

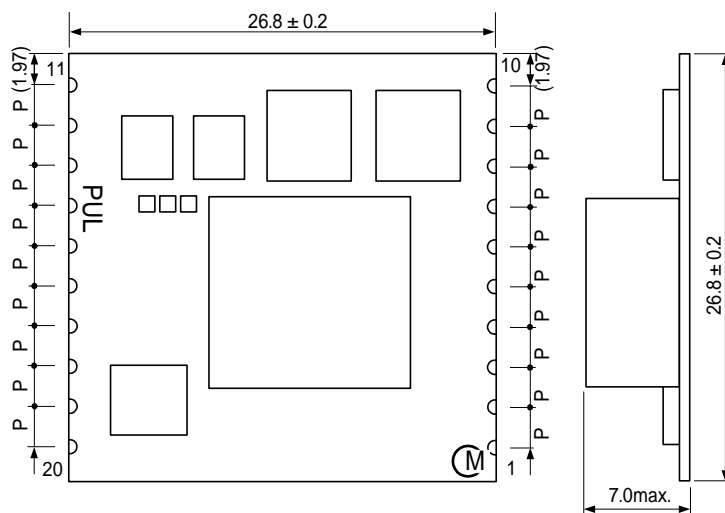
DC-DC Converter Application Manual

MPDRX313S

1. Features

- Ultra high-speed response is realized by using original ripple detecting control.
- Up to 26A output current, non-isolated POL.
- Wide adjustable output voltage range by connecting external resistance (0.8V to 3.3V).
- Wide operating temperature (-40°C to +85°C) .
- UVLO function, ON/OFF function, Output voltage sense function, Over-current function and, 2-PowerGood signal output function are built in.

2. Appearance, Dimensions




()...reference value

$P = 2.54 \pm 0.2$ mm

Tolerance is not accumulated.

Marking

- (1) Pin No.1 Marking / MFG ID 
- (2) Parts No. PUL
- (3) Lot No.

Production factory Mark

Production Year

Production Month (1,2,3,...9,O,N,D)

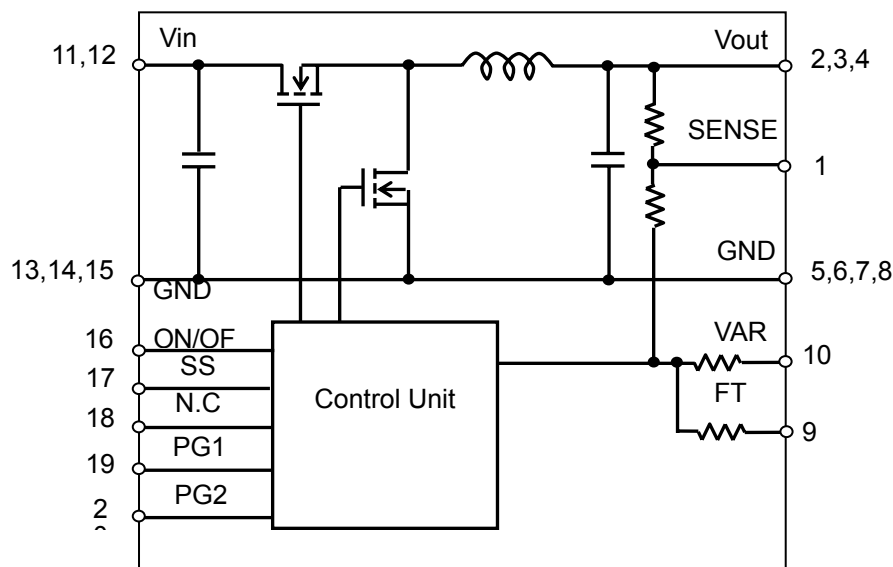
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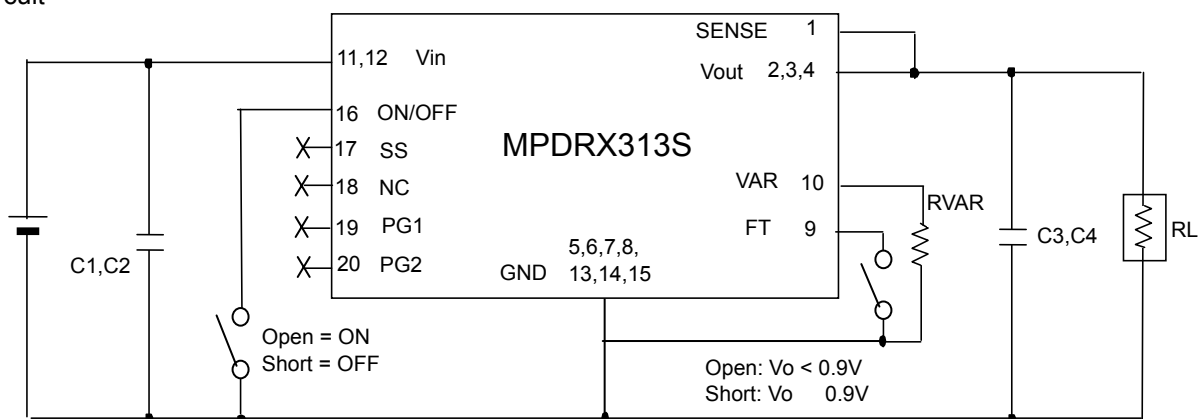
Pin Number and Function

Pin No.	Symbol	Function
1	SENSE	Output Voltage sense
2,3,4	Vout	Output Voltage
5,6,7,8,13,9,10	GND	GND
9	FT	Output Trim
10	VAR	Vout Adjustment
11,12	Vin	Input Voltage
17	SS	Soft Start
18	N.C.	Non Connect
19	POW-GOOD1	Power Good
20	POW-GOOD2	Power Good
16	ON/OFF	Remote ON/OFF

3. Block Diagram



4. Test Circuit



C1,C2 : 100 μ F / 10V Ceramic Capacitor

C3,C4 : 100 μ F / 6.3V Ceramic Capacitor

Please make sure to place C1,C2,C3 and C4 nearby input and output terminal of DC-DC converter.

