Descriptions

400W，DC-DC Converter



RoHS

CE Report EN62368-1

UKCA Report BS EN62368-1

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

Applications

- railway systems

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.)		
--	DRWFB400-F1D05(H)	P	110 (66-160)	170	5	64000/0	84/86	10000
	DRWFB400-F1D09(H)				9	44440/0	88/90	6800
	DRWFB400-F1D12(H)				12	33330/0	89/91	4000
	DRWFB400-F1D15(H)				15	26670/0	89/91	4000
EN/BSEN	DRWFB400-F1D24(H)				24	16670/0	90/92	2700
--	DRWFB400-F1D28(H)				28	14290/0	90/92	2700
	DRWFB400-F1D36(H)				36	11111/0	90/92	680
EN/BSEN	DRWFB400-F1D48				48	8333/0	90/92	680
--	DRWFB400-F1D48H							
	DRWFB400-F1D54(H)				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;
④Product images are for reference only; the actual product shall prevail.

Specifications

Product Specifications	Item	Operating Conditions		Min.	Typ.	Max.	Unit
Input Specifications	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
Output Specifications	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 & Noise②	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			
General Specifications	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 Temperature③	Soldering spot is 1.5mm away from the case, 10 seconds max.	--	--	+300	℃
		Wave soldering, maximum 10 seconds	255	260	265	
	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	DRWFB400-F1Dxx	116.80 x 61.00 x 13.00mm			
		DRWFB400-F1DxxH	116.80 x 61.00 x 31.00mm			
	Weight	DRWFB400-F1Dxx	272g (Typ.)			
		DRWFB400-F1DxxH	428g (Typ.)			
	Cooling Method	Free air convection (20LFM) or forced air convection				

Note:
①The Ctrl pin voltage is referenced to input -Vin;
②For ripple and noise measuring method, please refer to Fig. 1;
③The pin soldering temperature tolerance is not the actual temperature set by the soldering iron but the temperature required for proper solder joints. The actual temperature set by the customer should be determined comprehensively based on factors such as PCB thickness, copper coverage, soldering iron power, and soldering iron tip selection.

Electromagnetic Compatibility (EMC)

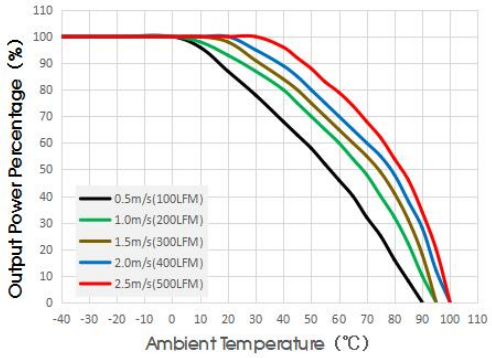
Emissions	CE	CISPR32/EN55032 CLASS A (see Fig. 3 for recommended circuit)	
	RE	CISPR32/EN55032 CLASS A (see Fig. 3 for recommended circuit)	
Immunity	ESD	IEC/EN61000-4-2 GB/T17626.2 Contact ±6KV/Air ±8KV	perf.Criteria A
	RS	IEC/EN61000-4-3 GB/T17626.3 20V/m	perf.Criteria A
	EFT	IEC/EN61000-4-4 GB/T17626.4 ±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)

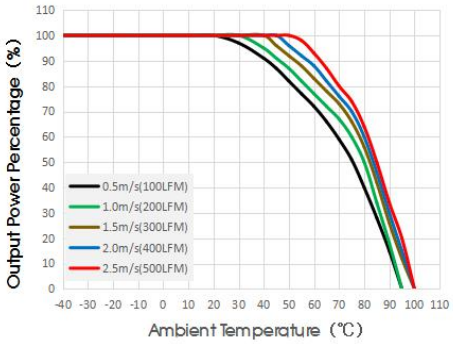
Emissions	CE	EN50121-3-2 150kHz-500kHz 99dBuV (see Fig. 3 for recommended circuit) EN55016-2-1 500kHz-30MHz 93dBuV	
	RE	EN50121-3-2 30MHz-230MHz 40dBuV/m at 10m (see Fig. 3 for recommended circuit) EN55016-2-1 230MHz-1GHz 47dBuV/m at 10m	
Immunity	ESD	EN50121-3-2 Contact ±6KV/Air ±8KV	perf. Criteria 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

