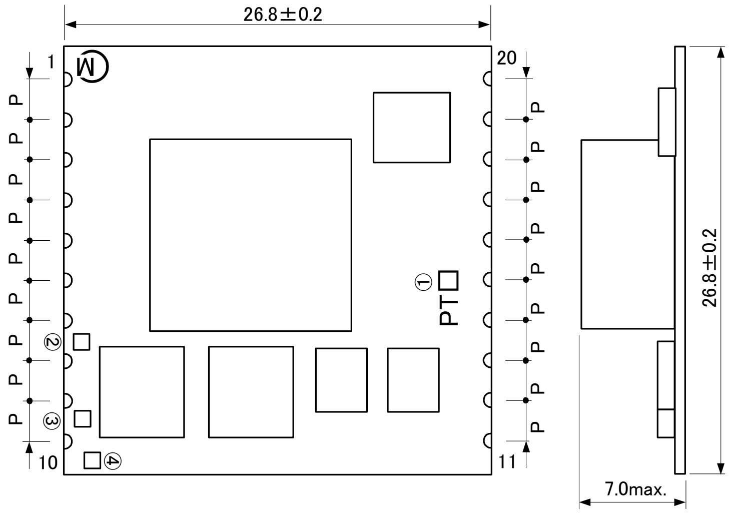
DC-DC Converter Application Manual

MPDRX303S,MPDRX304S

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 3.63V).
・Wide operating temperature（-40°C to +85°C）
・UVLO function, ON/OFF function, Output voltage sense function, Over-current function and PowerGood signal output function are built in.

2. Appearance, Dimensions



( )…reference value
P=2.54 ±0.2mm
Tolerance is not accumulated.

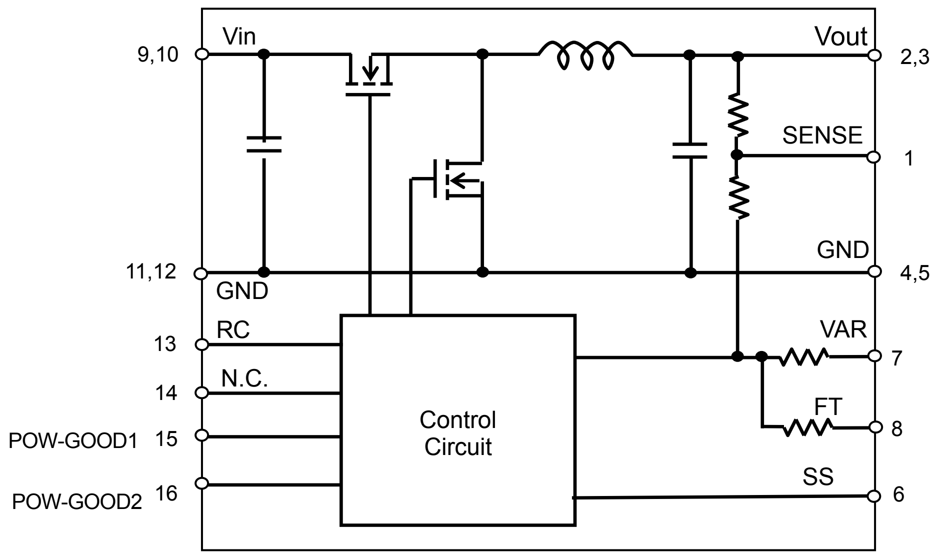
[unit : mm]

Marking (1) Pin No.1 Marking / MFG ID
(2) Part No. PT□
①
① E : MPDRX303S
D : MPDRX304S
(3) Lot No. ②③④
②Production factory Mark
③Production Year
④Production Month（1,2,3,…9,O,N,D）

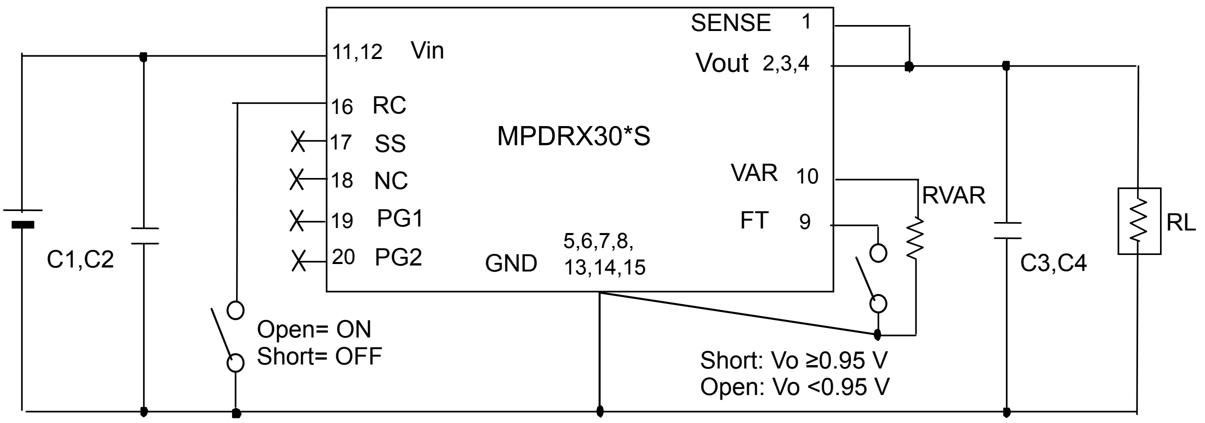
Pin number and Function

Pin No.	Symbol	Function
1	SENSE	Output voltage sense
2,3	Vout	Output
4,5,11,12	GND	GND
8,	FT	Output trim
7,	VAR	Output voltage adjustment
9,10	Vin	Input
6,	SS	Soft start
14	N.C.	This pin must be left open.
15	POW-GOOD1	Power Good
16	POW-GOOD2	Power Good
13	RC	Remote ON/OFF