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5. Characteristics

5. 1 Electrical Characteristics (Ta=25 °C)

Item	Symbol	Condition	Value			Unit	
			Min.	Typ.	Max.		
Input Voltage Range	Vin		4.5	5.0	5.5	V	
Rising UVLO Threshold	UVLOr	Vin Increasing	-	4.3	-	V	
Falling UVLO Threshold	UVLOf	Vin Decreasing	-	3.9	-	V	
Output Voltage Adjustable Range	Vout	FT=Open	0.8	-	0.9	V	
		FT=Short	0.9	-	3.3		
Output Voltage Tolerance	Vo tol	Over Vin, Io, Temperature Range Rset=1% tolerance	Vout=0.8 ~ 0.9V FT=Open	-2.5	-	+2.5	%Vo
		Vout=0.9 ~ 3.3V FT=Short	-2.0	-	+2.0		
Output Current	Iout	See the thermal derating curve in section 5.2.	0	-	26	A	
Ripple Voltage	Vrpl	Vin =5.0V, Iout=0 ~ 26A BW=20MHz	-	20	50	mV(pp)	
Efficiency	EFF	Vin =5.0V, Iout=26A	Vout=3.3V	-	91	-	%
			Vout=1.8V	-	86	-	
			Vout=1.2V	-	83	-	
Operating Frequency	Frq	Vin =5.0V, Vout=1.2V, Iout=26A	-	600	-	kHz	
		Vin =5.0V, Vout=0.8V, Iout=26A	-	400	-		
Power Good	PWGL	Power Good low threshold	-	0.87Vo	-	V	
	PWGH	Power Good high threshold	-	1.13Vo	-		
ON/OFF pin High Voltage	VIH	ON/OFF pin is pulled up to Vin inside of the DC-DC converter. If ON/OFF pin is left open, the DC-DC converter shall be "ON". This pin will be pulled down to GND inside the DC-DC converter when UVLO events occur. Please do NOT connect this pin to power supply with low impedance line, so as not to damage the converter.					
ON/OFF pin Low Voltage	VIL	If ON/OFF pin is connected to GND, the DC-DC Converter shall be "OFF".	OFF	0	-	0.3	V
Short Circuit Protection	SCP	If output is shorted to GND, DC-DC converter will shut down. After reject the abnormal mode, DC-DC converter will restart by re-inputting Vin or toggling ON/OFF pin.	-	60	-	A	
External Output Capacitor	Cout	When input voltage is ideal voltage source	200	-	2000	μF	
Ramp Rate	Tr	Vo=10% ~ 90%, SS= Open	1	2	5	msec	
Rising Overshoot	Vover		-	-	+10	%	
Startup Delay	Td	RC High : Vin Low → High SS= Open	0.1	0.5	2	msec	
RC Startup Delay	Trcd	Vin High : RC Low → High/Open Vo=10%	0.1	0.4	2	msec	

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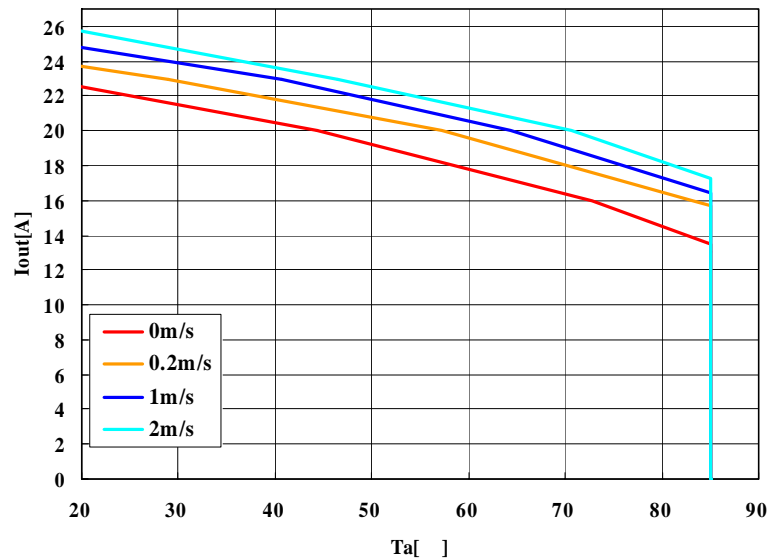
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In case V_{in} is below the Falling UVLO threshold (UVLO_F) or equation of V_{in} and V_{out} is $V_{in}-V_{out}<0.8V$ due to the transient power deviation, this device may cause abnormal operation. Please use it under the condition to keep V_{in} 4.5V or more.

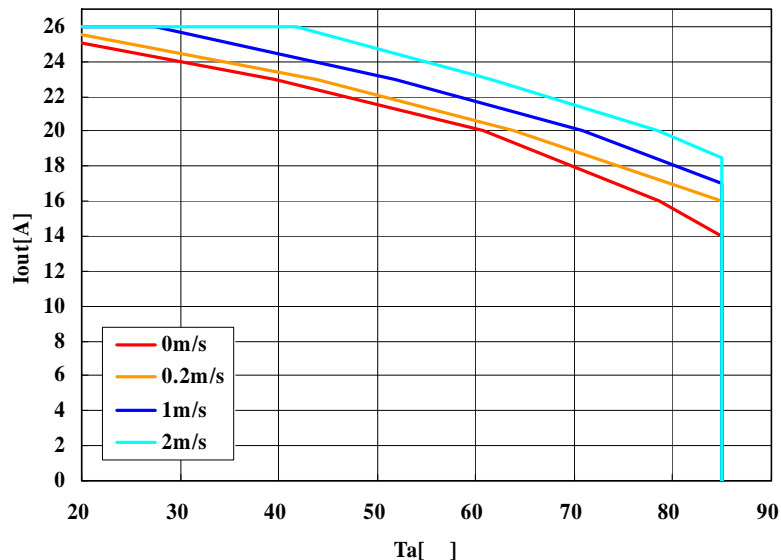
This DC-DC converter thermally shuts down when temperature of a control IC reaches to 180 °C typically.

