2 A Non-Isolated Step-Down DC / DC Converter Modules

Features and Benefits

- Wide input voltage range: V_{IN} = 8 to 30 V
- High efficiency: 95% (max) for MPM80, 88% (max) for MPM81, and 93% (max) for MPM82
- Output voltage: 3.0 to 16 V for MPM80, 3.3 V for MPM81, and 5.0 V for MPM82
- Maximum output current: I_O = 2 A
- Operating frequency: 630 kHz
- Few external components required:
  - Built-in inductor
  - Built-in phase compensation circuit
- A variety of protection features include:
  - Overcurrent (OCP) with auto restart
  - Overvoltage (OVP)
  - Undervoltage lockout (UVLO)
  - Overtemperature (OTP) with auto restart

Package: TO-220-8L

Not to scale

Description

The MPM80, MPM81, and MPM82 are hybrid module ICs that include a non-isolated step-down DC / DC converter circuit with an inductor in a full-mold package. These features allow simple circuit configurations using few components, contributing to a reduction in design time and PCB space.

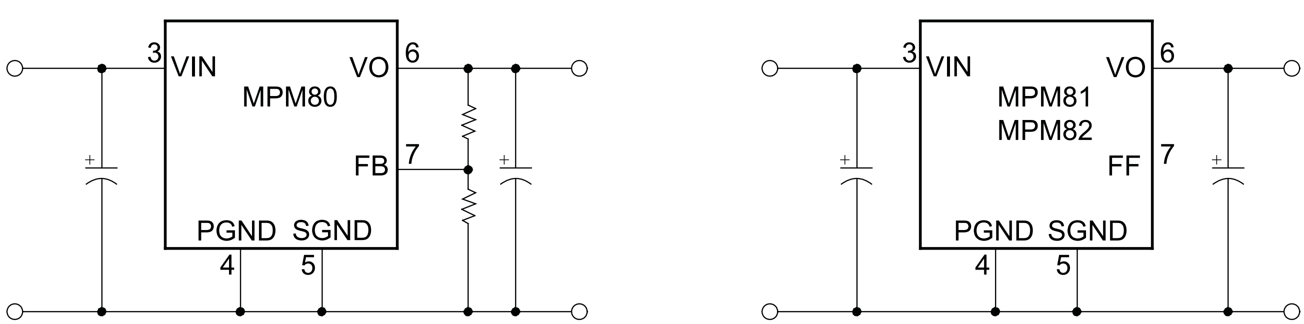
This product can operate by simply connecting an input smoothing capacitor, an output smoothing capacitor, and output voltage setting resistors. This contributes to a reduction in man-hours for design and evaluation. Because this product contains a power inductor, the burdensome work of selecting and evaluating an inductor is unnecessary.

Adoption of the free-standing full-mold package provides the design flexibility of either screwing the package to a heatsink or mounting the package directly on a PCB substrate without installing a heatsink, depending on the output voltage setting and load conditions.

Applications:

- FA devices
- Communication devices
- Consumer devices
- Others

Typical Application Circuits



SANKEN ELECTRIC CO., LTD.
http://www.sanken-ele.co.jp/en/

Selection Guide

Part Number	Input Voltage (VDC)	Output Voltage (VDC)	Output Current (A)	Drive Frequency (kHz)	Efficiency (% Max)
MPM80	8 to 30	3 to 16	2	630	95
MPM81	8 to 30	3.3	2	630	88
MPM82	8 to 30	5	2	630	93

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

Absolute Maximum Ratings, valid at T_A = 25°C if not otherwise specified

Characteristic	Symbol	Conditions	Rating	Unit
Voltage Between VIN and GND Pins	V_{IN}	PGND and SGND tied together externally	35	V
Voltage Between FB and GND Pins	V_{FB}	PGND and SGND tied together externally	5	V
Voltage Between VO and GND Pins	V_O	PGND and SGND tied together externally	20	V
MIC Capacity Loss	P_{LOSS}	No radiator added	2	W
Junction Temperature	T_J		−20 to 125	°C
Storage Temperature	T_{stg}		−20 to 125	°C
Thermal Resistance	$R_{\theta JA}$	Between MIC junction and air; no heatsink	50	°C/W

Recommended Operating Conditions[1,2]

Characteristic	Symbol	Conditions		Min.	Max.	Unit
Input Voltage Range[3]	V_{IN}			8	30	V
Output Voltage Range	V_O	MPM80	Variable with external resistors	3.0	16.0	V
		MPM81	Fixed voltage	3.23	3.37	V
		MPM82	Fixed voltage	4.9	5.1	V
Output Current Range[4]	I_O			0	2.0	A
Operating Junction Temperature	T_{JOP}			−20	125	°C
Operating Temperature Range[4]	T_A	With derating		−20	85	°C

[1]Recommended operating conditions refer to operating conditions to maintain normal circuit functions specified in the Electrical Characteristics table in this document and they must be followed in actual use.
[2]When connected as shown in figure 1.
[3]Derating is required; refer to the Thermal Characteristics section.
[4]Minimum value must be either 8 V or V_O + 3 V, whichever is greater.

