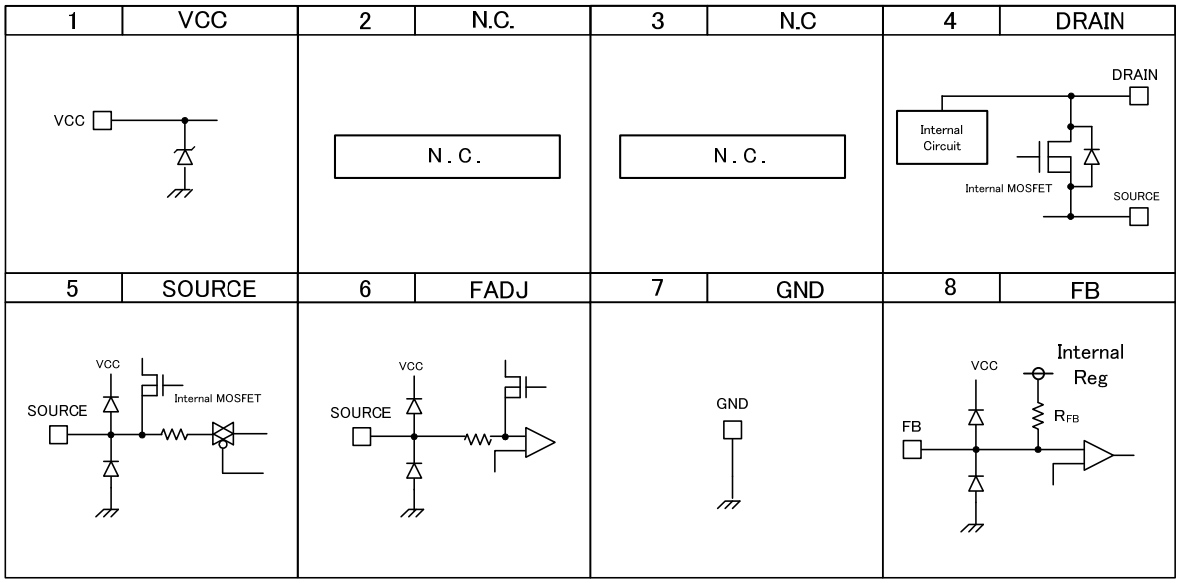


Figure 2. I/O Equivalent Circuit Diagram

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●Block Diagram

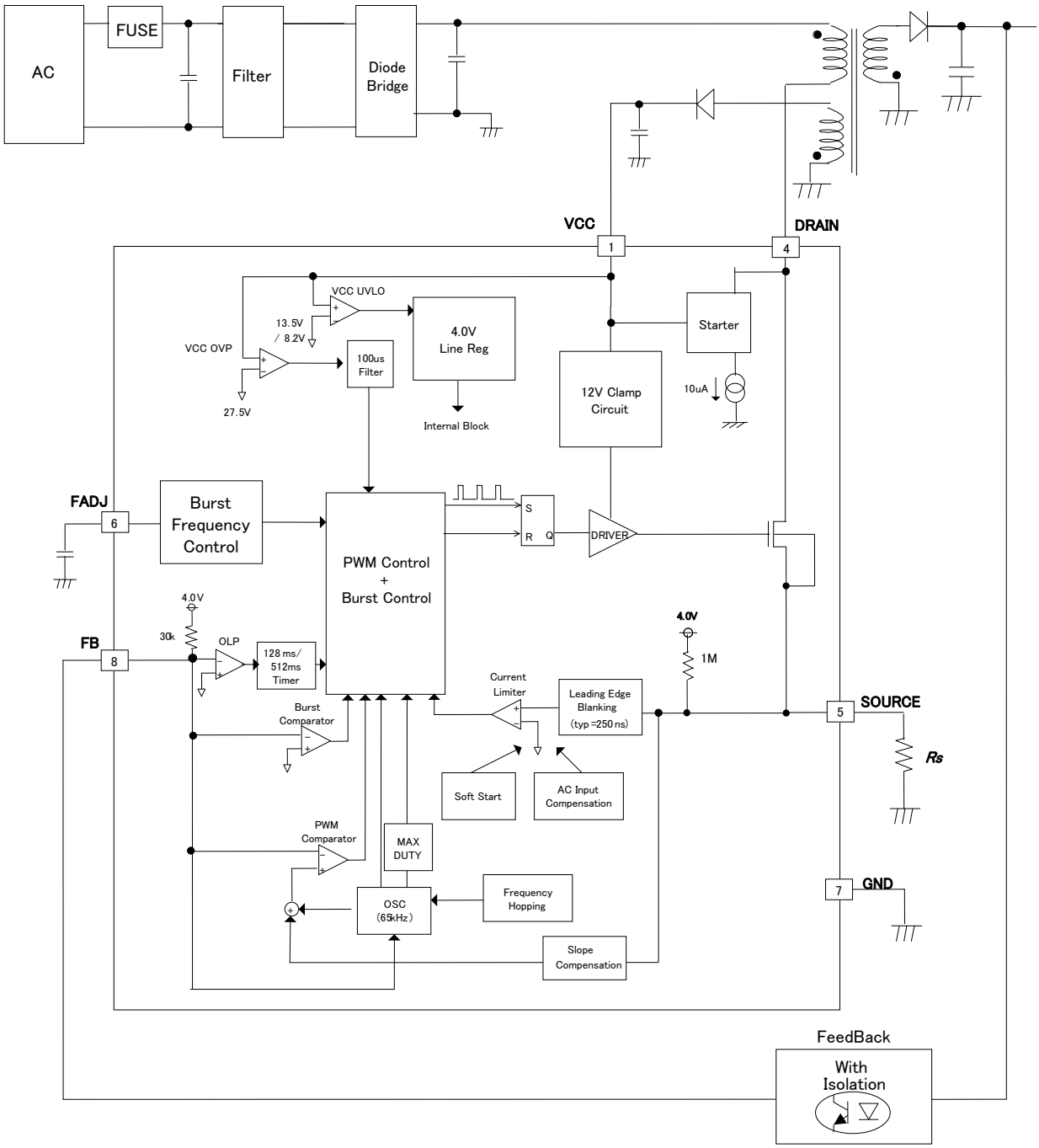


Figure 3. Block Diagram

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●**Line up**

		On Resistance [ohm typ.]	VCC OVP Function	FB OLP	Frequency Reduction Function
1	BM2P095F	8.50	Latch	Auto Restart	✔
2	BM2P045F	4.00			
3	BM2P096F	8.50	Auto Restart	Auto Restart	✔
4	BM2P046F	4.00			
5	BM2P097F	8.50	Latch	Latch	✔
6	BM2P047F	4.00			
7	BM2P098F	8.50	Auto Restart	Latch	✔
8	BM2P048F	4.00			
9	BM2PA95F	8.50	Latch	Auto Restart	–
10	BM2PA45F	4.00			
11	BM2PA96F	8.50	Auto Restart	Auto Restart	–
12	BM2PA46F	4.00			
13	BM2PA97F	8.50	Latch	Latch	–
14	BM2PA47F	4.00			
15	BM2PA98F	8.50	Auto Restart	Latch	–
16	BM2PA48F	4.00			

