DC/DC Converter

URF1D_FB-400W(H)R3 Series

MORNSUN®

400W isolated DC-DC converter
Wide input and regulated single output

Patent Protection RoHS

FEATURES

- Wide input voltage range: 66 -160VDC
- High efficiency up to 92%
- Reinforced insulation, I/O isolation test voltage 3k VAC, Input-case test voltage 2.1k VAC
- Operating ambient temperature range -40℃ to +100℃
- Input under-voltage protection, output over-current, over–voltage, short-circuit protection, over-temperature protection
- Industry standard full-brick and pin-out
- Meet IEC/EN/UL62368/EN50155 standards

URF1D_FB-400(H)WR3 series is a high-performance product specifically designed for a variety of railway applications. The DC-DC converters feature 400W output power with no requirement for minimum load, wide input voltage from 66-160VDC, and allowing operating temperature as high as 100℃. Additional product features include input under-voltage protection, output over-current, over-voltage, short-circuit and over-temperature protection, remote On/Off control, remote sense compensation, output voltage trim adjustment. The products meet IEC/EN/UL62368/EN50155 standards and they are widely used in railway systems and associated equipment.

Selection Guide

Certification	Part No.①	Ctrl Logic②	Input Voltage (VDC)		Output		Full Load Efficiency(%) Min./Typ.	Max. Capacitive Load(μF)
			Nominal (Range)	Max.③	Voltage (VDC)	Current (mA) (Max./Min.)		
--	URF1D05FB-400W(H)R3	P	110 (66-160)	170	5	64000/0	84/86	10000
	URF1D09FB-400W(H)R3				9	44440/0	88/90	6800
	URF1D12FB-400W(H)R3				12	33330/0	89/91	4000
	URF1D15FB-400W(H)R3				15	26670/0	89/91	4000
	URF1D24FB-400W(H)R3				24	16670/0	90/92	2700
	URF1D28FB-400W(H)R3				28	14290/0	90/92	2700
	URF1D36FB-400W(H)R3				36	11111/0	90/92	680
	URF1D48FB-400W(H)R3				48	8333/0	90/92	680
	URF1D54FB-400W(H)R3				54	7410/0	90/92	680

Note:
①Use "H" suffix for heat sink mounting. We recommend to choose modules with a heat sink for enhanced heat dissipation and applications with extreme temperature requirements;
②"P" means positive logic, "N" means negative logic;
③Exceeding the maximum input voltage may cause permanent damage.

Input Specifications

Item	Operating Conditions		Min.	Typ.	Max.	Unit
Input Current (full load/no-load)	Nominal input voltage	5V output	--	4229/110	4329/140	mA
		9V output	--	4041/110	4132/140	
		12V, 15V output	--	3996/110	4086/140	
		Others	--	3953/110	4041/140	
Reflected Ripple Current	Nominal input voltage		--	100	--	
Surge Voltage (1sec. max.)			-0.7	--	185	VDC
Start-up Voltage			--	--	66	
Input Under-voltage Protection			55	58	--	
Start-up Time	Nominal input voltage, constant resistance load		--	40	100	ms
Input Filter			Pi filter			
Hot Plug			Unavailable			

Ctrl①	Module on	Ctrl open circuit or connected to TTL high level (3.5-12VDC)			
	Module off	Ctrl pin connected to -Vin or low level (0-1.2VDC)			
	Input current when off	--	5	10	mA
Idle input power	Ctrl pin pulled low to -Vin, DC-DC OFF（66-160V input）	--	0.5	1.2	W
Note: ①The Ctrl pin voltage is referenced to input -Vin.					

Output Specifications

Item	Operating Conditions		Min.	Typ.	Max.	Unit
Voltage Accuracy	Nominal input voltage, 0%-100% load		--	±1	±3	%
Linear Regulation	Input voltage variation from low to high at full load		--	±0.2	±0.5	
Load Regulation	Nominal input voltage, 0%-100% load	5V output	--	±0.8	±1.0	
		Others	--	±0.4	±0.5	
Transient Recovery Time	25% load step change @25℃		--	200	500	μs
Transient Response Deviation			--	±3	±5	%
Temperature Coefficient	Full load		--	--	±0.03	%/℃
Ripple & Noise①	20MHz bandwidth, 10%-100% load		--	150	200	mVp-p
Trim			90	--	110	%Vo
Sense			--	--	105	
Over-temperature Protection	Max. Case Temperature		--	105	115	℃
Over-voltage Protection	Input voltage range		110	130	160	%Vo
Over-current Protection			110	140	150	%Io
Short-circuit Protection			Hiccup, continuous, self-recovery			
Note: ①For ripple and noise measuring method, please refer to Fig. 1.						