MPM80 Electrical Characteristics[1] T_A = 25°C, V_{IN} = 12 V, if not otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Output Voltage Setting Reference Voltage	V_{FBREF}	I_O = 1 A	0.784	0.800	0.816	V
Output Voltage Setting Reference Voltage Temperature Coefficient	$\Delta V_{FBREF} / \Delta T$	T_A = –20 to 85°C	–	±0.05	–	mV / °C
Line Regulation[2]	V_{LINE}	V_{IN} = 8 to 30 V, V_O = 5 V, I_O = 1 A	–2	–	2	%
Oscillation Frequency	f		567	630	693	kHz
Load Regulation[2]	V_{LOAD}	V_O = 5 V, I_O =0 to 2 A	–3	–	3	%
Overcurrent Protection (OCP) Starting Current[3]	I_S	V_O = 5 V, drooping/automatic restoration of operation when fault removed	2.4	–	4.0	A
Circuit Current	I_{IN}	I_O = 0 A, V_{FB} = 1 V	–	2.5	–	mA
Overvoltage Protection (OVP) Starting Voltage[4]	V_{OVP}	V_{IN} = 8 to 35 V	–	1.1 × V_{FBREF}	–	V
MIC Overtemperature Protection (OTP) Starting Temperature	T_{JOTP}	V_{IN} = 8 to 35 V, automatic restoration of operation when fault removed	135	150	–	°C
Undervoltage Lockout (UVLO) Voltage	V_{UVLO}		6.0	7.0	7.5	V
UVLO Release Voltage	$V_{UVLO(OFF)}$		5.5	6.5	7.0	V
UVLO Hysteresis Voltage[4]	$V_{UVLOHYS}$		–	0.5	–	V
Minimum Input-Output Difference	$V_{INVO(MIN)}$	When V_O is set to 12 V	3	–	–	V
Built-In Software Start Time[4]	t_{SS}	V_{IN} = 12 V, I_O = 1.0 A	–	6.4	–	ms
Maximum On Duty Cycle[4]	D_{MAX}		–	90	–	%
Minimum On-Time[4]	t_{MIN}		–	160	–	ns
Inductance Value	L		4.48	5.60	6.72	μH

[1]The Electrical Characteristics value specifications apply when the MPM80 is connected as shown in figure 1.
[2]V_{LINE} and V_{LOAD} do not include output voltage setting deviation. Note that output voltage setting deviation is affected by precision of the external resistors R1 and R2. For details, refer to the Application Information section.
[3]When the output voltage, V_O, is set to any value other than 5.0 V, the inductance value and operating frequency of the built-in inductor change in direct proportion with to the setting output voltage. Therefore, the OCP operating point may vary significantly from the value when V_O = 5.0 V.
[4]Determined by design, not tested in production.

MPM81 Electrical Characteristics[1] T_A = 25°C, V_{IN} = 12 V, if not otherwise specified

Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Output Voltage Setting Reference Voltage	V_{FBREF}	V_{IN} = 8 to 30 V, I_O = 1 A	3.23	3.30	3.37	V
Line Regulation	V_{LINE}	V_{IN} = 8 to 30 V, I_O = 1 A	–2	–	2	%
Oscillation Frequency	f		567	630	693	kHz
Load Regulation	V_{LOAD}	I_O =0 to 2 A	–3	–	3	%
Overcurrent Protection (OCP) Starting Current	I_S	V_O = 5 V, drooping/automatic restoration of operation when fault removed	2.7	–	4.4	A
Circuit Current	I_{IN}	I_O = 0 A, V_{FB} = 1 V	–	2.5	–	mA
Overvoltage Protection (OVP) Starting Voltage[2]	V_{OVP}	V_{IN} = 8 to 35 V	–	1.1 × V_{FBREF}	–	V
MIC Overtemperature Protection (OTP) Starting Temperature	T_{JOTP}	V_{IN} = 8 to 35 V, automatic restoration of operation when fault removed	135	150	–	°C
Undervoltage Lockout (UVLO) Voltage	V_{UVLO}		6.0	7.0	7.5	V
UVLO Release Voltage	$V_{UVLO(OFF)}$		5.5	6.5	7.0	V
UVLO Hysteresis Voltage[2]	$V_{UVLOHYS}$		–	0.5	–	V
Minimum Input-Output Difference	$V_{INVO(MIN)}$		3	–	–	V
Built-In Software Start Time[2]	t_{SS}	V_{IN} = 12 V, I_O = 1.0 A	–	6.4	–	ms
Maximum On Duty Cycle[2]	D_{MAX}		–	90	–	%
Minimum On-Time[2]	t_{MIN}		–	160	–	ns
Inductance Value	L		4.48	5.60	6.72	μH

[1]The Electrical Characteristics value specifications apply when the MPM80 is connected as shown in figure 1.
[2]Determined by design, not tested in production.