5. 2 Thermal Derating

MPDRX313S
($V_{in}=4.5 \sim 5.5V$, $V_{out}=3.3V$)

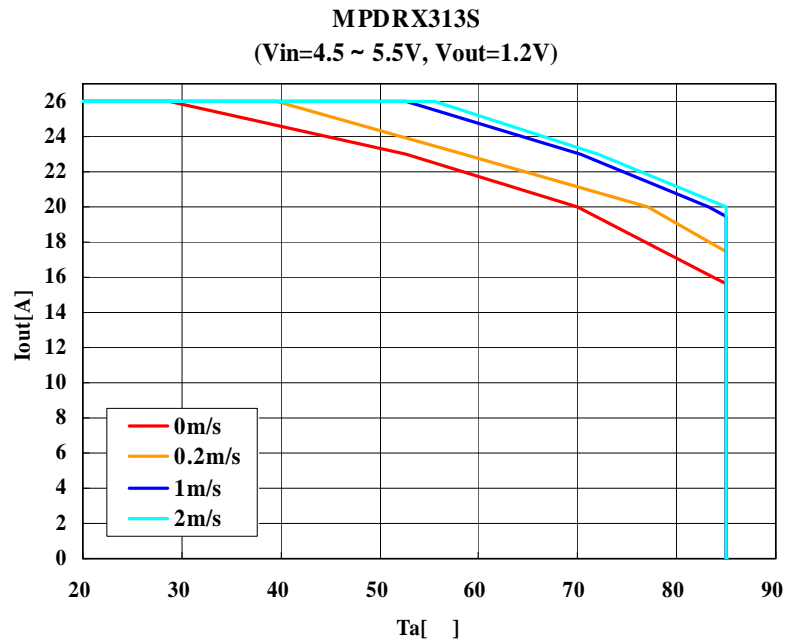


MPDRX313S
($V_{in}=4.5 \sim 5.5V$, $V_{out}=1.8V$)

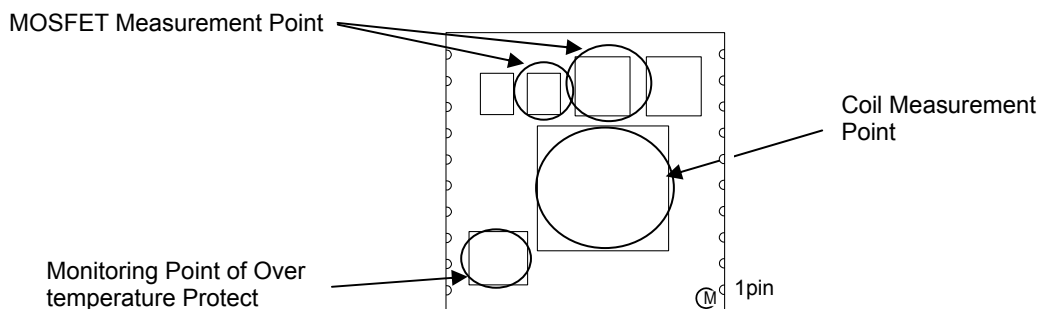


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The above derating limits apply to this product soldered directly to 101.6*180mm*1.6mm PCB (6 layer, with 70um copper). Any adjacent parts of high temperature may cause overheating. For reliable operation, please ensure that the FET temperature of this product is maintained below 120°C and the inductor temperature is below 106°C.



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6. Pin Description

6.1. Adjusting the Output Voltage

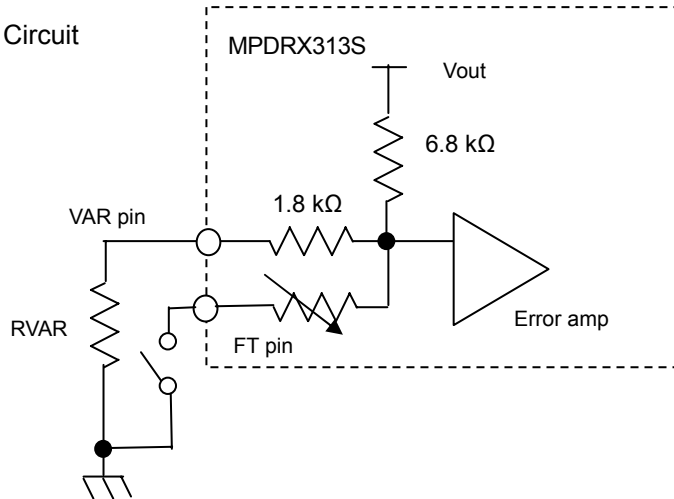
The output voltage can be adjusted by connecting resistors between VAR-pin(10Pin) to GND-pin.

The following equation gives the required external-resistor values to adjust the output voltage to Vo-adj.

It is highly recommended that evaluation of the characteristics of this DC-DC converter's operation under your board conditions be thoroughly conducted.

Since output voltage is used more than 0.95V, please connect FT-pin(9pin) to GND.