3. Block Diagram



4. Test Circuit



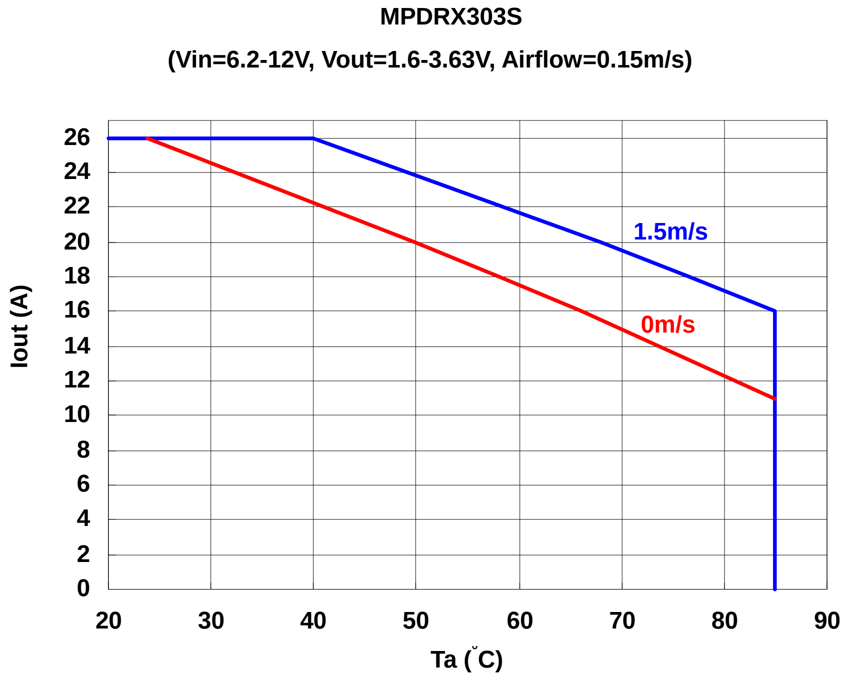
C1,C2：22µF／25V×2　　(Ceramic Capacitor)
C3,C4：100µF／6.3V×2（GRM32EB30J107ME16L, Murata）（Ceramic Capacitor）
※Please make sure to place C1, C2,C3 amd C4 nearby input and output terminal of DC-DC converter.DC-DC converter.

5. Characteristics

5-1 . Electrical Characteristics (Ta=25°C) MPDRX303S

Item	Symbol	Condition		Value Min.	Typ.	Max.	Unit
Output Voltage Range	Vout	FT= Short		1.6		3.63	V
Output Current	Iout	See the Power derating curve		0	-	26	A
Output Voltage Accuracy	Vo tol	Over Io, Temperature range Vin=5.6~13.2V Rset=1% tolerance、FT= Short		-2.0	-	+2.0	%Vo
Ripple Noise Voltage	Vnoise	BW = 100 MHz,				100	mV
Efficiency	EFF	Vin=9.6V, Iout=26A Ta=25°C	Vout=3.3V	-	91	-	%
			Vout=2.5V	-	88	-	
			Vout=1.8V	-	86	-	
Operating Frequency	Frq	Vin =9.6V, Vout=3.3V		-	600	-	kHz
		Vin =9.6V, Vout=1.8V		-	350	-	
Short Circuit Protection	SCP	If output is shorted to GND, DC-DC converter will shut down. (mask time 180mstyp)After reject the abnormal mode , DC-DC converter will restart by re-inputting Vin or toggling RC pin.		26	46	-	A
Over Temperature Protection	OTP	Reset, followed by auto-recovery		-	180	-	°C.
External Input Capacitor	Cin	When input voltage is ideal voltage source		40	-	5000	μF
External Output Capacitor	Cout	When input voltage is ideal voltage source		200	-	2000	μF
Ramp Rate	Tr	Vo=10%~90%, SS= Open, Ta=25°C		1	2	5	msec
Rising Overshoot	Vover	Ta=25°C		-	0	+10	%Vo
Startup Delay	Td	RC High : Vin Low →High Vo=10% SS= Open, ta=25°C		0.1	0.5	2	msec
RC Startup Delay	Trcd	Vin High : RC Low → High/Open Vo=10%,Ta=25°C		0.1	0.4	2	msec

5-2 . Thermal Derating MPDRX303S



The left derating limits apply to this product soldered directly to 101.6*180mm*1.6mm PCB (double-sided, 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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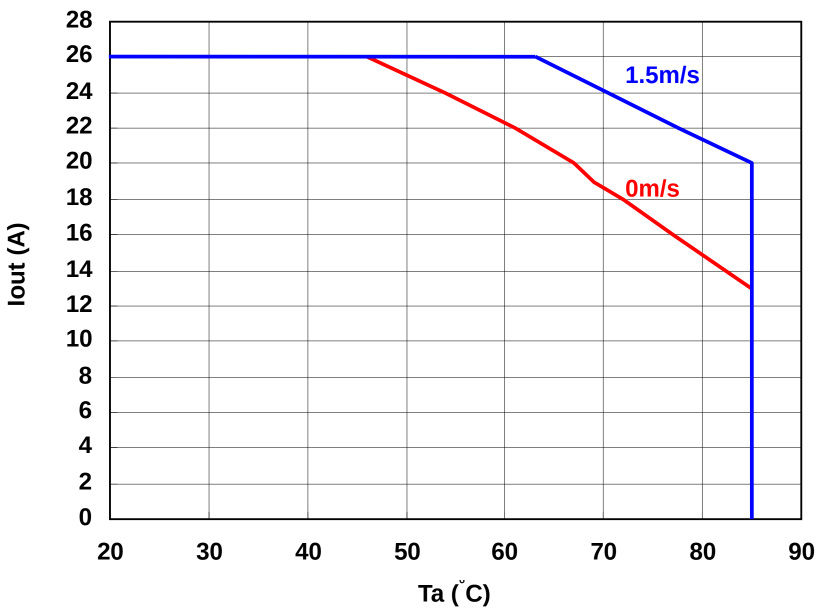
5-3 . Electrical Characteristics (Ta=25˚C)   MPDRX304S

