AC/DC Converter IC

PWM Type DC/DC Converter IC Integrated Switching MOSFET

BM2P061EK-LB BM2P101EK-LB

General Description

This is the product guarantees long time support in Industrial market. It is suitable when it is used for in long time support.

This series IC is a PWM type DC/DC converter for AC/DC which provides an optimum system for various electrical products that require an electrical outlet. It supports both Isolated and non-isolated devices, enabling simpler design of various types of low power consumption electrical converters.

This series also has a built-in HV starter circuit that can withstand up to 800V, which contributes to low power consumption. Since current mode control is utilized, current is restricted in each cycle and excellent performance is demonstrated in bandwidth and transient response. Switching frequency is fixed at 65kHz or 100kHz. At light load, the switching frequency is reduced and high efficiency is achieved. A frequency hopping function is also built-in, which contributes to low EMI. In addition, this product has a built-in super junction MOSFET which has a withstand voltage of 800V.

Feature

- Long Time Support Products for Industrial Applications.
- PWM Frequency: 65kHz/100kHz
- PWM Current Mode Control
- Frequency Hopping Function
- Burst Operation at Light Load
- Frequency Reduction Function
- Built-in 800V Starter Circuit
- Built-in 800V Switching MOSFET
- VCC Pin Under Voltage Protection
- VCC Pin Over Voltage Protection
- Over Current Limiter Function Per Cycle
- Over Current Limiter AC Voltage Correction Function
- Soft Start Function
- Brown IN/OUT Function
- ZT Pin OVP Function

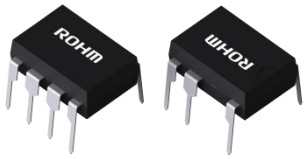
Key Specification

- Power Supply Voltage Operation Range:
  VCC : 10.90V to 30.0V
  DRAIN : 800V(Max)
- Normal Operating Current: 1.00mA (Typ)
- Burst Operating Current: 0.30mA (Typ)
- PWM Frequency(1a, 1b): 65kHz,100kHz (Typ)
- Operating Temperature Range: - 40°C to +105°C
- MOSFET ON Resistance: 1.6Ω (Typ)

Package

W(Typ) x D(Typ) x H(Max)

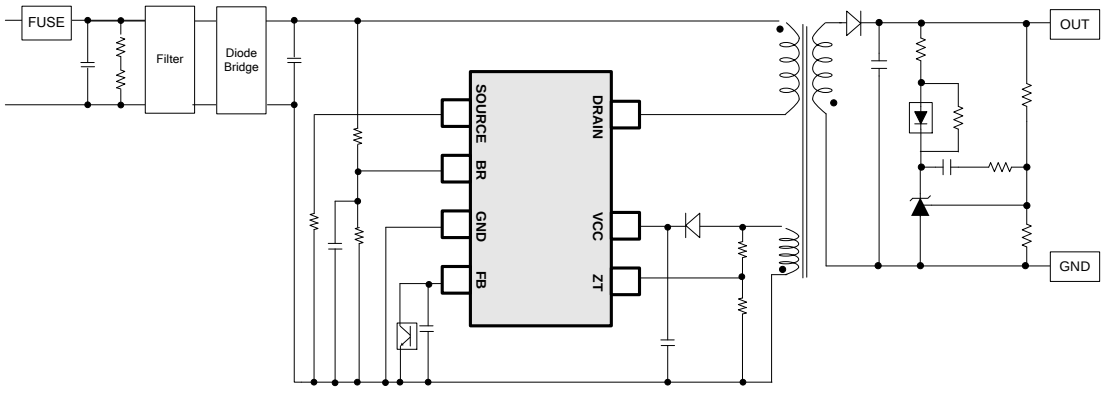
DIP7AK: 9.27mm×6.35mm×5.33mm pitch 2.54mm



Application

Industrial Equipment, Household Electrical Appliances, Adapters, etc.

Typical Application Circuit

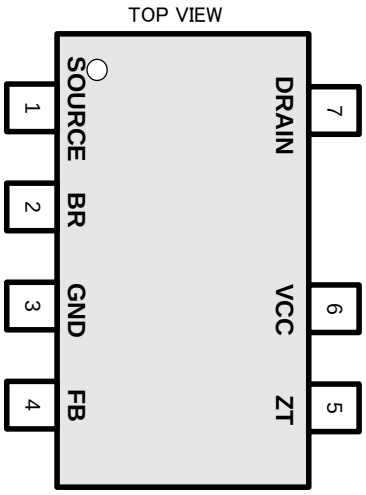


○Product structure : Silicon monolithic integrated circuit ○This product has no designed protection against radioactive rays

© 2016 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

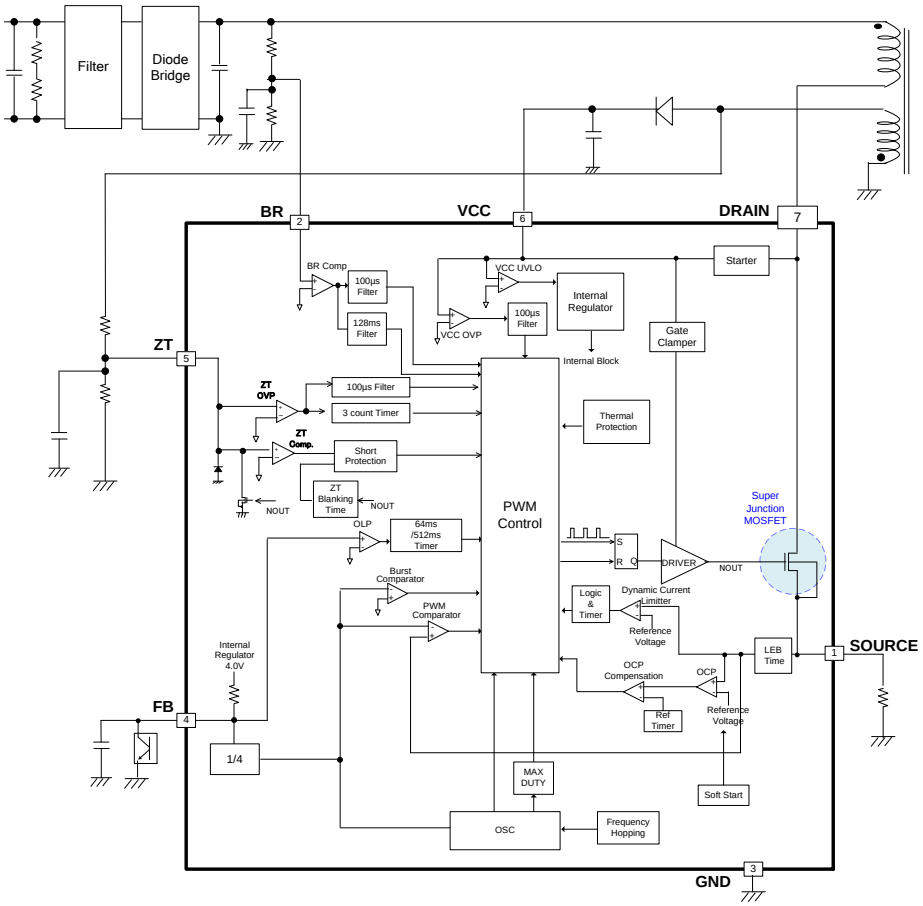
Pin Configuration



Pin Description

Pin No.	Pin Name	I/O	Function	ESD Diode	
				VCC	GND
1	SOURCE	I/O	MOSFET SOURCE pin	-	✓
2	BR	I	AC voltage detect pin	-	✓
3	GND	I/O	GND pin	✓	-
4	FB	I	Feedback signal input pin	-	✓
5	ZT	I	Auxiliary winding input pin	-	✓
6	VCC	I	Power supply input pin	-	✓
7	DRAIN	I/O	MOSFET DRAIN pin	-	✓

Block Diagram



© 2016 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

Description of Blocks

1. Starter Circuit (DRAIN: 7pin)

This IC enables low standby electric power and high-speed startup because it has a built-in start circuit (800V tolerance). The current consumption after startup is only OFF current I_{START3} (Typ=10μA).