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●Block Description

(1) Start circuit (DRAIN: Pin 4)

This IC has a built-in start circuit. It enables low standby mode electricity and high speed start.
After start up, consumption power is determined by idling current I_{START3}（Typ=10uA）only.
Reference values of starting time are shown in Figure 6. When C_{vcc}=10uF it can start in less than 0.1 sec.

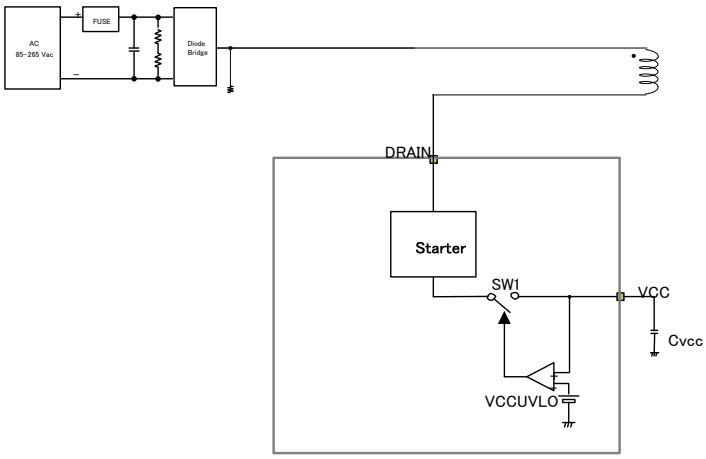


Figure 4. Block Diagram of Start Circuit

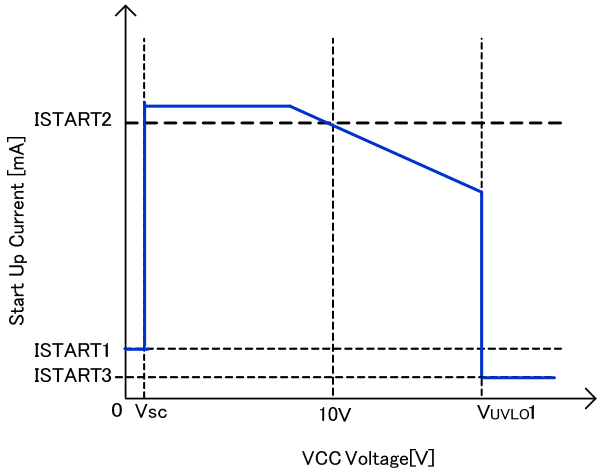


Figure 5. Start Current vs VCC Voltage

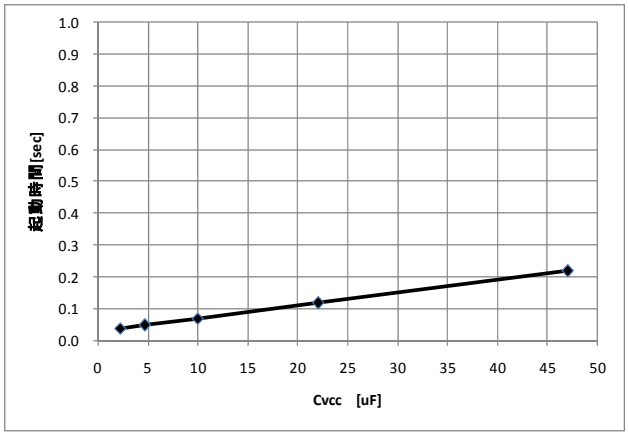


Figure 6. Start Time (reference value)

* Start current flows from the DRAIN pin

Ex) Consumption power of start circuit only when Vac=100V
PVH＝100V*√2*10uA=1.41mW

Ex) Consumption power of start circuit only when Vac=240V
PVH＝240V*√2*10uA=3.38mW

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(2) Start sequences
(Soft start operation, light load operation, and auto recovery operation during overload protection)

Start sequences are shown in Figure 7. See the sections below for detailed descriptions.

