Descriptions

50W isolated，DC/DC Converter

CE Report EN62368-1　UKCA Report BS EN62368-1　RoHS　3 Years Warranty

Features

- Ultra-wide 12:1 input voltage range: 14 -160VDC
- High efficiency up to 90%
- Reinforced insulation, I/O isolation test voltage 3k VAC
- Operating ambient temperature range -40℃ to +105℃
- Active hold-up control, programmable input under-voltage control
- Input reverse polarity protection, Input under-voltage protection, output over-voltage, over-current, short-circuit protection, over-temperature protection
- Industry standard 1/4-Brick package
- Design to meet AREMA standards
- Design to meet UL62368 standards

Applications

- Vehicle-mounted switches
- Train control systems
- Associated equipment

Selection Guide

Certification	Part No.①	Input Voltage (VDC)		Output		Full Load Efficiency(%) ③ Min./Typ.	Max. Capacitive Load(μF)
		Nominal (Range)	Max.②	Voltage (VDC)	Current (mA) (Max./Min.)		
EN/BS EN	DRUQB50-F1D12(F)	110 (14-160)	180	12	4160/0	88/90	3500
--	DRUQB50-F1D12H						
EN/BS EN	DRUQB50-F1D15(F)			15	3330/0		2200
--	DRUQB50-F1D15H						
EN/BS EN	DRUQB50-F1D24(H)			24	2080/0	86/88	1000
--	DRUQB50-F1D24F						
EN/BS EN	DRUQB50-F1D28			28	1790/0		1000
--	DRUQB50-F1D28H/F						
EN/BS EN	DRUQB50-F1D48			48	1040/0	88/90	470

--	DRUQB50-F1D48H/F						
EN/BS EN	DRUQB50-F1D54			54	930/0		470
--	DRUQB50-F1D54H/F						

Note:
①Product model suffix "H" for the package with heat sink, "F" means the product with aluminum base, such as used in the case of higher heat dissipation requirements, you can choose with heat sink module;
②Exceeding the maximum input voltage may cause permanent damage;
③Efficiency is tested at nominal voltage 48V and full load at +25℃ ambient.

Specifications

Product Specifications	Item	Operating Conditions		Min.	Typ.	Max.	Unit
Input Specifications	Input Current (full load)	24V input voltage	24V, 28V output	--	2422	2480	mA
			12V, 15V, 48V, 54V output	--	2315	2368	
		36V input voltage	24V, 28V output	--	1596	1634	
			12V, 15V, 48V, 54V output	--	1544	1578	
		48V input voltage	24V, 28V output	--	1183	1211	
			12V, 15V, 48V, 54V output	--	1158	1184	
		72V input voltage	24V, 28V output	--	789	807	
			12V, 15V, 48V, 54V output	--	772	790	
		96V input voltage	24V, 28V output	--	599	613	
			12V, 15V, 48V, 54V output	--	579	592	
	Input Current (full load)	110V input voltage	24V, 28V output	--	522	534	
			12V, 15V, 48V, 54V output	--	506	517	
	Reflected Ripple Current	Nominal input voltage		--	150	--	
	Surge Voltage (1sec. max.)			-0.7	--	200	VDC
	Start-up Voltage			--	--	14	
	Start-up Current	Nominal 48 input voltage, full load		--	--	2500	mA
	Start-up Time	Nominal input voltage, constant resistance load		--	50	100	ms
	Input Filter			LC filter			
	Hot Plug			Unavailable			
	No-load Input Power	Ctrl pin open or pulled high, DC-DC ON (14-160VDC)		--	1.2	2.0	W
	Idle Input Power	Ctrl pin pulled low to -Vin, DC-DC OFF (14-160VDC)		--	0.7	1.6	
	Ctrl①	Module on		Ctrl pin open or pulled high (3.5-12VDC)			
		Module off		Ctrl pin pulled low to -Vin (0-1.2VDC)			
	Input Under-voltage Protection			10	11	--	VDC
	UVLO②	Operating temperature range, UVLO pin open, module off		10	--	--	
		Operating temperature range, UVLO pin connect to -Vin, module off		60	--	--	