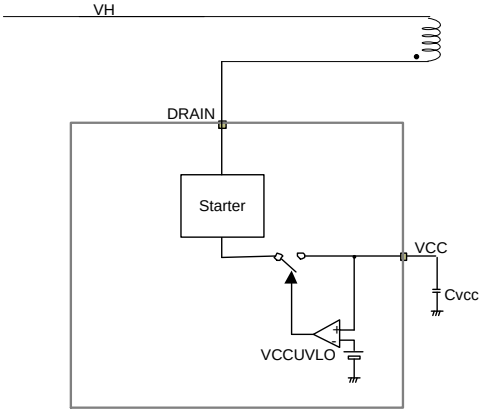


Figure 1. Start circuit block diagram

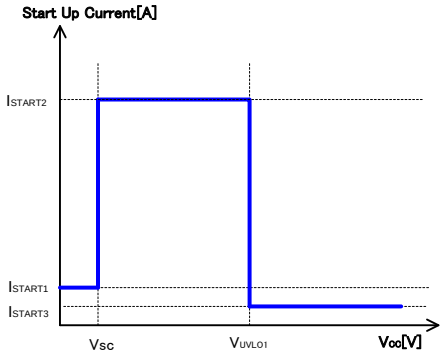


Figure 2. Start up current vs. VCC voltage

2. Start Sequence (start-up operation, light load operation, over load protection function)

Start sequence is shown in Figure 3. See the sections below for detailed descriptions.

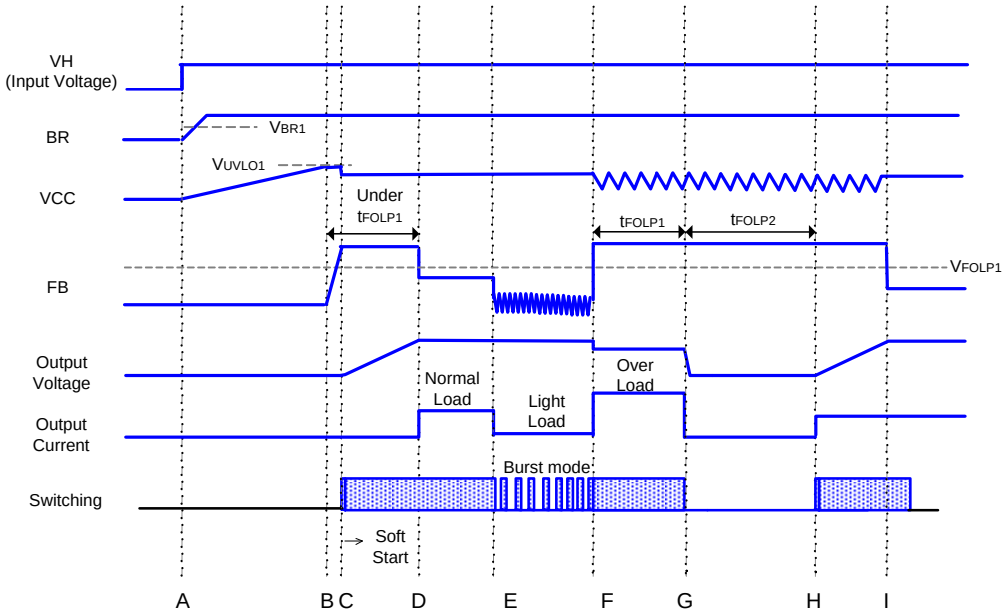


Figure 3. Start sequences timing chart

A: Input voltage VH is applied to the IC. As VH voltage is applied, the BR pin voltage becomes higher than V_{BR1}(Typ=0.7V).

B: When the VCC pin voltage exceeds V_{UVLO1} (Typ=15.5V), the IC starts to operate. When the IC judges the other protection functions as normal condition, switching operation starts. Until the secondary output voltage becomes constant from start-up, the VCC pin voltage drops by the VCC pin consumption current. When the VCC pin voltage becomes less than V_{CHG1} (Typ=10.7V), VCC charge operation starts.

C: Switching operation starts with the soft start function, over current limit value is restricted to prevent any excessive rise in voltage or current. Output voltage will be set to rated voltage within the t_{FOLP1}(Typ=64ms).

D: Once the output voltage is stable, VCC voltage also is stable.

E: When the FB pin voltage becomes lower than V_{BST1} (Typ=0.40V) at light load, the IC starts burst operation to reduce the power consumption.

F: When FB pin voltage becomes higher than V_{FOLP1} (Typ=3.4V), overload protection function operates.

G When FB pin voltage stays at V_{FOLP1} (Typ=3.4V) for t_{FOLP1} (Typ=64ms) or more, switching stops. When FB pin voltage becomes less than V_{FOLP2} (Typ=3.2V), the IC's FB OLP timer is reset.

H: Continued for t_{FOLP2} (Typ=512ms), IC starts switching again.

I: Same as D.

© 2016 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

Description of Blocks – continued

3. VCC Pin Protection Function

This IC has the internal protection functions at the VCC pin.

1) Under voltage protection function UVLO (Under Voltage Lockout)
2) Over voltage protection function VCC OVP (Over Voltage Protection)
3) VCC charge function

VCC charge function charges VCC pin from the high voltage line through a built-in starter circuit.

(1) VCC UVLO / VCC OVP Function

VCC UVLO function and VCC OVP function are auto recovery type comparators with voltage hysteresis. Switching is stopped by the VCC OVP function when VCC pin voltage > V_{OVP1} (Typ=32.0V), and restarts when VCC pin voltage < V_{OVP2} (Typ=24.0V)

