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# MPM00 Series

## General Descriptions

The MPM series is a full molded hybrid IC which contains a non-insulated buck type DC/DC converter in one package. A power supply circuit can be composed in a simple way by using this hybrid IC which requires a small part count.

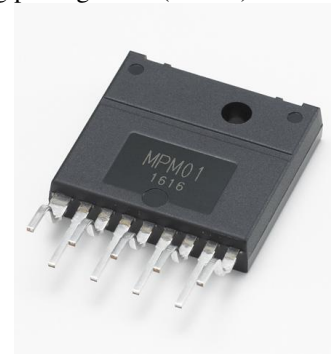
By connecting only an input smoothing electrolytic capacitor, an output smoothing electrolytic capacitor and an output voltage setting resistor, the hybrid IC can be operated. Because of this simple composition, time required for design evaluation is significantly reduced. Since a power inductor is built in, it is not required to select and evaluate the inductor separately. By adopting a full molding package which can be fitted to the heat sink by screwing, board mounting can be made in self-supporting state without the heat sink subject to the output voltage setting and load conditions.

## Features & Benefits

- Current mode type synchronization rectification PWM control system
- By connecting only an input smoothing electrolytic capacitor, an output smoothing electrolytic capacitor and an output voltage setting resistor, the hybrid IC can be operated.
- Since a power inductor is built in, it is not required to select and evaluate the inductor separately.
- Maximum efficiency 91%
- Output current range 0 to 3A
- Operating frequency 250kHz
- Reference voltage  $0.5V \pm 2\%$
- Built-in protection function  
Over Current Protection (OCP)  
Thermal Shutdown (TSD)  
Under Voltage Lockout (UVLO)
- Built-in phase compensation
- Built-in Soft-Start function

## Package

- Full molding package SIP9(LF971)



Pin Assignment		
Pin	Symbol	Function
1,3	GND	Ground terminal
2	VIN	Input power supply terminal
4	FB	Feedback terminal
5,6,7	OUT	Output terminal
8,9	SW	Switching-Frequency-measurement

## Electrical Characteristics

- Input voltage range : MPM01 : 9V to 40V  
MPM04 : 16V to 40V
- Output voltage range : MPM01 : 1.8V to 12V  
MPM04 : 12V to 24V
- Output current  $I_O = 3A$
- Operating frequency: 250kHz

## Applications

- FA machine / Communications equipment  
Domestic products
- Amusement machine / others

## Line up

Product name	fsw	VIN	Vo	Io	Lead Forming	
MPM01	250kHz	9V to 40V *1	1.8V to 12V	3A	LF971	Self-supporting
					LF972	Right angle
MPM04	16V to 40V *2	12V to 24V	LF971		Self-supporting	
			LF972		Right angle	

<sup>(1)</sup>The minimum input voltage shall be either of 9V or  $V_O+4V$ , whichever is higher.

<sup>(2)</sup>The minimum input voltage shall be either of 16V or  $V_O+4V$ , whichever is higher. And than  $V_{in(MIN)}36V$  in  $20V < V_O < 24V$  more than  $V_{in(MIN)}30V$  in  $18V < V_O < 20V$ .

# MPM00 Series

## Typical Application Circuits

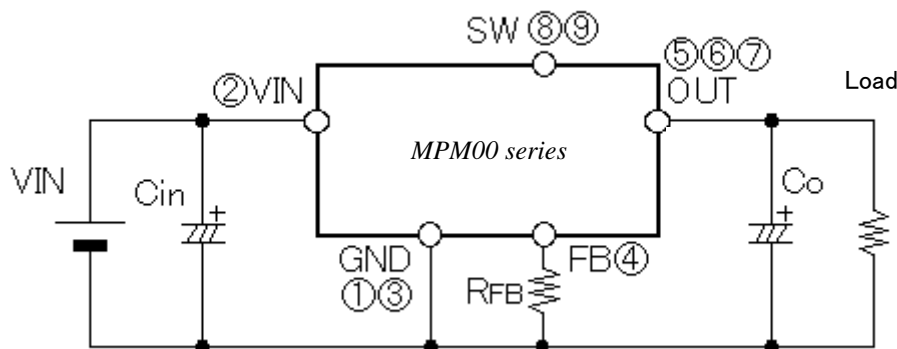


fig.1

## Absolute maximum ratings

Table 2

Items	symbol	Specifications	units	condition
VIN terminal voltage	VIN	-0.3 to 41	V	
FB terminal voltage	VFB	-0.3 to 6	V	
OUT terminal voltage	Vo	-0.3 to 13	V	MPM01
		-0.3 to 25		MPM04
SW terminal voltage	Vsw	-8 to Vin	V	Pulse width $\leq 20$ ns
		-1.3 to Vin		
VIN-SW voltage	VVIN-SW	55	V	< 30nS
Allowable power dissipation	Ploss	2.5	W	without a Radiator
Junction temperature	Tj	-20 to 150	°C	(3), (4)
Storage temperature	Tstg	-20 to 120	°C	(5)
Thermal resistance(between MIC junction and frame)	$\theta_{j-f}$	7.7	°C/W	

(3),(4).Only MIC,However, it is limited for overheat protection. The overheat protection detection temperature is approximately 160°C. Allowable power dissipation Ploss is applicable only to the semiconductor chip..

(5). Because the highest temperature limit of the circuit board for power-semiconductor chip is 125°C.

## Recommended operating conditions (6)

Table 3

Items	Symbol	Specifications		Units	Conditions
		Min	Max		
Input voltage range	VIN	9	40	V	MPM01 (8)
		16	40		MPM04 (9)
Output current range (7)	Io	0	3	A	
Junction temperature in operation	Tjop	-20	125	°C	
Output voltage setup range	Vout	1.8	12	V	MPM01 (8)
		12	24		MPM04 (9)
Ambient temperature range in operation(7)	Ta	-20	85	°C	Note:refer to Thermal derating curve

- (6). The recommended operating conditions means operating conditions required to maintain normal circuit functions shown in the electrical characteristics and in the actual use, they should be maintained within these recommended conditions.
- (7). However, you must use it within Thermal derating curve. Refer to the fig.6.
- (8). The minimum input voltage shall be either of 9V or  $V_O+4V$ , whichever is higher.
- (9). The minimum input voltage shall be either of 16V or  $V_O+4V$ , whichever is higher. And than  $V_{in(MIN)}36V$  in  $20V < V_O < 24V$  more than  $V_{in(MIN)}30V$  in  $18V < V_O < 20V$ .