Output Specifications	Voltage Accuracy	Nominal input voltage, 0%-100% load		--	--	±2	%
	Linear Regulation	Input voltage variation from low to high at full load		--	±0.2	±0.5	
	Load Regulation	Nominal input voltage, 10%-100% load		--	±0.5	±1	
	Transient Recovery Time	25% load step change @25℃		--	--	500	μs
	Transient Response Deviation	25% load step change @25℃		--	±3	±5	%
	Temperature Coefficient	Nominal output voltage, full load		--	--	±0.03	%/℃
	Ripple & Noise③	20MHz bandwidth, 10%-100% load		--	150	300	mVp-p
	Trim			90	--	110	%Vo
	Sense			--	--	105	
	Over-temperature Protection	Max. Case Temperature		--	115	125	℃
	Over-voltage Protection	Input voltage range (14-160V)		110	--	160	%Vo
	Over-current Protection			105	160	260	%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	2500	--	--	
			Output-case	2100	--	--	
	Insulation Resistance	Input-output resistance at 500VDC		1000	--	--	MΩ
	Isolation Capacitance	Input-output capacitance at 100KHz/0.1V		--	1100	--	pF
	Operating Temperature			-40	--	105	℃
	Storage Temperature			-55	--	125	
	Pin Soldering Resistance Temperature	Soldering spot is 1.5mm away from case for 10 seconds		--	--	300	
	Storage Humidity	Non-condensing		5	--	95	%RH
	Switching Frequency	PWM mode		--	175	--	kHz
	MTBF	IEC 61709 @25℃		1000	--	--	k hours
	Cooling Test	EN60068-2-1					
	Dry Heat	EN60068-2-2					
	Damp Heat	EN60068-2-30					
	Shock and Vibration Test	IEC/EN61373 Class B					
	Pollution Level	PD 3					
	Fire & Smoke Compliance	EN45545-2, HL3					
	Salt Mist Test	EN60068-2-11, Ka					
	Cyclic Damp Heat Test	EN60068-2, Db variant 2					
	Altitude④	5000m					
	Low Temperature Start-up and Storage Test	EN60068-1, Ad and Ab					
Mechanical Specifications	Case Material	Aluminum alloy case; Black plastic bottom, flame-retardant and heat-resistant (UL94 V-0)					
	Dimension	Without heat sink	57.90 x 36.80x 12.70mm				
		With H heat sink	57.90 x 36.80x 25.40mm				
		With F heat sink	62.00 x 56.00 x 14.50mm				

	Weight	Without heat sink	79.5g (Typ.)
		With H heat sink	109.5g (Typ.)
		With F heat sink	99.5g (Typ.)
	Cooling Method	Conduction cooling or forced air cooling Free air convection cooling with additional heat sink	

Note:
①The Ctrl pin voltage is referenced to input -Vin;
②The UVLO pin voltage is referenced to input -Vin, please refer to Fig. 9;
③The "Tip and barrel method" is used for ripple and noise test, for details please refer to Fig.3;
④When the altitude is above 2000m, the product surface max. temperature must be below 105℃.

Electromagnetic Compatibility (EMC)(EN50121-3-2)

Emissions	CE	EN50121-3-2	EN55016-2-1 150kHz-500kHz 99dBuV (see Fig. 6 for recommended circuit) 500kHz-30MHz 93dBuV (see Fig. 6 for recommended circuit)	
		EN55032	EN55032-11 150kHz-500kHz 79dBuV (see Fig. 6 for recommended circuit) 500kHz-30MHz 73dBuV (see Fig. 6 for recommended circuit)	
	RE	CISPR16-2-3	30MHz-230MHz 40dBuV/m at 10m (see Fig. 6 for recommended circuit) 230MHz-1GHz 47dBuV/m at 10m (see Fig. 6 for recommended circuit) 1GHz-6GHz 47dBuV/m at 10m (see Fig. 6 for recommended circuit)	
Immunity	ESD	EN61000-4-2	Contact ±6kV/Air ±8kV	perf. Criteria A
	RS	EN61000-4-3	80 - 800MHz 20V/m 800 - 1000MHz 20V/m 1400 - 2000MHz 10V/m 2000 - 2700MHz 5V/m 5100 - 6000MHz 3V/m	perf. Criteria A
	EFT	EN61000-4-4	±2kV 5/50ns 5kHz (see Fig. 6 for recommended circuit)	perf. Criteria A
	Surge	EN61000-4-5	line to line ±1kV (42Ω, 0.5μF) line to ground ±2kV(42Ω, 0.5μF) (see Fig. 6 for recommended circuit) line to line ±1kV (2Ω, 18μF) line to ground ±2kV(12Ω, 9μF) (see Fig. 6 for recommended circuit)	perf. Criteria A
	CS	EN61000-4-6	0.15MHz-80MHz 10V r.m.s	perf. Criteria A