General Specifications

Item	Operating Conditions		Min.	Typ.	Max.	Unit
Isolation	Electric Strength Test for 1 minute with a leakage current of 5mA max	Input-output	3000	--	--	VAC
		Input-case	2100	--	--	
		Output-case	1500	--	--	
Insulation Resistance	Input-output resistance at 500VDC		100	--	--	MΩ
Isolation Capacitance	Input-output capacitance at 100KHz/0.1V		--	1000	--	pF
Operating Temperature	See temperature derating curves		-40	--	+100	℃
Storage Temperature			-55	--	+125	
Storage Humidity	Non-condensing		5	--	95	%RH
Pin Soldering Resistance Temperature	Wave-soldering, 10 seconds		--	--	260	℃
	Soldering spot is 1.5mm away from case for 10 seconds		--	--	300	
Cooling Requirement			EN60068-2-1			
Dry-heat Requirement			EN60068-2-2			
Damp-heat Requirement			EN60068-2-30			
Shock And Vibration			IEC/EN61373 - Category 1, Grade B			
Switching Frequency	PFM mode		--	260	--	KHz
MTBF	MIL-HDBK-217F@25℃		250	--	--	K hours

Mechanical Specifications

Case Material	Aluminum alloy bottom, flame-retardant and heat-resistant (PA66)	
Dimension	URF1D_FB-400WR3	116.80 x 61.00 x 13.00mm
	URF1D_FB-400WHR3	116.80 x 61.00 x 31.00mm
Weight	URF1D_FB-400WR3	272g (Typ.)
	URF1D_FB-400WHR3	428g (Typ.)
Cooling Method	Free air convection (20LFM) or forced air convection	

Electromagnetic Compatibility (EMC)

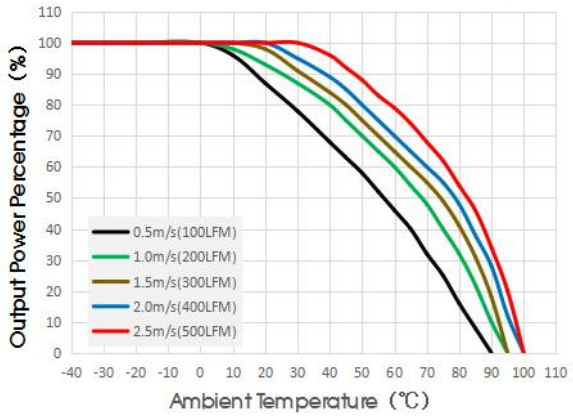
Emissions	CE	CISPR32/EN55032	CLASS A (see Fig. 3 for recommended circuit)
	RE	CISPR32/EN55032	CLASS A (see Fig. 3 for recommended circuit)
Immunity	ESD	IEC/EN61000-4-2 GB/T17626.2	Contact ±6KV/Air ±8KV perf.Criteria A
	RS	IEC/EN61000-4-3 GB/T17626.3	20V/m perf.Criteria A
	EFT	IEC/EN61000-4-4 GB/T17626.4	±2KV(5KHz, 100KHz) (see Fig. 3 for recommended circuit) perf.Criteria A
	Surge	IEC/EN61000-4-5 GB/T17626.5	line to line ±2KV (1.2μs/50μs, 2Ω) (see Fig. 3 for recommended circuit) perf.Criteria A
	CS	IEC/EN61000-4-6 GB/T17626.6	10 Vr.m.s perf.Criteria A

Electromagnetic Compatibility (EMC) (EN50155)

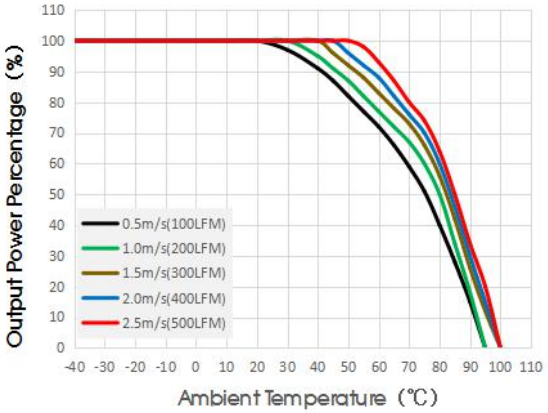
Emissions	CE	EN50121-3-2 150kHz-500kHz 99dBuV (see Fig. 3 for recommended circuit) EN55016-2-1 500kHz-30MHz 93dBuV	
	RE	EN50121-3-2 30MHz-230MHz 40dBuV/m at 10m (see Fig. 3 for recommended circuit) EN55016-2-1 230MHz-1GHz 47dBuV/m at 10m	
Immunity	ESD	EN50121-3-2 Contact ±6KV/Air ±8KV	perf. Criteria A
	RS	EN50121-3-2 20V/m	perf. Criteria A
	EFT	EN50121-3-2 ±2kV 5/50ns 5kHz (see Fig. 3 for recommended circuit)	perf. Criteria A
	Surge	EN50121-3-2 line to line ±1KV（42Ω, 0.5μF） (see Fig .3 for recommended circuit)	perf. Criteria A
	CS	EN50121-3-2 0.15MHz-80MHz 10 Vr.m.s	perf. Criteria A