Internal Circuit



$$(a) 0.8 \quad V_{out} < 0.9V \quad (\text{FT-pin : OPEN})$$

$$RVAR = \frac{5440}{V_{o-adj}[V] - 0.8[V]} - 1800 \quad [\Omega]$$

$$(b) 0.9 \quad V_{out} = 3.3V \quad (\text{FT-pin : SHORT to GND})$$

$$RVAR = \frac{5440}{V_{o-adj}[V] - 0.9[V]} - 1800 \quad [\Omega]$$

<RVAR Calculation Example>

Vo-adj [V]	Calculated RVAR[Ω]	RVAR Example	FT pin
3.3	470	470	Short to GND
2.5	1600	1.6k	Short to GND
1.8	4240	3.9 k + 330	Short to GND
1.5	7270	6.8 k + 470	Short to GND
1.2	16330	16 k + 330	Short to GND
1.0	52600	47 k + 5.6k	Short to GND
0.9		Open	Short to GND
0.8		Open	Open

6.2 ON/OFF Control

ON/OFF function

Using the ON/OFF feature, the operation of this product can be disabled without removal of the input voltage. Sequencing of a power supply system and power-saving control can be easily achieved using this function.

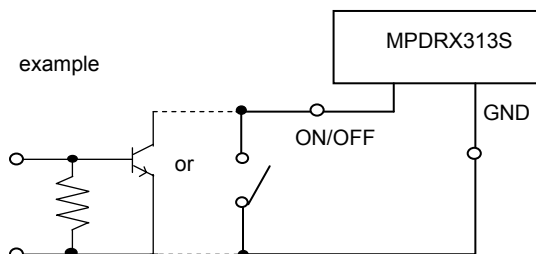
ON/OFF Control Operation

When ON/OFF-pin(16pin) is left open

..... Output Voltage =ON

When ON/OFF-pin(16pin) is connected to GND

..... Output Voltage=OFF



< Caution >

ON/OFF pin is pulled up inside of the DC-DC converter, so voltage appears up to Vin at ON/OFF pin.

ON/OFF pin will be pulled down to GND inside the DC-DC converter when UVLO events occur.

Please do NOT connect this pin to power supply, so as not to damage the converter.

⚠ Note:

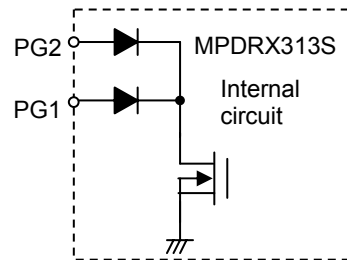
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6.3. Power Good

Powergood signal is appeared within the value of clause 5.1. (Open-drain output)

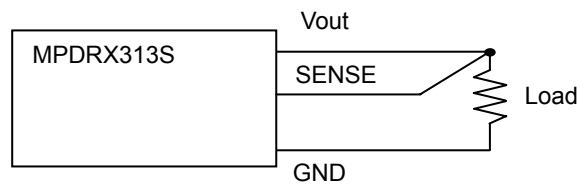
Output voltage is within voltage detection threshold: POW-GOOD is open.

Output Voltage is out of voltage detection threshold : POW-GOOD is connected to GND.

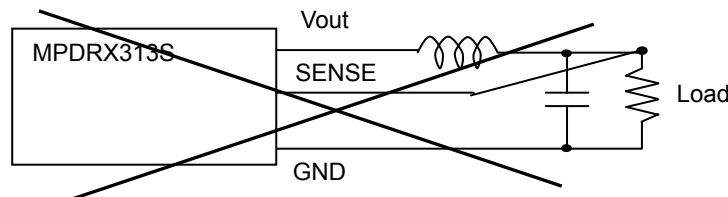


6.4 Output voltage sensing

By connecting SENSE-pin to the load, output voltage drop in wiring shall be compensated.



Please do NOT connect SENSE-pin to the output of LC filter that is set to the Vout line. When using this way, this product will not operate properly.



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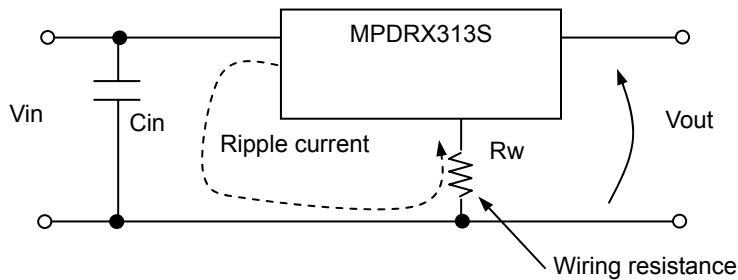
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6.5. Input External capacitor

It is recommended to connect a low-impedance electrolytic capacitor of 40 μ F or more at Vin terminal. Smaller input capacitor may leads to an unstable operation of this product caused by input voltage fluctuation. Please check the proper operation of it on your product when smaller input capacitor is used.

Using ceramic capacitors as input capacitor may cause an increase of output voltage, because input ripple current flows through the external input capacitor and wiring resistance.

This phenomenon is affected by the position of external capacitors, the value of external capacitors and voltage difference between Vin and Vout. Using low-impedance electrolytic capacitor will ease this problem. Please check the proper operation of it on your product when ceramic input capacitor is used.



$R_w \times I_{rpl}$ appears as additional output ripple voltage.

6.6. Output External capacitor

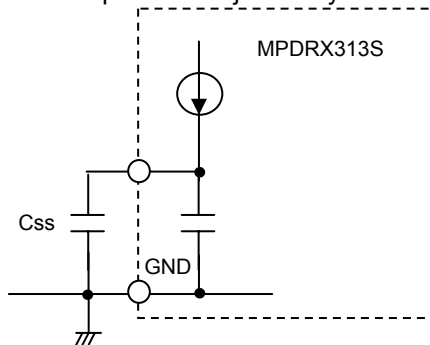
Ceramic capacitors are recommended as output external capacitor. Using ceramic capacitors, small output variation and small ripple voltage are realized.

