DC-to-DC Converter Module

Features and Benefits

- Fewer external components required: IC operates just by connecting an input smoothing capacitor, an output smoothing capacitor, and output voltage setup resistance.
- Built-in inductor: Built-in power inductor eliminates requirement to evaluate and select the inductor separately.
- Sanken proprietary fully molded and integrated package: The full-mold package allows a screw clamp connection to a heatsink. Depending on an output voltage setup and load conditions, the IC can be operated without a heatsink.
- Wide input voltage range, high efficiency: Input voltage range of 9 VDC to output of 16 to 40 V. When V_O = 12 V at 3 A, the efficiency is 91% (typ).
- Various protection functions: Protection functions such as Overcurrent protection (OCP), Overvoltage protection (OVP) and Thermal Shutdown (TSD) are built-in.

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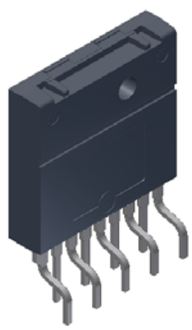
Package: Fully-molded 9-pin 3GR-S

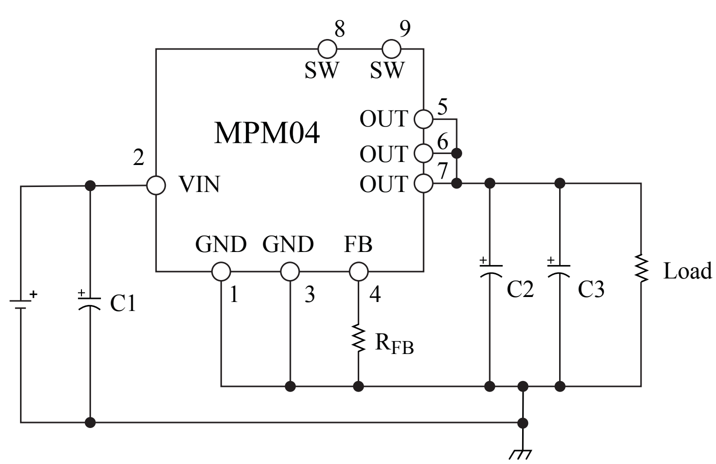


Not to scale

Description

The MPM (Micro Power Module) series is a hybrid IC which incorporates a non-isolated buck DC-to-DC converter circuit with an inductor in a single fully molded package. The IC enables designing a power supply circuit with fewer external components. It is ideal for the replacement of a discrete DC-to-DC converter IC, such as a local regulator on various systems, to lower component count, and to save space.

Typical Application Circuit



- Pins 8 and 9 (SW) are test-only terminals for measuring oscillating frequency. Please leave open for normal operation.
- R_{FB} is the resistance for setting output voltage. Refer to the Setting Output Voltage section.
- C1, C2, C3 recommended values switching mode power supply applications, not for general electronic circuits:
  - C1: 50 V / 1000 μF
  - C2, C3: 25 V / 1000 μF × 2 units

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http://www.sanken-ele.co.jp/en/
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Features and Benefits (continued)

- Built-in phase compensation: Eliminates the requirement for an external constant clock; the reference voltage of the IC output has 0.5 V ±2% accuracy, and is a control drive type phase compensation.

Selection Guide

Part Number	Input Voltage (VDC)	Output Voltage (VDC)	Output Current (A)	Drive Frequency (kHz)
MPM04	16 to 40	12 to 24	3	250

The polarity value for current specifies a sink as "+," and a source as "−," referencing the IC.

Absolute Maximum Ratings

Characteristic	Symbol	Notes	Rating	Unit
VIN Pin Voltage	V_{IN}		–0.3 to 41	V
FB Pin Voltage	V_{FB}		–0.3 to 6	V
V_O Pin Voltage	V_O		–0.3 to 25	V
SW Pin Voltage	V_{SW}		–0.3 to V_{IN}	V
Voltage Between VIN and SW Pins	V_{VIN-SW}	30 ns [Japanese text]	55	V
[Japanese text]	P_{LOSS}	[Japanese text]	2.5	W
Operating Ambient Temperature	T_j	Limited due to the overtemperature protection; overtemperature protection detection temperature is about 160°C [Japanese text]	–20 to 150	°C
Storage Temperature	T_{stg}		–20 to 120	°C
Thermal Resistance (MIC to leadframe)	$R_{\theta J-F}$		7.7	°C/W