Typical Performance Curves

URF1D05FB-400WR3 Temperature Derating Curves



URF1D05FB-400WHR3 Temperature Derating Curves



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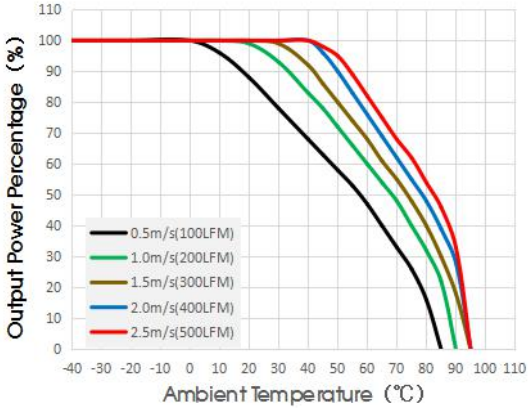

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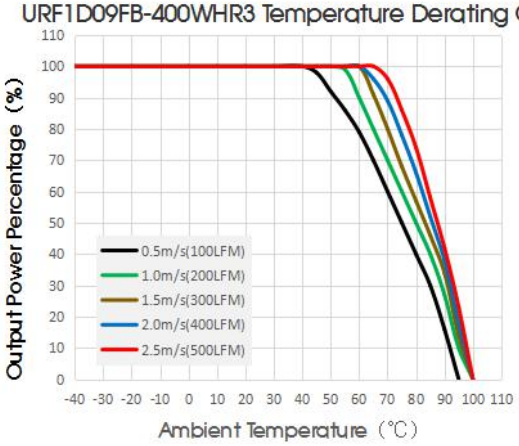

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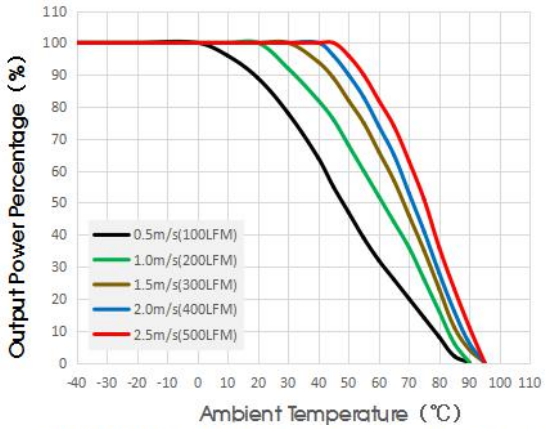

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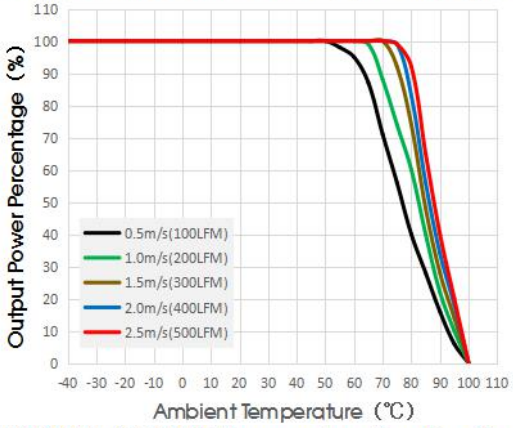

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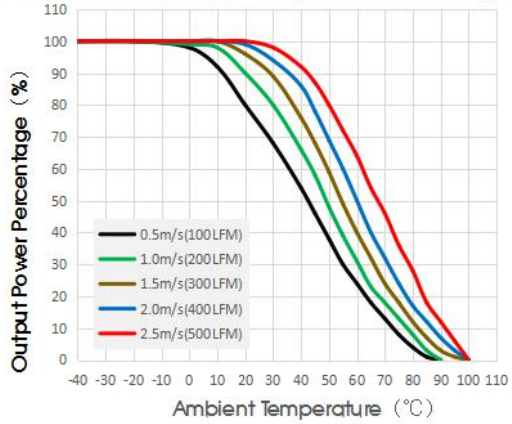

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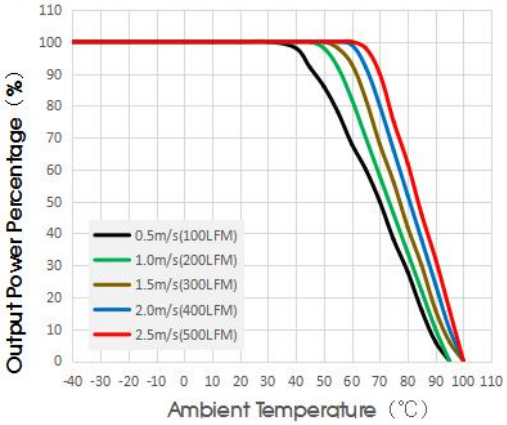

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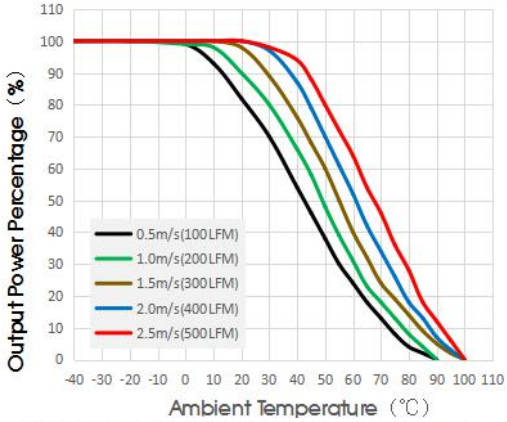