Item	Symbol	Condition	Value Min.	Value Typ.	Value Max.	Unit
Output Voltage Range	Vout	FT= Open	0.8	-	0.95	V
		FT= Short	0.95	-	1.65	
Output Current	Iout	See the Power derating curve in clause 9.1.6	0	-	26	A
Output Voltage Accuracy	Vo tol	Over Io, temperature range Vin=5.6~13.2V, Rset=1% tolerance: Vout=0.8～0.95V FT= Open, Ta=0～85˚C	-2.0	-	+2.0	%Vo
		Vout=0.8～0.95V FT=Open, Ta=-40～0˚C	-2.5	-	+2.5	
		Vout=0.95～1.65V FT= Short	-2.0	-	+2.0	
Ripple Noise Voltage	Vnoise	BW = 100 MHz, Vin=1.65V, Iout = 0～26 A, Cout=200μF			100	mV(pp)
Efficiency	EFF	Vin=9.6V,Iout=26A, Ta=25˚C: Vout=1.5V	-	85	-	%
		Vout=1.2V	-	83	-	
		Vout=0.8V	-	79	-	
Operating Frequency	Frq	Vin =9.6V, Vout=1.5V	-	550	-	kHz
		Vin =9.6V, Vout=0.8V	-	320	-	
Short Circuit Protection	SCP	If output is shorted to GND, DC-DC converter will shut down. (mask time 180mstyp)After reject the abnormal mode , DC-DC converter will restart by re-inputting Vin or toggling RC pin.	26	46	-	A
Over Temperature Protection	OTP	Reset, followed by auto-recovery	-	180	-	˚C
External Input Capacitor	Cin	When input voltage is ideal voltage source	40	-	5000	μF
External Output Capacitor	Cout	When input voltage is ideal voltage source	200	-	2000	μF
Ramp Rate	Tr	Vo=10%～90%, SS= Open, Ta=25˚C	1	2	5	msec
Rising Overshoot	Vover	Ta=25˚C	-	0	+10	%Vo
Startup Delay	Td	RC High : Vin Low →High Vo=10% SS= Open, Ta=25˚C	0.1	0.5	2	msec
RC Startup Delay	Trcd	Vin High : RC Low → High/Open Vo=10%, Ta=25˚C	0.1	0.4	2	msec

5-4. Thermal Derating   MPDRX304S

MPDRX304S
(Vin=6.2-12V, Vout=0.8-1.65V, Airflow=0.15m/s)



The left derating limits apply to this product soldered directly to 101.6*180mm*1.6mm PCB (double-sided, 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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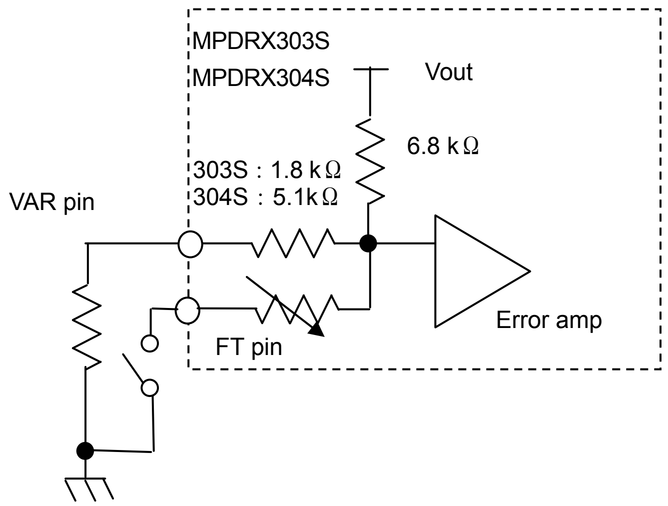
6. Pin Description

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 value to adjust the output voltage to Vout.
・ The following equation gives the required external-resistor value to adjust the output voltage to Voadj. It is strictly recommended to evaluate the characteristics of DC-DC converter at your board conditions.
・Since output voltage is used more than 0.95V, please connect FT-pin(9pin) to GND.

Internal circuit



①MPDRX303S (FT-pin： SHORT to GND)

$$RVAR = \frac{5440}{Voadj[V] \times 1.002 - 1.5[V]} - 1800 \quad [\Omega]$$

②MPDRX304S

(a)0.8≦ Vout ＜0.95V (FT-pin：OPEN)

$$RVAR = \frac{5440}{Voadj[V] \times 1.002 - 0.8[V]} - 5100 \quad [\Omega]$$

(b)0.95≦ Vout ≦1.65V (FT-pin：SHORT to GND)

$$RVAR = \frac{5440}{Voadj[V] \times 1.002 - 0.95[V]} - 5100 \quad [\Omega]$$

＜RVAR calculation example＞

MPDRX303S

Voadj [V]	Calculated RVAR[Ω]	FT pin (9pin)
3.63	745	Short to GND
3.3	1211	Short to GND
2.5	3613	Short to GND
1.8	16118	Short to GND
1.6	50913	Short to GND

MPDRX304S

Voadj [V]	Calculated RVAR[Ω]	FT pin(9pin)
1.65	2635	Short to GND
1.5	4737	Short to GND
1.2	16453	Short to GND
1.0	99515	Short to GND
0.95	2858058	Short to GND
0.9	48338	Open
0.8	3394900	Open

6. 2 ON/OFF Control

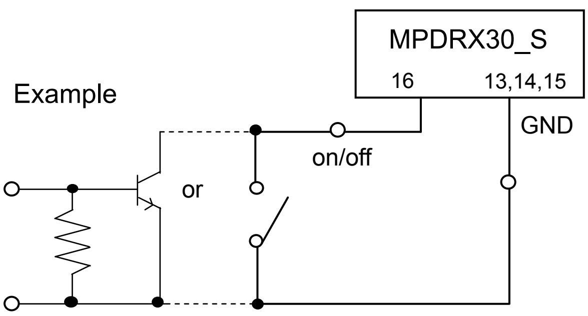
ON/OFF function

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

ON/OFF Control Operation

When ON/OFF-pins (pins 16) - Open Output Voltage =ON
When ON/OFF-pins (pins 16) -connected to GND Output Voltage=OFF

Example



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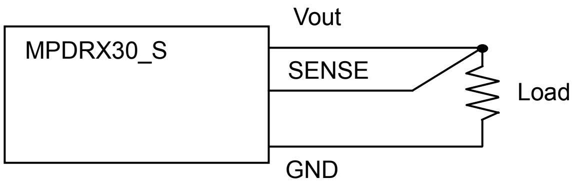
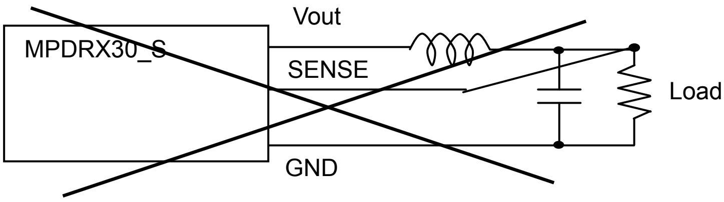
6. 3 Output Voltage Sense

Connecting the SENSE-pin (pins 1) to the load compensates for any Vout drop between the device



Vout terminal and the load due to interconnect impedances.