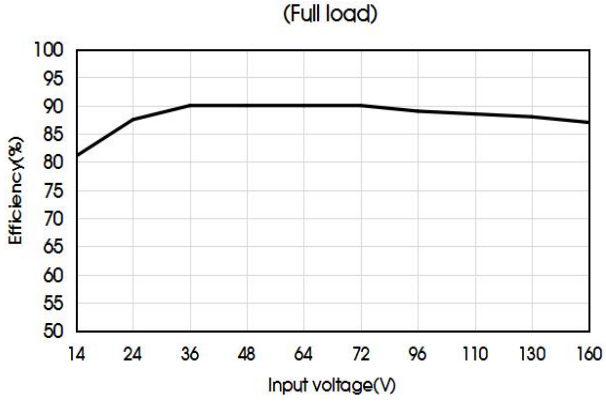
Electromagnetic Compatibility (EMC)(AREMA)

Emissions	CE	CISPR16-2-1	150kHz-500kHz	79dBuV (see Fig. 6 for recommended circuit)
		CISPR16-1-2	500kHz-30MHz	73dBuV (see Fig. 6 for recommended circuit)
	RE	CISPR16-2-3	30MHz-230MHz	40dBuV/m at 10m (see Fig. 6 for recommended circuit)
			230MHz-1GHz	47dBuV/m at 10m (see Fig. 6 for recommended circuit)
Immunity	ESD	IEC61000-4-2	Contact ±6kV/Air ±8kV	perf. Criteria A
	RS	IEC61000-4-3	80 - 1000MHz 10V/m 160 - 165MHz 20V/m 450 - 470MHz 20V/m 800 - 960MHz 20V/m 1400 - 2000MHz 20V/m 2100 - 2500MHz 5V/m	perf. Criteria A

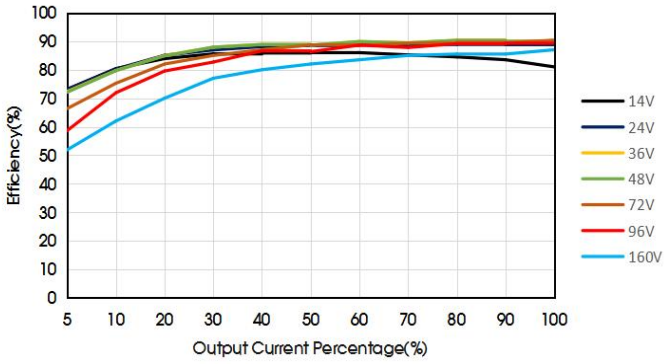
	EFT	IEC61000-4-4	±2kV 5/50ns 5kHz (see Fig. 6 for recommended circuit)	perf. Criteria A
	Surge	IEC61000-4-5	line to line ±2kV (2Ω, 18μF) line to ground ±2kV(2Ω, 18μF) (see Fig. 6 for recommended circuit)	perf. Criteria A
	CS	IEC61000-4-6	0.15MHz-80MHz 10V r.m.s	perf. Criteria A
	MS	IEC61000-4-8	60Hz 100A/m (see Fig. 6 for recommended circuit)	perf. Criteria A
			60Hz 300A/m (see Fig. 6 for recommended circuit)	

Characteristic Curve

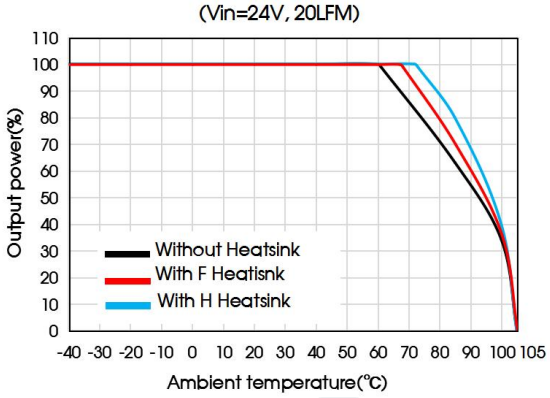
DRUQB50-F1D12 Efficiency Vs Input voltage