## Electrical characteristics (Ta = 25°C) (10)

Table 4

Parameter	Symbol	Ratings			Units	Conditions
		Min	typ	Max		
Reference voltage	VFBref	0.490	0.500	0.510	V	VIN=33V, Io=1A
Efficiency (11)	$\eta$	-	91	-	%	VIN=33V, Vo=12V, Io=3A
Switching frequency	fo	212	250	288	kHz	VIN=33V, Vo=12V, Io=3A
Line regulation (12)	Vline	—	—	$\pm 2$	%	VIN=16-40V, Vo=12V, Io=1A
Load regulation (12)	Vload	—	—	$\pm 3$	%	VIN=33V, Vo=12V, Io=0-3A
Overcurrent protection threshold	Is	3.2	5.60	6.41	A	VIN=33V, Vo=12V Auto-restart (13)
Supply Current	Iin	-	12	-	mA	VIN=33V, Io=0A, VFB=1V
Thermal shutdown threshold temperature (14)	Tj	151	160	-	°C	VIN=16V to 40V
Under voltage lockout protection	UVLO	-	7.3	8.0	V	
Start-up delay time	Tstart	-	50	—	ms	Applied at VIN = 16 to 40V up to the Vo constant voltage accuracy

(10) The electrical characteristics mean the characteristics to be assured in the case that the IC is operated under the above-mentioned measurement conditions in the measurement circuit diagram.

(11) The efficiency can be calculated by the equation 1 as follows:

$$\eta (\%) = \frac{V_o \times I_o}{V_{IN} \times I_{in}} \times 100 \quad \dots(1)$$

(12) The line/load regulation does not include any set deviation of output voltage.

It should be noted that the deviation of set output voltage is affected by the accuracy of the external  $R_{FB}$ .

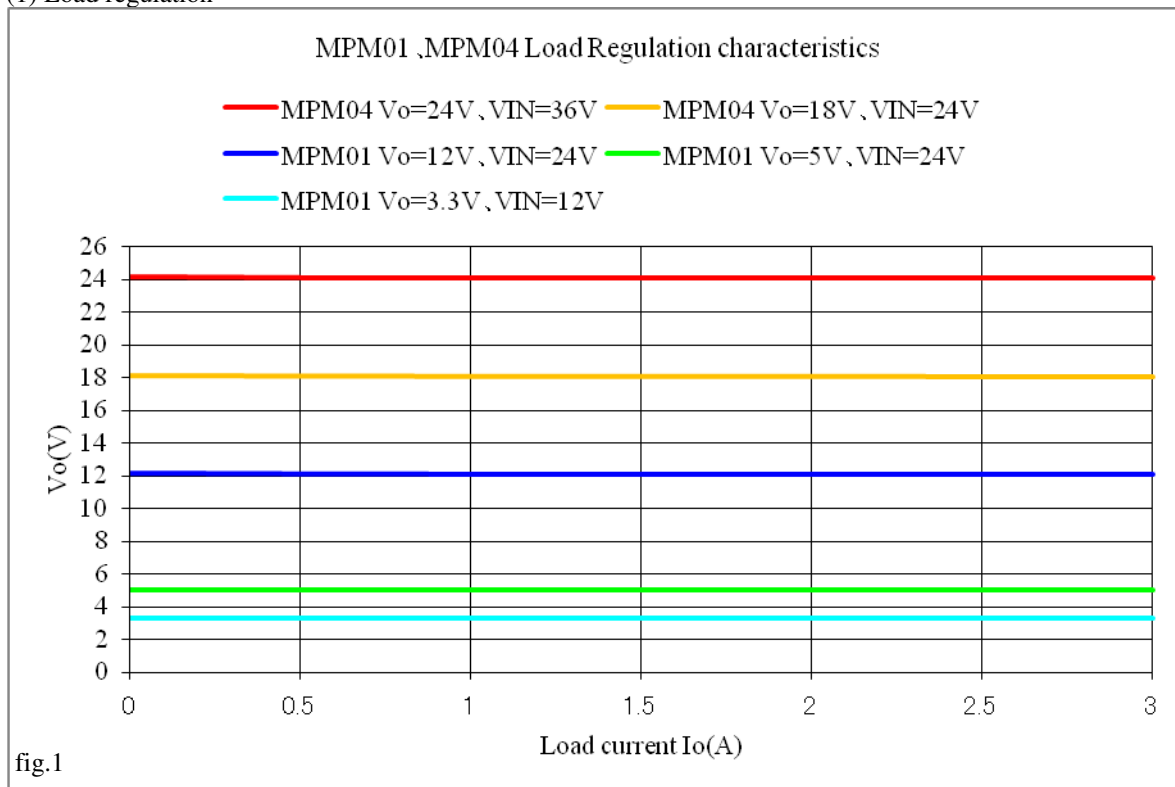
As for details, please refer to the fig.10.

(13) At the time of setting the output voltages except  $V_o = 12V$ , it should be noted that the OCP operation point may fluctuate from the values of  $V_o = 12V$  because the inductance of the built-in coil and the frequency are constant.