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Recommended Operating Conditions[1]

Characteristic	Symbol	Test Conditions	Min.	Max.	Unit
Input Voltage Range[2]	V_{IN}		16	40	V
Output Voltage Range	V_{OUT}		12	24	V
Output Current Range[3]	I_O		0	3	A
Operating Junction Temperature	T_{JOP}		–20	125	°C
Operating Ambient Temperature[3]	T_A	With derating	–20	85	°C

[1]A recommended operating conditions is an operating condition required in order to maintain the normal circuit functions shown in the Electrical Characteristics table, and it is necessary to remain within the condition in actual use.
[2]Depending on the setup of the output voltage, V_O, V_{IN}(min) < V_O condition may occur. Because this product is not a boost regulator, $V_{IN} > V_O$ shall be a condition of operation. Please refer to the Minimum Input/Output Voltage Difference section.
[3]However, it is necessary to use it within a derating curve. Please refer to Temperature Derating curves.

Electrical Characteristics[1] Unless specifically noted, V_O = 12 V, T_A is 25°C

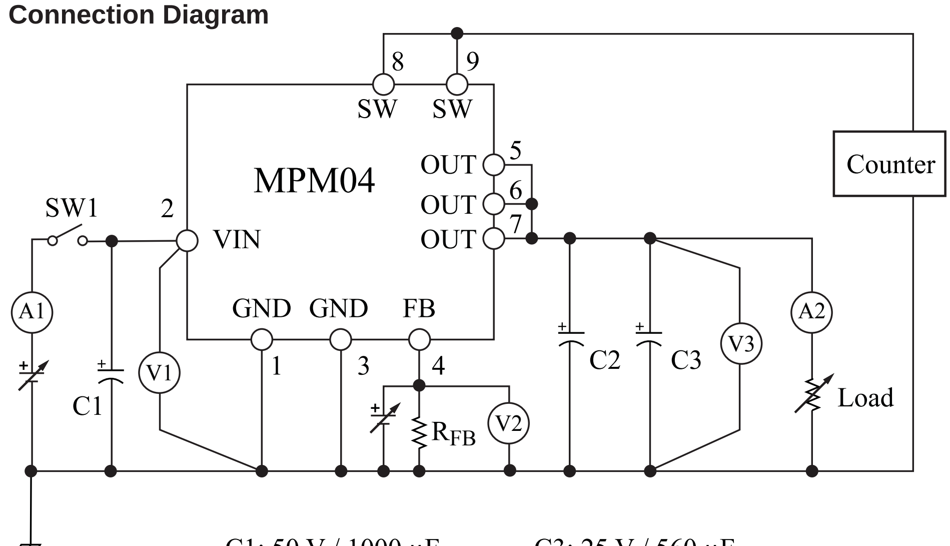
Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Reference Voltage	$V_{FB(REF)}$	V_{IN} = 33 V, set on I_O = 1 A	0.490	0.500	0.510	V
Efficiency[2]	η	V_{IN} = 33 V, V_O = 12 V, set on I_O = 3 A	–	91	–	%
SW Frequency	f_O	V_{IN} = 33 V, V_O = 12 V, set on I_O = 3 A	212	250	288	kHz
Line Regulation[3]	V_{LINE}	Input V_{IN} = 16 to 40 V, set on V_O = 12 V, I_O = 1 A	–	–	±2	%
Load Regulation[3]	V_{LOAD}	V_{IN} = 33 V, V_O = 12 V, set on I_O = 0 to 3 A	–	–	±3	%
Over Current Protection Starting Current[4]	I_S	Set V_{IN} = 33 V, V_O = 12 V, auto restart / voltage drooping over current protection	3.2	5.6	7.0	A
Input Circuit Current	I_{IN}	V_{IN} = 33 V, I_O = 0 A, V_{FB} = 1 V	–	12	–	mA
MIC Thermal Protection Start-up Temperature[5]	T_J	Input V_{IN} = 16 to 40 V	151	160	–	°C
Supply Voltage Undervoltage Protection	V_{UVLO}		–	7.3	8.0	V
Start-up Delay Time	t_{START}	V_{IN} =16 to 40 V, start-up to V_O reaching the target voltage level	–	50	–	ms

[1]Values apply when the device is configured as shown in the Standard Connection Diagram.
[2]Efficiency is calculated by the following formula:

$$\eta\,(\%) = \frac{V_O \times I_O}{V_{IN} \times I_{IN}} \times 100 \qquad (1)$$

[3]The value for V_O cited here is nominal, and does not take take into consideration variance of the external resistor R_{FB} (V_O is set by R_{FB}, please refer to the Application section for details). To determine the actual load regulation, the user must check the variance of R_{FB} in the application.
[4]Because the inductance of the built-in coil and the frequency of output are constant, the OCP operating point may vary when V_O is not 12 V. In using the device at a V_O other than 12 V, the user must check the actual OCP operating point in the application.
[5]Thermal protection has automatic restart.