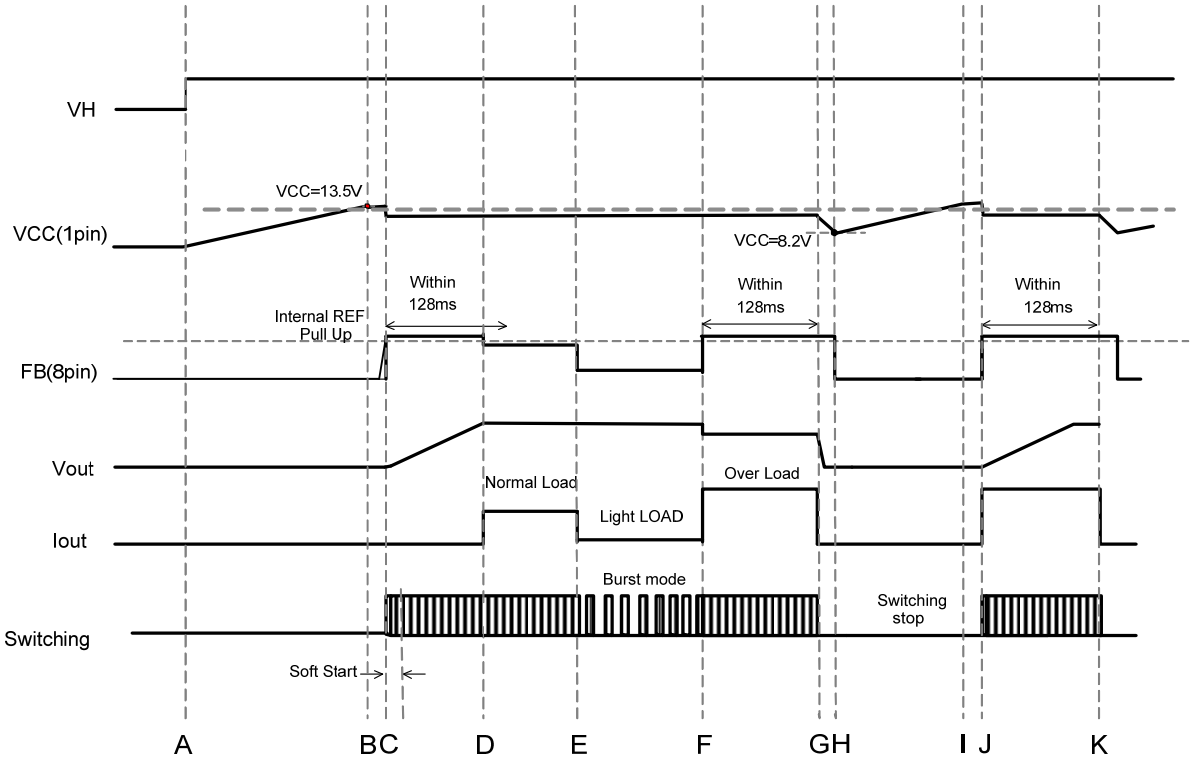


Figure 7. Start Sequences Timing Chart

A: Input voltage VH is applied.
B: This IC starts operating when VCC > V_{UVLO1} (13.5 V Typ).
Switching function starts when other protection functions are judged as normal.
When the secondary output voltage becomes constant, VCC pin current causes the VCC voltage to drop. As a result, IC should be set to start switching until VCC<V_{UVLO2} (8.2V Typ).
C: With the soft start function, over current limit value is restricted to prevent any excessive rise in voltage or current.
D: When the switching operation starts, VOUT rises.
Once the output voltage starts, set the rated voltage within the T_{FOLP} period (128ms Typ).
E: When there is a light load, it makes FB voltage < V_{BST} (0.3V Typ). Burst operation is used to keep power consumption down. During burst operation, it operates at low-power consumption mode.
F: When the FB pin Voltage＞V_{FOLP1A}（2.8V Typ）, it overloads.
G: When the FB pin voltage keeps V_{FOLP1A} (= 2.8V Typ) at or goes above T_{FOLP} (128ms Typ), the overload protection function is triggered and the switching stops. During the T_{FOLP} period (128ms Typ), if the FB pin voltage becomes <V_{FOLP1B} even once, the IC's internal timer is reset.
H: If the VCC voltage drops to < V_{UVLO2} (7.7V Typ) or below, restart is executed.
I: The IC's circuit current is reduced and the VCC pin value rises. (same as B)
J: Same as F
K: Same as G

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(3) VCC pin protection function

These ICs have a built-in VCC low voltage protection function VCCUVLO (Under Voltage Lock Out), over voltage protection function VCCOVP (Over Voltage Protection), and a VCC recharge function that operates in case of a drop in VCC voltage. VCC charge function stabilizes the secondary output voltage, charged from high voltage lines by the start circuit when VCC voltage drops.

(3-1) VCC UVLO ／ VCC OVP function

VCCUVLO is an auto recovery comparator while VCCOVP is a latch type or auto restart type comparator with voltage hysteresis.

VCCOVP operates in case of continuing VCC pin voltage > V_{OVP}（Typ=27.5V）.

This function has a built-in mask time T_{LATCH}（Typ=100us）. Through this function, the IC is protected from pin generated surge, etc. Figure 8 is showed about VCC OVP latch type.