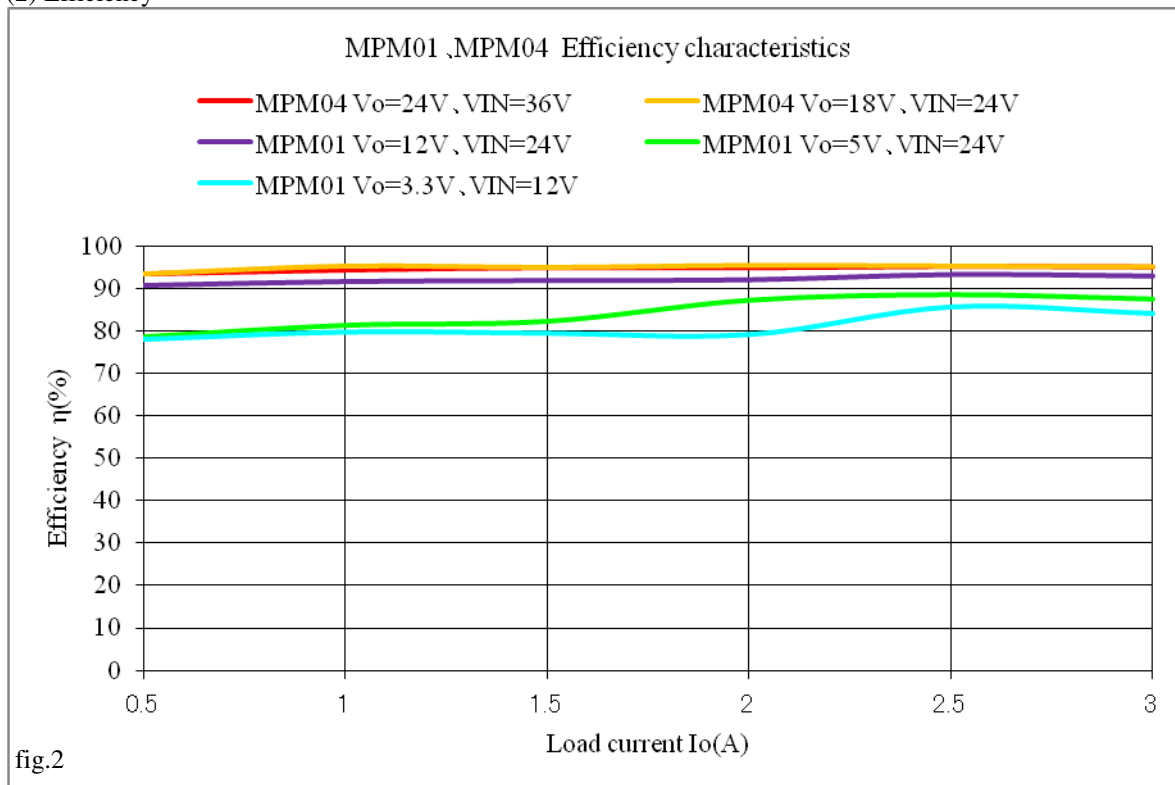
(14) Overheat protection is of automatic recovery type.