※Note: Please do NOT connect SENSE-pin to the output of LC filter that is set to the Vout line.
Using in this way will cause the device to operate improperly.

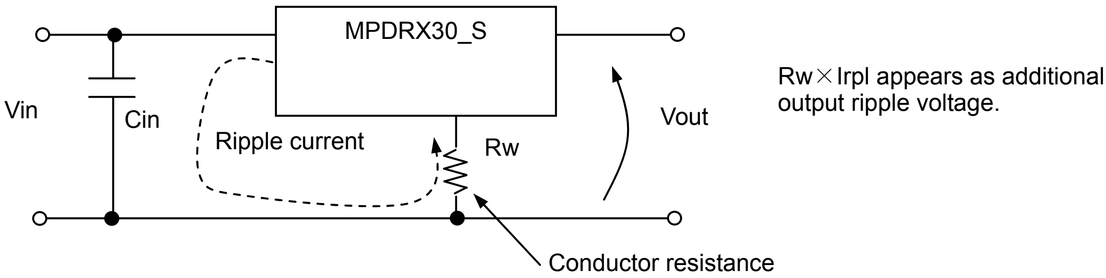


6. 4 Input External capacitor

It is recommended to connect a low-impedance ceramic capacitor of 40uF 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 for the input capacitor may cause an increase of output voltage as input ripple current flows through the external input capacitor and conductor resistance.

This phenomenon is affected by the position & value of external capacitors and the voltage difference between Vin and Vout. Using low-impedance electrolytic capacitors will minimize the effect.
Please check the proper operation of the device on your product if a ceramic input capacitor is used.



6. 5 Output External capacitor

Ceramic capacitors are recommended for the output external capacitor.
Using ceramic capacitors, Output variations and ripple voltage are minimized.

The output capacitor value should be within 200μF to 2000μF and be placed near the output terminal.
When using plural capacitors, be sure to place a capacitor of at least 200μF near the output terminal, and the others near the load.

When using an LC output filter, be sure to place a capacitor of at least 200μF near the output terminal.

7. Typical Characteristics Data

7-1. Load Transient Response

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

Vin=9.6V, Vo=2.5V(MPDRX303S) , 1.2V(MPDRX304S)
Io=0A ->10A, di/dt=20A/us, Cout=200uF(Ceramic), Ta=25°C

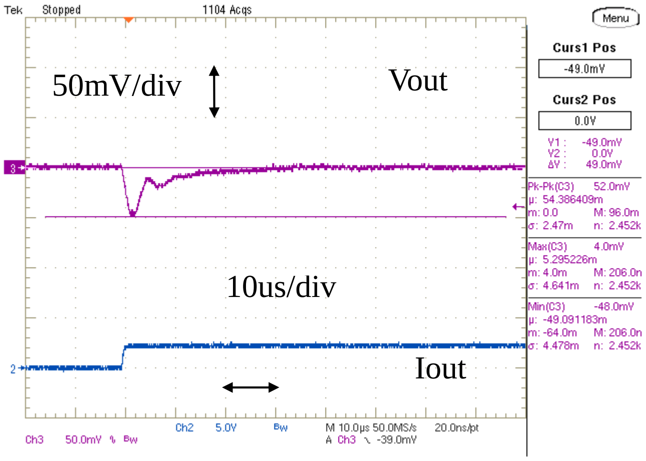


Fig.7-1a. Load Transient Response (MPDRX303S)

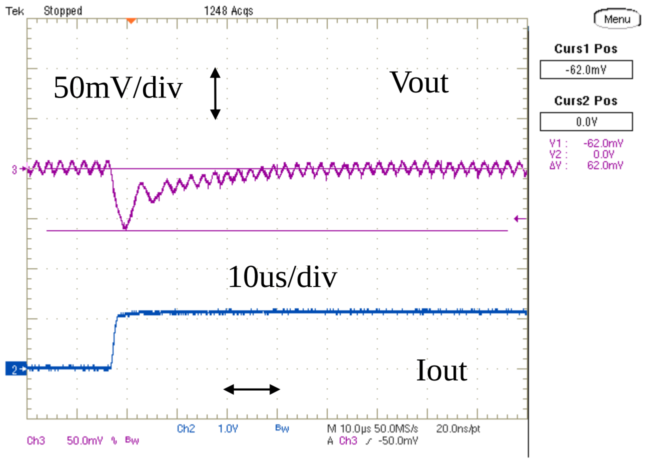


Fig.7-1b.Load Transient Response (MPDRX304S)