Output capacitor should be within 200 μ F to 2000 μ F. Output capacitor shall be placed near the output terminal. When using plural capacitors, please make sure to place a capacitor of at least 200 μ F near the output terminal, and place other capacitors near the load.

When using LC output filter, please make sure to place a capacitor of at least 200 μ F near the output terminal.

6.7. Soft start function

By using the soft start function, ramp-rate of the output-starting is adjustable. Adjustment range of ramp-rate is from 2 to 10ms. Ramp rate is adjusted by external capacitor between SS-pin(17pin) and GND.



The equation of starting time about output voltage

$$\text{Starting time: } T_d = \frac{(C_{ss} + 1.2 \times 10^{-8}) \times 0.8}{5 \times 10^{-6}} + 2 \times 10^{-4} \text{ [s]}$$

C_{ss} : The capacitance of external capacitor.(F)

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7. Typical Characteristics Data

7.1 Load Transient Response

Our original ripple-detective control method achieves much better load transient responses.

$V_{in}=5.0V$, $V_o=3.3V$ (Fig.7-1a) , $1.8V$ (Fig.7-1b)

$I_o=10A \rightarrow 20A$, $di/dt=20A/\mu s$, $C_{out}=200\mu F$ (Ceramic), $T_a=25^\circ C$

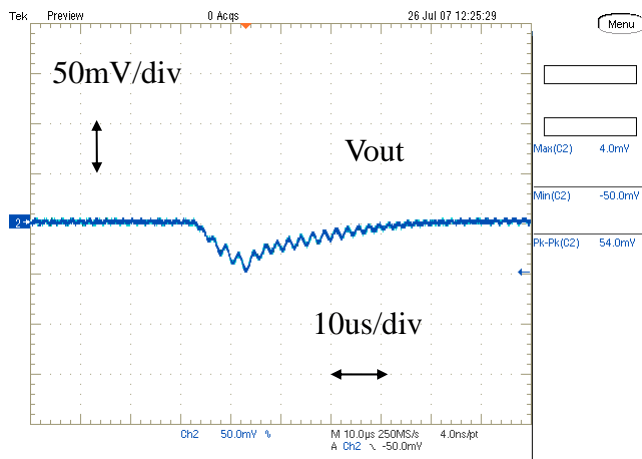


Fig.7-1a. Load Transient Response ($V_{out}:3.3V$)

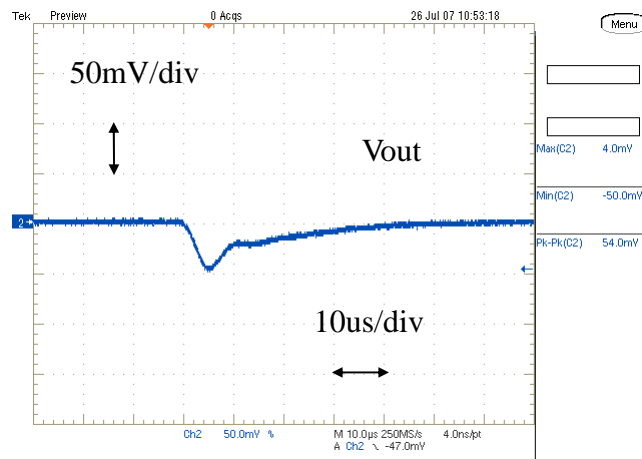


Fig.7-1b. Load Transient Response ($V_{out}:1.8V$)

7.2 Output Impedance characteristics

Our original ripple-detective control method achieves very low output impedance in wide frequency range.

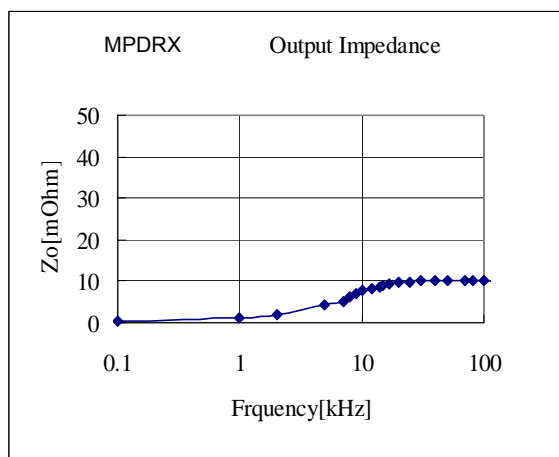


Fig.7-2-1. Output Impedance of MPDRX

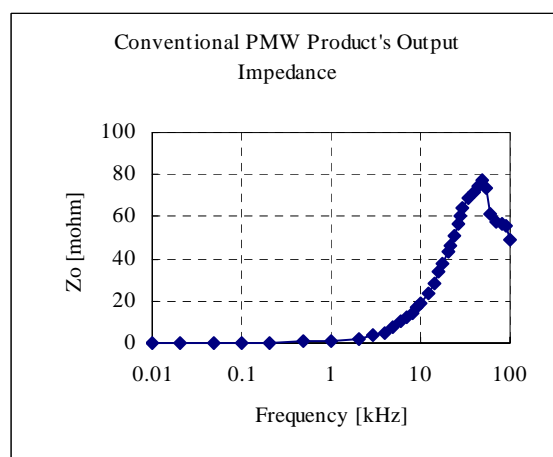


Fig.7-2-2. Output Impedance of conventional product

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7. 3 Other electrical characteristics