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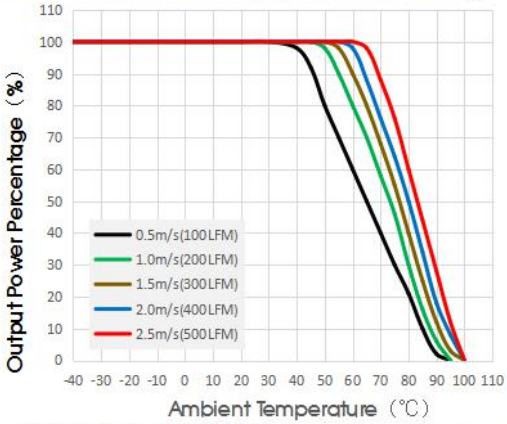

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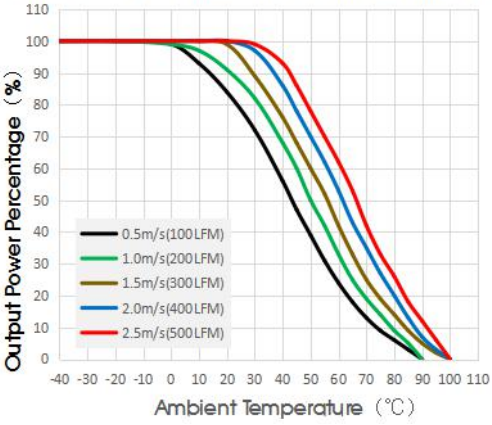

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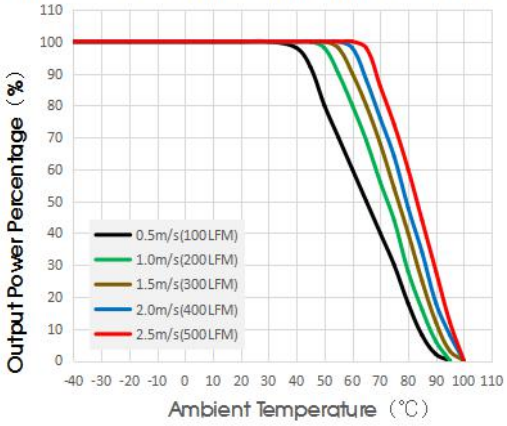

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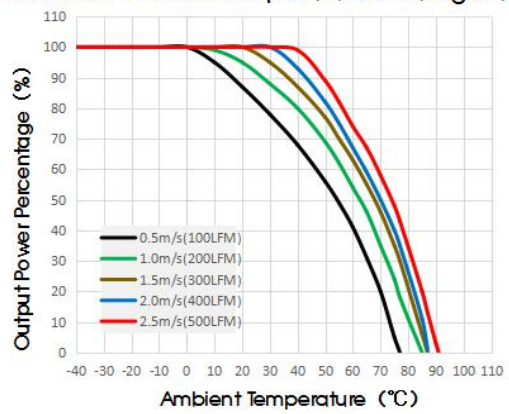

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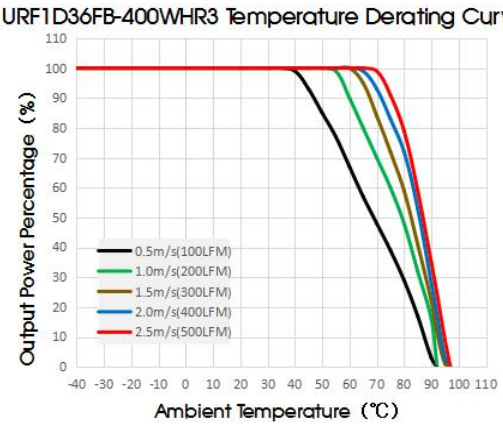
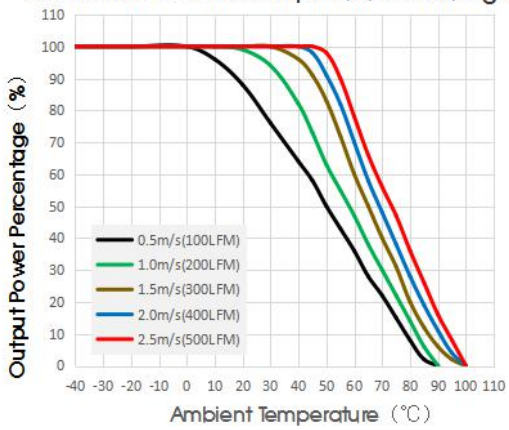
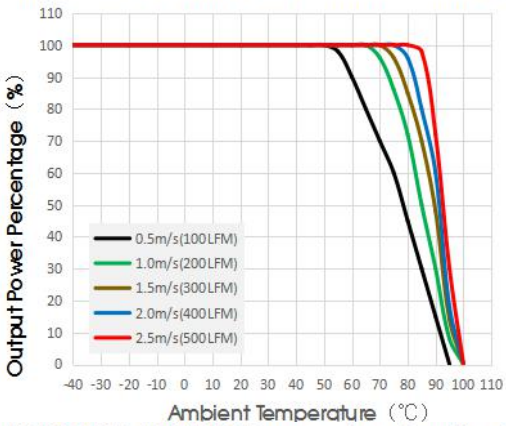