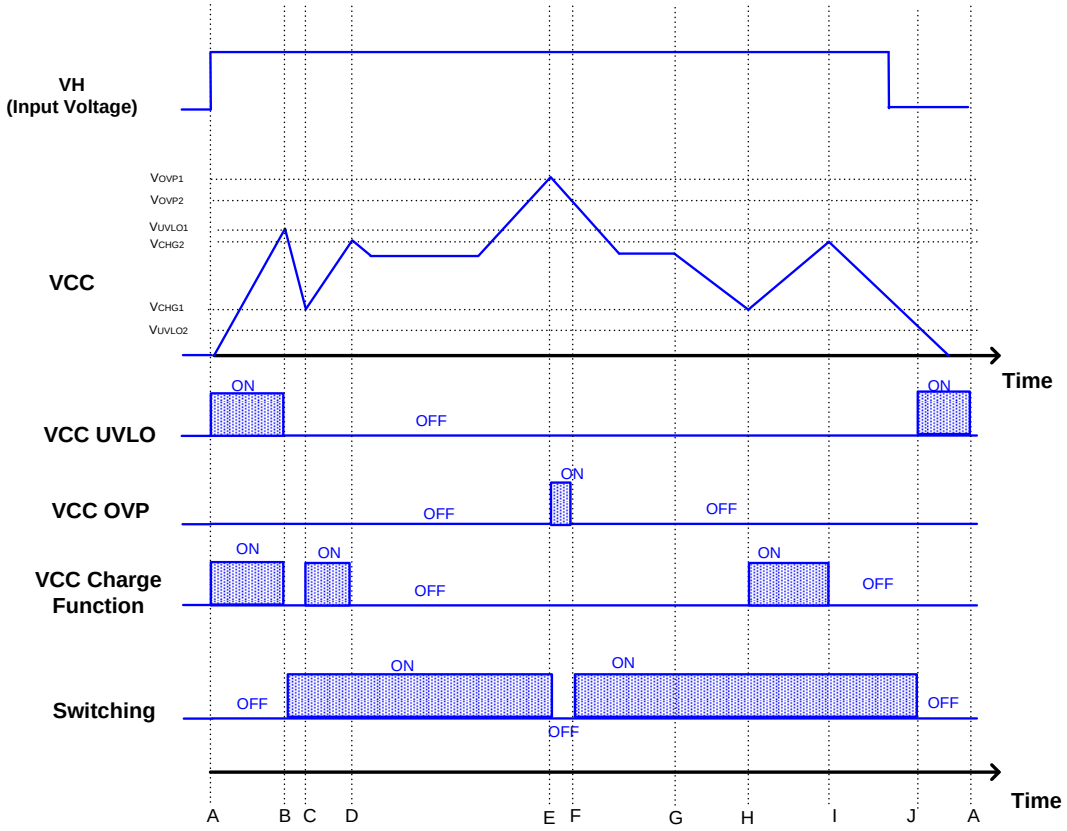


Figure 4. VCC UVLO / VCC OVP / VCC Charge Function timing chart

A: VCC pin voltage rises.
B: When VCC pin voltage is more than V_{UVLO1}(Typ=15.5V), the VCC UVLO function is released and DC/DC operation starts.
C: When VCC pin voltage is less than V_{CHG1}(Typ=10.7V), VCC charge function operates and VCC voltage rises.
D: When VCC pin voltage is more than V_{CHG2}(Typ=15.0V), VCC charge function stops.
E: When VCC pin voltage is more than V_{OVP1}(Typ=32.0V) switching continues for t_{COMP1} (Typ=100µs), After that, switching is stopped by the VCCOVP function.
F: When VCC pin voltage becomes less than V_{OVP2}(Typ=24.0V), switching operation restarts.
G: VCC voltage drops.
H: The same as C.
I: The same as D.
J: When input voltage "VH" drops and VCC pin voltage becomes less than V_{UVLO2}(Typ=10.2V), switching operation is stopped by the VCC UVLO function.

(2) VCC Charge Function

The IC starts to operate when the VCC pin voltage becomes more than V_{UVLO1}(Typ=15.5V). After that, VCC charge function operates when the VCC pin voltage becomes less than V_{CHG1}(Typ=10.7V). During this time, the VCC pin is charged from the DRAIN pin through starter circuit. By this operation, failure at start up is prevented. Once the VCC charge function resumes, it continues charge operation until VCC voltage > V_{CHG2}(Typ=15.0V), after which the charge function stops.

© 2016 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

Description of Blocks – continued

4. DC/DC Driver(PWM Comparator, Frequency Hopping, Slope Compensate, OSC, Burst)

This IC uses current mode PWM control. The internal oscillator sets the switching frequency at a fixed value when FB voltage > V_{DLT1}(Typ=1.25V).It also has a built-in switching frequency hopping function. Max duty cycle is fixed at 75% (Typ) and Minimum pulse width is fixed at 500 ns (Typ).With current mode control, when the duty cycle exceeds 50%, sub harmonic oscillation may occur. As a countermeasure, IC has built-in slope compensation function. IC it also has a built-in burst mode circuit and frequency reduction circuit to achieve lower power consumption in light load. FB pin is pulled up by R_{FB} (Typ=30kΩ) to an internal regulator. The FB pin voltage varies with secondary output voltage (secondary power).Burst mode operation and frequency reduction operate by monitoring FB pin voltage.

(1) Frequency Reduction Circuit

Figure 5 shows the relationships of switching frequency to FB voltage, and DC/DC operation modes.

mode1: Burst voltage has hysteresis. Switching stops when FB voltage < V_{BST1}(Typ=0.4V), and resumes when FB voltage > V_{BST2}(Typ=0.45V).

mode2: When FB voltage<V_{DLT2}(Typ=0.65V), switching frequency is at f_{SW2}(Typ=25kHz or 27kHz).At V_{DLT2} < FB voltage < V_{DLT1}, switching frequency changes within the range of f_{SW1} to f_{SW2}.

mode3: Fixed frequency(Typ=65kHz or 100kHz) operation

mode4: IC detects OLP within a period of t_{FOLP1}(Typ=64ms), and stops switching operation for t_{FOLP2}(Typ=512ms).

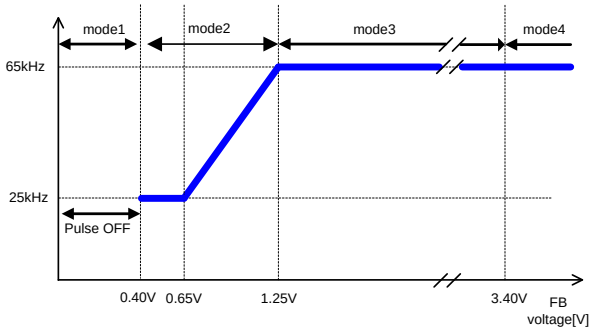


Figure 5a. Switching frequency(BM2P061EK-LB)

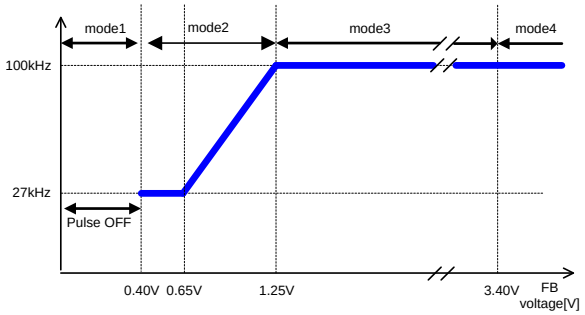


Figure 5b. Switching frequency(BM2P101EK-LB)

(2) Frequency Hopping Function

Frequency hopping function achieves low EMI by changing the frequency at random. The pulse width changes by +-6% for fundamental frequency.

(3) Over Current Limiter

This IC has built-in over current limiter per cycle. When SOURCE pin voltage exceeds OCP voltage V_{CSa}(Typ=0.4V) or V_{CSb}(Typ=0.3V) for 1 pulse, switching is turned off after passing internal delay time. The delay time varies in relation to the time by which SOURCE voltage reaches V_{CSa}(Typ=0.4V). During this time, AC voltage correction function operates. The relation of the time by which SOURCE voltage reaches V_{CSa}(Typ=0.4V) and the additional delay time are below.