Characteristic Curve

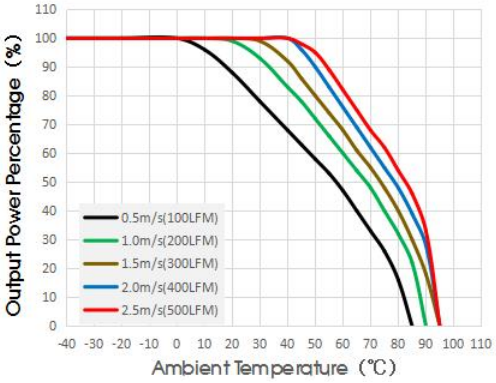
DRWFB400-F1D05 Temperature Derating Curves



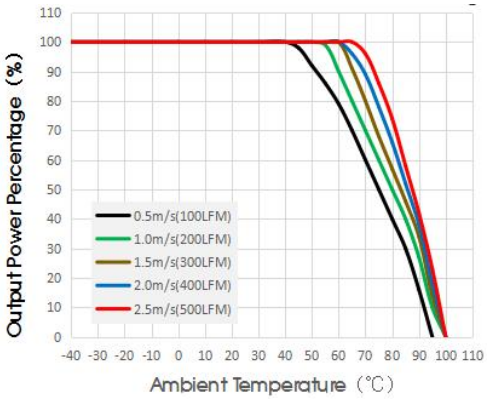
DRWFB400-F1D05H Temperature Derating Curves



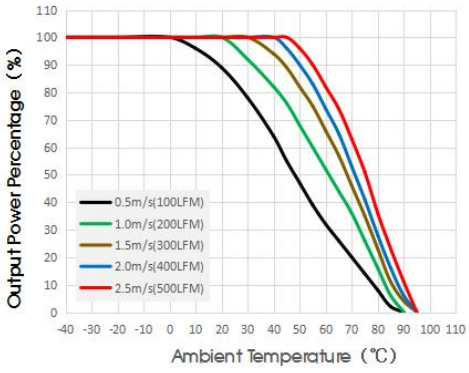
DRWFB400-F1D09 Temperature Derating Curves



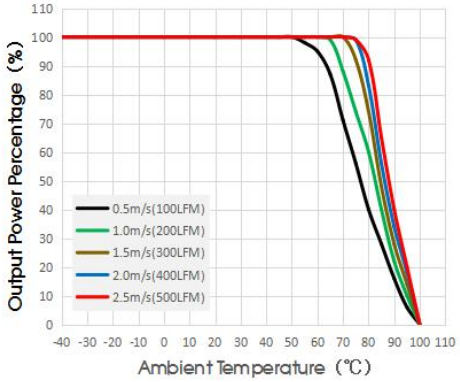
DRWFB400-F1D09H Temperature Derating Curves



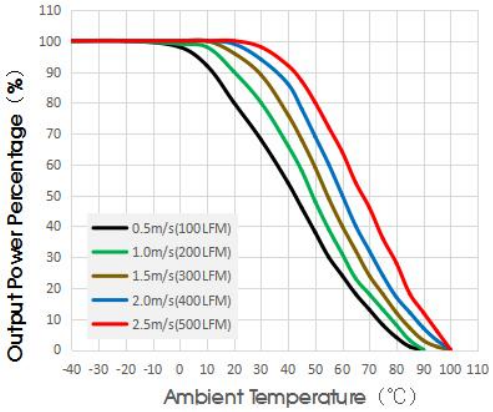
DRWFB400-F1D12 Temperature Derating Curves