## A representative characteristic example .

### (1) Load regulation

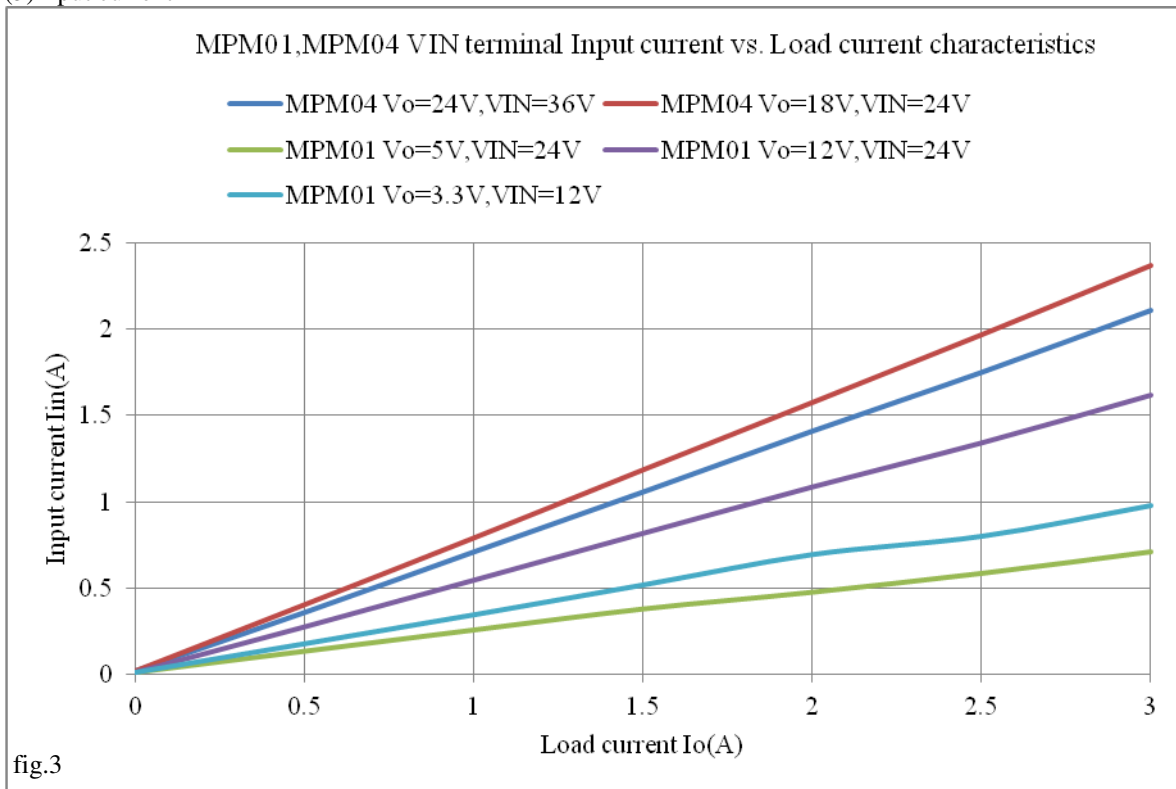


### (2) Efficiency

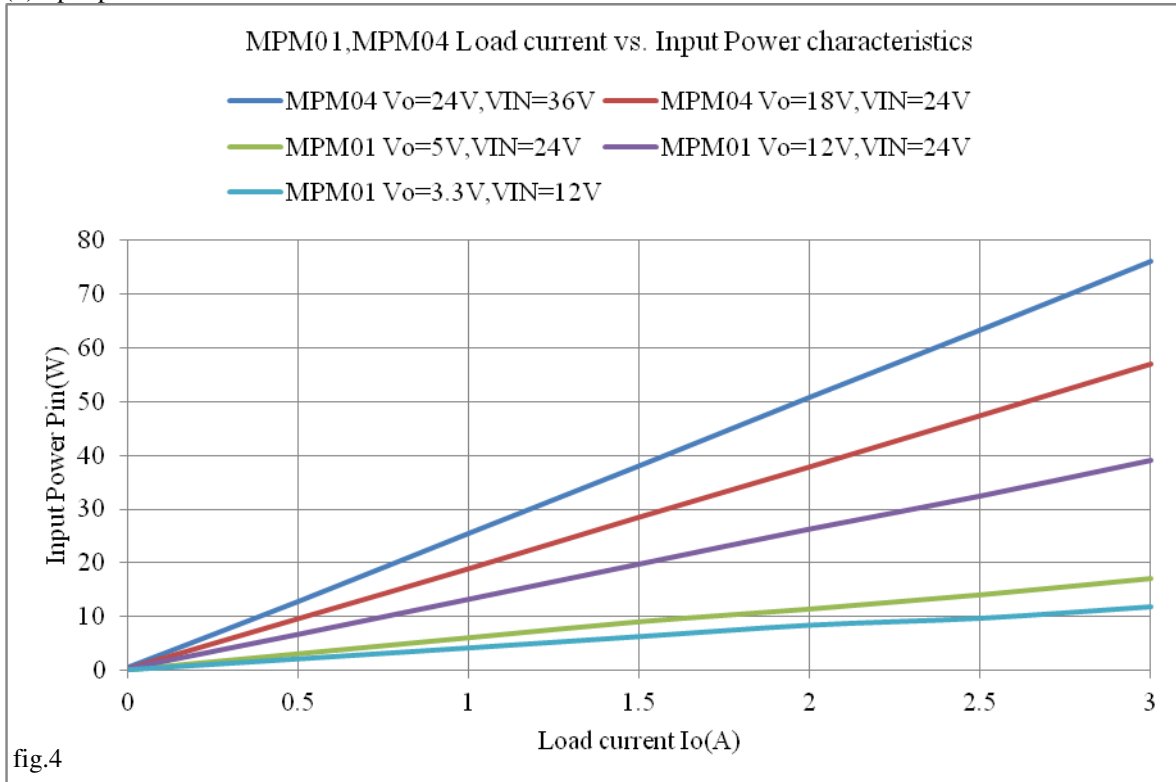


# **MPM00 Series**

(3)Input current

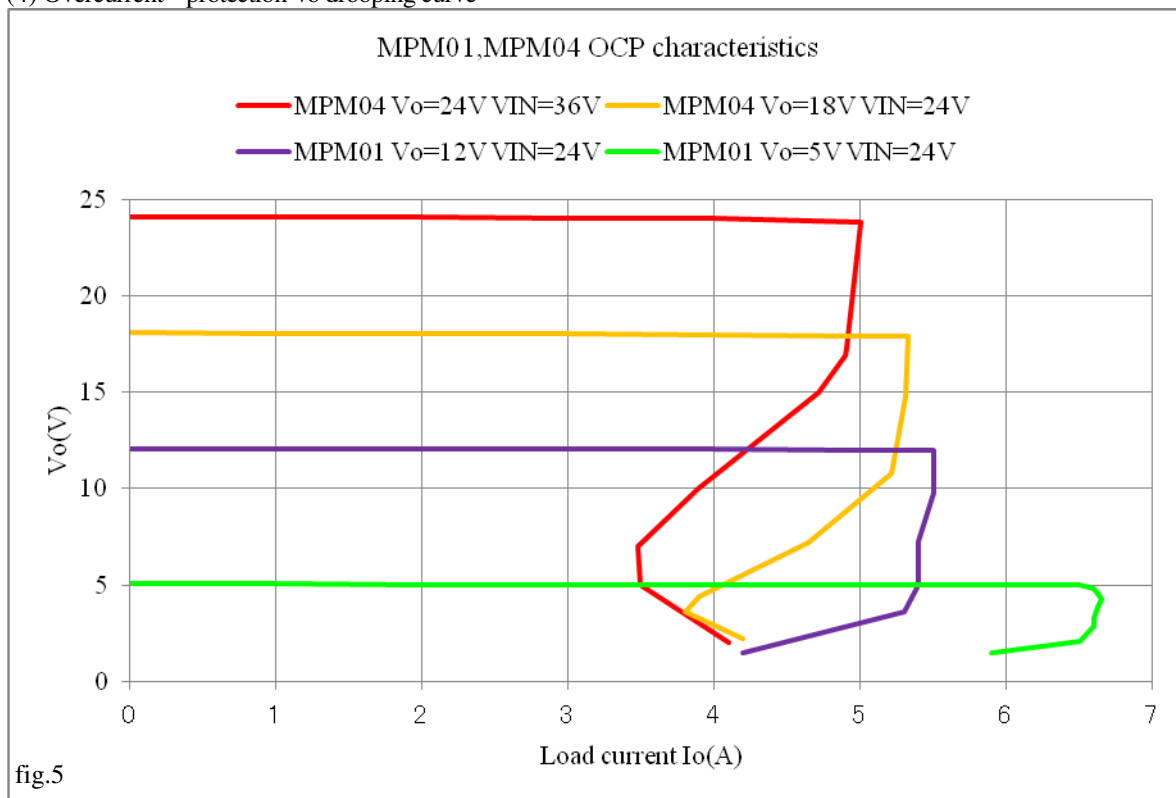


(3)Input power

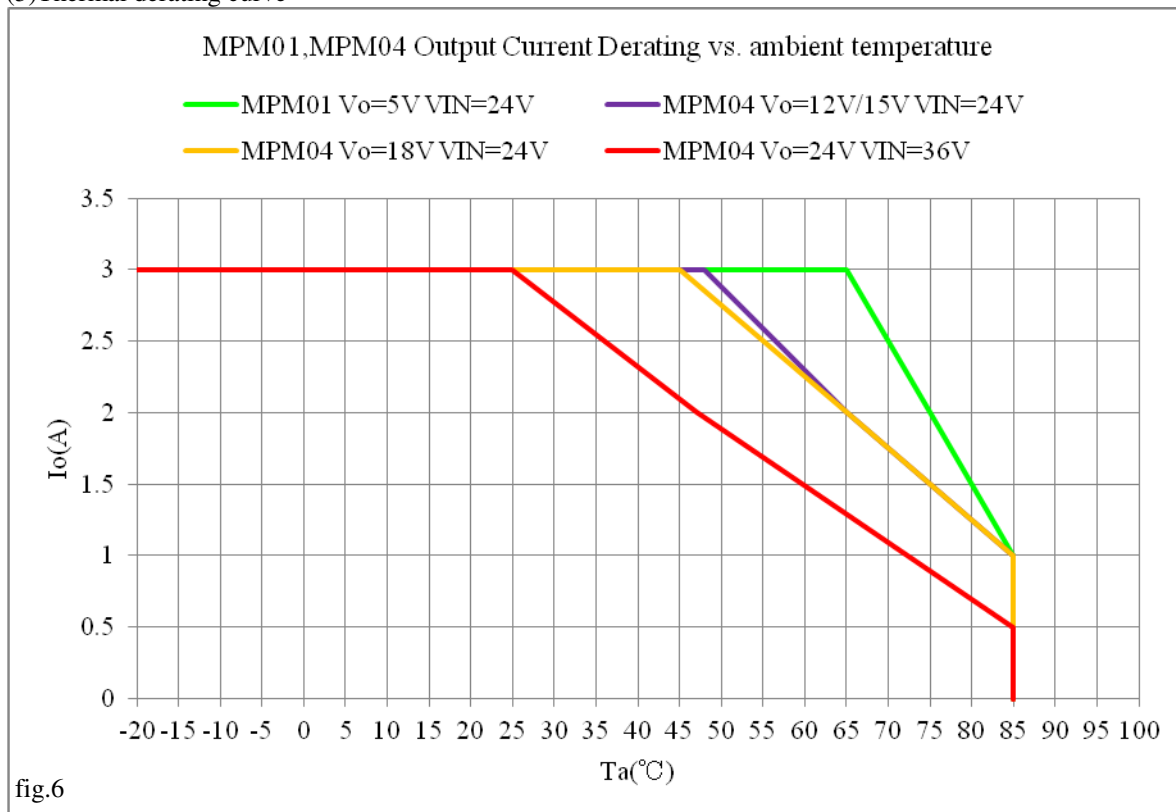


# *MPM00 Series*

(4) Overcurrent protection Vo drooping curve



(5) Thermal derating curve



\*condition : self-cooling, MPM00 self-standing on circuit board without a radiator.

# MPM00 Series

## About thermal derating curve of output current \*It is a setup of commonness of MPM01/04.

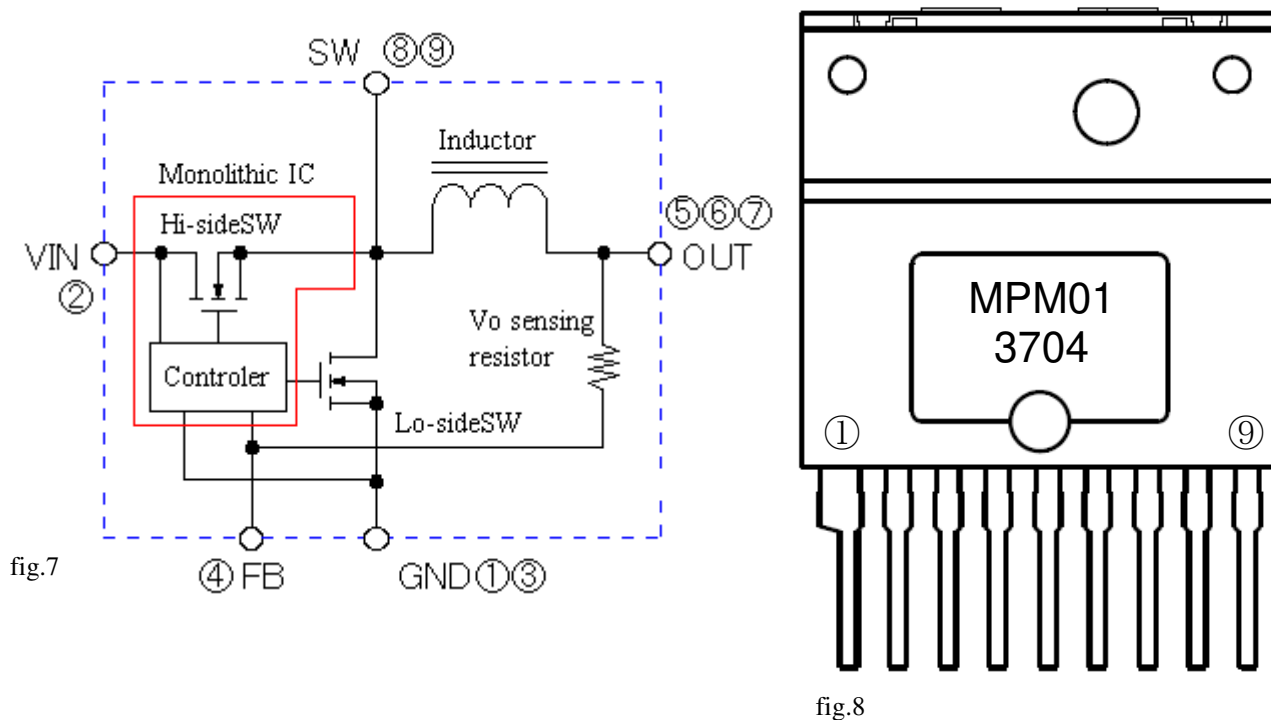
Thermal derating curve of the figure 6 is without the radiator which is a standard use condition fundamentally of MPM01/04. By the use of cooling-fan / radiator installation, output current beyond 3A can't be agreed.

OCP(overcurrent protection) threshold value can't be changed, because it is fixed by built-in MIC.

\*With package design of MPM00, though radiator installation is possible by the screw, keep the following strictly:

- 1) You must surely use load current with less than 3Amps.
- 2) You must use the radiator of the form that package surface temperature is less than 100°C.  