Standard Connection Diagram



C1: 50 V / 1000 µF
C2: 25 V / 560 µF
C3: 25 V / 560 µF
R1: 200 Ω (at V_O = 12 V)

Characteristic Performance

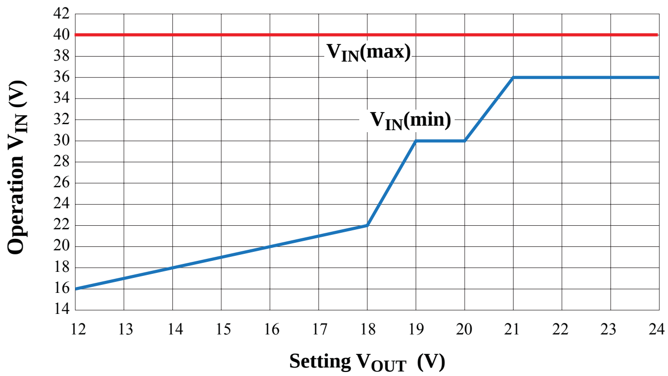


Figure 1. Output Current Derating versus Ambient Temperature

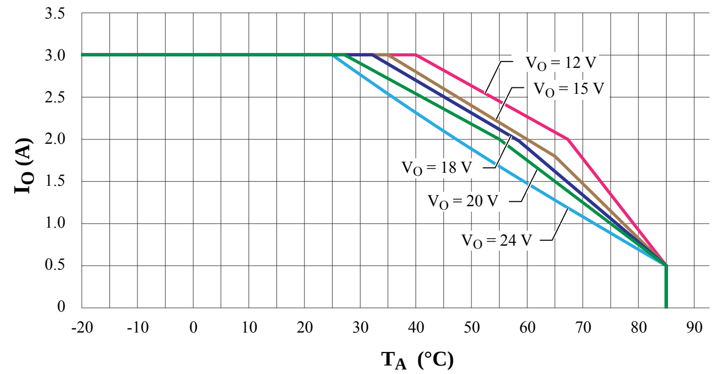


Figure 2. Output Current Derating versus Ambient Temperature

Functional Description

Setting Output Voltage

Output voltage is set by the value selected for R_{FB} (see figure 3), according to the following formula:

$$V_O = V_{FB}\left(1 + \frac{R_3}{R_{FB}}\right) \qquad (2)$$

R_{FB} for output voltage V_O = 5 V can be calculated as 500 Ω, and for V_O =12 V as 200 Ω (typical value).

Figure 8 shows the value of V_O for various R_{FB} values. The limit at V_O = 12 V applies to the MPM04, which has an Absolute Maximum Rating of 13 V.