MPM82 Electrical Characteristics[1] T_A = 25°C, V_{IN} = 12 V, if not otherwise specified

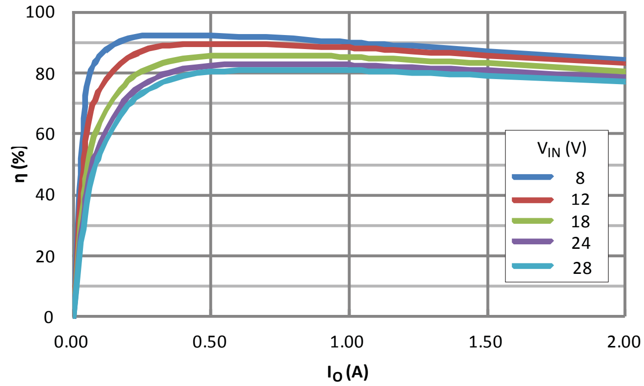
Characteristic	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
Output Voltage Setting Reference Voltage	V_{FBREF}	V_{IN} = 8 to 30 V, I_O = 1 A	4.90	5.00	5.10	V
Line Regulation	V_{LINE}	V_{IN} = 8 to 30 V, I_O = 1 A	–2	–	2	%
Oscillation Frequency	f		567	630	693	kHz
Load Regulation	V_{LOAD}	I_O =0 to 2 A	–3	–	3	%
Overcurrent Protection (OCP) Starting Current	I_S	V_O = 5 V, drooping/automatic restoration of operation when fault removed	2.4	–	4.0	A
Circuit Current	I_{IN}	I_O = 0 A, V_{FB} = 1 V	–	2.5	–	mA
Overvoltage Protection (OVP) Starting Voltage[2]	V_{OVP}	V_{IN} = 8 to 35 V	–	1.1 × V_{FBREF}	–	V
MIC Overtemperature Protection (OTP) Starting Temperature	T_{JOTP}	V_{IN} = 8 to 35 V, automatic restoration of operation when fault removed	135	150	–	°C
Undervoltage Lockout (UVLO) Voltage	V_{UVLO}		6.0	7.0	7.5	V
UVLO Release Voltage	$V_{UVLO(OFF)}$		5.5	6.5	7.0	V
UVLO Hysteresis Voltage[2]	$V_{UVLOHYS}$		–	0.5	–	V
Minimum Input-Output Difference	$V_{INVO(MIN)}$		3	–	–	V
Built-In Software Start Time[2]	t_{SS}	V_{IN} = 12 V, I_O = 1.0 A	–	6.4	–	ms
Maximum On Duty Cycle[2]	D_{MAX}		–	90	–	%
Minimum On-Time[2]	t_{MIN}		–	160	–	ns
Inductance Value	L		4.48	5.60	6.72	μH

[1]The Electrical Characteristics value specifications apply when the MPM80 is connected as shown in figure 1.
[2]Determined by design, not tested in production.