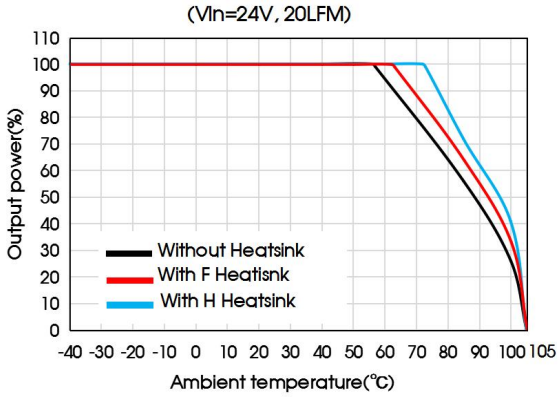
DRUQB50-F1D12 Efficiency Vs Output load



WTH1D12/15 Temperature Derating Curves



DRUQB50-F1D24/28/48/54 Temperature Derating Curves



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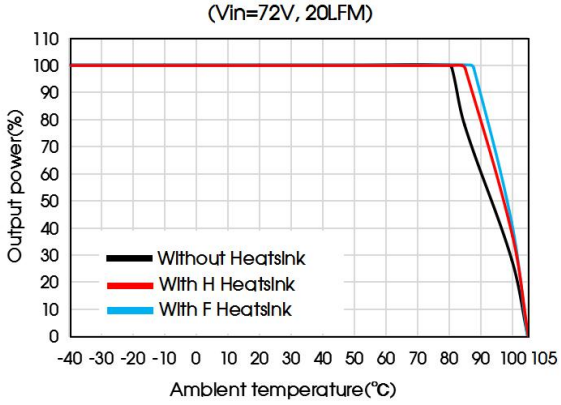
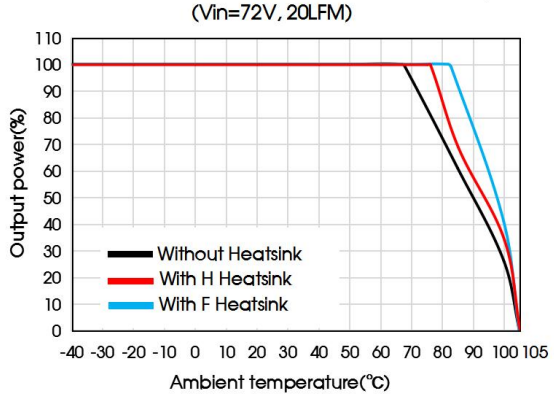
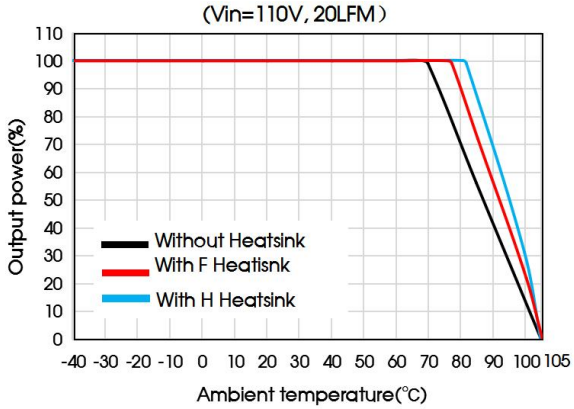


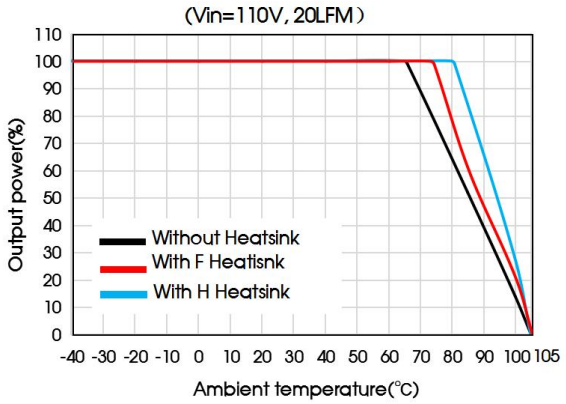
DRUQB50-F1D24/28/48/54 Temperature Derating Curves



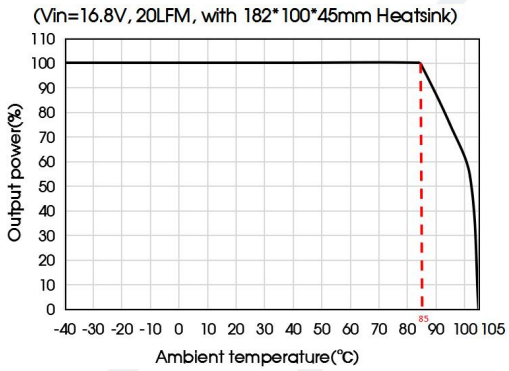
DRUQB50-F1D12/15 Temperature Derating Curves