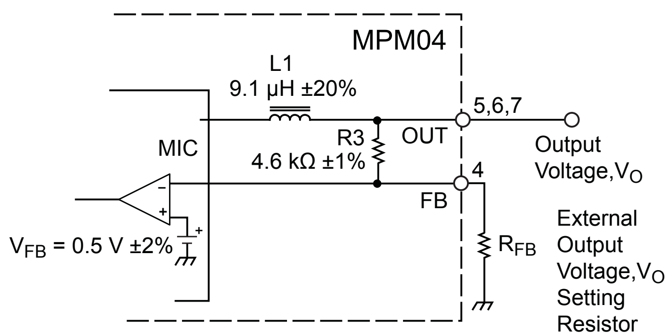


Figure 3. RFB placement for output voltage setting

Application Information

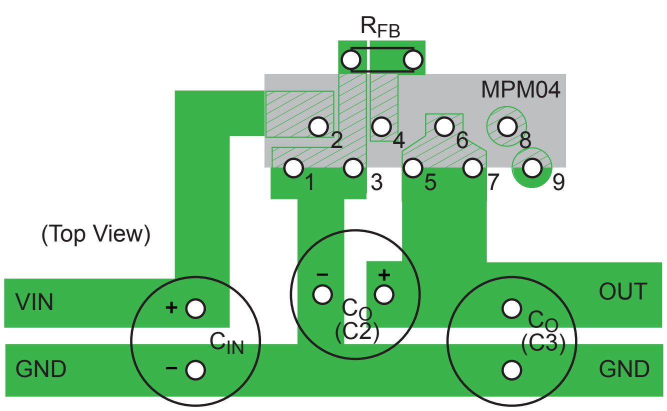
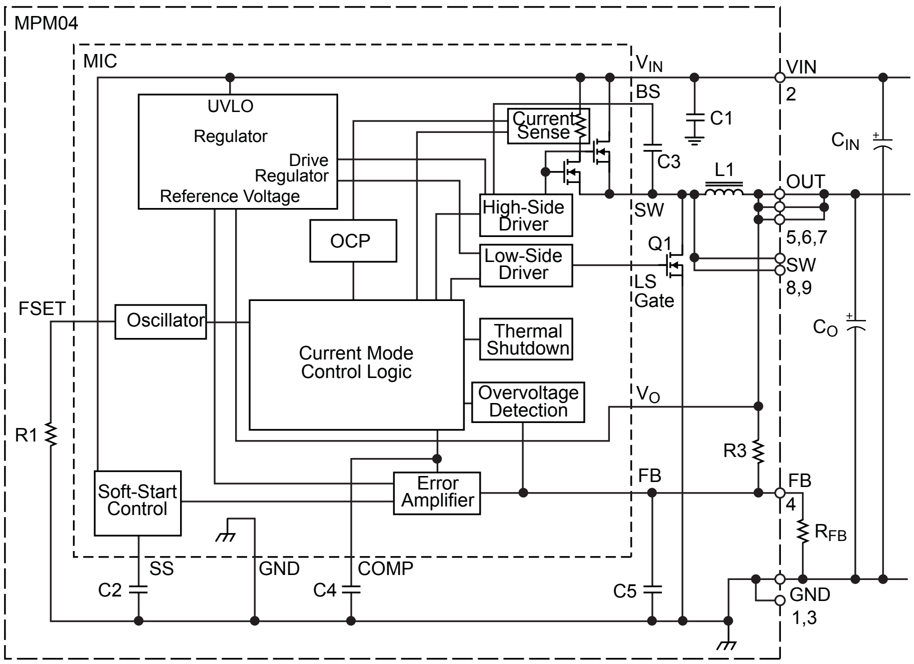


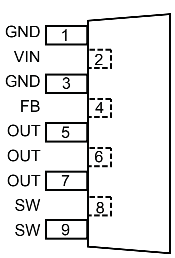
Figure 4. Recommended board layout

- It is recommended that the traces between the negative side of the output capacitors (C_O) and the GND pins (1 and 3), be as short as possible in order to minimize the impedance of the loop, including the IC internal circuit.
- Pins 8 and 9 (SW) are test-only terminals for measuring oscillating frequency. Please leave open for normal operation. The pins should be mounted only on isolated lands, and should not connect with traces of other potentials. That might cause a failure.
- Please place R_{FB} as near the IC as possible, with the shortest trace length. The circuit may malfunction if the R_{FB} trace is too long.