7-2. Output Impedance characteristics

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

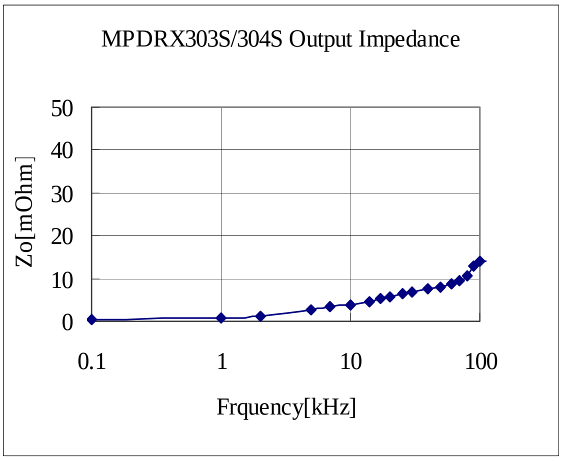


Fig.7-2-1. Output Impedance of MPDRX303S/304S

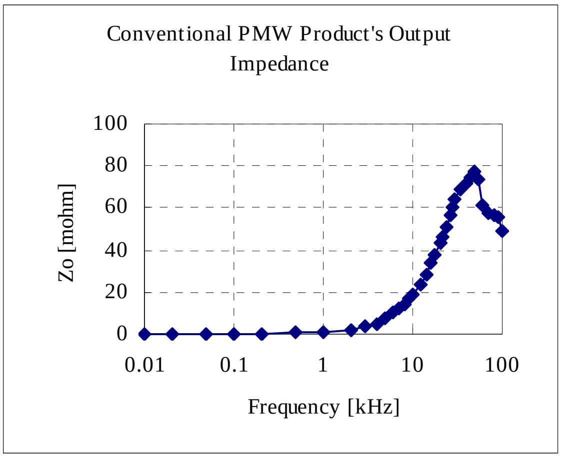


Fig.7-2-2. Output Impedance of conventional product

7-3. Other electrical characteristics

7-3-1. Vout=3.3V（MPDRX303S）

（Ta=25°C, Cin= GRM32ER71C226KE15L×2, Cout=GRM32EB30J107ME16L×2, Rtrim=1211Ω）

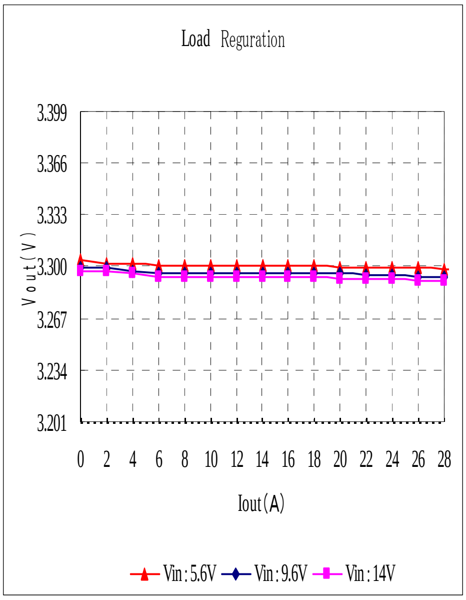


Fig.7-3-1. Output Voltage v.s. Output Current

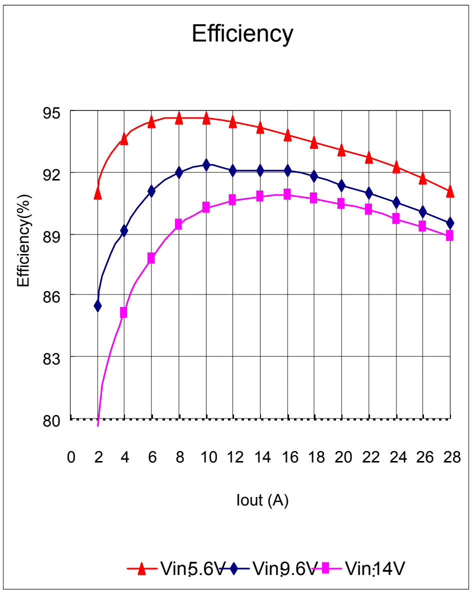


Fig.7-3-2. Efficiency v.s. Output Current

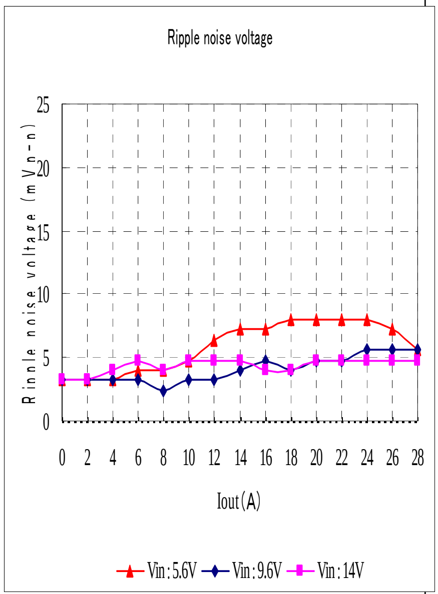


Fig.7-3-3. Ripple Voltage v.s. Output Current

7-3-2. Vout=2.5V（MPDRX303S）

（Ta=25°C, Cin= GRM32ER71C226KE15L×2,Cout=GRM32EB30J107ME16L×2, Rtrim=3613kΩ）

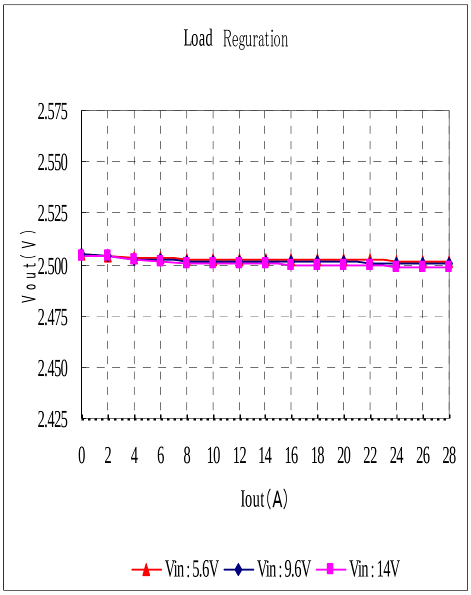


Fig.7-3-4. Output Voltage v.s. Output Current

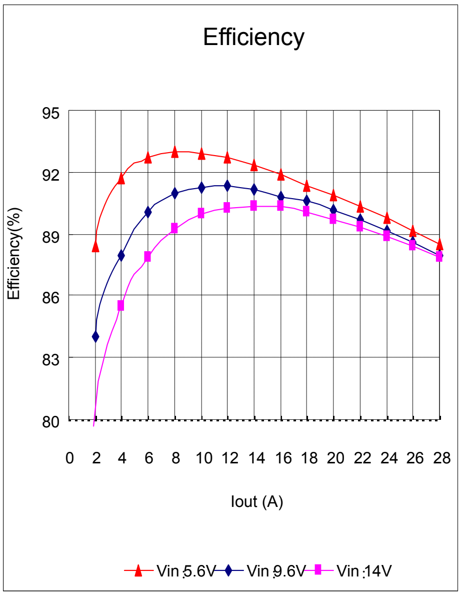


Fig.7-3-5. Efficiency v.s. Output Current

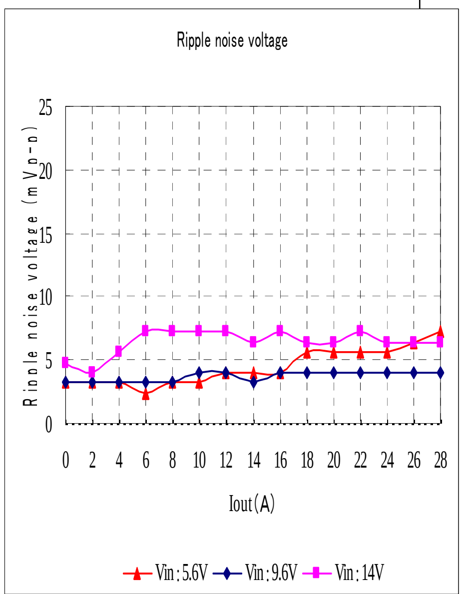


Fig.7-3-6. Ripple Voltage v.s. Output Current

7-3-3. Vout=1.8V（MPDRX303S）

（Ta=25°C, Cin= GRM32ER71C226KE15L×2, Cout=GRM32EB30J107ME16L×2, Rtrim=16118kΩ）

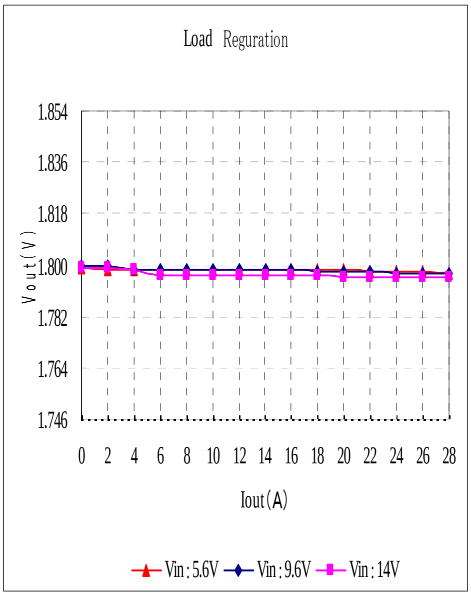