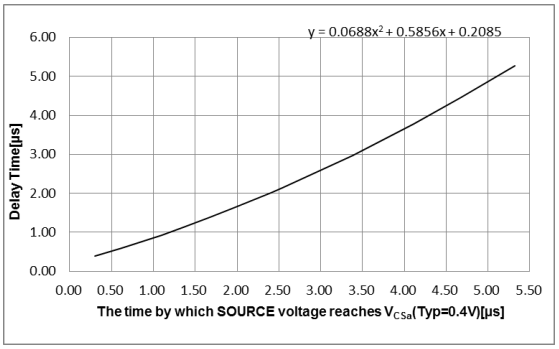


Figure 6a. Over current limiter delay time (BM2P061EK-LB)

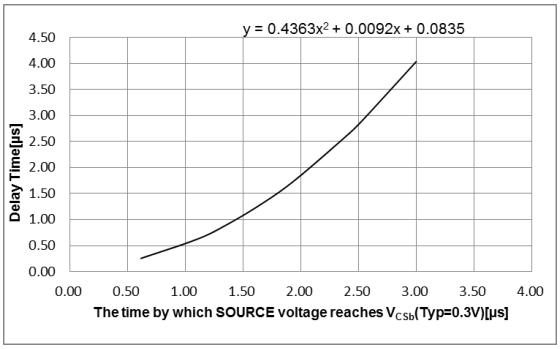


Figure 6b. Over current limiter delay time (BM2P101EK-LB)

© 2016 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

Over Current Limiter – continued

Ip is calculated by the following expression:

$$Ip = \frac{Vin}{Lp} \times (ton + td + tdelay)$$

Vin is AC input voltage
Lp is Primary inductance
ton is Vcs=time from 0V to V_{CSa} or V_{CSb}
td is Additional delay time introduced by IC (Refer to Figure 6)
tdelay is IC inherent delay time (Typ=0.2μs)

(4) Dynamic over current limiter

This IC has a built-in dynamic over current limiter circuit. When SOURCE voltage exceeds V_{DCS}(Typ=1.0V) for two consecutive times, it stops switching operation for t_{DCS} (Typ=128μs)

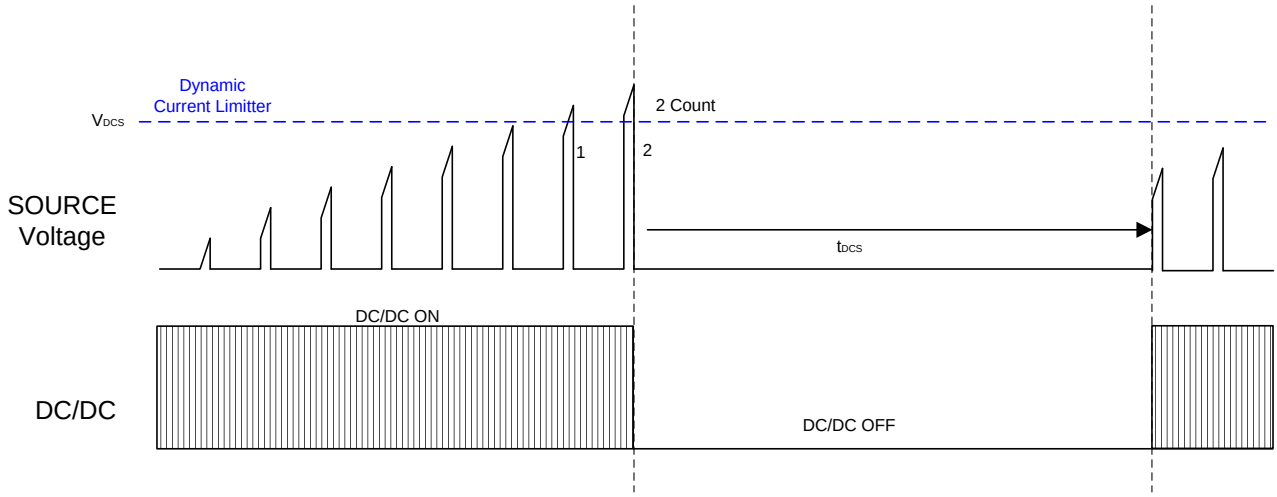


Figure 7. State transition of switching frequency

(5) Soft start Function

This function controls the over current limiter value in order to prevent any excessive rise in voltage or current upon start up. Figure 8 shows the details of soft start function. The IC implements soft start function by changing the over current limiter value with time.

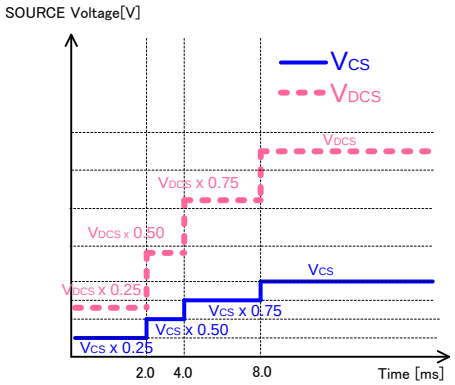


Figure 8. Soft start operation

(6) L.E.B. time.

When MOSFET is turned ON, surge current occurs capacitive elements and MOSFET drive. During this time, there is a probability of detection error in the over current limiter circuit due to a rise in SOURCE voltage. To prevent false reduction, there is a built-in L.E.B function (Leading Edge Blanking function) to mask the SOURCE voltage for t_{LEB} (Typ=250ns) after turn ON.

© 2016 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

Description of Blocks – continued

5. SOURCE pin short protection.

When the SOURCE pin is shorted to ground, IC may overheat and get destroyed. To prevent destruction, IC has a built-in short protection function. SOURCE pin short protection operates when SOURCE voltage <V_{CSSHT}(Typ=0.06V) within a period of t_{CSSHT}(Typ=2.0μs).

6. Output over load protection function (FB OLP Comparator)

Output over load protection function monitors the load condition and stops switching operation when overload condition is detected. IC detects FB OLP at FB voltage>V_{FOLP1} (Typ=3.4V) and releases FB OLP at FB voltage <V_{FOLP2}(Typ=3.2V). As output voltage decreases during over load condition, and if power dissipation is more than the limits of the IC for t_{FOLP1} (Typ=64ms), over loaded condition is detected and switching operation stops. FB OLP detection will be released after the auto-recovery period t_{FOLP2} (Typ=512ms).

7. Temperature protection circuit

Temperature protection circuit will stop the switching operation of DC/DC when operating temperature reaches T_{SD1} (Typ=175°C).If the IC is operated above the Maximum Junction Temperature, temperature protection circuit is not guaranteed to protect the IC from destruction. Always design not to operate exceeding Maximum Junction Temperature.

8. Input voltage protection function(Brown IN/OUT)

This IC has a built-in UVLO function monitor input voltage through the BR pin. This prevents the IC from heating by over-current when input voltage is low. When this UVLO function is released, IC operates by soft start.BR pin capacitor must be connected to prevent malfunction.

Example) If BR UVLO is released when input voltage is 130Vac.

$$\frac{130V\times\sqrt{2}\times R_{BR2}}{R_{BR1}+R_{BR2}} = V_{BR1}$$

When R_{BR1} is set to 1.23MΩ, R_{BR2} is calculated to 4.7kΩ. Then, BR UVLO voltage is calculated as:

$$\frac{(R_{BR1}+R_{BR2})\times V_{BR2}}{R_{BR2}\times\sqrt{2}} = 71 \text{ [Vac]}$$

Therefore, the hysteresis is 59Vac.