DRUQB50-F1D24/28/48/54 Temperature Derating Curves



DRUQB50-F1D24 Temperature Derating Curves



Remote Sense Application

1. Remote Sense Connection if not used

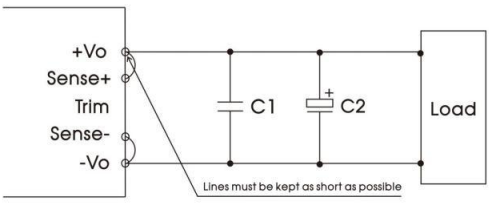


Fig.1

Notes:

1. If the sense function is not used for remote regulation the user must connect the +Sense to +Vo and -Sense to -Vo.

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

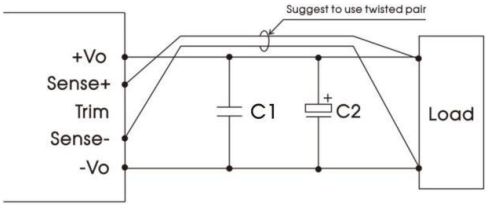


Fig.2

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 pairs 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. 3.

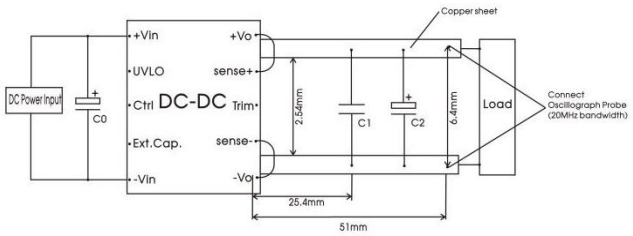


Fig.3

Capacitors value / Output voltage	C0(μF)	C1(μF)	C2(μF)
12VDC	100μF, voltage≥ 200V	1μF, voltage≥ 1.2*Vo	330μF, voltage≥ 1.2*Vo
15VDC			
24VDC			
28VDC			
48VDC			
54VDC			

2. Typical application

1. EMC circuit is recommended, 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.

2. Output ripple can be further reduced by appropriately increasing the output capacitor values C3 and/or by selecting capacitors with a low ESR (equivalent series resistance). Also make sure that the capacitance is not exceeding the specified max. capacitance load value of the product.

3. The UVLO pin can adjust the point of input under-voltage protection by the external resistance RUVLO. Please refer to Fig.9 for the value of RUVLO, if the pin is left open, the under-voltage protection point is 11V.

4. Ctrl current-mode logic recommended circuit design refer to fig.4.

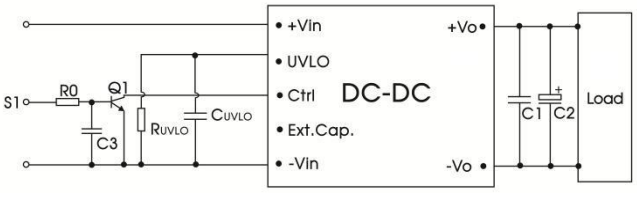


Fig.4

Components	Value	Recommended
R0	10K	--
C3	0.1μF	voltage≥25V
Q1	Ic≥10mA	voltage≥30V
Note: S1 pin open, DC-DC ON.		

Trim Function for Output Voltage Adjustment (open if unused)

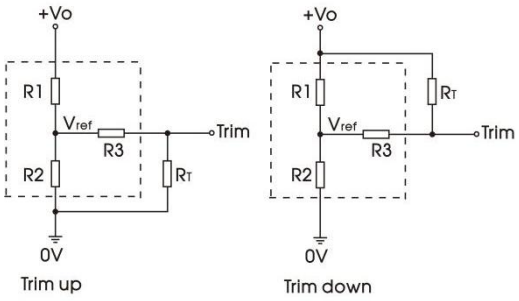


Fig.5

Trim resistor connection (dashed line shows internal resistor network)

Calculation formula of Trim resistance:

$$\text{Trim up}: R_T = \frac{a * R_2}{R_2 - a} - R_3 \qquad a = \frac{2.5 * R_1}{Vo - 2.5}$$

$$\text{Trim down}: R_T = \frac{b * R_1}{R_1 - b} - R_3 \qquad b = \frac{(Vo - 2.5) * R_2}{2.5}$$

Note:

a , b: self-defined parameter, round to the nearest hundredth

R_T[kΩ]: Resistance of Trim.

Vo: Output voltage change.

V_{ref}[VDC]: Reference voltage.