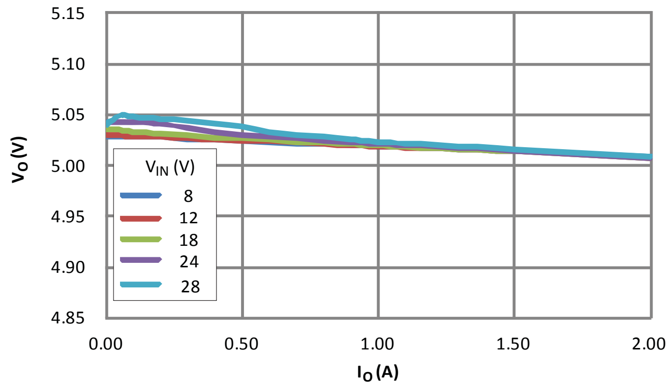
Characteristic Performance

MPM80 Device

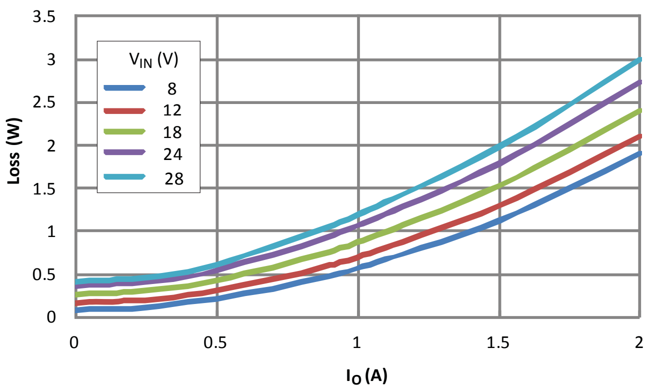
Efficiency versus Output Current
V_O = 5 V, T_A = 25°C



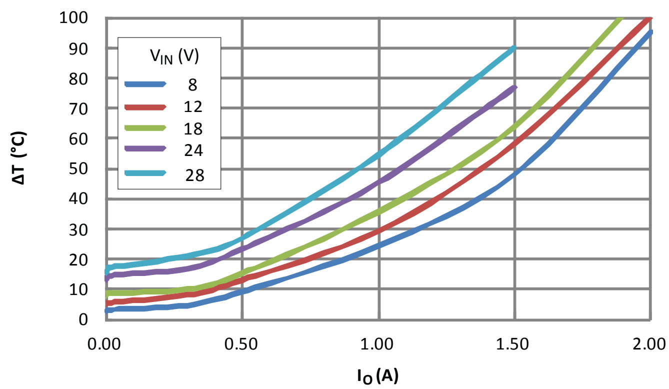
Load Regulation versus Output Current
V_O = 5 V, T_A = 25°C



Internal Loss versus Output Current
V_O = 5 V, T_A = 25°C

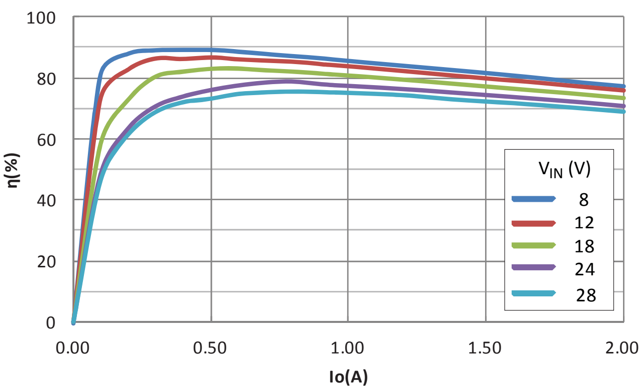


Temperature Rise versus Output Current
V_O = 5 V, T_A = 25°C

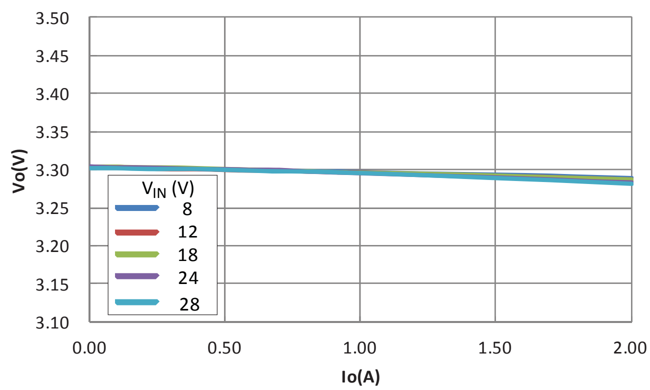


MPM81 Device

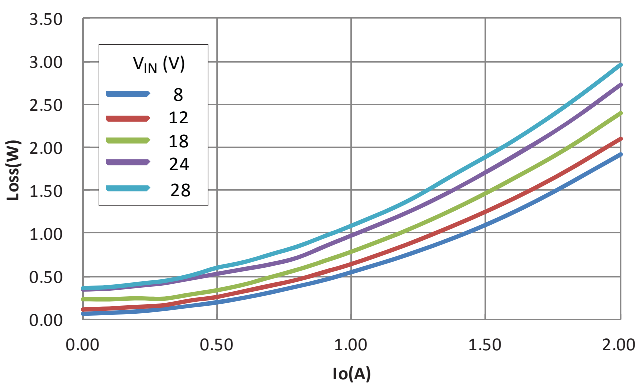
Efficiency versus Output Current
V_O = 5 V, T_A = 25°C