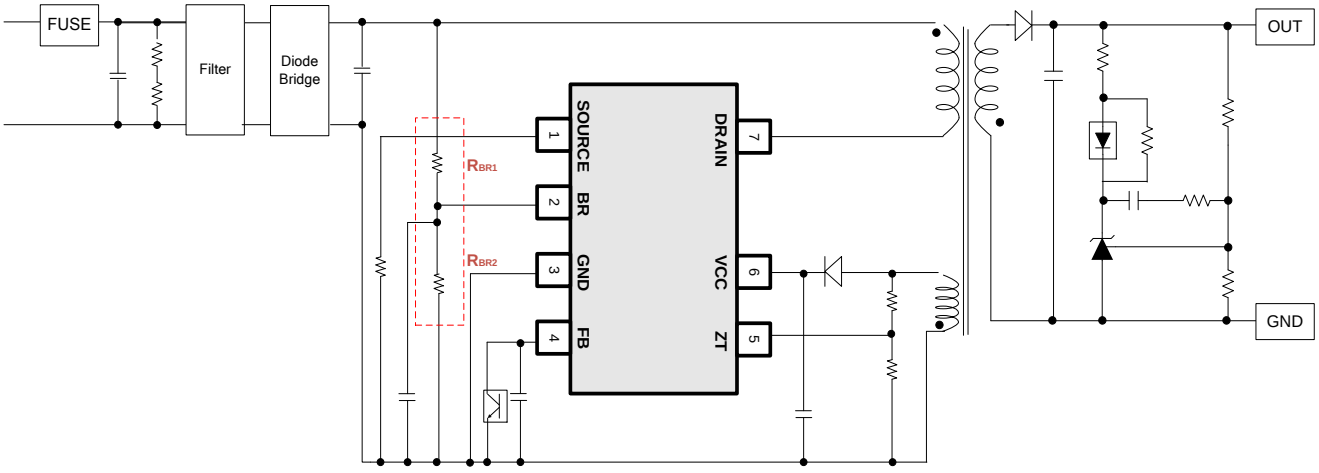


Figure 9. Brown IN/OUT circuit example.

© 2016 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

Description of Blocks – continued

9. ZT Pin Over Voltage Protection.

ZT OVP has 2 protection functions(Pulse detection and DC detection), both operating by latch protection.

Pulse detection) After ZT pin voltage>V_{ZTOVP}(Typ=3.5V) for 3 consecutive switching times and continues for t_{ZTOVP}(Typ=100μs), IC detects ZT OVP.

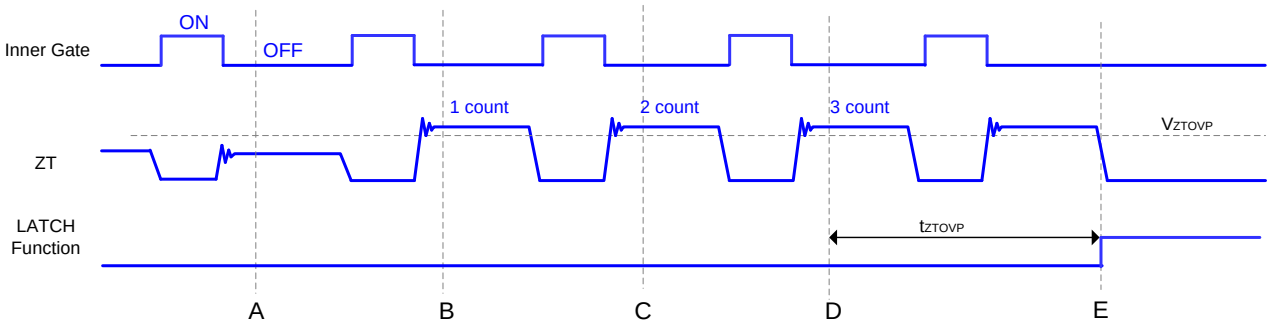


Figure 10. ZT pin over voltage protection (Pulse detection)

A: ZT pin voltage< V_{ZTOVP}(Typ=3.5V) normal operation
B: ZT pin voltage>V_{ZTOVP}(Typ=3.5V) 1pulse OVP detection
C: ZT pin voltage>V_{ZTOVP}(Typ=3.5V) 2pulses OVP detection
D: ZT pin voltage>V_{ZTOVP}(Typ=3.5V) 3pulses OVP detection. Then internal timer starts to operate.
E: The status of D continues for T_{ZTOVP}(Typ=100μs) from D, IC stops by latch.

DC detection) When ZT voltage >V_{ZTOVP}(Typ=3.5V) status continues for t_{ZTOVP} (Typ=100μs), IC detects ZT OVP.

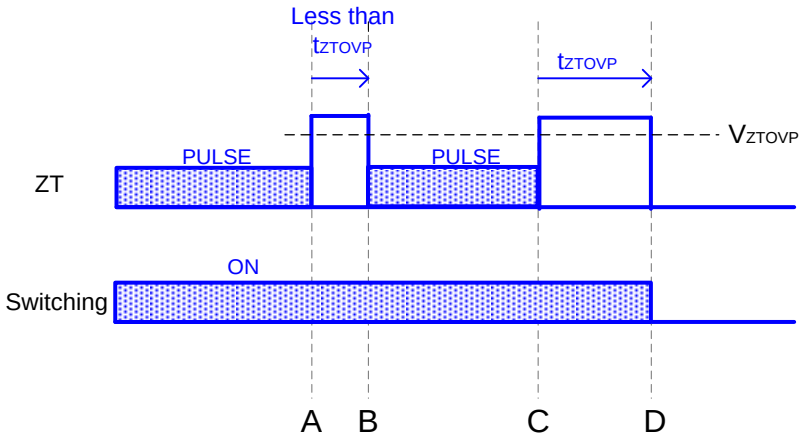


Figure 11. ZT pin over voltage protect (DC detection)

A: ZT pin voltage > V_{ZTOVP}(Typ=3.5V)
B: ZT pin voltage > V_{ZTOVP} (Typ=3.5V) status is less than t_{ZTOVP}(Typ=100μs)period, DC/DC returns to normal operations.
C: ZT pin voltage > V_{ZTOVP}(Typ=3.5V)
D: ZT pin voltage > V_{ZTOVP}(Typ=3.5V) status continues for t_{ZTOVP}(Typ=100μs), latching occurs and DC/DC is turned OFF.

© 2016 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

Description of Blocks – continued

10. ZT Trigger Mask Function

When switching is set ON / OFF, the superposition of noise may occur at ZT pin. During this time, the ZTOVP comparator is masked for the duration of t_{ZTMASK} (Typ=0.60μs) to prevent false detection of the ZT comparator.

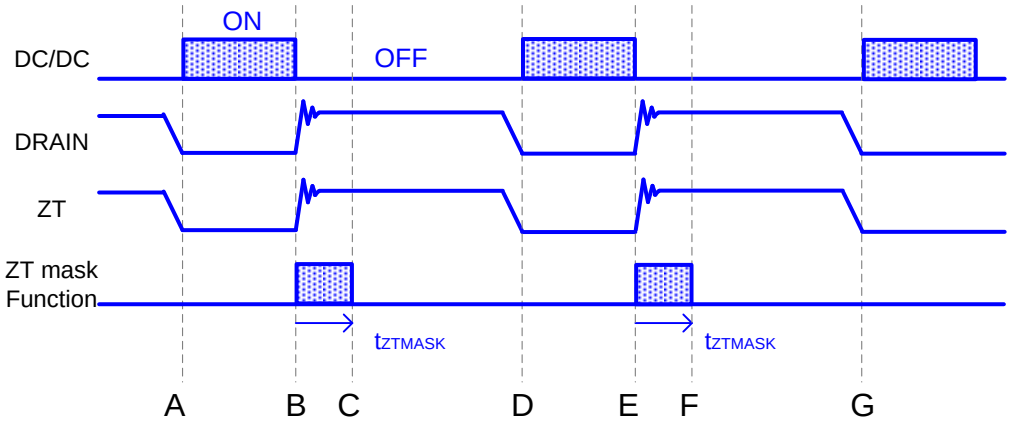


Figure 12. ZT Trigger Mask Function

A: DC/DC OFF → ON
B: DC/DC ON → OFF
C: Noise occurs at the ZT pin, and ZT comparator is masked for t_{ZTMASK} (Typ=0.60μs).
D: Same as A.
E: Same as B
F: Same as C
G: Same as A