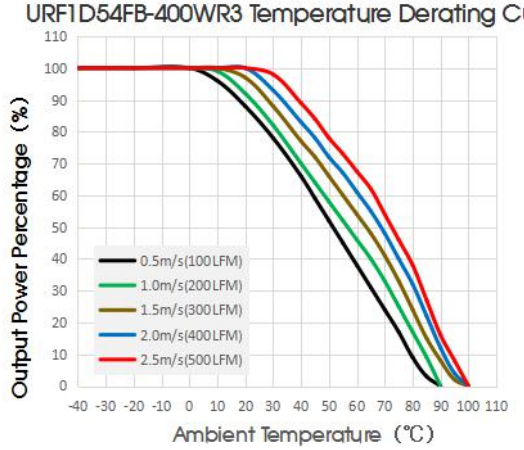
URF1D48FB-400WR3 Temperature Derating Curves



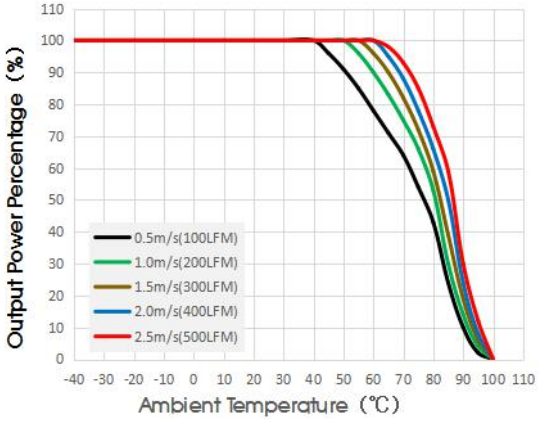
URF1D48FB-400WHR3 Temperature Derating Curves



URF1D54FB-400WR3 Temperature Derating Curves

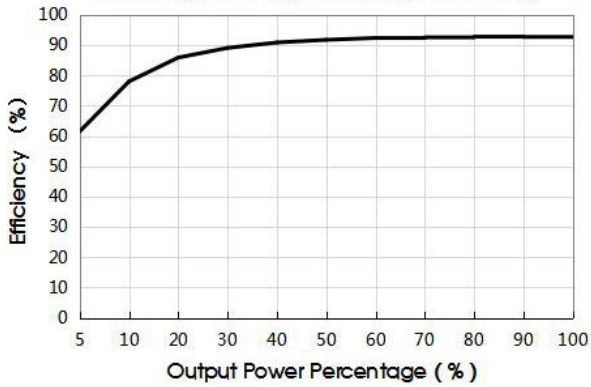


URF1D54FB-400WHR3 Temperature Derating Curves



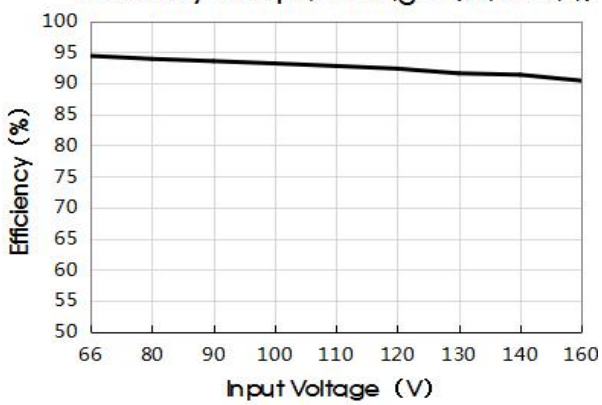
URF1D24FB-400WR3

Efficiency VS Output Load (Vin=110V)



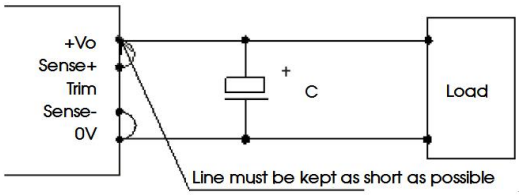
URF1D24FB-400WR3

Efficiency VS Input Voltage （Full Load）



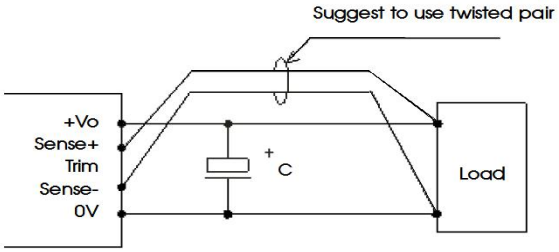
Remote Sense Application

1. Remote Sense Connection if not used



Notes:
(1) If the sense function is not used for remote regulation the user must connect the +Sense to +Vo and -Sense to 0V at the DC-DC converter pins and will compensate for voltage drop across pins only.
(2) The connections between Sense lines and their respective power lines must be kept as short as possible, otherwise they may be picking up noise, interference and/or causing unstable operation of the power module.