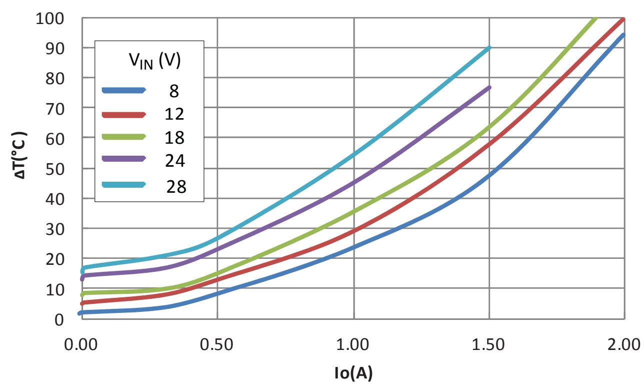
Load Regulation versus Output Current
V_O = 5 V, T_A = 25°C



Internal Loss versus Output Current
V_O = 5 V, T_A = 25°C

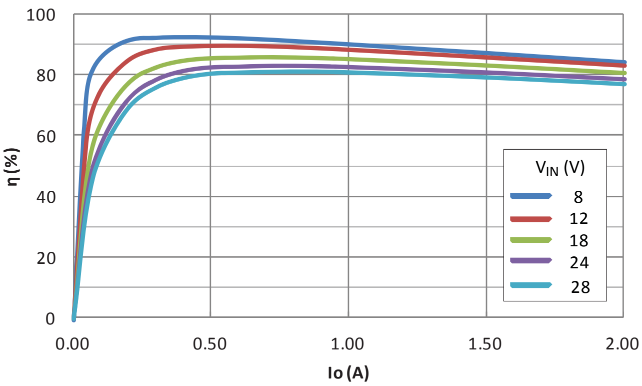


Temperature Rise versus Output Current
V_O = 5 V, T_A = 25°C

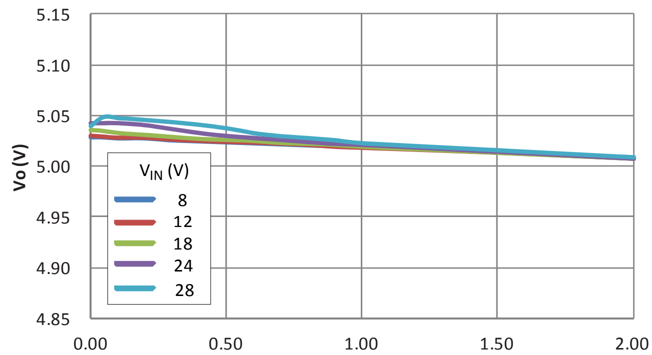


MPM82 Device

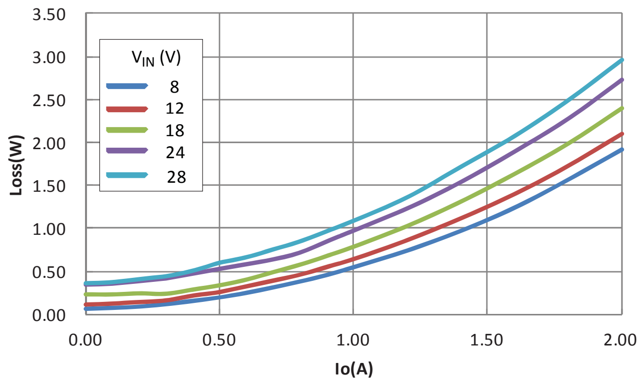
Efficiency versus Output Current
V_O = 5 V, T_A = 25°C



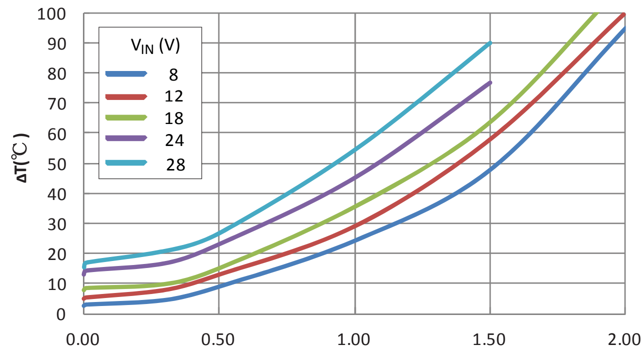
Load Regulation versus Output Current
V_O = 5 V, T_A = 25°C