© 2016 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

Absolute Maximum Ratings (Ta=25°C)

Parameter	Symbol	Rating	Unit	Conditions
Maximum Applied Voltage 1	V_{MAX1}	-0.3 to +800	V	DRAIN
Maximum Applied Voltage 2	V_{MAX2}	-0.3 to +35.0	V	VCC
Maximum Applied Voltage 3	V_{MAX3}	-0.3 to +6.5	V	BR, FB, SOURCE, ZT
DRAIN Current (DC)	I_{DD1}	5.0	A	
DRAIN Current(Pulse)	I_{DD2}	20.0	A	P_W=10μs, Duty cycle=1%
Power Dissipation	Pd	1.00	W	
Maximum Junction Temperature	Tjmax	+150	°C	
Storage Temperature Range	Tstg	-55 to +150	°C	

Caution 1: *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.*

Caution 2: *Should by any chance the maximum junction temperature rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. In case of exceeding this absolute maximum rating, design a PCB boards with power dissipation taken into consideration by increasing board size and copper area so as not to exceed the maximum junction temperature rating.*

(Note 1) Reduce by 8mW/°C when operating Ta = 25°C or more when mounted on 70 mm × 70 mm, 1.6 mm thick, glass epoxy on single-layer substrate.

Thermal Loss

The thermal design should set operation for the following conditions.

1. The ambient temperature Ta must be 105 °C or less.
2. The IC's loss must be within the power dissipation Pd.

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

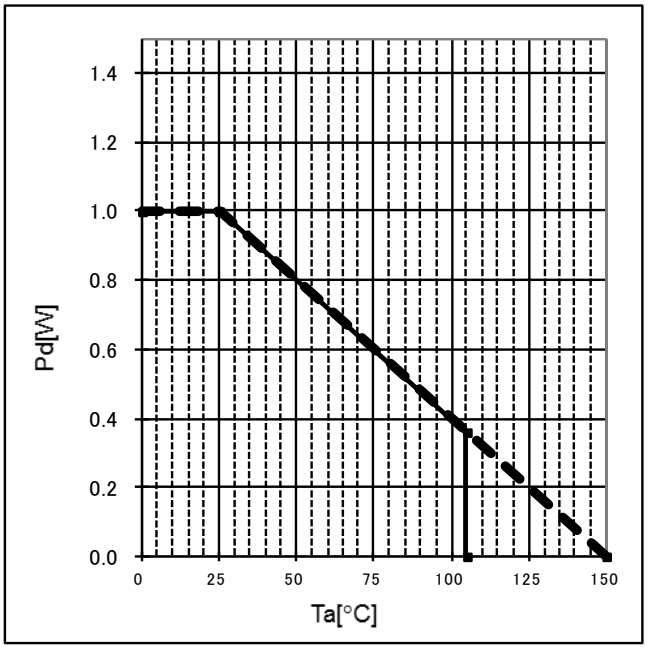


Figure 13. Thermal Reduction Characteristics

© 2016 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

Recommended Operating Condition

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Power Supply Voltage Range 1	V_{DRAIN}	-	-	800	V	DRAIN
Power Supply Voltage Range 2	VCC	10.90	15.0	30.0	V	VCC *(Note 2)*
Operating Temperature	Topr	-40	+25	+105	°C	Surrounding Temperature

(Note 2) VCC recharge function operates in the VCC voltage range of less than 10.7V (Refer to P-7 [3-2] VCC charge function)

Recommended External Component Condition

Parameter	Symbol	Recommended	Unit	Conditions
BR Pin Capacitor	C_{BR}	0.01µF or more	µF	

Electrical Characteristics in MOSFET Part (Unless otherwise noted, Ta=25°C VCC=15V)

Parameter	Symbol	Specifications			Unit	Conditions
		Min	Typ	Max		
DRAIN to SOURCE Voltage	V_{DDS}	800	-	-	V	I_D=1mA , V_{GS}=0V
DRAIN Leak Current	I_{DSS}	-	0	100	µA	V_{DS}=800V , V_{GS}=0V
ON Resistance	$R_{DS(ON)}$	-	1.60	2.15	Ω	I_D=0.25A , V_{GS}=10V

Electrical Characteristics in Starter Circuit Part (Unless otherwise noted, Ta=25°C VCC=15V)

Parameter	Symbol	Specifications			Unit	Conditions
		Min	Typ	Max		
Start Current 1	I_{START1}	0.100	0.300	0.600	mA	VCC= 0V
Start Current 2	I_{START2}	3.00	5.50	8.50	mA	VCC=10V
OFF Current	I_{START3}	-	10	20	µA	
Start Current Switching Voltage	V_{SC}	0.400	0.800	1.200	V	

© 2016 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

Electrical Characteristics in Control IC Part (Unless otherwise noted, Ta=25°C VCC=15V)

Parameter	Symbol	Specifications			Unit	Conditions
		Min	Typ	Max		
[Circuit Current]						
Circuit Current (ON)1	I_{ON1}	-	1000	1800	μA	Pulse Operation(V_{FB}=2.0V) Drain = OPEN
Circuit Current (ON)2	I_{ON2}	150	300	450	μA	Burst Operation (V_{FB} =0.3V)
[VCC Pin Protection Function]						
VCC UVLO Voltage1	V_{UVLO1}	14.50	15.50	16.50	V	VCC rise
VCC UVLO Voltage2	V_{UVLO2}	9.50	10.20	10.90	V	VCC fall
VCC UVLO Hysteresis	V_{UVLO3}	-	5.30	-	V	V_{UVLO3} = V_{UVLO1} - V_{UVLO2}
VCC OVP Voltage1	V_{OVP1}	30.0	32.0	34.0	V	VCC rise
VCC OVP Voltage2	V_{OVP2}	-	24.0	-	V	VCC fall
VCC OVP Hysteresis	V_{OVP3}	-	8.0	-	V	
VCC OVP Timer	t_{COMP1}	50	100	150	μs	
Latch Release VCC Voltage	V_{LATCH}	-	$V_{UVLO2-0.5}$	-	V	
VCC charge Start Voltage	V_{CHG1}	9.70	10.70	11.70	V	
VCC charge Stop Voltage	V_{CHG2}	14.00	15.00	16.00	V	
Over Temperature Protection 1 *(Note 3)*	T_{SD1}	150	175	200	°C	Control block's Tj rise
Over Temperature Protection 2 *(Note 3)*	T_{SD2}	-	100	-	°C	Control block's Tj fall
Over Temperature Protection Hysteresis	T_{SD3}	-	75	-	°C	
Over Temperature Protection Timer	t_{COMP2}	50	100	150	μs	
[PWM Type DC/DC Driver Block]						
PWM Frequency1a	f_{SW1a}	61.5	65.0	68.5	kHz	V_{FB}=2.0V(BM2P061EK-LB)
PWM Frequency2a	f_{SW2a}	20	25	30	kHz	V_{FB}=0.5V(BM2P061EK-LB)
Frequency Hopping width1a	f_{DEL1a}	-	4.0	-	kHz	V_{FB}=2.0V(BM2P061EK-LB)
PWM Frequency1b	f_{SW1b}	95.0	100.0	105.0	kHz	V_{FB}=2.0V(BM2P101EK-LB)
PWM Frequency2b	f_{SW2b}	20	27	34	kHz	V_{FB}=0.5V(BM2P101EK-LB)
Frequency Hopping Width1b	f_{DEL1b}	-	6.0	-	kHz	V_{FB}=2.0V(BM2P101EK-LB)
Minimum Pulse Width	t_{MIN}	-	500	-	ns	*(Note 4)*
Soft Start Time1	t_{SS1}	1.20	2.00	2.80	ms	
Soft Start Time 2	t_{SS2}	2.40	4.00	5.60	ms	
Soft Start Time3	t_{SS3}	4.80	8.00	11.20	ms	
Maximum Duty	D_{MAX}	68.0	75.0	82.0	%	
FB Pin Pull-up Resistor	R_{FB}	23	30	37	kΩ	
FB / CS Gain	Gain	-	4.00	-	V/V	
FB Burst Voltage1	V_{BST1}	0.300	0.400	0.500	V	V_{FB} fall
FB Burst Voltage2	V_{BST2}	0.350	0.450	0.550	V	V_{FB} rise
Frequency Reduction Start FB Voltage	V_{DLT1}	1.10	1.25	1.40	V	
Frequency Reduction Stop FB Voltage	V_{DLT2}	0.50	0.65	0.80	V	
FB OLPvoltage1	V_{FOLP1}	3.20	3.40	3.60	V	OLP detect V_{FB} rise
FB OLPvoltage2	V_{FOLP2}	3.00	3.20	3.40	V	OLP release V_{FB} fall
FB OLP ON Timer	t_{FOLP1}	40	64	88	ms	
FB OLP OFF Timer	t_{FOLP2}	358	512	666	ms	
Over Current Detection Voltage a	V_{CSa}	0.380	0.400	0.420	V	BM2P061EK-LB
Over Current Detection Voltage b	V_{CSb}	0.280	0.300	0.320	V	BM2P101EK-LB
Dynamic Over Current Detection Voltage	V_{DCS}	0.950	1.050	1.150	V	
Dynamic Over Current Detection timer	t_{DCS}	64	128	196	μs	
Leading Edge Blanking Time	t_{LEB}	-	250	-	ns	*(Note 4)*
SOURCE Pin Short Protection Voltage	V_{CSSHT}	0.030	0.060	0.090	V	
SOURCE Pin Short Protection Time	t_{CSSHT}	1.0	2.0	3.0	μs	