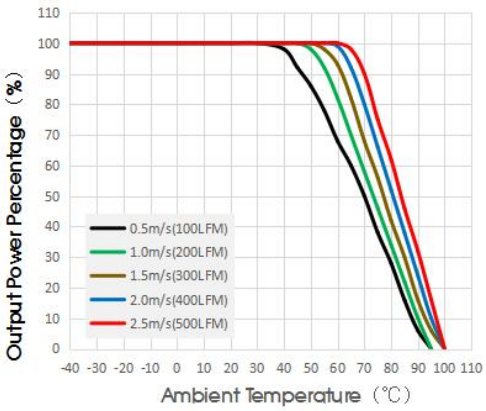
DRWFB400-F1D12H Temperature Derating Curves



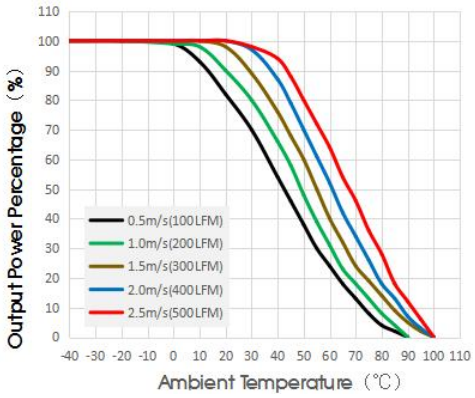
DRWFB400-F1D15 Temperature Derating Curves



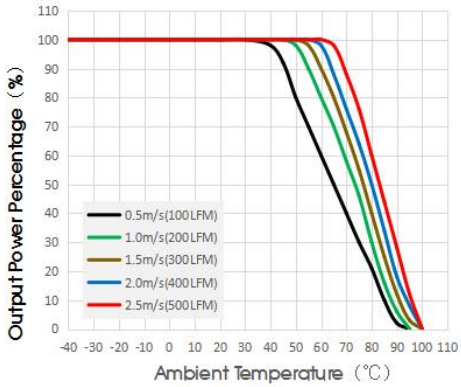
DRWFB400-F1D15H Temperature Derating Curves



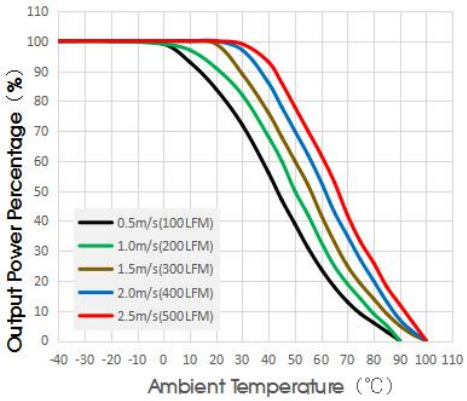
DRWFB400-F1D24 Temperature Derating Curves



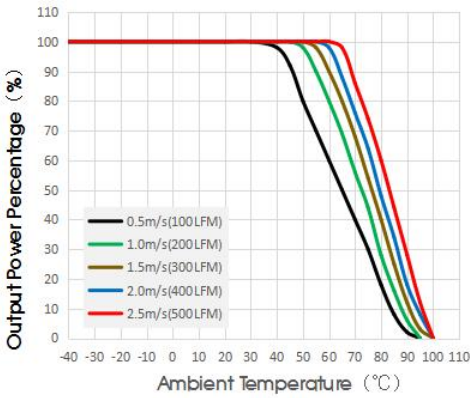
DRWFB400-F1D24H Temperature Derating Curves



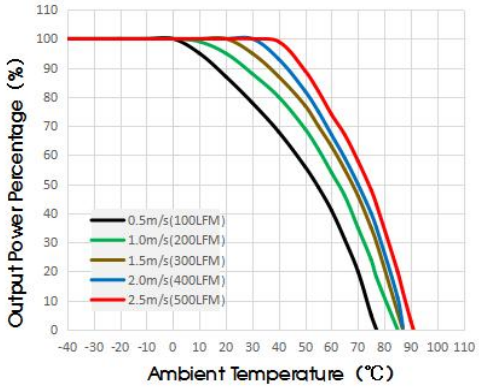
DRWFB400-F1D28 Temperature Derating Curves