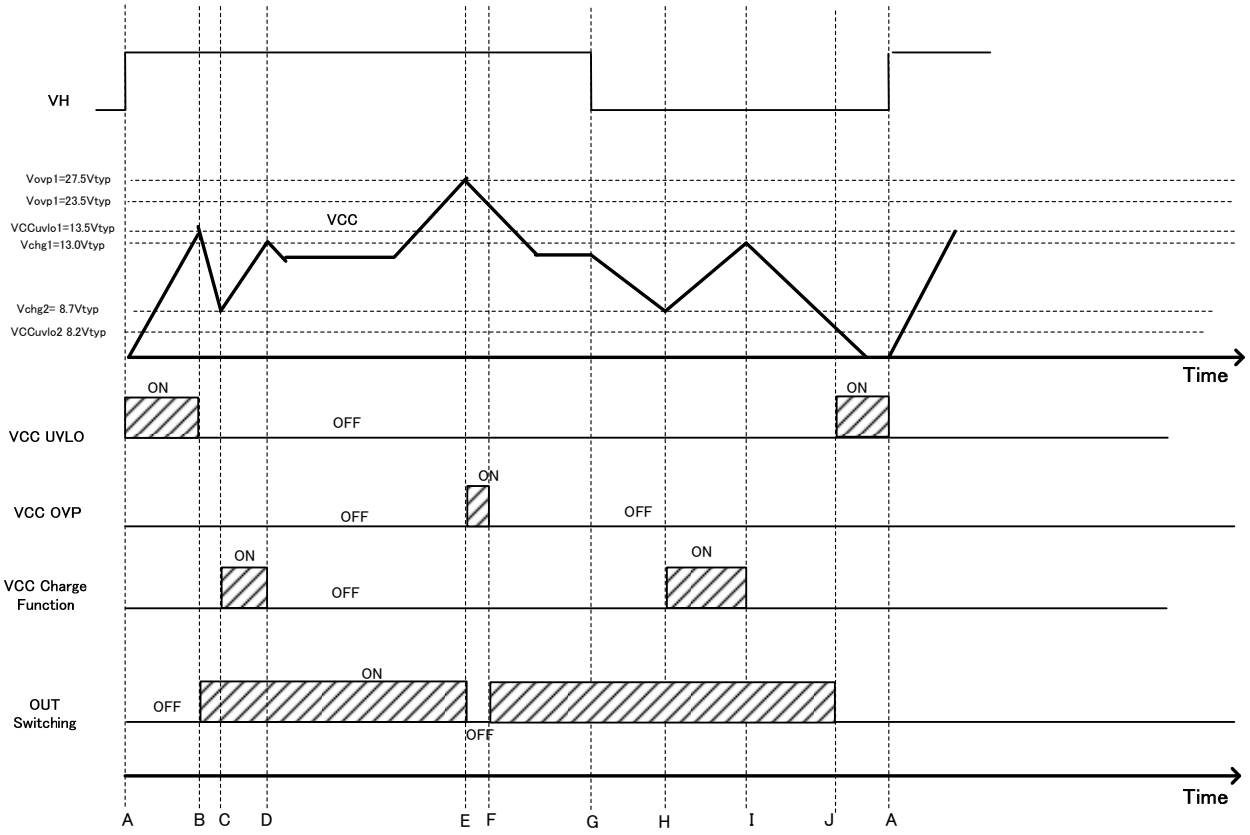


Figure 8. VCC UVLO / OVP Timing Chart

A: DRAIN voltage input, VCC pin voltage starts rising.
B: VCC>V_{uvlo1}, DC/DC operation starts.
C: VCC< V_{CHG1}, VCC charge function operates and the VCC voltage rises.
D: VCC > $V_{CHG2,}$ VCC charge function stops.
E: VCC > $V_{OVP1,}$ T_{LATCH} (Typ =100us) continues, switching is stopped by the VCCOVP function.
F: VCC < V_{OVP2}, DC/DC operation restarts.
G: VH is OPEN. VCC Voltage falls.
H: Same as C
I: Same as D
J: VCC<V_{uvlo2}, DC/DC operation stops.

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(3-2) VCC charge function

BM2PxxxF has the recharge function.
VCC charge function operates once the VCC pin >V_{UVLO1} and when the DC/DC operation starts. The VCC pin voltage then drops to <V_{CHG1}. At that time the VCC pin is charged from the DRAIN pin through the start circuit.
Through this operation, these series prevent failure.
VCC pin voltage rises until VCC >V_{CHG2}. The operation is shown in figure 9.

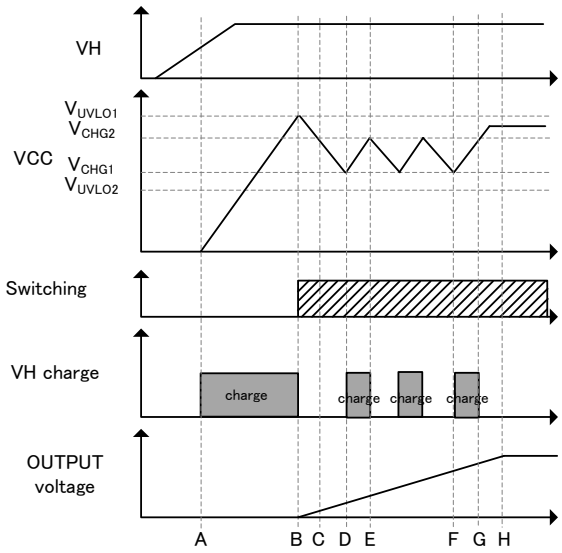


Figure 9. VCC Pin Charge Operation

A: DRAIN pin voltage rises, charges VCC pin through the VCC charge function.
B: VCC > $V_{UVLO1,}$ VCC UVLO function releases, VCC charge function stops, DC/DC operation starts.
C: When the DC/DC operation starts, the VCC voltage drops.
D: VCC < $V_{CHG1,}$ VCC recharge function operates.
E: VCC > $V_{CHG2,}$ VCC recharge function stops.
F: VCC < $V_{CHG1,}$ VCC recharge function operates.
G: VCC > $V_{CHG2,}$ VCC recharge function stops.
H: After the output voltage is finished rising, VCC is charged by the auxiliary winding, and VCC pin stabilizes.

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(4) DCDC driver (PWM comparator, frequency hopping, slope compensation, OSC, burst)

BM2PxxxF has a current mode PWM control.
An internal oscillator sets a fixed switching frequency (65 kHz Typ).
BM2PxxxF has an integrated switching frequency hopping function, which causes the switching frequency to fluctuate as shown in figure 10 below.
The fluctuation cycle is 125 Hz (Typ).

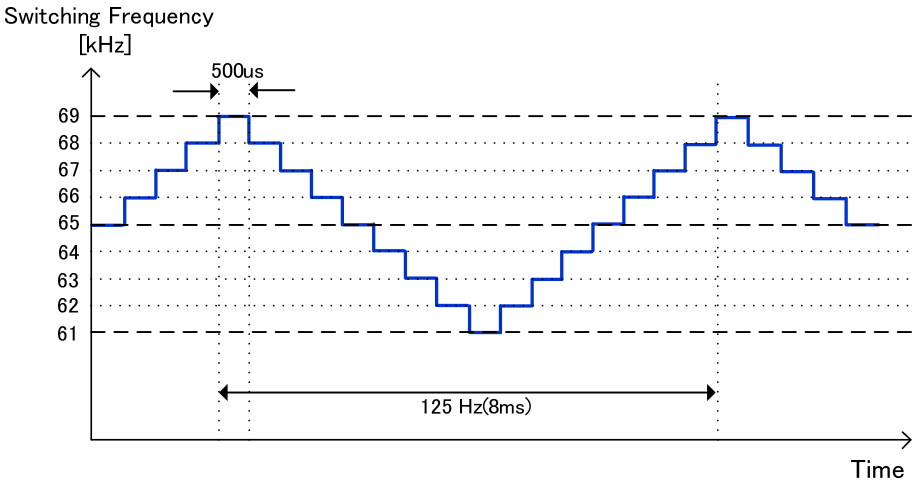


Figure 10. Frequency Hopping Function

Maximum duty cycle is fixed at 75% (Typ) and minimum pulse width is fixed at 400 ns (Typ).
In current mode control, sub-harmonic oscillation may occur when the duty cycle exceeds 50%.
As a countermeasure, this IC has built-in slope compensation circuits.

This IC has built-in burst mode and frequency reduction circuits to achieve lower power consumption when the load is light.
(Only BM2P0xxF series have frequency reduction circuits)
FB pin is pulled up by R_{FB} (30 kΩ Typ).
FB pin voltage is changed by secondary output voltage (secondary load power).
FB pin is monitored, burst mode operation and frequency detection start.

Figure 11 shows the FB voltage, and the DCDC switching frequency operation.