Internal Loss versus Output Current
V_O = 5 V, T_A = 25°C



Temperature Rise versus Output Current
V_O = 5 V, T_A = 25°C



Standard Connection Diagram

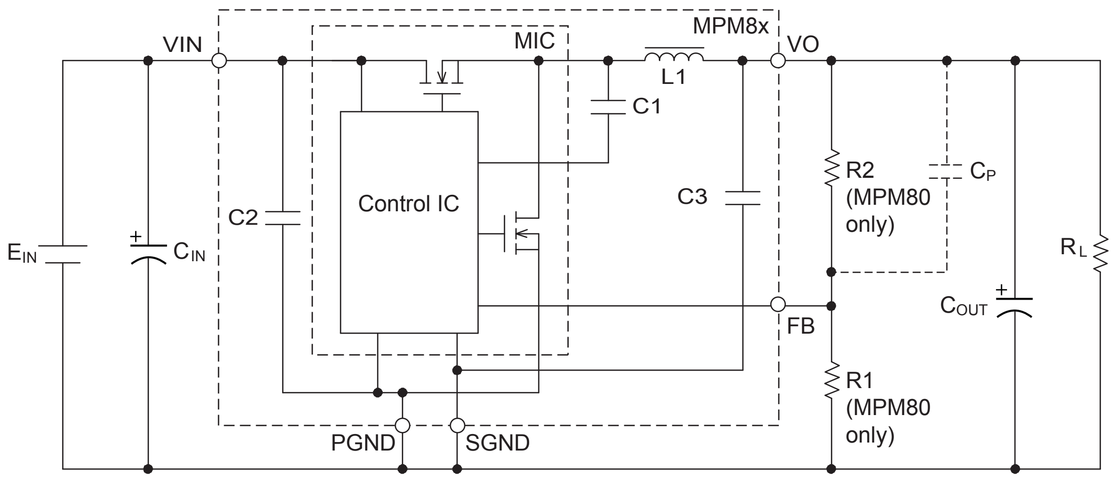


Figure 1. MPM8x standard circuit connection diagram

Recommended Circuit Constants*

MPM80, MPM81, and MPM82	
E_{IN}	Source of input voltage
C_{IN}	100 to 1000 μF; not required if the input voltage is stable
C_{OUT}	220 to 1000 μF (electrolytic capacitor) or 47 to 100 μF (ceramic capacitor); when using an electrolytic capacitor, use a low-impedance capacitor
C_P	100 to 470pF (Add CP. when ceramic capacitor is used for COUT.)
R_L	Load
MPM80 Only	
R1	680 Ω to 1.5 kΩ
R2	With R1 sets the output voltage, according to the following formula: $$R_2 = \left(\frac{V_O}{V_{FBREF}} - 1 \right) \times R_1 \quad (1)$$ where V_O is the target output voltage, and V_{FBREF} is the FB pin reference voltage, 0.8 V (typ)

*If operation is unstable, add a bypass capacitor (1 μF, ceramic) as near as possible to the device, between VIN and PGND pins.

Thermal Derating

Figure 2 shows thermal derating curves for the MPM80. The MPM80 requires derating based on the ambient temperature, T_A, in use.

Use the MPM80 within the thermal derating curves shown in figure 2. If using the MPM80 outside the curves, consider using a heatsink. In this case, the thermal resistance, $R_{\theta J\text{-}C}$, between the MPM80 junction and case is 8 °C/W. Therefore, use the MPM80 at a junction temperature, T_J, of 125°C or less, with T_J calculated using the following procedure.

1. The internal loss, P_{LOSS}, of the MPM80 in use is calculated as follows:

$$P_{LOSS} = (I_{IN} \times V_{IN}) - (I_O \times V_O) \quad (2)$$

where

P_{LOSS} is the internal loss of the MPM80, in watts,

I_{IN} is the input current of the MPM80, in amperes,

V_{IN} is the input voltage of the MPM80, in volts,

I_O is the output current of the MPM80 in amperes, and

V_O is the output voltage of the MPM80, in volts.

Overall thermal resistance, $R_{\theta J\text{-}H}$, is determined by adding the thermal resistances of the MPM80 and a heatsink, as follows:

$$R_{\theta J\text{-}H} = R_{\theta J\text{-}C} + R_{\theta H} \quad (3)$$

where

$R_{\theta J\text{-}H}$ is the thermal resistance between the MPM80 and heat-sink, in degrees Celsius per watt,

$R_{\theta J\text{-}C}$ is the thermal resistance between the MPM80 junction and the MPM80 case, in degrees Celsius per watt, and

$R_{\theta H}$ is the thermal resistance of the heatsink, in degrees Celsius per watt.

Junction temperature, T_J, is calculated as follows:

$$T_J = P_{LOSS} \times R_{\theta J\text{-}H} \quad (4)$$

Because the maximum T_J rating of the MPM80 is 125°C, please use the MPM80 at a junction temperature of 125°C or less.