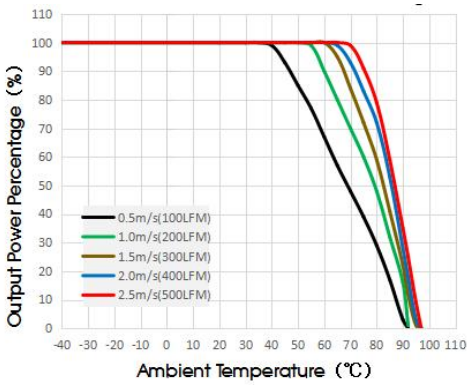
DRWFB400-F1D28H Temperature Derating Curves



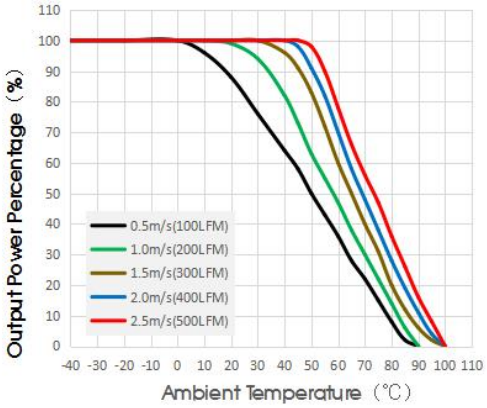
DRWFB400-F1D36 Temperature Derating Curves



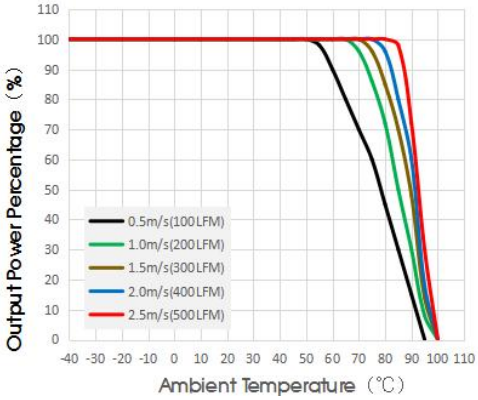
DRWFB400-F1D36H Temperature Derating Curves



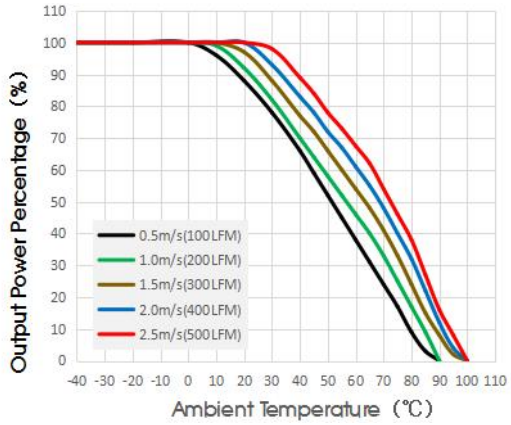
DRWFB400-F1D48 Temperature Derating Curves