2. Remote Sense Connection used for Compensation



Notes:
(1) Using remote sense with long wires may cause unstable output, please contact technical support if long wires must be used.
(2) PCB-tracks or cables/wires for Remote Sense must be kept as short as possible. Twisted pair or shielded wires are suggested for remote compensation and must be kept as short as possible.
(3) We recommend using adequate cross section for PCB-track layout and/or cables to connect the power supply module to the load in order to keep the voltage drop below 0.3V and to make sure the power supply's output voltage remains within the specified range.
(4) Note that large wire impedance may cause oscillation of the output voltage and/or increased ripple. Consult technical support or factory for further advice of sense operation.

Design Reference

1. Ripple & noise

All the DC-DC converters of this series are tested before delivery using the recommended circuit shown in Fig. 1.

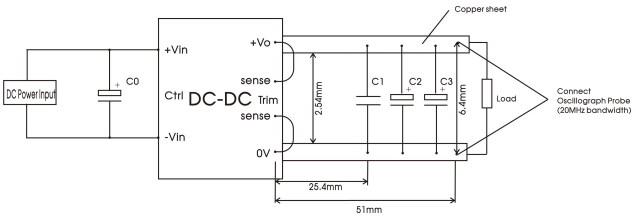


Fig.1

Output voltage \ Capacitors value	C0	C1	C2	C3
5VDC	100μF aluminum Electrolytic capacitor (Voltage≥ 200V)	105K/50V ceramic capacitor	10μF/35V tantalum capacitor	680μF/35V electrolytic capacitor
9VDC				
12VDC				
15VDC				
24VDC				
28VDC		105K/100V ceramic capacitor	--	220μF/100V electrolytic capacitor
36VDC				
48VDC				
54VDC				

2. Typical application

We recommended using Mornsun's EMC circuit, otherwise please ensure that at least a 100μF electrolytic capacitors is connected at the input in order to ensure adequate voltage surge suppression and protection.

Input and/or output ripple can be further reduced by appropriately increasing the input & output capacitor values Cin and Cout and/or by selecting capacitors with a low ESR (equivalent series resistance). Also make sure that the capacitance is not exceeding the specified max. capacitive load value of the product.

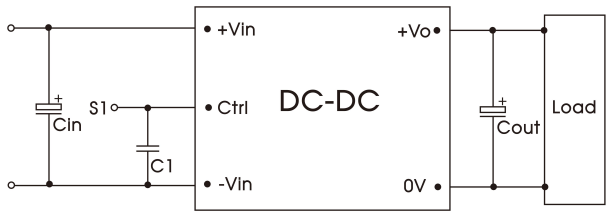


Fig.2

Output Voltage \ Capacitor Valu	Cout	Cin	C1
5V/9V/12V/15V/24V/ 28V/36V/48V/54V	220μF/63V	100 μF/200V	104K/50V

3. EMC solution-recommended circuit

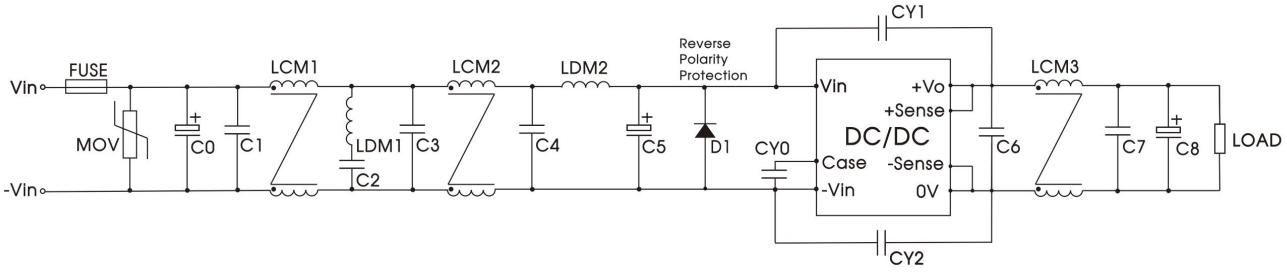
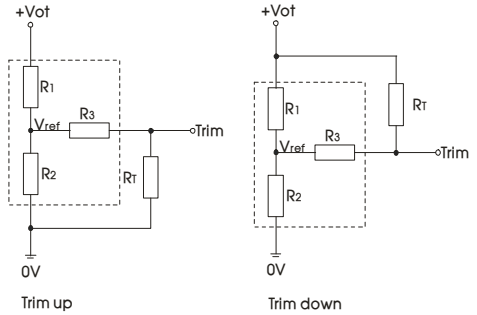