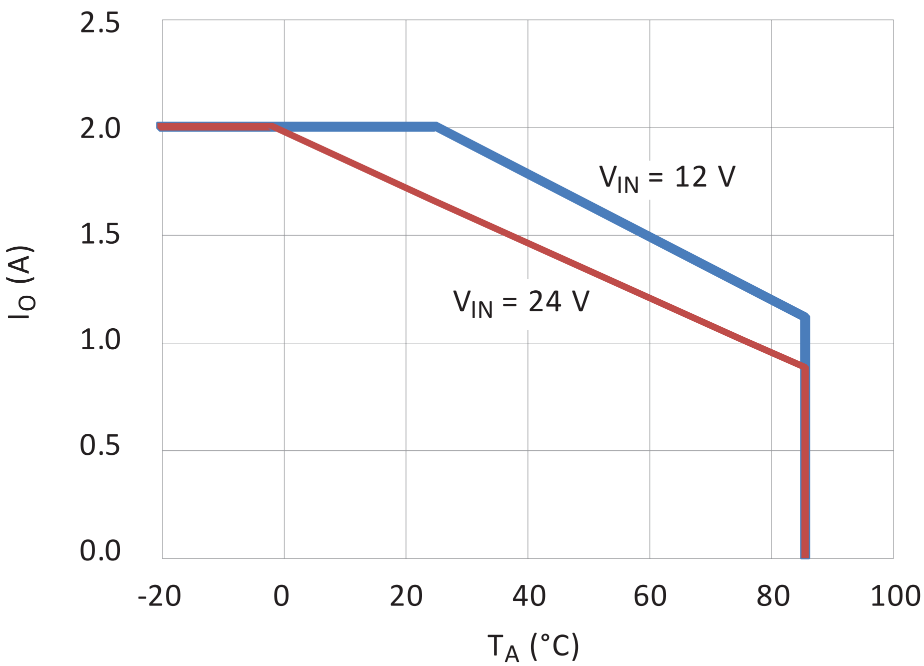
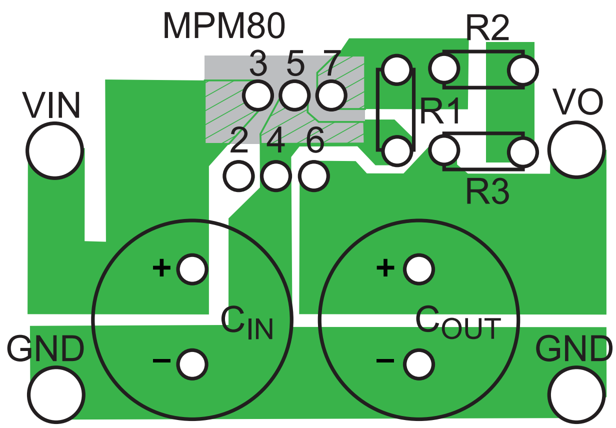


Figure 2. MPM80 thermal derating curve; measurement conditions: V_O = 5 V, no heatsink

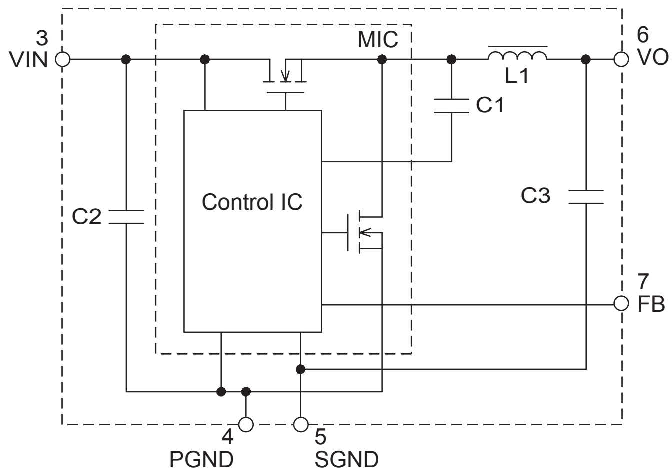
Recommended PCB Layout



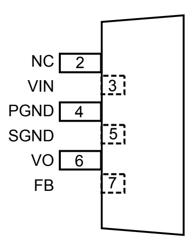
C_{IN}: Input capacitor
C_{OUT}: Output capacitor
R1: Output voltage setting resistor (FB to GND resistance)
R2 and R3: Output voltage setting resistors (VO to FB resistance)

- Place C_{IN} and C_{OUT} as close to the MPM80 as possible.
- Connect R1, R2, and R3 from the output voltage connection point to the SGND (5th) pin.
- A switching current flows through the PGND (4th) pin along the connection between C_{OUT} and the MPM80 and therefore the common impedance of the GND loop and the switching current cause a voltage drop. Note that connecting this circuit to the GND point for output voltage detecting resistance may result in deterioration of regulation.