＜BM2P0xxF＞
- mode1 : Burst operation
- mode2 : Frequency reduction operation
- mode3 : Fixed frequency operation (operates at max frequency)
- mode4 : Overload operation (detects the overload state and stops the pulse operation)

＜BM2PAxxF＞
- mode1 : Burst operation
- mode2 : Fixed frequency operation (operates at max frequency)
- mode3 : Fixed frequency operation (operates at max frequency)
- mode4 : Overload operation (detects the overload state and stops the pulse operation)

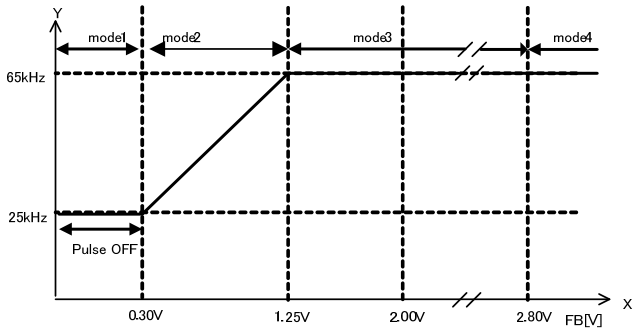


Figure 11-1. Switching Operation State Changes by FB Pin Voltage (BM2P0xxF series)

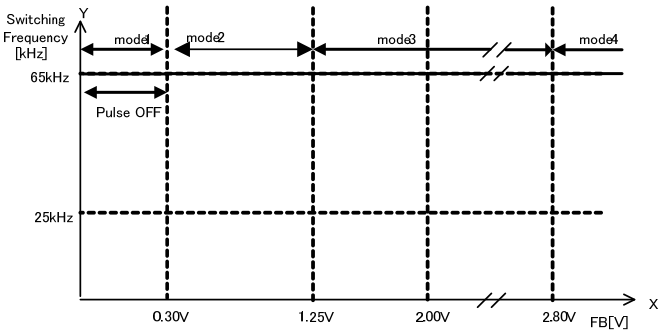


Figure 11-2. Switching Operation State Changes by FB Pin Voltage (BM2PAxxF series)

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(4-1) MAX Burst frequency setting

This IC can reduce a burst sound to fix a burst frequency.
This IC has two clocks, so this IC can fix the burst frequency.

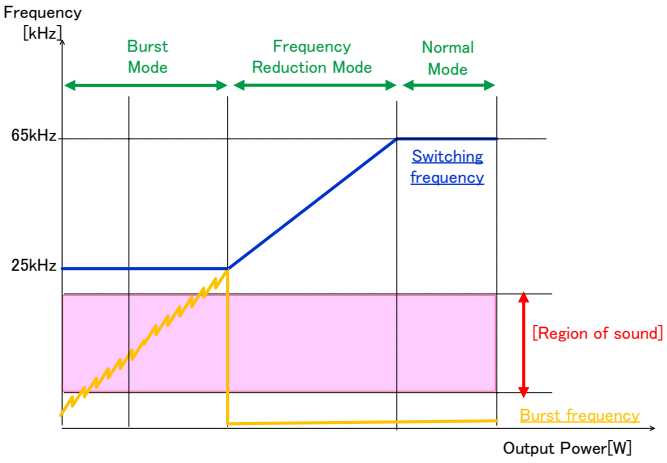


Figure 12-1. No setting

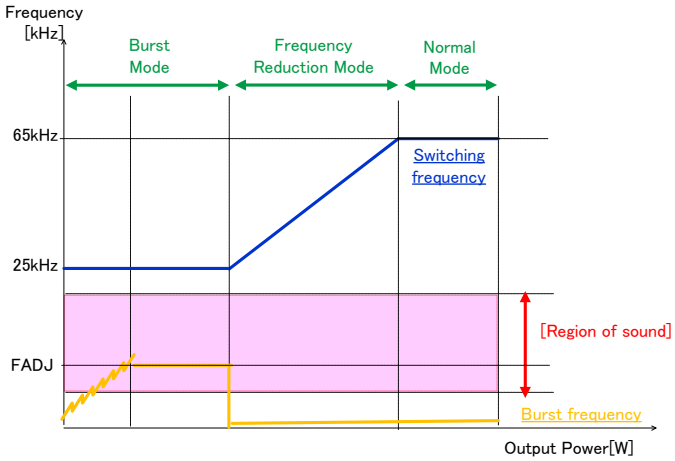


Figure 12-2. setting

Setting external capacitor of FADJ pin, the burst frequency is fixed.
It is showed an example of max burst frequency setting using FADJ pin
This frequency is decided by FADJ source current, FADJ comparator voltage and external capacitor.