Fig. 3

Components	Recommended Component value		
	05V, 09V, 12V, 15V	24V, 36V, 48V, 54V	28V
CY1	2.2nF/400VAC Y1 safety capacitor	2.2nF/400VAC Y1 safety capacitor	3.2nF/400VAC Y1 safety capacitor
CY2	2.2nF/400VAC Y1 safety capacitor	4.4nF/400VAC Y1 safety capacitor	4.4nF/400VAC Y1 safety capacitor
FUSE	Choose according to actual input current		
MOV	S20K130 (Varistor)		
D1	250V/20A diode		
C0	330μF/250V electrolytic capacitor		
C5	330μF/200V electrolytic capacitor		
C8	220μF/63V electrolytic capacitor		
C1, C2, C3, C4, C6, C7	2.2μF/ 250V ceramic capacitor		
LCM1	Mornsun P/N: FL2D-60-451		
LCM2	Mornsun P/N: FL2D-60-402		
LCM3	Mornsun P/N: FL2D-D0-040		
LDM1	0.47uH Shielded inductor		
LDM2	1.5uH Shielded inductor		
CY0	2.2nF/400VAC Y1 safety capacitor		

4. Trim Function for Output Voltage Adjustment (open if unused)



TRIM resistor connection (dashed line shows internal resistor network)
Fig.4

Calculation formula of Trim resistance:

$$up:\ R_T=\frac{aR_2}{R_2-a}-R_3 \qquad a=\frac{Vref}{Vo'-Vref}\cdot R_1$$

$$down:\ R_T=\frac{aR_1}{R_1-a}-R_3 \qquad a=\frac{Vo'-Vref}{Vref}\cdot R_2$$

Note:
Value for R1, R2, R3, and V_{ref} refer to the above table 1.
R_T: Resistance of Trim.
a: User-defined parameter, no actual meanings.
Vo': The trim up/down voltage.

Vo / Res	5(VDC)	9(VDC)	12(VDC)	15(VDC)	24(VDC)	28(VDC)	36(VDC)	48(VDC)	54(VDC)
R1(KΩ)	2.92	7.58	11	14.49	24.87	29.4	68	58.69	60.77
R2(KΩ)	2.87	2.87	2.87	2.87	2.87	2.87	5.04	3.21	2.94
R3(KΩ)	8.66	15	17.8	20	20	20	27	20	20
Vref(V)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

Practical Example trim up +10% for 12V output:

$$a = \frac{2.5 * 11}{13.2 - 2.5} = 2.57 \quad R_T = \frac{2.57 * 2.87}{2.87 - 2.57} - 17.8 = 6.786K\Omega$$

R_T according to E24≈6.8kΩ

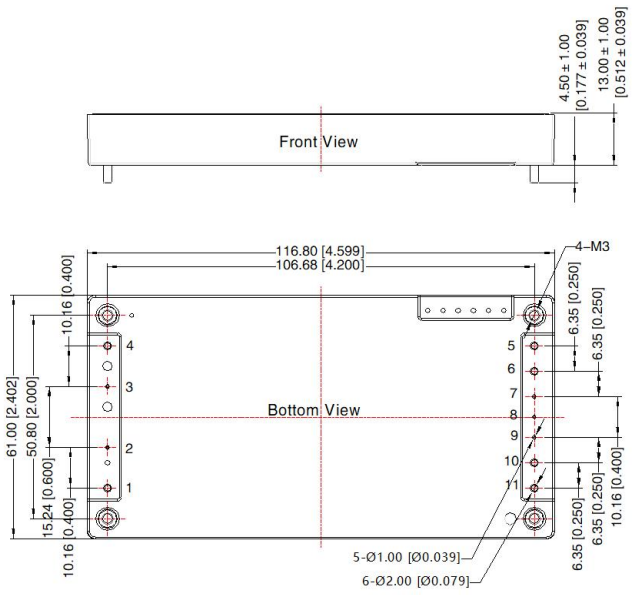
Practical Example trim up -10% for 12V output:

$$b = \frac{(10.8 - 2.5) * 2.87}{2.5} = 9.53 \quad R_T = \frac{9.53 * 11}{11 - 9.53} - 17.8 = 53.51K\Omega$$

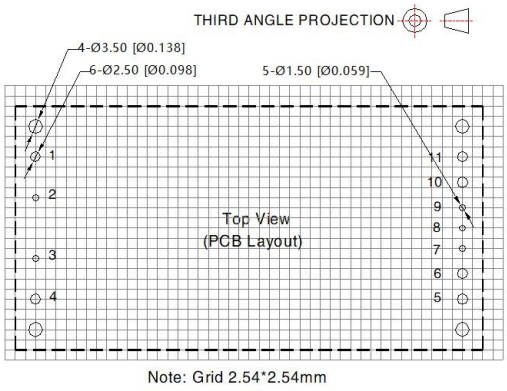
R_T according to E24≈53.6kΩ

6. The products do not support parallel connection of their output
7. For additional information please refer to DC-DC converter application notes on www.mornsun-power.com