Fig.7-3-7. Output Voltage v.s. Output Current

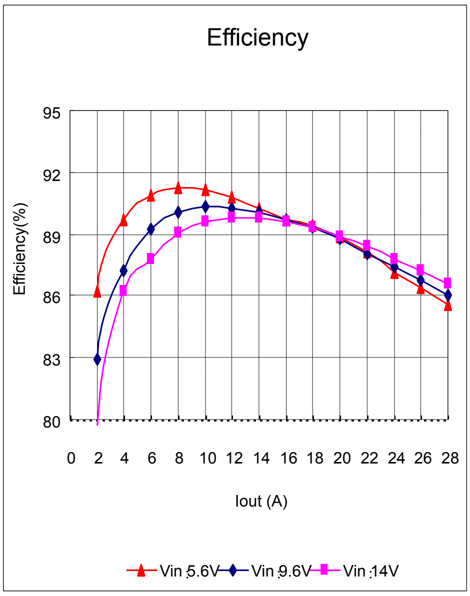


Fig.7-3-8. Efficiency v.s. Output Current

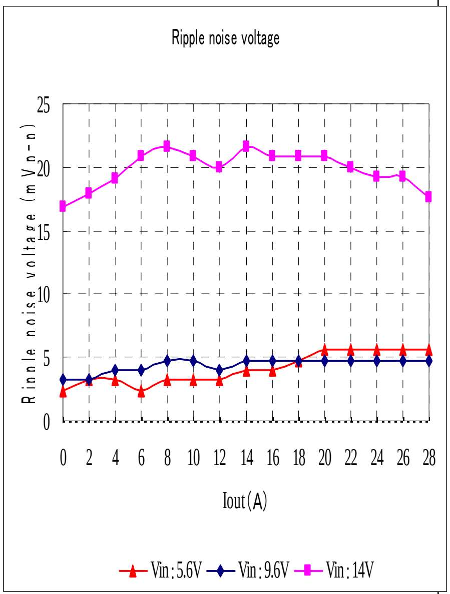


Fig.7-3-9. Ripple Voltage v.s. Output Current

7-3-4. Vout=1.5V（MPDRX304S）

（Ta=25°C, Cin= GRM32ER71C226KE15L×2, Cout=GRM32EB30J107ME16L×2, Rtrim=4737Ω）

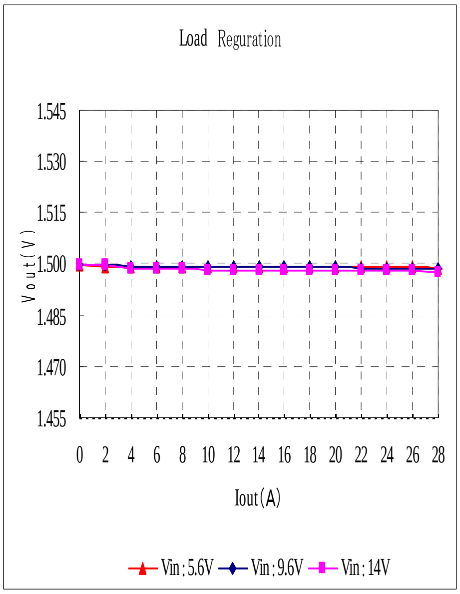


Fig.7-3-10. Output Voltage v.s. Output Current

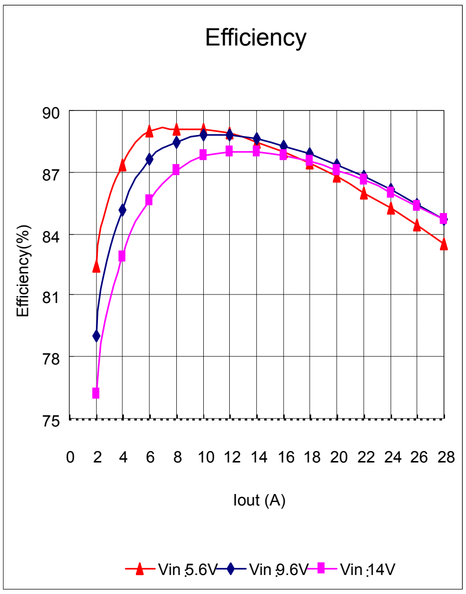


Fig.7-3-11. Efficiency v.s. Output Current

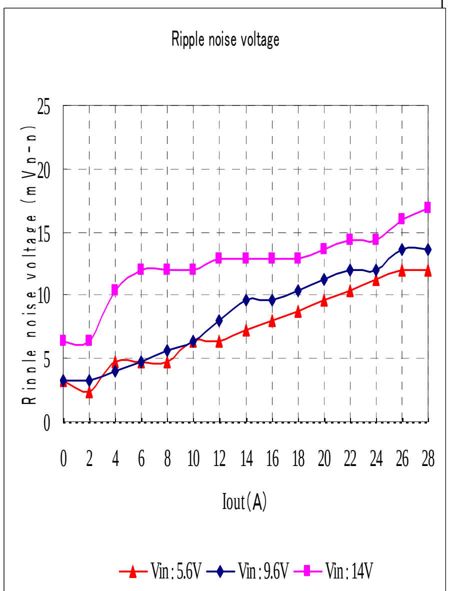


Fig.7-3-12. Ripple Voltage v.s. Output Current

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7-3-5. Vout=1.2V（MPDRX304S）

（Ta=25˚C, Cin= GRM32ER71C226KE15L×2, Cout=GRM32EB30J107ME16L×2, Rtrim=16453kΩ）

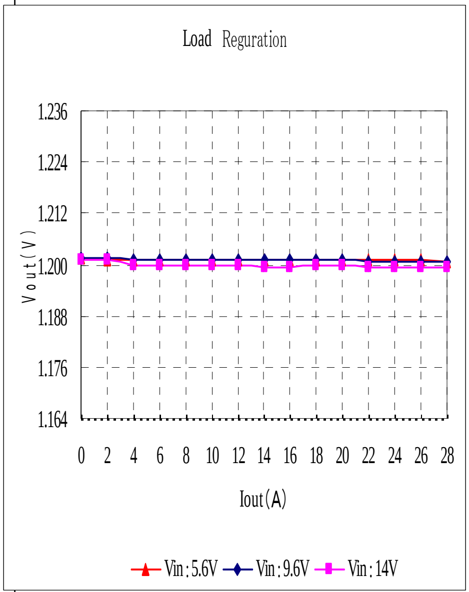

Fig.7-3-13. Output Voltage v.s. Output Current

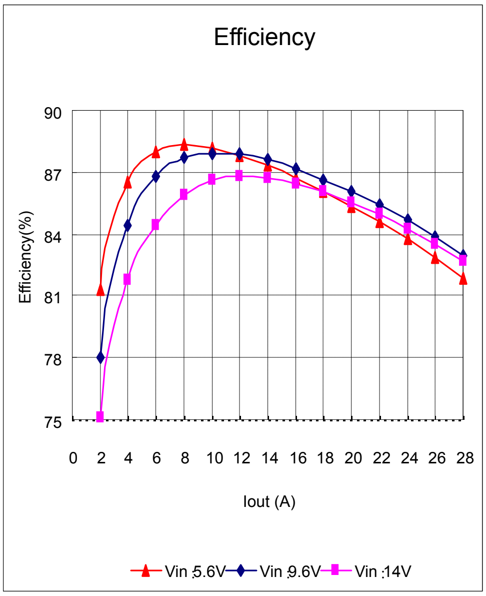

Fig.7-3-14. Efficiency v.s. Output Current

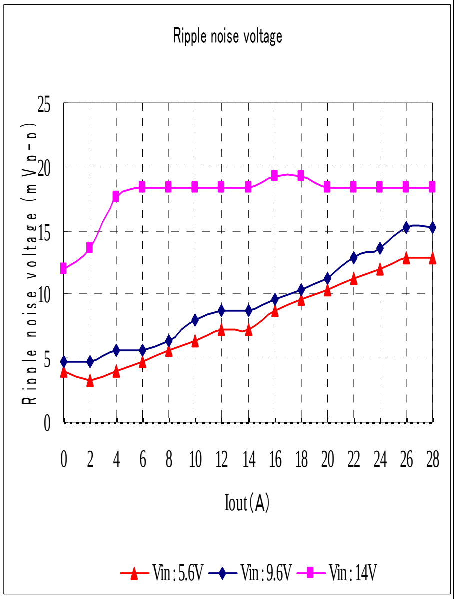

Fig.7-3-15. Ripple Voltage v.s. Output Current

7-3-6. Vout=0.8V（MPDRX304S）

（Ta=25˚C, Cin= GRM32ER71C226KE15L×2, Cout=GRM32EB30J107ME16L×2, Rtrim=3394900Ω）

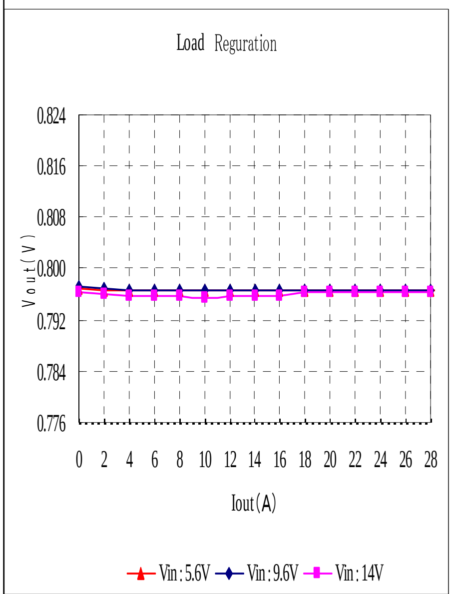