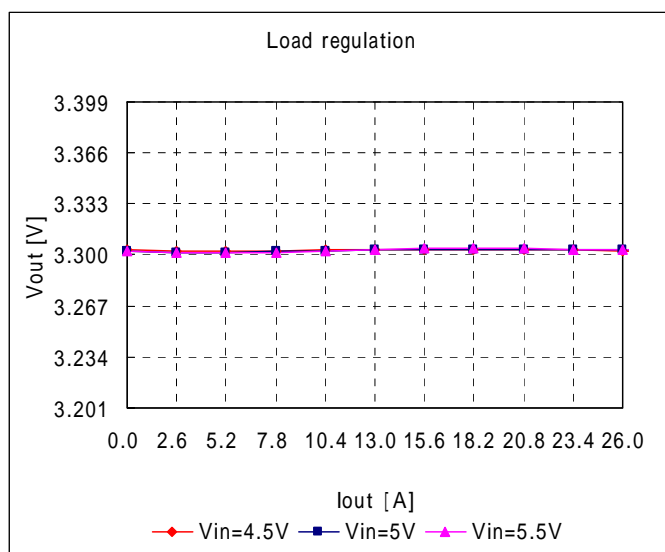
7. 3. 1 $V_{out}=3.3V$ ($T_a=25^{\circ}C$, $C_{out}= GRM32EB30J107ME16\times 2$, $RVAR=470\Omega$)

Fig.7-3-1. Output Voltage v.s. Output Current

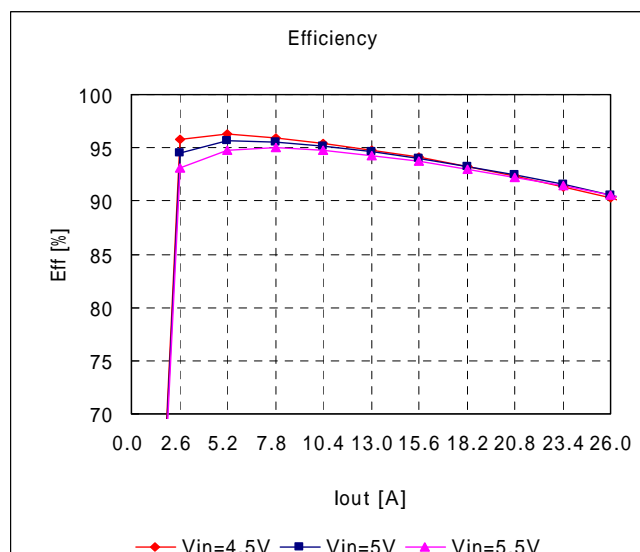


Fig.7-3-2. Efficiency v.s. Output Current

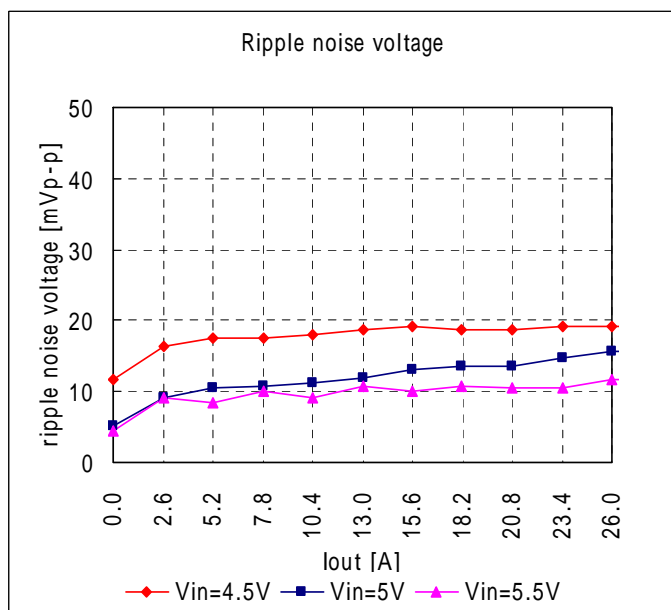


Fig.7-3-3. Ripple Voltage v. s. Output Current

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7. 3. 2 Vout=1.8V

(Ta=25 °C, Cout= GRM32EB30J107ME16×2,, RVAR=4240Ω)