(Note 3) Over temperature protection operates over Maximum Junction Temperature. Since, IC cannot guarantee for the operation over Maximum Junction Temperature, always operate at Maximum Junction Temperature or less.
(Note 4) Not 100% tested.

© 2016 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

Electrical Characteristics in Control IC Part (Unless otherwise noted, Ta=25°C VCC=15V)

Parameter	Symbol	Specifications			Unit	Conditions
		Min	Typ	Max		
[BR pin function]						
BR Pin UVLO Detection Voltage1	V_{BR1}	0.64	0.70	0.76	V	V_{BR} rise
BR Pin UVLO Detection Voltage 2	V_{BR2}	0.32	0.38	0.44	V	V_{BR} fall
BR Pin UVLO Hysteresis Voltage	V_{BR3}	-	0.32	-	V	$V_{BR3} = V_{BR1} - V_{BR2}$
BR Pin UVLO Detection Delay Time1	t_{BR1}	50	100	150	µs	V_{BR} rise
BR Pin UVLO Detection Delay Time2	t_{BR2}	64	128	196	ms	V_{BR} fall
[ZT pin function]						
ZT OVP Voltage	V_{ZTOVP}	3.250	3.500	3.750	V	
ZT OVP Timer	t_{ZTOVP}	50	100	150	µs	
ZT Trigger Mask Time	t_{ZTMASK}	-	0.60	-	µs	*(Note 4)*

(Note 4) Not 100% tested.

Protection Circuit Operation Modes

The operation modes of the various protection functions of the IC are shown in Table 1.

Table 1 Protection Circuit Operation Modes

Function	VCC UVLO	VCC OVP	TSD	FB OLP	SOURCE Short Protection	BR UVLO	ZT OVP
Detection	$VCC<V_{UVLO2}$ (VCC fall)	$VCC>V_{OVP1}$ (VCC rise)	$Tj>T_{SD1}$ (Tj rise)	$V_{FB}>V_{FOLP1}$ (V_{FB} rise)	$SOURCE<V_{CSSHT}$ (t_{CSSHT}=2µs)	$V_{BR}<V_{BR2}$ (V_{BR} fall)	$V_{ZT}<V_{ZTOVP}$ (pulse)
Release	$VCC>V_{UVLO1}$ (VCC rise)	$VCC<V_{OVP2}$ (VCC fall)	$Tj<T_{SD2}$ (Tj fall)	$V_{FB}<V_{FOLP2}$ (V_{FB} fall)	Reset Pulse by Pulse	$V_{BR}>V_{BR1}$ (V_{BR} rise)	$V_{ZT}<V_{ZTOVP}$ (pulse)
Detection Timer	-	100µs	100µs	64ms	-	128ms	3count +100µs
Release Timer	-	-	-	512ms	-	100µs	-
Mode	Auto Recovery	Auto Recovery	Auto Recovery	Auto Recovery	Auto Recovery	Auto Recovery	Latch

© 2016 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

I/O Equivalence Circuit

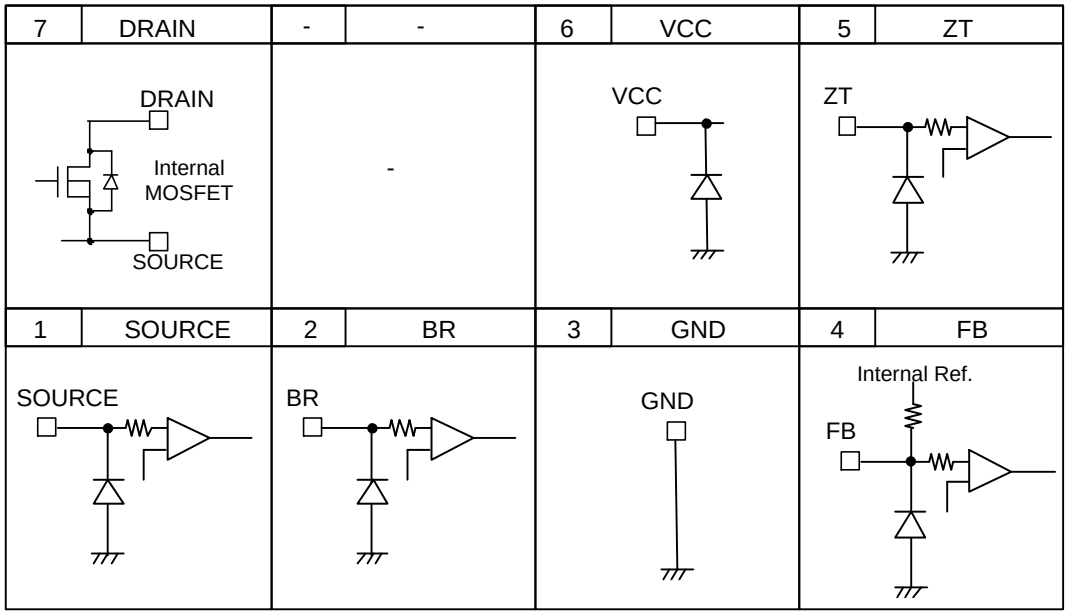


Figure 14. I/O Equivalence Circuits

© 2016 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

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. 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. **Recommended Operating Conditions**
   The function and operation of the IC are guaranteed within the range specified by the recommended operating conditions. The characteristic values are guaranteed only under the conditions of each item specified by the electrical characteristics.

6. **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.

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

8. **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.

9. **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.

10. **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.

© 2016 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

Operational Notes – continued

11. 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.