Fig.7-3-16. Output Voltage v.s. Output Current

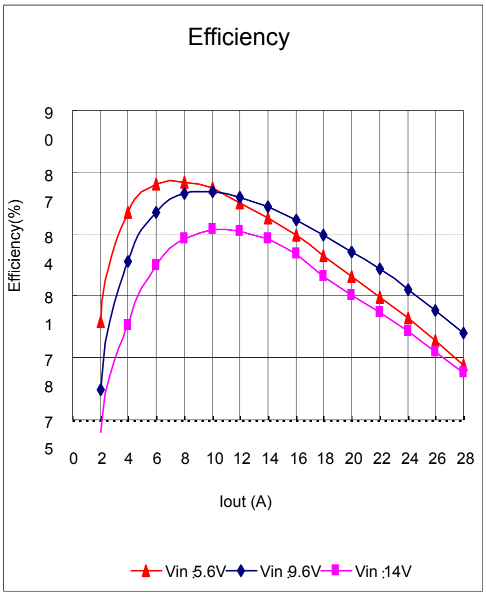

Fig.7-3-17. Efficiency v.s. Output Current

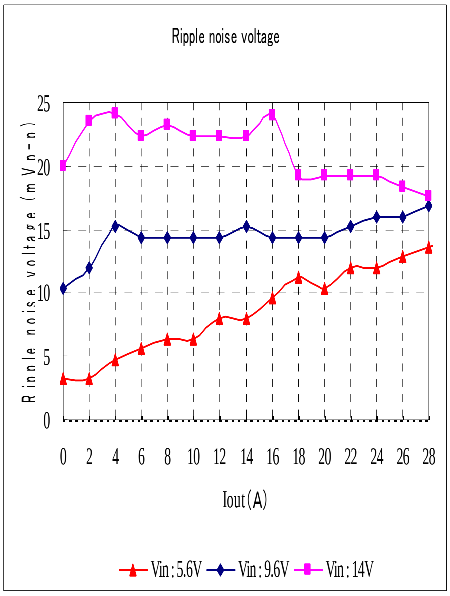

Fig.7-3-18. Ripple Voltage v.s. Output Current

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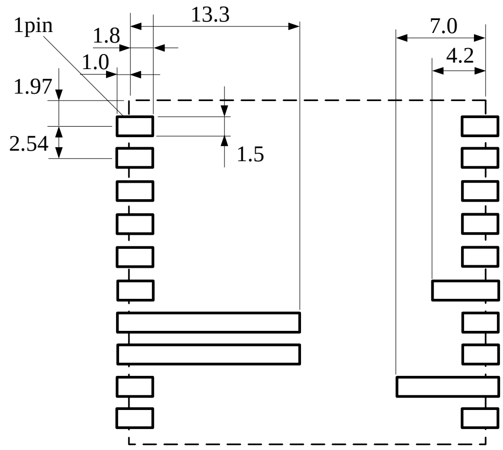
8. Mounting Condition

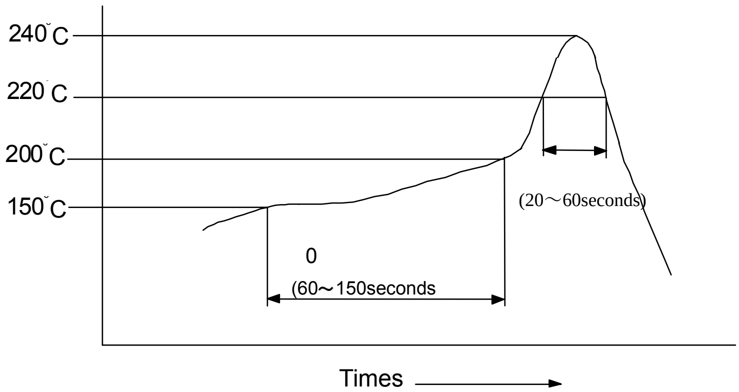
8-1. PCB Land Pattern Recommendation



8-2. Recommended Soldering Conditions

・Reflow Soldering Profile

Method : Full convection reflow soldering
Soldering temperature : 245°C +0/-5°C (Parts surface temperature)
Soldering time : 20 to 60 seconds max. (Over 220°C)
Preheating : 60 to 150 seconds (150-200°C)
Time : 1 time

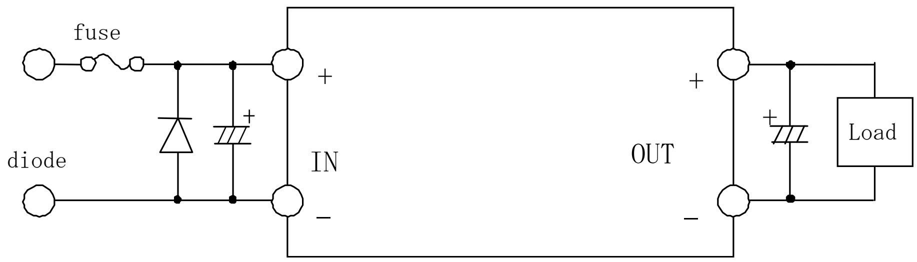


Elimination of any additional vibration applied to this product during reflow is highly recommended.
Careful regulation of temperature is recommended to avoid the separation of mounted components from this product during reflow.

9. Notice

・Input / Output capacitor
①Both 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.
②Please 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 a diode/ fuse combination after confirming the operation of your product.

⚠ Note

1. Please contact our main sales office or local sales office before using Murata's products for the applications listed below. These applications are known to require especially high reliability for the prevention of defects which might directly cause damage to a third party's life, body or property.

①Aircraft equipment
②Aerospace equipment
③Undersea equipment
④Power plant control equipment
⑤Medical equipment
⑥Transportation equipment (vehicles, trains, ships, etc.)
⑦Traffic signal equipment
⑧Disaster prevention /crime prevention equipment
⑨Data-processing equipment
⑩Application of similar complexity and/or reliability requirements to the applications listed in the above.

2. This document was released in Oct. 2007. The content is subject to change without notice. Please confirm specifications before ordering. If there are questions regarding the content, please contact our main or local sales office.

3. Typical data and specifications within this document are referenced for your information only. Please approve Murata's product specifications or transact the approval sheet for product specifications before ordering.

NOTE: This document is subject to revision without prior or subsequent notice.