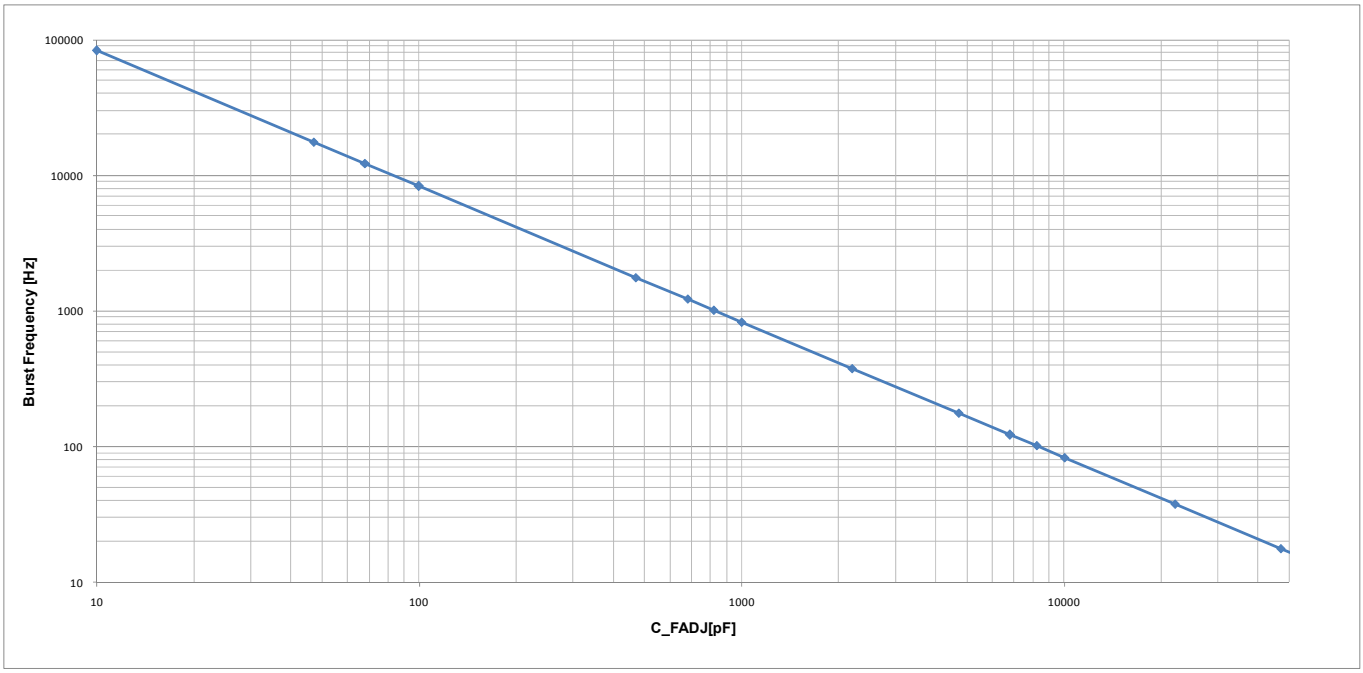


Figure 13. Example of max burst frequency setting using FADJ pin

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(5) Over Current limiter

BM2PxxxF has a built-in over current limiter per cycle. If the SOURCE pin exceeds a certain voltage, switching stops. It also has a built-in AC voltage compensation function. With this function, the over current limiter level is high until the time the AC voltage is compensated.

Shown in figure-14, 15, and 16.

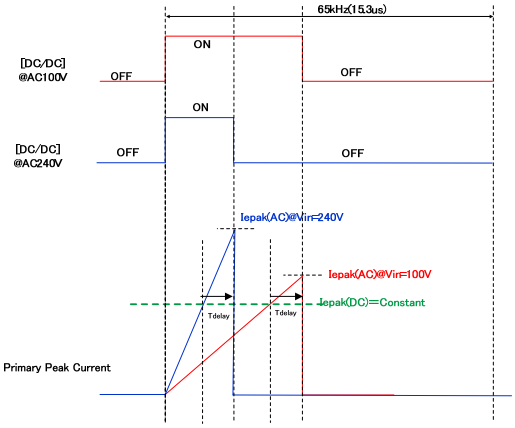


Figure 14. No AC Voltage Compensation Function

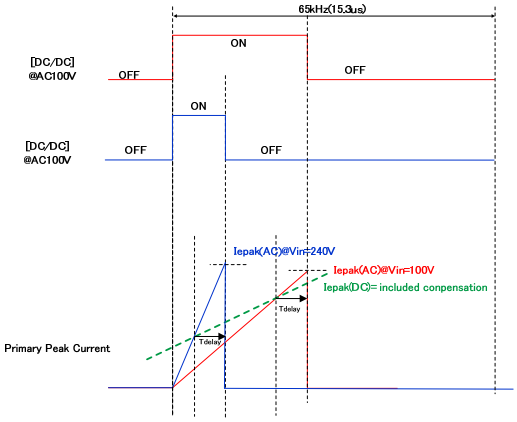


Figure15. Built-in AC Compensation Voltage

Primary peak current is calculated using the formula below.

Primary peak current: $I_{peak} = V_{cs}/Rs + V_{dc}/L_p * T_{delay}$

V_{cs}: Over current limiter voltage (internal), Rs: Current detection resistance, V_{dc}: Input DC voltage, L_p: Primary inductance, T_{delay}: Delay time after detection of over current limiter

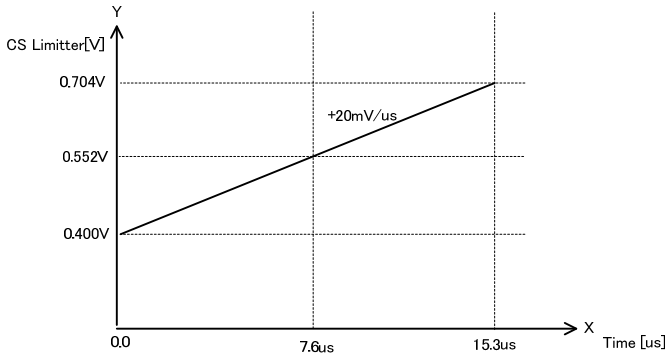


Figure 16. Over Current Limiter Voltage

(6) L. E. B. Blanking Period

When the MOSFET driver is turned ON, surge current flows through each capacitor component and drive current is generated. Therefore, when the SOURCE pin voltage rises temporarily, detection errors may occur in the over current limiter circuit. To prevent detection errors, DRAIN is switched from high to low and the SOURCE signal is masked for 250ns by the on-chip LEB (Leading Edge Blanking) function.

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(7) SOURCE pin (pin 5) short protection function

When the SOURCE pin (pin 5) is shorted, BM2PxxxF overheats.
BM2PxxxF has a built-in short protection function to prevent destruction.

(8) SOURCE pin (pin 5) open protection

If the SOURCE pin becomes OPEN, BM2PxxxF may be damaged.
To prevent it from being damaged, BM2PxxxF has a built-in OPEN protection circuit（auto recovery protection）.

((9) Output over load protection function （FB OLP Comparator）

The output overload protection function monitors the secondary output load status at the FB pin and stops switching whenever overload occurs. When there is an overload, the output voltage is reduced and current no longer flows to the photo coupler, so the FB pin voltage rises.
When the FB pin voltage > V_{FOLP1A} (2.8 V Typ) continuously for the period T_{FOLP} (128ms Typ), it is judged as an overload and switching stops.
When the FB pin > V_{FOLP1A} (2.8 V Typ), if the voltage goes lower than V_{FOLP1B} (2.6V Typ) during the period T_{FOLP} (128ms Typ), the overload protection timer is reset. The switching operation is performed during this period T_{FOLP} (128ms Typ).
At startup, the FB voltage is pulled up to the IC's internal voltage, so operation starts at a voltage of V_{FOLP1A} (2.8 V Typ) or above. Therefore, at startup the FB voltage must be set to V_{FOLP1B} (2.6 V Typ) or below during the period T_{FOLP} (128ms Typ), and the secondary output voltage's start time must be set within the period T_{FOLP} (128ms Typ) following startup of the IC.
Recovery is after the period T_{FOLP2}(512 ms Typ), from the detection of FBOLP.

●Operation mode of protection circuit

Operation mode of protection functions are shown in Table 2.

Table 2. Operation Mode of Protection Circuit

Function	Operation mode
VCC Under Voltage Locked Out	Auto recovery
VCC Over Voltage Protection	BM2Pxx5F :Latch（with 100us timer） BM2Pxx6F :Auto recovery BM2Pxx7F :Latch（with 100us timer） BM2Pxx8F :Auto recovery
TSD	Auto recovery
FB Over Limited Protection	BM2PXX5F:Auto recovery（with 128ms timer） BM2PXX6F:Auto recovery （with 128ms timer） BM2PXX7F:Latch（with 128ms timer） BM2PXX8F:Latch（with 128ms timer）
SOURCE Short Protection	Auto recovery
SOURCE Open Protection	Auto recovery

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● **Thermal loss**

The thermal design should set the operation for the following conditions.
(Since the temperature shown below is the guaranteed temperature, be sure to take into account a sufficient margin.)