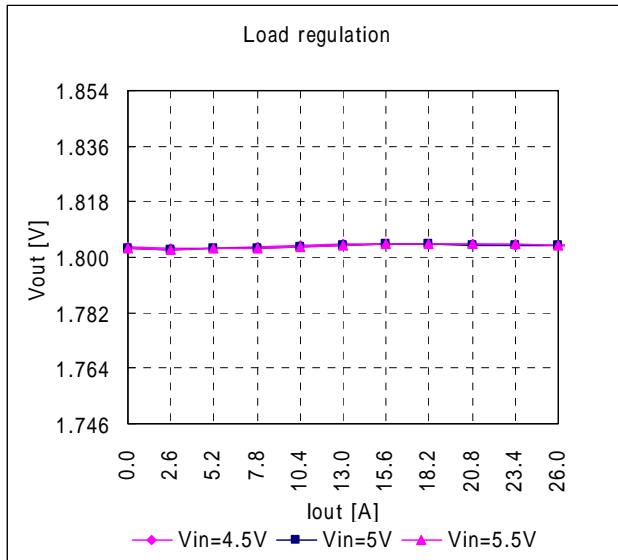


Fig.7-3-4. Output Voltage v.s. Output Current

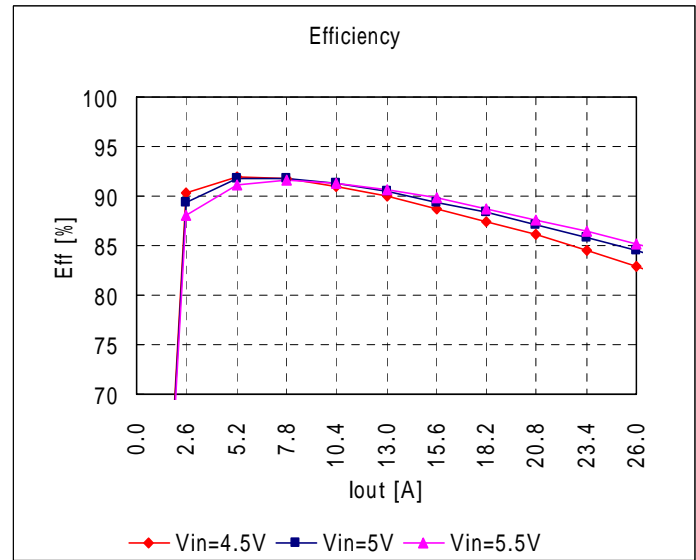


Fig.7-3-5. Efficiency v.s. Output Current

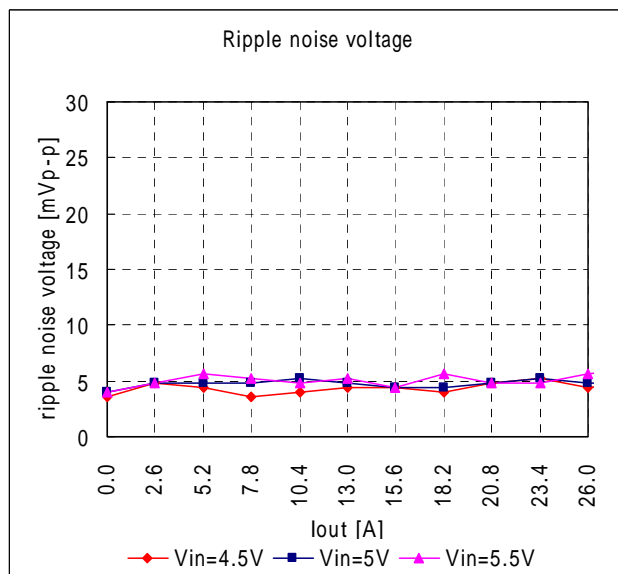


Fig.7-3-6. Ripple Voltage v.s. Output Current

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7.3.3 $V_{out}=0.8V$

(Ta=25 °C, Cout= GRM32EB30J107ME16×2,, RVAR=Open)

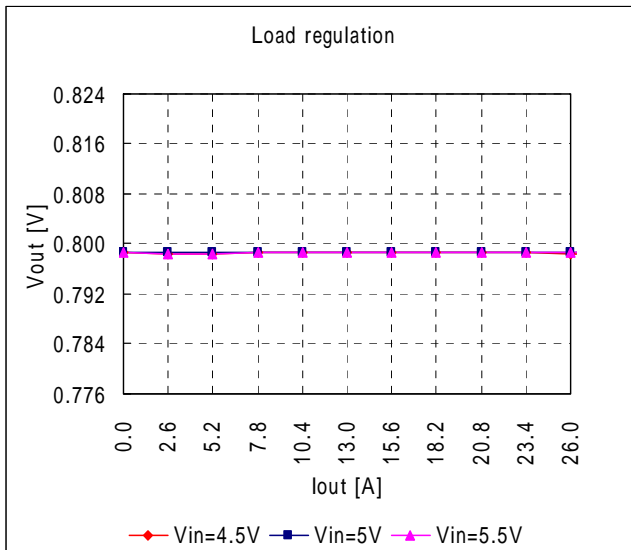


Fig.7-3-7. Output Voltage v.s. Output Current

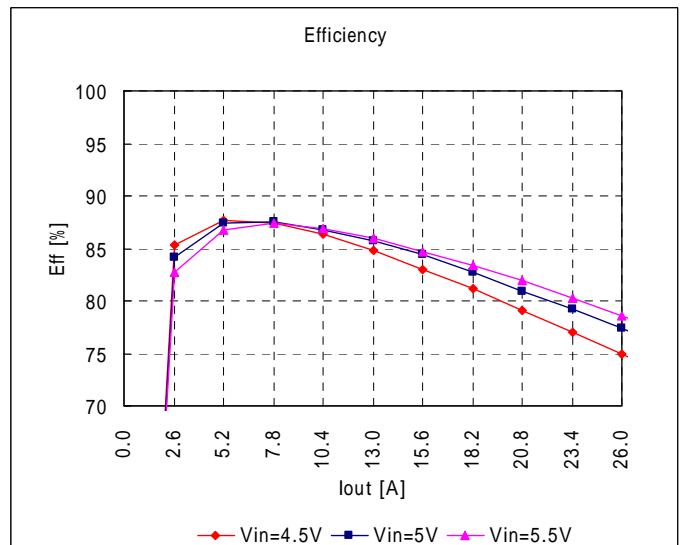


Fig.7-3-8. Efficiency v.s. Output Current

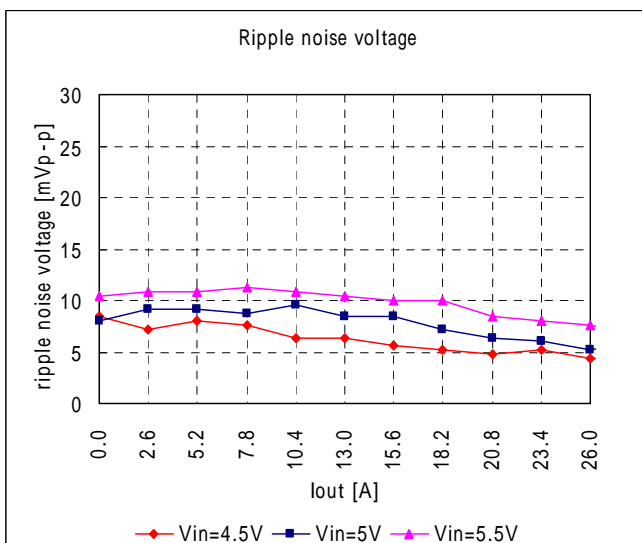


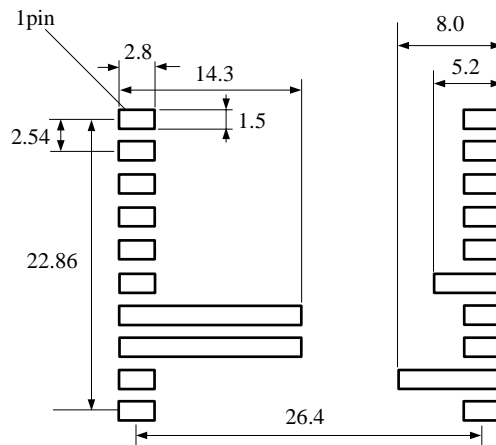
Fig.7-3-9. Ripple Voltage v.s. Output Current

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8. Mounting Condition

8. 1 PCB Land Pattern Recommendation



8. 2 Recommended Soldering Conditions

Reflow Soldering

This product is RoHS compliant. The following profile is recommended for the reflow of this product using Pb-free solder paste (Sn-Ag-Cu).