DRWFB400-F1D48H Temperature Derating Curves

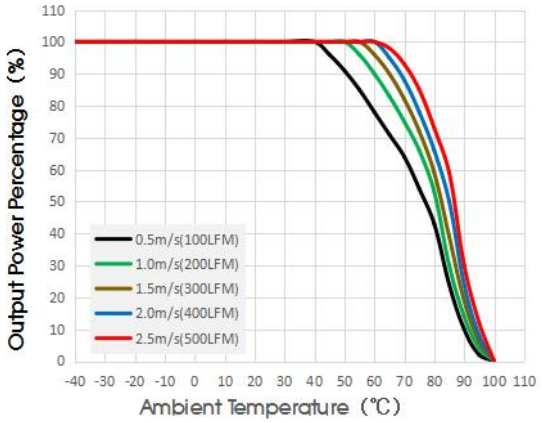


DRWFB400-F1D54 Temperature Derating Curves

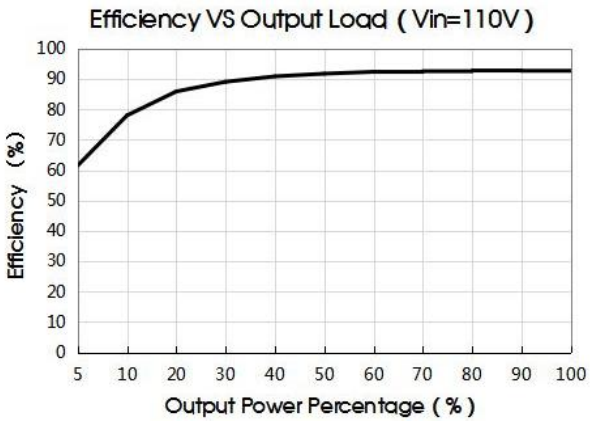


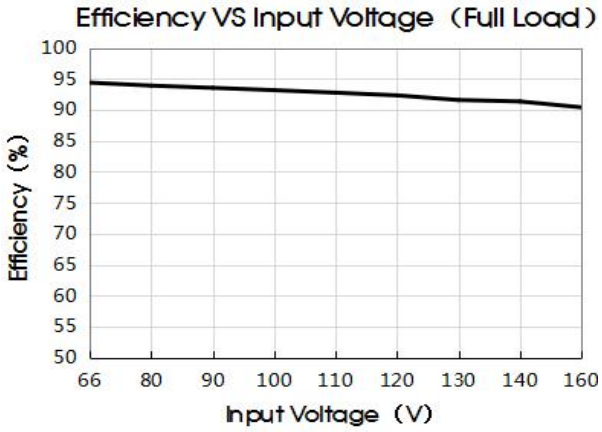
DRWFB400-F1D24

DRWFB400-F1D54H Temperature Derating Curves



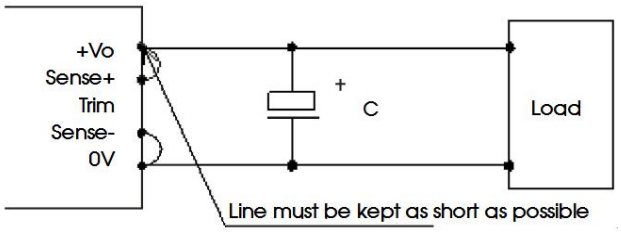
DRWFB400-F1D24





Remote Sense Application

1. Remote Sense Connection if not used

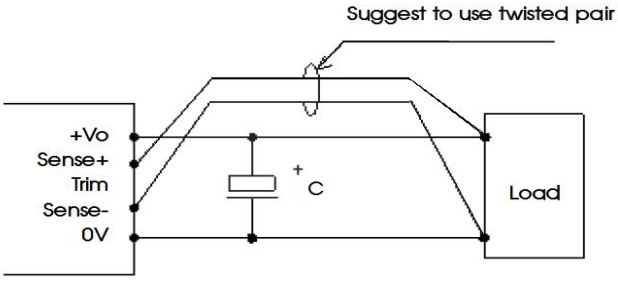


Notes:

(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.

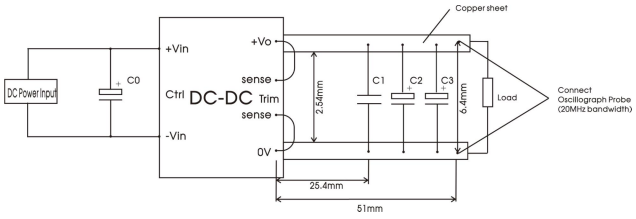


Fig.1

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

①We 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.

②Input 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.