1. The ambient temperature Ta must be 105℃ or less.
2. The IC's loss must be within the allowable dissipation P_d.

The thermal dissipation characteristics are as follows.
(PCB: 70 mm × 70mm × 1.6 mm, mounted on glass epoxy substrate)

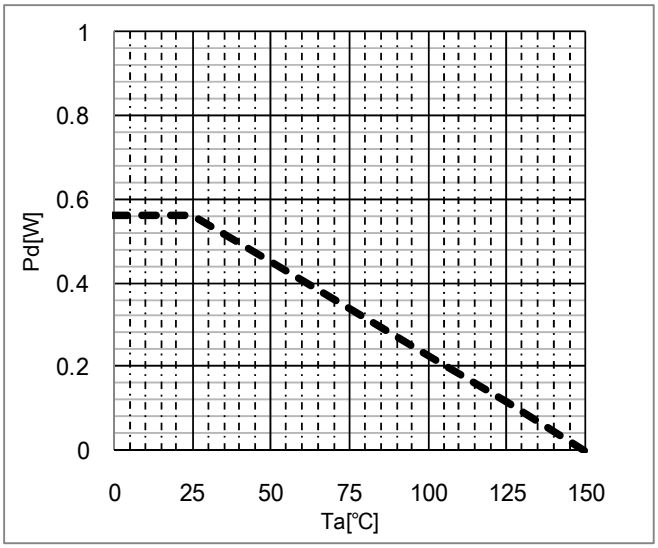


Figure 17. SOP8 Thermal Dissipation Characteristics

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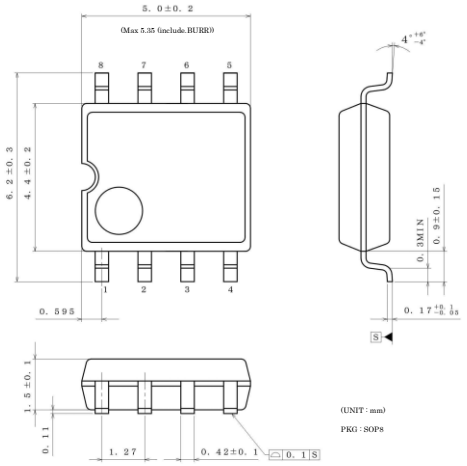
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●Ordering Information

B M 2 P X X X F - GE 2

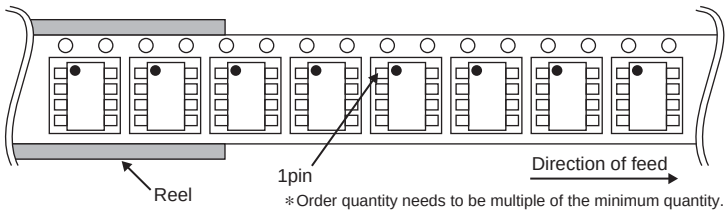
- Product name
- Package F: SOP8
- Packaging and forming specification E2: Embossed tape and reel

●Physical Dimension Tape and Reel Information



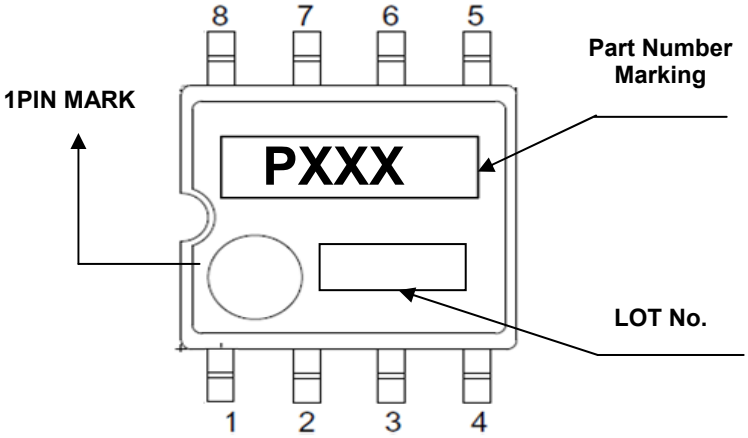
<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



＊Order quantity needs to be multiple of the minimum quantity.

●Marking Diagram



●Line Up

	Product name	Part Number Marking
1	BM2P095F	P095
2	BM2P045F	P045
3	BM2P096F	P096
4	BM2P046F	P046
5	BM2P097F	P097
6	BM2P047F	P047
7	BM2P098F	P098
8	BM2P048F	P048
9	BM2PA95F	PA95
10	BM2PA45F	PA45
11	BM2PA96F	PA96
12	BM2PA46F	PA46
13	BM2PA97F	PA97
14	BM2PA47F	PA47
15	BM2PA98F	PA98
16	BM2PA48F	PA48

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Operational Notes

1. **Reverse Connection of Power Supply**
   Connecting the power supply in reverse polarity can damage the IC. Take precautions against reverse polarity when connecting the power supply, such as mounting an external diode between the power supply and the IC's power supply pins.

2. **Power Supply Lines**
   Design the PCB layout pattern to provide low impedance supply lines. Separate the ground and supply lines of the digital and analog blocks to prevent noise in the ground and supply lines of the digital block from affecting the analog block. Furthermore, connect a capacitor to ground at all power supply pins. Consider the effect of temperature and aging on the capacitance value when using electrolytic capacitors.

3. **Ground Voltage**
   Ensure that no pins are at a voltage below that of the ground pin at any time, even during transient condition.

4. **Ground Wiring Pattern**
   When using both small-signal and large-current ground traces, the two ground traces should be routed separately but connected to a single ground at the reference point of the application board to avoid fluctuations in the small-signal ground caused by large currents. Also ensure that the ground traces of external components do not cause variations on the ground voltage. The ground lines must be as short and thick as possible to reduce line impedance.

5. **Thermal Consideration**
   Should by any chance the power dissipation rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. The absolute maximum rating of the Pd stated in this specification is when the IC is mounted on a 70mm x 70mm x 1.6mm glass epoxy board. In case of exceeding this absolute maximum rating, increase the board size and copper area to prevent exceeding the Pd rating.