(But, ambient temperature "Ta" makes 85°C an upper limit.)

## Block diagram \*It is a setup of commonness of MPM01/04.



## Pin assign & function/name

Table 5

Terminal number	symbol	Functions/names
①	GND	Ground terminal
②	VIN	Input power supply terminal
③	GND	Ground terminal
④	FB	Feedback terminal/resistor RFB connection terminal for output voltage setting
⑤⑥⑦	OUT	Output terminal
⑧⑨	SW	Oscillating frequency measurement terminal (15)

(15) The "SW" terminal is for the measurement (switching frequency) in the manufacture process. Connect nothing on the circuit board in case of use.

\*Confirm a terminal number referring to the fig.8.



**Application circuit example** \*It is a setup of commonness of MPM01/04.

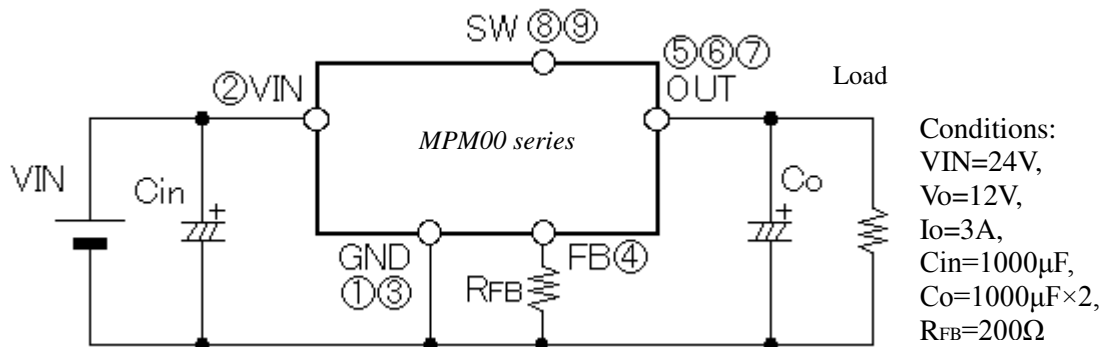


fig.9

## A design guide for add-on parts

### (1)Input capacitor “Cin”

•If output impedance of the VIN power supply is ideally endless and it is near-zero, the ripple-current doesn't flow to Cin. To make stabilize movement of MPM01/04, You must connect the input capacitor "Cin" between ②pin to ①③pin in the shortest path. As for Cin, The withstand-voltage and allowable ripple-current ask for the selection which has a margin.