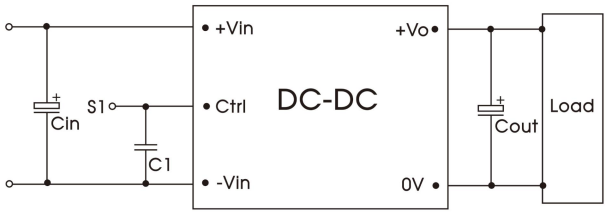


Fig.2

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

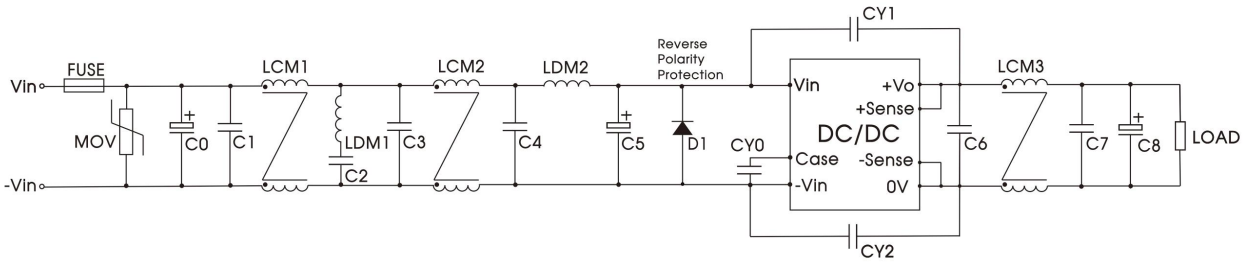
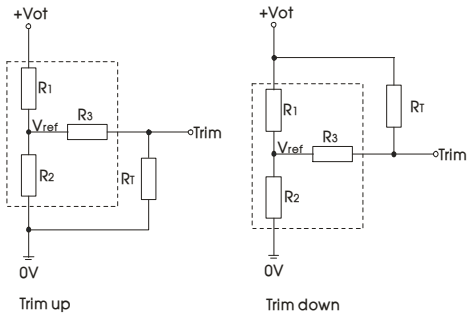


Fig. 3

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	P/N: EFL2D-6-451		
LCM2	P/N: EFL2D-6-402		
LCM3	5V/9V output		
	Others		
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 Vref refer to the above table 1.

RT: Resistance of Trim.

a: User-defined parameter, no actual meanings.

Vo': The trim up/down voltage.

Res \ Vo	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:

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

R_T according to E24≈6.8kΩ

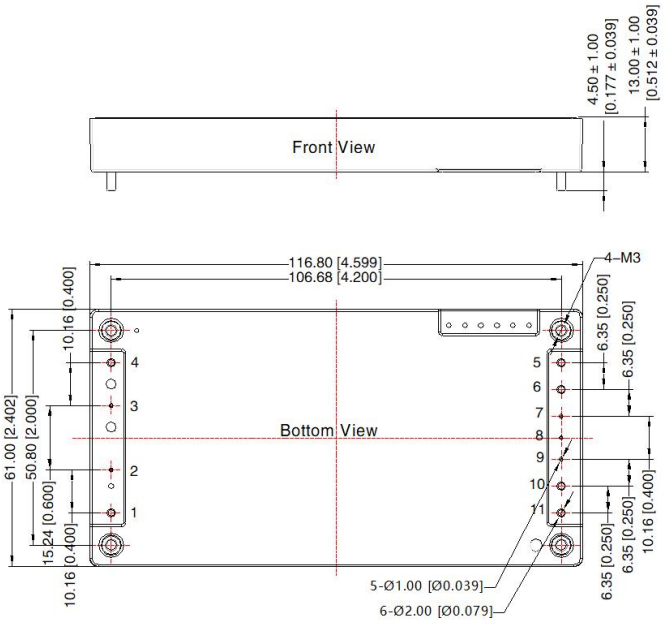
Practical Example trim up -10% for 12V output:

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

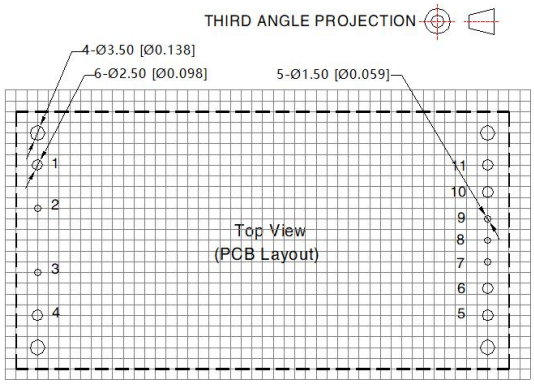
R_T according to E24≈53.6kΩ

5. The products do not support parallel connection of their output

DRWFB400-F1Dxx Dimensions and Recommended Layout

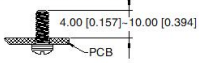


Note:
Unit: mm[inch]
Pin1, 4, 5, 6, 10, 11's diameter: 2.00[0.079]
Pin2, 3, 7, 8, 9's diameter: 1.00[0.039]
Pin diameter tolerances: ± 0.10[± 0.004]
General tolerances: ± 0.50[± 0.020]
Mounting hole screwing torque: Max 0.4 N・m



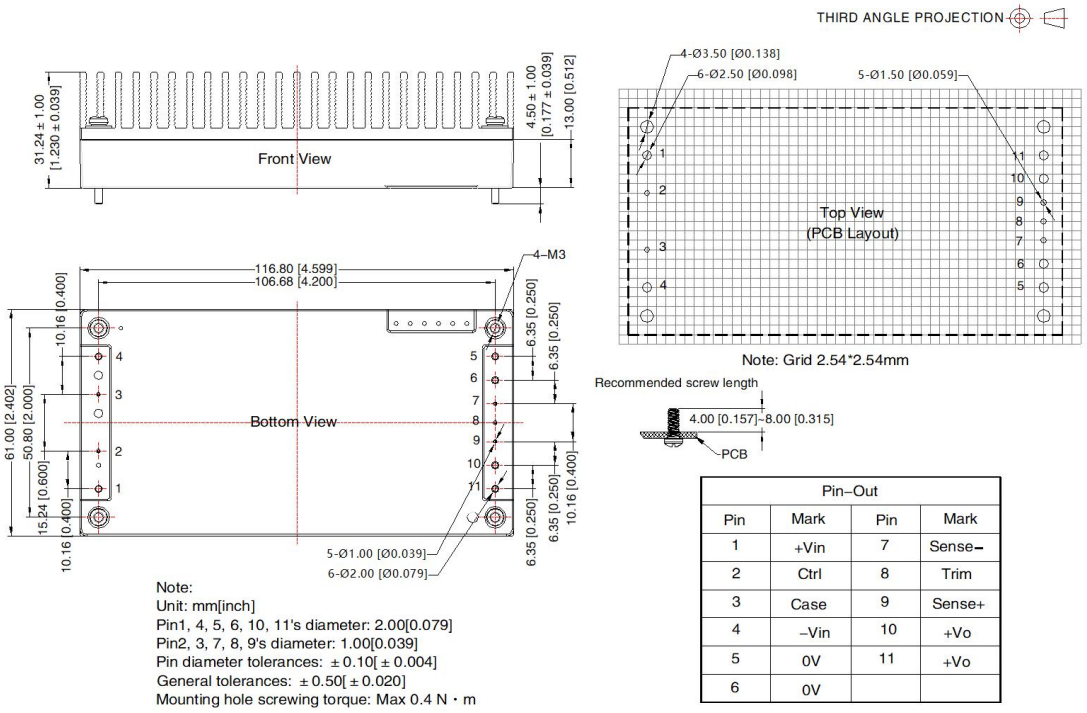
Note: Grid 2.54*2.54mm

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		

DRWFB400-F1DxxH Dimensions and Recommended Layout



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		

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

Notes:

1. It is suggested 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;
2. 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;
3. The maximum capacitive load offered were tested at input voltage range and full load;
4. 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;
5. All index testing methods in this datasheet are based on company corporate standards;
6. Products are related to laws and regulations: see "Features" and "EMC";
7. Our products shall be classified according to ISO14001 and related environmental laws and regulations, and shall be handled by qualified units;
8. The image certification marks are for reference only; please refer to the selection table for actual specifications. Certification is based on the physical mark or packaging label.