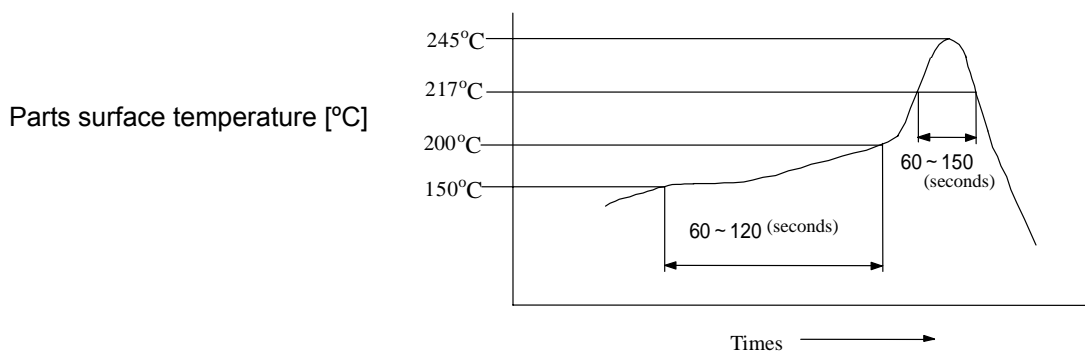
Method : Full convection reflow soldering

Reflow Soldering Profile

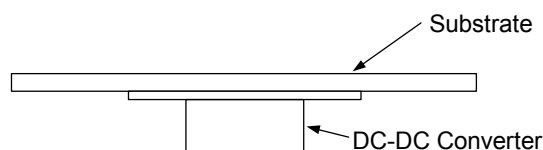
JEDEC IPC/JEDEC J-STD-020D
Table 5-2 Classification Reflow Profile
Pb-Free Assembly Large Body

Profile details

Soldering temperature : 245°C+0/-5°C
Soldering time : 30 seconds, 240 to 245°C
Heating time : 60 to 150 seconds, over 217°C
Preheating time : 60 to 120 seconds, 150 to 200°C
Programming rate : 3°C/ sec. Max., 217 to 245°C
Descending rate : 6°C/ sec. Max.
Total soldering time : 8 minutes Max., 25 to 245°C
Times : 1 time



Elimination of any additional vibration applied to this device during reflow is highly recommended. Careful regulation of temperature is recommended to avoid the separation of mounted components from this device during reflow.



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9. Notice

Input / Output capacitor

Both input-side and output side, please make the wiring loop between plus and minus as small as possible. The influence of a leakage inductance can be reduced. Please make the power line pattern as wide and short as possible.

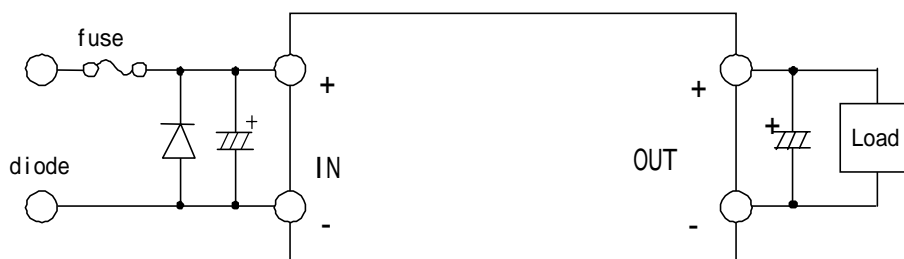
This product should not be operated in parallel or in series.

Please do not use a connector or a socket to connect this product to your product. The electric characteristics may be deteriorated by the influence of contact resistance.

Be sure to provide an appropriate fail-safe function on your product to prevent secondary damage that may be caused due to abnormal functional or failure of this product.

Inrush current protection is not a feature of this product.

Please connect the input terminals with the correct polarity. If an error in polarity connection is made this product may be damaged. If this product is damaged internally, an elevated input current may flow, and so this product may exhibit an abnormal temperature rise, or your product may be damaged. Please add a diode and fuse per the following diagram to protect them.



Please select diode and fuse after confirming the operation of your product.



Note

1. Please contact our main sales office or nearby sales office before using our products for the applications listed below which require especially high reliability for the prevention of defects which might directly cause damage to the third party's life, body or property or this products for any other applications that described in the above.

Aircraft equipment
 Aerospace equipment
 Undersea equipment
 Power plant control equipment
 Medical equipment
 Transportation equipment (vehicles, trains, ships, etc.)
 Traffic signal equipment
 Disaster prevention /crime prevention equipment
 Data-processing equipment
 Application of similar complexity and/or reliability requirements to the applications listed in the above.

2. This catalog is indicated in March 2009. About the written contents, since changing without a preliminary announcement for improvement and supply are sometimes stopped, please confirm in case of ordering. If written contents are unknown, please ask to our main sales office or nearby sales office.
3. Types and specification in this catalog are referenced for your information only. Please confirm detailed specifications by approving our individual drawing and specification sheet.

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