### (2)Output capacitor “Co”

•The ripple-current that is switching frequency flows to output-capacitor "Co".Refer to an application notebook for the way of calculating the output-ripple-current. As for Co, Use the capacitor which has low-impedance character for the switch mode power-supply. To reduce the output-ripple-noise, You must connect the output capacitor "Co" between ⑤⑥⑦pin - ①③pin at shortest. As well as the case of Cin , The withstand-voltage and allowable ripple-current ask for the selection which has a margin.

### (3) Output voltage setup resistor RFB

•With MPM01/04, An output voltage  $V_o$  can be set up by adjusting  $R_{FB}$ . Refer to an application notebook for the details. fig.10 becomes output voltage value for  $R_{FB}$ . Connect  $R_{FB}$  between ④pin - ①③pin at shortest.

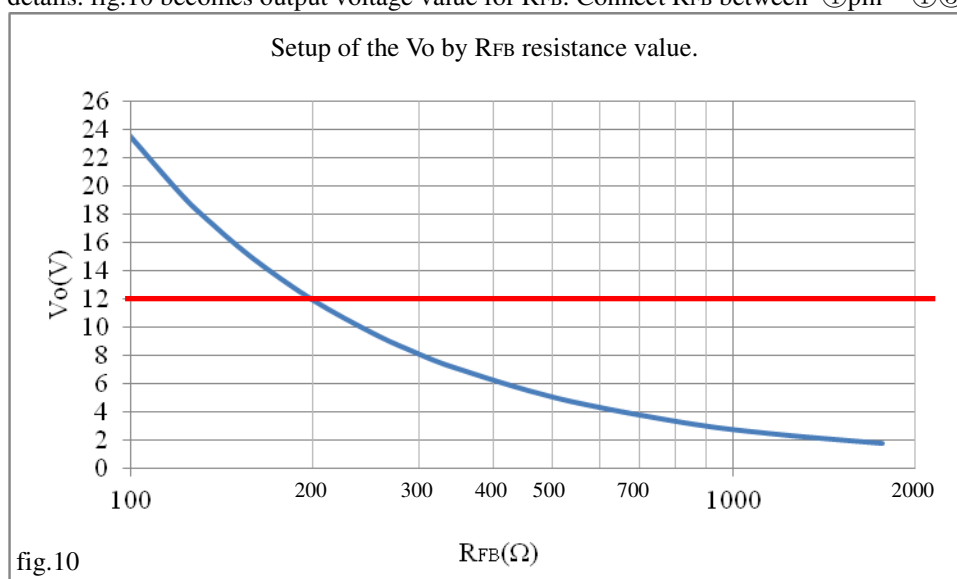


fig.10

**\*Attention .**  
 As for a setup of  $V_o$  of MPM01, 12V is an upper limit.  
 Use MPM04 when an output voltage exceeds 12V.

**\*Example.**  
 In case of  $V_o=5V$ ,  
 $R_{FB}=510\Omega$

In case of  $V_o=12V$ ,  
 $R_{FB}=200\Omega$

## PCB layout recommendation

- (1) As for GND-line, give priority to and connect ①&③pin to the (-) side of output-capacitor  $C_o$ .
- (2) Arrange RFB near MPM01/04, and connect a pattern to RFB at shortest as much as possible. It has the possibility that the aggravation of Line and Load regulation and a un-stable movement happen when the pattern route of RFB is long.
- (3) ⑧&⑨pin are terminal for switching-frequency measurement in the manufacture process. In case of use, make it electrically open. But, install LAND for the lead-pin fixation in the circuit board.

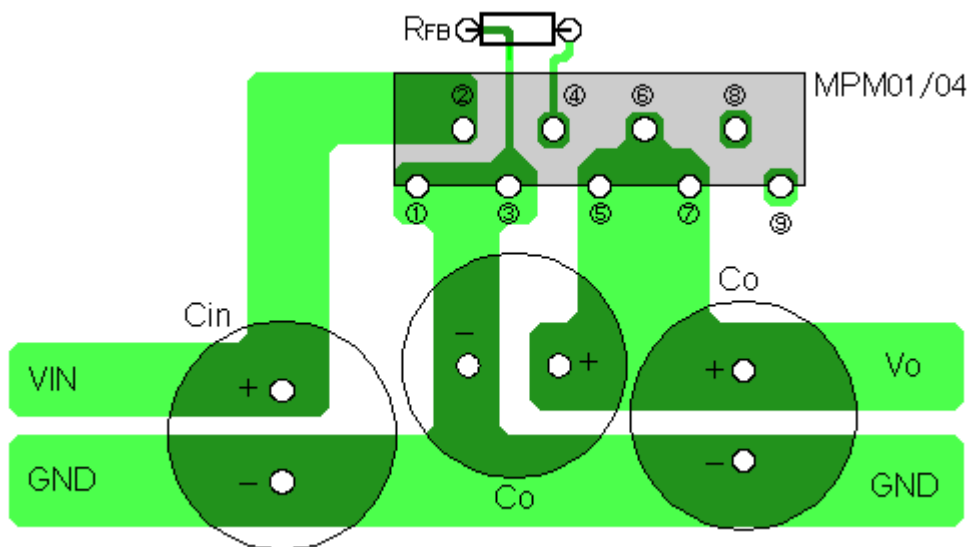


fig.11

PCB layout /parts mounting side (single side circuit board)

### Note:

- 1) PCB size: 50mm × 35mm (The part occupation area of the outline .)
- 2) Drawing is not to scale.