Functional Block Diagram



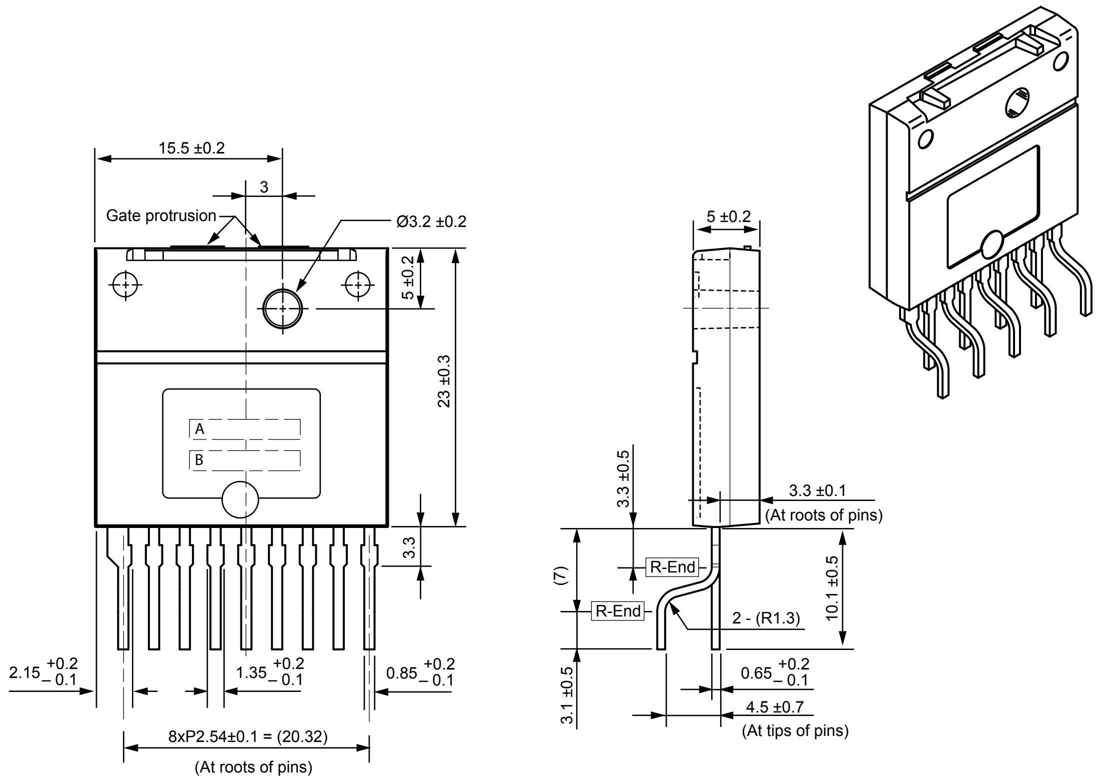
Pin-out Diagram

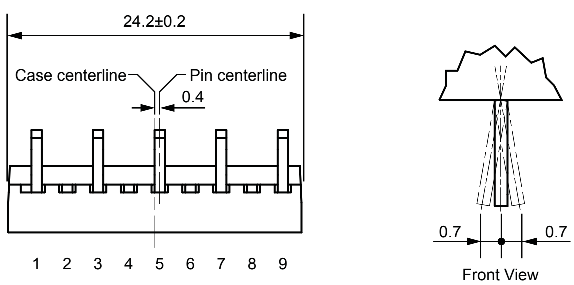


Pin List Table

Number	Name	Function
1	GND	Ground
2	VIN	Input power pin
3	GND	Ground pin
4	FB	Feedback pin, and connection pin for resistor R_{FB} for output voltage setup
5, 6, 7	OUT	Output pin
8, 9	SW	Oscillation frequency measuring pin

Package Diagram
3GR-S package





Branding
Line A: MPM04
Line B: Lot number

Leadform: LF971
Pin material: Cu
Pin coating: Nickle and solder dip to 3.3 mm from body
Weight: Approximately 20 g
Screw clamp bolting torque: 0.588 to 0.785 N • m

Pb-free. Device composition compliant with the RoHS directive.

Cautions and Warnings

• The parallel operation to increase the current is not available.

• Thermal shutdown. The MPM04 has a thermal protection circuit. This circuit keeps the IC from overheating due to overload. But this circuit cannot guarantee long-term reliability against continuously overloaded status.

• Heat radiation and reliability. The reliability of an IC is inseparable from the temperature in its operation. Careful consideration should be given to heat radiation and a sufficient safety margin must be allowed when designing a heatsink. When mounting the MPM04 to the heatsink, be sure to apply silicone grease and securely screw it. Please use one of the following greases we suggest:

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

• Cautions for mounting to heatsink. When the flatness around screw holes is insufficient, such as when mounting the product to the heatsink with extruded (burred) screw holes, the product can be damaged even with a lower screw torque than the recommended value. For mounting products, the mounting surface flatness should be 0.05 mm or less.
Please select suitable screws for product shape. Do not use a flathead machine screw because of the stress to products. A tapping screw is not recommended for the packages. When using tapping screws, a screw may enter diagonally, not vertically, depending on the conditions of hole before threading or the work situation. That may stress on the products and may cause failures.

For tightening screws, if a tightening tool (such as a driver) hits the product, the package may crack, and stress, which shortens the element lifetimes and can cause the destruction, is put on internally. Tightening with an air driver makes a large impact. A screw torque higher than recommended torque can be applied and the package may be damaged. Therefore, an electric driver is recommended. When the package is secured at two or more places, tighten with the specified torque, after pre-tightening with a torque at all places. For using a driver, torque control is mandatory.