6. **Recommended Operating Conditions**
   These conditions represent a range within which the expected characteristics of the IC can be approximately obtained. The electrical characteristics are guaranteed under the conditions of each parameter.

7. **Inrush Current**
   When power is first supplied to the IC, it is possible that the internal logic may be unstable and inrush current may flow instantaneously due to the internal powering sequence and delays, especially if the IC has more than one power supply. Therefore, give special consideration to power coupling capacitance, power wiring, width of ground wiring, and routing of connections.

8. **Operation Under Strong Electromagnetic Field**
   Operating the IC in the presence of a strong electromagnetic field may cause the IC to malfunction.

9. **Testing on Application Boards**
   When testing the IC on an application board, connecting a capacitor directly to a low-impedance output pin may subject the IC to stress. Always discharge capacitors completely after each process or step. The IC's power supply should always be turned off completely before connecting or removing it from the test setup during the inspection process. To prevent damage from static discharge, ground the IC during assembly and use similar precautions during transport and storage.

10. **Inter-pin Short and Mounting Errors**
    Ensure that the direction and position are correct when mounting the IC on the PCB. Incorrect mounting may result in damaging the IC. Avoid nearby pins being shorted to each other especially to ground, power supply and output pin. Inter-pin shorts could be due to many reasons such as metal particles, water droplets (in very humid environment) and unintentional solder bridge deposited in between pins during assembly to name a few.

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Operational Notes – continued

11. Unused Input Pins

Input pins of an IC are often connected to the gate of a MOS transistor. The gate has extremely high impedance and extremely low capacitance. If left unconnected, the electric field from the outside can easily charge it. The small charge acquired in this way is enough to produce a significant effect on the conduction through the transistor and cause unexpected operation of the IC. So unless otherwise specified, unused input pins should be connected to the power supply or ground line.

12. Regarding the Input Pin of the IC

This monolithic IC contains P+ isolation and P substrate layers between adjacent elements in order to keep them isolated. P-N junctions are formed at the intersection of the P layers with the N layers of other elements, creating a parasitic diode or transistor. For example (refer to figure below):

When GND > Pin A and GND > Pin B, the P-N junction operates as a parasitic diode.
When GND > Pin B, the P-N junction operates as a parasitic transistor.

Parasitic diodes inevitably occur in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions that cause these diodes to operate, such as applying a voltage lower than the GND voltage to an input pin (and thus to the P substrate) should be avoided.

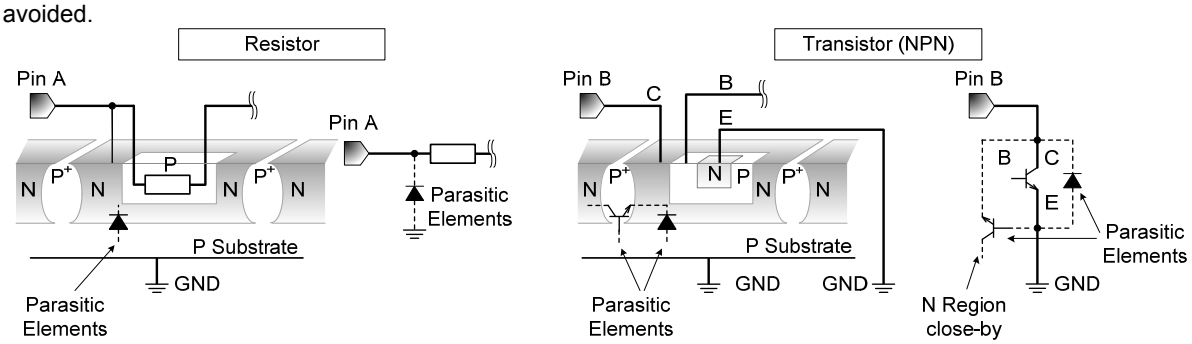


Figure 18. Example of monolithic IC structure

13. Ceramic Capacitor

When using a ceramic capacitor, determine the dielectric constant considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.

14. Area of Safe Operation (ASO)

Operate the IC such that the output voltage, output current, and power dissipation are all within the Area of Safe Operation (ASO).

15. Thermal Shutdown Circuit(TSD)

This IC has a built-in thermal shutdown circuit that prevents heat damage to the IC. Normal operation should always be within the IC's power dissipation rating. If however the rating is exceeded for a continued period, the junction temperature (Tj) will rise which will activate the TSD circuit that will turn OFF all output pins. The IC should be powered down and turned ON again to resume normal operation because the TSD circuit keeps the outputs at the OFF state even if the TJ falls below the TSD threshold.

Note that the TSD circuit operates in a situation that exceeds the absolute maximum ratings and therefore, under no circumstances, should the TSD circuit be used in a set design or for any purpose other than protecting the IC from heat damage.

16. Over Current Protection Circuit (OCP)

This IC incorporates an integrated overcurrent protection circuit that is activated when the load is shorted. This protection circuit is effective in preventing damage due to sudden and unexpected incidents. However, the IC should not be used in applications characterized by continuous operation or transitioning of the protection circuit.

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date	Rev. NO.	Revision Point
21/Apr/2014	001	New release
28/Nor/2016	002	P3. Electrical Characteristics , add Minimum On pulse

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(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

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   [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
   [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl_2, H_2S, NH_3, SO_2, and NO_2
   [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
   [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   [f] Sealing or coating our Products with resin or other coating materials
   [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
   [h] Use of the Products in places subject to dew condensation

4. The Products are not subject to radiation-proof design.

5. Please verify and confirm characteristics of the final or mounted products in using the Products.

6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse. is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7. De-rate Power Dissipation depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction temperature.

8. Confirm that operation temperature is within the specified range described in the product specification.

9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

Precaution for Mounting / Circuit board design

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2. In principle, the reflow soldering method must be used on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

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Precautions Regarding Application Examples and External Circuits

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2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

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This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
   - [a] the Products are exposed to sea winds or corrosive gases, including Cl2, H2S, NH3, SO2, and NO2
   - [b] the temperature or humidity exceeds those recommended by ROHM
   - [c] the Products are exposed to direct sunshine or condensation
   - [d] the Products are exposed to high Electrostatic

2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

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BM2P095F - Web Page

Part Number	BM2P095F
Package	SOP8
Unit Quantity	2500
Minimum Package Quantity	2500
Packing Type	Taping
Constitution Materials List	inquiry
RoHS	Yes

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