# **MPM00 Series**

## **Package outline, dimensions**

(Units : mm) SIP9, "3GR-S" package (Sanken original) Lead-forming : LF971(self-supporting)

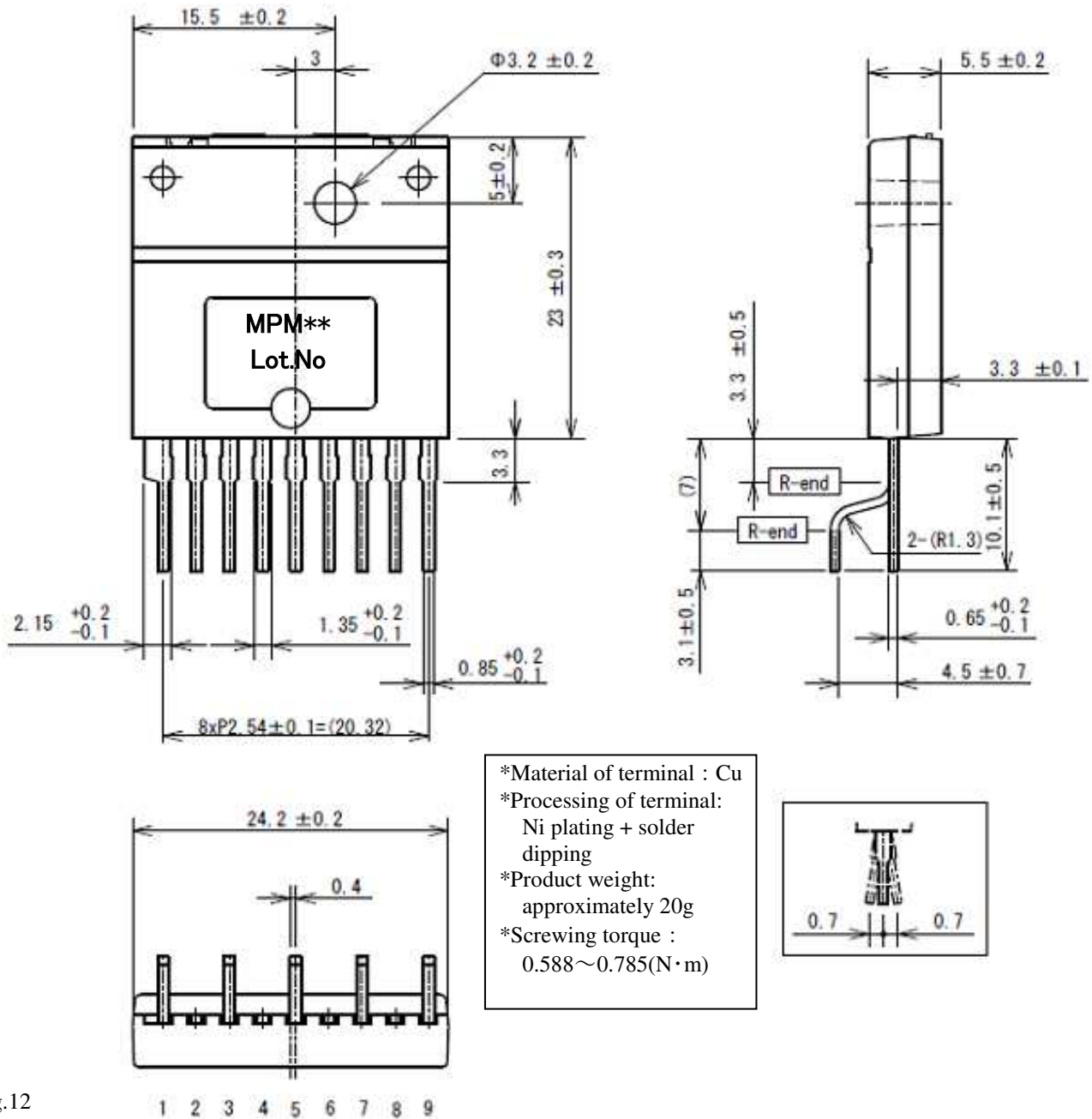


fig.12

\*In the fig.12 of front view which is common to MPM01-04, product numbers of each model name should be printed in \*\*.

**\*Marking**

- 1) Product number : MPM01 or MPM04
- 2) Lot number (four digit) (Lot.No)  
 1st letter : The last digit of the year  
 2nd letter : Month  
 January to September : 1 to 9  
 October : O    November : N    December : D  
 3rd & 4th letter : manufacturing day: 01 ~ 31

- 3) Marking device:  
CO<sub>2</sub>/YAG Laser marker

# **MPM00 Series**

(Units : mm) SIP9, "3GR-S" package (Sanken original) Lead-forming : LF972(right angle)