URF1D_FB-400WR3 Dimensions and Recommended Layout

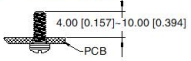


Note:
Unit: mm[inch]
Pin1, 4, 5, 6, 10, 11's diameter: 2.00[0.079]
Pin2, 3, 7, 8, 9's diameter: 1.00[0.039]
Pin diameter tolerances: ± 0.10[± 0.004]
General tolerances: ± 0.50[± 0.020]
Mounting hole screwing torque: Max 0.4 N・m



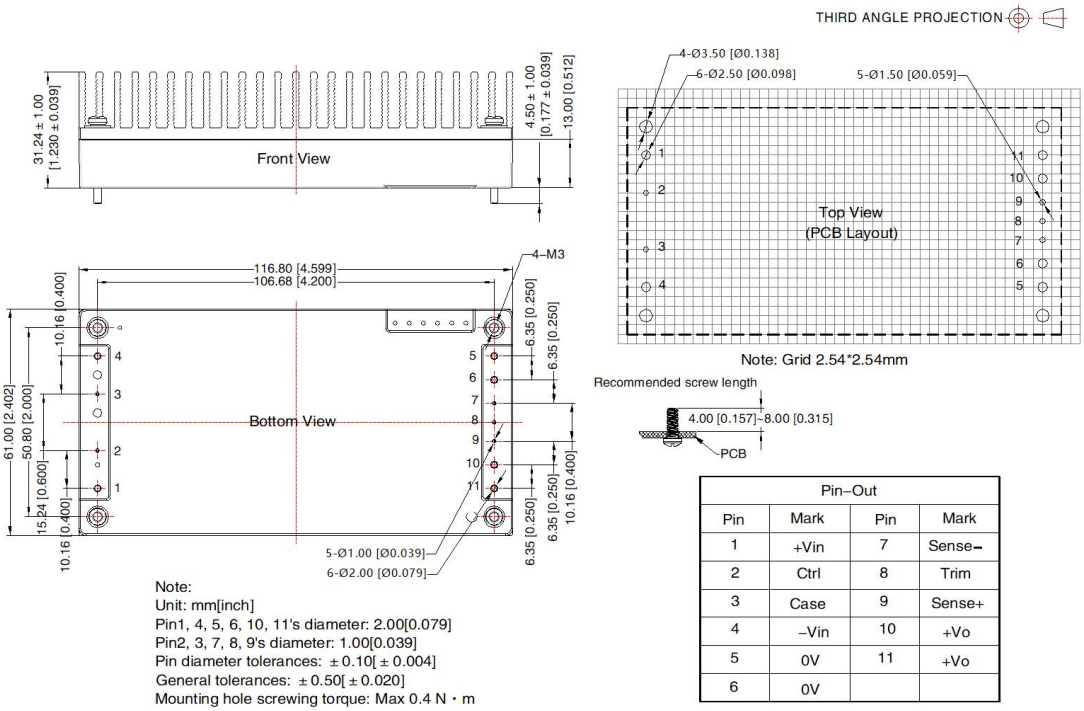
Note: Grid 2.54*2.54mm

Recommended screw length



Pin-Out			
Pin	Mark	Pin	Mark
1	+Vin	7	Sense−
2	Ctrl	8	Trim
3	Case	9	Sense+
4	−Vin	10	+Vo
5	0V	11	+Vo
6	0V		

URF1D_FB-400WHR3 Dimensions and Recommended Layout



Note:
Unit: mm[inch]
Pin1, 4, 5, 6, 10, 11's diameter: 2.00[0.079]
Pin2, 3, 7, 8, 9's diameter: 1.00[0.039]
Pin diameter tolerances: ±0.10[±0.004]
General tolerances: ±0.50[±0.020]
Mounting hole screwing torque: Max 0.4 N・m

Pin–Out			
Pin	Mark	Pin	Mark
1	+Vin	7	Sense–
2	Ctrl	8	Trim
3	Case	9	Sense+
4	–Vin	10	+Vo
5	0V	11	+Vo
6	0V		

Notes:
1. For additional information on Product Packaging please refer to www.mornsun-power.com. Packaging bag number: 58210118 (without heatsink), 58220029(with heatsink);
2. We suggest to use module at load of over 5%, if not, the ripple of the product may exceeds the specification, but does not affect the reliability of the product;
3. It is recommended that the load imbalance of the dual output is ⩽±5%. If it exceeds ±5%, the performance of the product cannot be guaranteed to meet as datasheet marked. For details, please contact our technical staff;
4. The maximum capacitive load offered were tested at input voltage range and full load;
5. Unless otherwise specified, parameters in this datasheet were measured under the conditions of Ta=25℃, humidity<75%RH with nominal input voltage and rated output load;
6. All index testing methods in this datasheet are based on company corporate standards;
7. We can provide product customization service, please contact our technicians directly for specific information;
8. Products are related to laws and regulations: see "Features" and "EMC";
9. Our products shall be classified according to ISO14001 and related environmental laws and regulations, and shall be handled by qualified units.

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