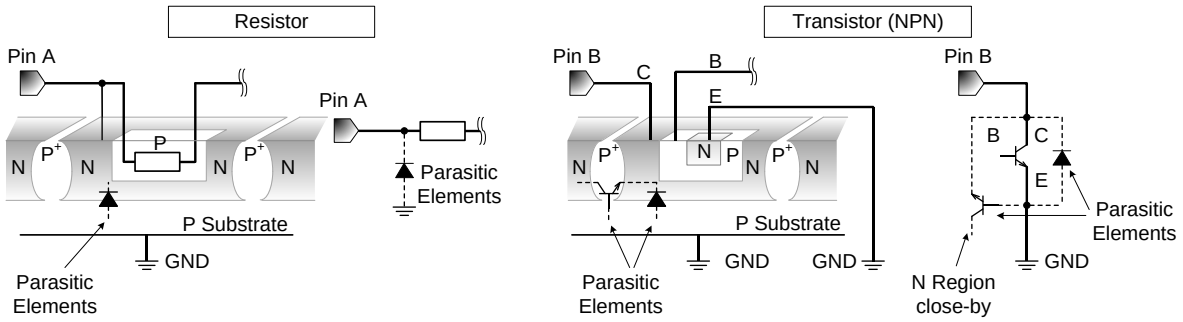


Figure 15. Example of monolithic IC structure

12. Ceramic Capacitor

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

13. Area of Safe Operation (ASO)

Operate the IC such that the output voltage, output current, and the maximum junction temperature rating are all within the Area of Safe Operation (ASO).

14. 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 maximum junction temperature 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 power output pins. When the Tj falls below the TSD threshold, the circuits are automatically restored to normal operation.
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.

15. 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.

© 2016 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

Ordering Information

B M 2 P x x x E K - L B

BM2: Integrated Switching MOSFET

P: PWM Type

PWM Frequency
06: 65kHz
10: 100kHz

MOS FET $R_{DS(ON)}$
1: 1.6Ω

E: Lineup No.

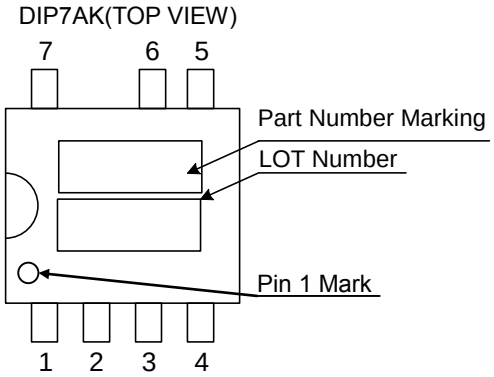
MOS FET Break Down Voltage
K: 800V

Product class
LB: For Industrial Applications

Lineup

PWM Frequency (kHz)	MOS FET $R_{DS(ON)}$ (Ω)	MOS FET Break Down Voltage	Package	Orderable Part Number
65	1.6	800V	DIP7AK	BM2P061EK-LB
100				BM2P101EK-LB

Making Diagram



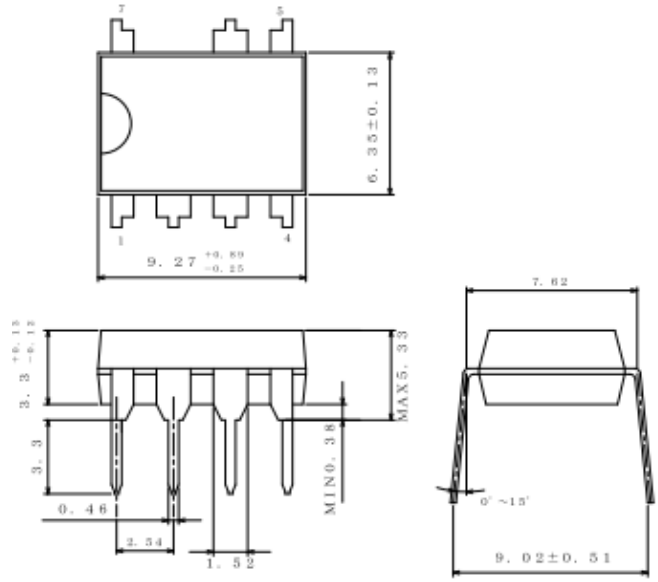
Part Number Marking
BM2P101EK
BM2P061EK

© 2016 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

Physical Dimension and Packing Information

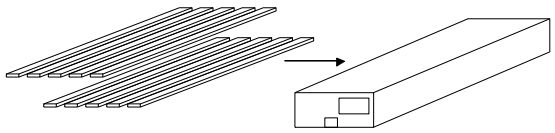
DIP7AK



[UNIT : mm]

<Tape and Reel information>

Container	Tube
Quantity	2000pcs
Direction of feed	Direction of products is fixed in a container tube



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

© 2016 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

Revision History

Date	Rev. No	Revision point
17.Aug.2017	001	New Release
21.Feb.2018	002	Modify explanation and Vcsb of BM2P101EK-LB

© 2016 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

Notice

Precaution on using ROHM Products

1. If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment (Note 1), aircraft/spacecraft, nuclear power controllers, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, 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 any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

2. ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
   [a] Installation of protection circuits or other protective devices to improve system safety
   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

3. Our Products are not designed under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
   [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
   [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

© 2015 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

Precautions Regarding Application Examples and External Circuits

1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.

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.

Precaution for Electrostatic

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.

Precaution for Product Label

A two-dimensional barcode printed on ROHM Products label is for ROHM's internal use only.

Precaution for Disposition

When disposing Products please dispose them properly using an authorized industry waste company.

Precaution for Foreign Exchange and Foreign Trade act

Since concerned goods might be fallen under listed items of export control prescribed by Foreign exchange and Foreign trade act, please consult with ROHM in case of export.

Precaution Regarding Intellectual Property Rights

1. All information and data including but not limited to application example contained in this document is for reference only. ROHM does not warrant that foregoing information or data will not infringe any intellectual property rights or any other rights of any third party regarding such information or data.

2. ROHM shall not have any obligations where the claims, actions or demands arising from the combination of the Products with other articles such as components, circuits, systems or external equipment (including software).

3. No license, expressly or implied, is granted hereby under any intellectual property rights or other rights of ROHM or any third parties with respect to the Products or the information contained in this document. Provided, however, that ROHM will not assert its intellectual property rights or other rights against you or your customers to the extent necessary to manufacture or sell products containing the Products, subject to the terms and conditions herein.

Other Precaution

1. This document may not be reprinted or reproduced, in whole or in part, without prior written consent of ROHM.

2. The Products may not be disassembled, converted, modified, reproduced or otherwise changed without prior written consent of ROHM.

3. In no event shall you use in any way whatsoever the Products and the related technical information contained in the Products or this document for any military purposes, including but not limited to, the development of mass-destruction weapons.

4. The proper names of companies or products described in this document are trademarks or registered trademarks of ROHM, its affiliated companies or third parties.

© 2015 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.

General Precaution

1. Before you use our Products, you are requested to carefully read this document and fully understand its contents. ROHM shall not be in any way responsible or liable for failure, malfunction or accident arising from the use of any ROHM's Products against warning, caution or note contained in this document.

2. All information contained in this document is current as of the issuing date and subject to change without any prior notice. Before purchasing or using ROHM's Products, please confirm the latest information with a ROHM sales representative.

3. The information contained in this document is provided on an "as is" basis and ROHM does not warrant that all information contained in this document is accurate and/or error-free. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties resulting from inaccuracy or errors of or concerning such information.

© 2015 ROHM Co., Ltd. All rights reserved.

Downloaded from Arrow.com.