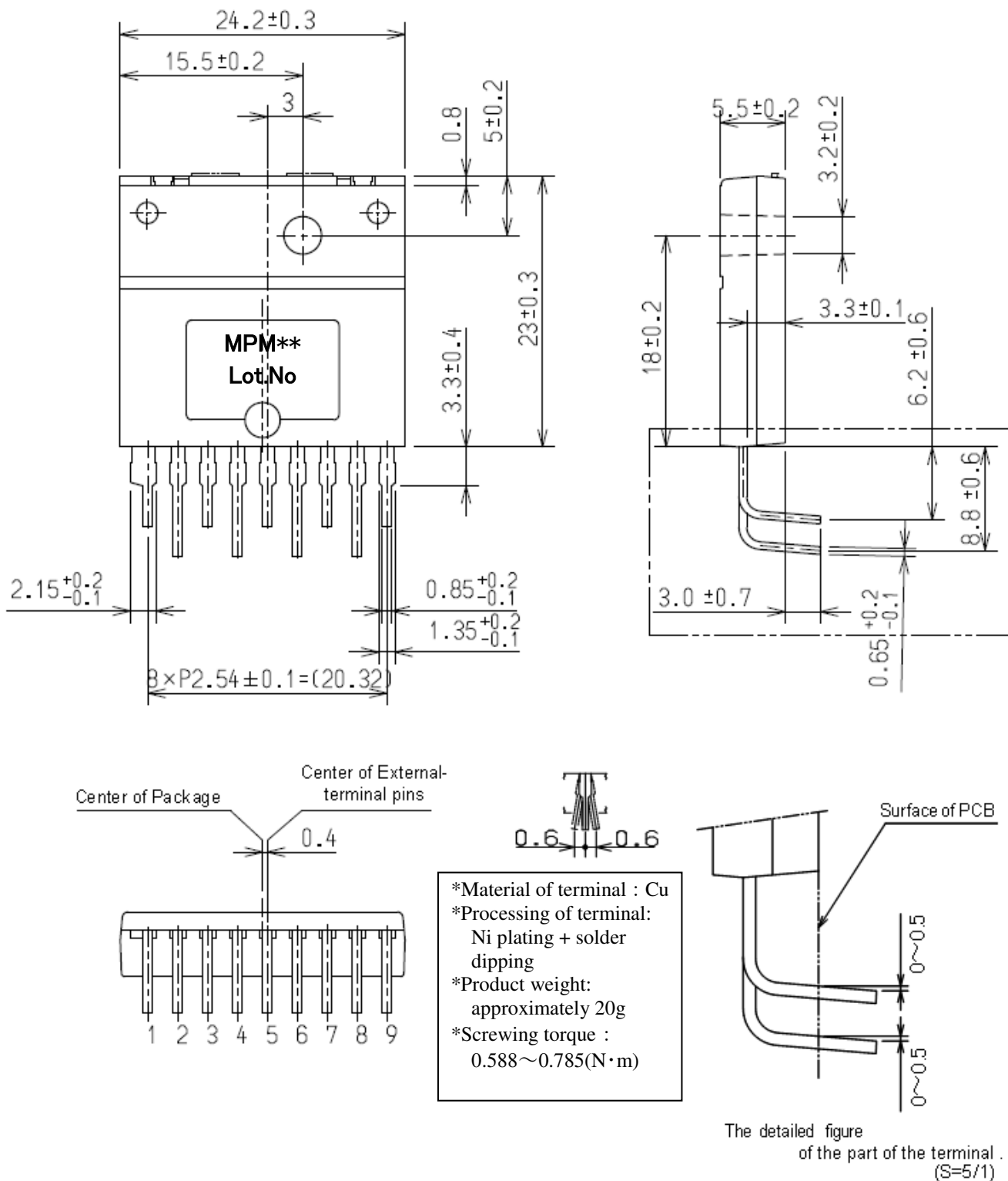


fig.13

\*In the fig.13 of front view which is common to MPM01-04, product numbers of each model name should be printed in \*\*.  
 \*The marking method is the same as the self-supporting lead forming type LF971.

## OPERATING PRECAUTIONS

In the case that you use Sanken products or design your products by using Sanken products, the reliability largely depends on the degree of derating to be made to the rated values. Derating may be interpreted as a case that an operation range is set by derating the load from each rated value or surge voltage or noise is considered for derating in order to assure or improve the reliability. In general, derating factors include electric stresses such as electric voltage, electric current, electric power etc., environmental stresses such as ambient temperature, humidity etc. and thermal stress caused due to self-heating of semiconductor products. For these stresses, instantaneous values, maximum values and minimum values must be taken into consideration. In addition, it should be noted that since power devices or IC's including power devices have large self-heating value, the degree of derating of junction temperature affects the reliability significantly.

Because reliability can be affected adversely by improper storage environments and handling methods, please observe the following cautions.

### Cautions for Storage

- Ensure that storage conditions comply with the standard temperature (5 to 35°C) and the standard relative humidity (around 40 to 75%); avoid storage locations that experience extreme changes in temperature or humidity.
- Avoid locations where dust or harmful gases are present and avoid direct sunlight.
- Reinspect for rust on leads and solderability of the products that have been stored for a long time.

### Cautions for Testing and Handling

When tests are carried out during inspection testing and other standard test periods, protect the products from power surges from the testing device, shorts between the product pins, and wrong connections. Ensure all test parameters are within the ratings specified by Sanken for the products.

### Remarks About Using Thermal Silicone Grease

- When thermal silicone grease is used, it shall be applied evenly and thinly. If more silicone grease than required is applied, it may produce excess stress.
- The thermal silicone grease that has been stored for a long period of time may cause cracks of the greases, and it cause low radiation performance. In addition, the old grease may cause cracks in the resin mold when screwing the products to a heatsink.
- Fully consider preventing foreign materials from entering into the thermal silicone grease. When foreign material is immixed, radiation performance may be degraded or an insulation failure may occur due to a damaged insulating plate.
- The thermal silicon greases that are recommended for the resin molded semiconductor should be used. Our recommended thermal silicone grease is the following, and equivalent of these.

Type	Suppliers
G746	Shin-Etsu Chemical Co., Ltd.
YG6260	Momentive Performance Materials Japan LLC
SC102	Dow Corning Toray Co., Ltd.

### Cautions for Mounting to a Heatsink

- When the flatness around the screw hole is insufficient, such as when mounting the products to a heatsink that has an extruded (burred) screw hole, the products can be damaged, even with a lower than recommended screw torque. For mounting the products, the mounting surface flatness should be 0.05mm or less.
- Please select suitable screws for the product shape. Do not use a flat-head machine screw because of the stress to the products. Self-tapping screws are not recommended. When using self-tapping screws, the screw may enter the hole diagonally, not vertically, depending on the conditions of hole before threading or the work situation. That may stress the products and may cause failures.
- Recommended screw torque: 0.588 to 0.785 N·m (6 to 8 kgf·cm).
- For tightening screws, if a tightening tool (such as a driver) hits the products, the package may crack, and internal stress fractures may occur, which shorten the lifetime of the electrical elements and can cause catastrophic failure. Tightening with an air driver makes a substantial impact. In addition, a screw torque higher than the set torque can be applied and the package may be damaged. Therefore, an electric driver is recommended. When the package is tightened at two or more places, first pre-tighten with a lower torque at all places, then tighten with the specified torque. When using a power driver, torque control is mandatory.

### Soldering

- When soldering the products, please be sure to minimize the working time, within the following limits:
  - 260 ± 5 °C 10 ± 1 s (Flow, 2 times)
  - 380 ± 10 °C 3.5 ± 0.5 s (Soldering iron, 1 time)

- Soldering should be at a distance of at least 1.5 mm from the body of the products.

When soldering the products, please be sure to minimize the working time, within the following limits:

- Reflow      Preheat ; 180 °C / 90 ± 30 s  
                 Solder heating ; 250 °C / 10 ± 1s (260 °C peak, 2 times)
- Soldering iron ; 380 ± 10 °C / 3.5 ± 0.5s (1 time)

## **Electrostatic Discharge**

- When handling the products, the operator must be grounded. Grounded wrist straps worn should have at least 1MΩ of resistance from the operator to ground to prevent shock hazard, and it should be placed near the operator.
- Workbenches where the products are handled should be grounded and be provided with conductive table and floor mats.
- When using measuring equipment such as a curve tracer, the equipment should be grounded.
- When soldering the products, the head of soldering irons or the solder bath must be grounded in order to prevent leak voltages generated by them from being applied to the products.
- The products should always be stored and transported in Sanken shipping containers or conductive containers, or be wrapped in aluminum foil.

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