Functional Block Diagram



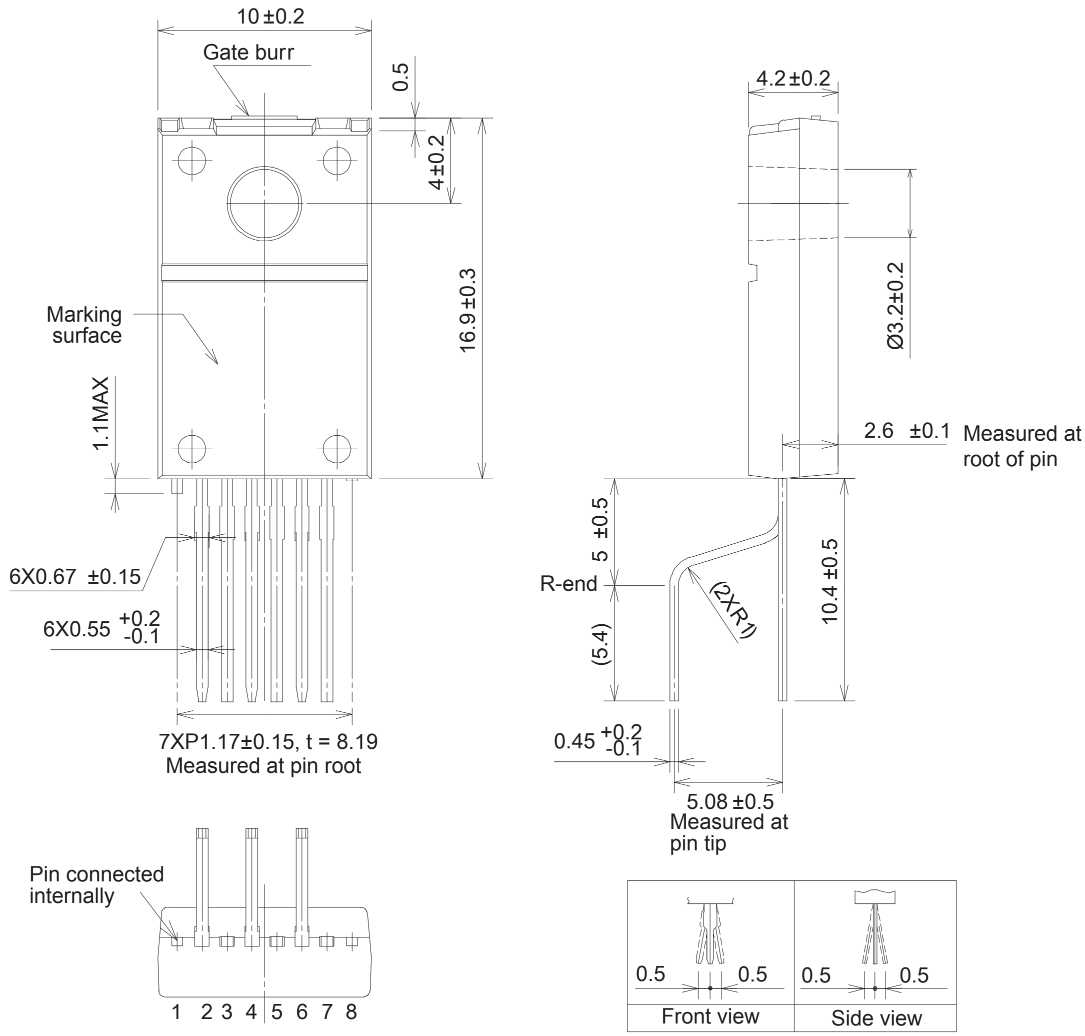
Pin-out Diagram



Pin List Table

Number	Name	Function
2	NC	Not connected
3	VIN	Power input
4	PGND	Ground, power circuits
5	SGND	Ground, control circuits
6	VO	Output
7	FB	Feedback

Package Outline Drawing, TO-220-8L



Unit: mm
Gate burr: 0,3 mm (max)
Pin core material: Cu
Pin treatment: Cu + solder dip
Product weight: Approximately 20 g
Heatsink screw tightening torque: 6 to 8 kgf • cm

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

Package Marking

Line 1. Product name: MPM8x
Line 1. Lot number
- 1st character: Last one digit of year
- 2nd character: Manufacture month
  - Jan. to Sep. = 1 to 9
  - Oct. = O, Nov. = N, Dec. = D
- 3rd and 4th characters: Manufacture day of month, 1 to 31

Cautions and Warnings

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

• Thermal shutdown. The MPM01 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 MPM01 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 flat-head 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.

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  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.
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