Res \ Vo	12(VDC)	15(VDC)	24(VDC)	28(VDC)	48(VDC)	54(VDC)
R1(KΩ)	11	14.35	24.8	28.8	54	61
R2(KΩ)	2.87	2.87	2.87	2.87	2.94	2.94
R3(KΩ)	20.2	20.2	16.1	16.1	18.2	18.2

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

$$b = \frac{(10.8 - 2.5) * 2.87}{2.5} = 9.53$$

$$R_T = \frac{9.53 * 11}{11 - 9.53} - 20.2 = 51.113K\Omega$$

R_T according to E24≈51 kΩ

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

$$a = \frac{2.5 * 11}{13.2 - 2.5} = 2.57$$

$$R_T = \frac{2.57 * 2.87}{2.87 - 2.57} - 20.2 = 4.386K\Omega$$

R_T according to E24≈4.3kΩ

4. EMC compliance circuit

1. The anti-reverse connection circuit is composed of a circuit breaker and a diode D1. The withstand voltage of the diode D1 must be greater than 250V;

2. The EMC filter part is composed of modular circuits. Please refer to Figure 6 for recommended circuits and parameters. Self-built circuits can also be used;

3. Resistor RUVLO is used to adjust the input under-voltage protection point. Refer to Figure 9 for the value.

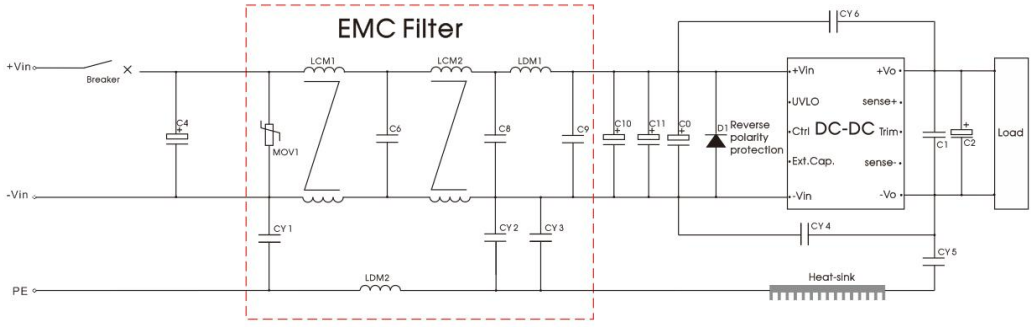


Fig.6

Components Value / Matching Power output	C4	C2	C1	CY4, CY5, CY6	D1
12V	100μF Voltage≥200V	330μF Voltage≥1.2*Vo	1μF Voltage≥1.2*Vo	3300 pF /400VAC Y1 safety capacitor	20A Voltage≥200V
15V					
24V					
28V					
48V					
54V					
Breaker	The Breaker value varies with different power modules and must be selected in accordance with the specified input current of the corresponding power converter, but not exceeding the filter specifications.				
Note: A ferrite core on the power lines and load lines can ensures a better EMI test margin.					

EMC Filter		
Components	Value	Recommended Component
C6	0.1μF	Voltage≥630V
C8	0.22μF	Voltage≥250V
C9	2.2μF	Voltage≥250V
LCM1	≧2mH	FL2D-A2-202
LCM2	≧4mH	COMMON MODE, ≧4mH, 35mΩ, -40 to +125℃
LDM1	0.47μH	Shielding Inductive
LDM2	150μH	Differential MODE, 150uH±35%, 30mΩ, -40 to +125℃ Core T10*6*4, Ø0.5mm×25Ts
CY1, CY2	2200 pF /400VAC	Y1 safety capacitor
CY3	1000 pF /400VAC	Y1 safety capacitor
MOV1	7D221K	Varistor

Surge standard	Components	Value	Recommended Component
line to line ±1KV (42Ω, 0.5μF) line to ground ±2kV (42Ω, 0.5μF)	C0	100μF	Voltage≥250V
	C10, C11	--	--
line to line ±1KV (2Ω, 18μF) line to ground ±2kV (12Ω, 9μF)	C0, C10	100μF	Voltage≥250V
	C11	--	--
line to line ±2KV (2Ω, 18μF) line to ground ±2kV (2Ω, 18μF)	C0, C10, C11	100μF	Voltage≥250V

5. Hold-up time setup capacitor

Fig.7 Recommended circuit and PCB layout for hold-up time

The hold-up time capacitor CExt. Cap is used to hold the output when the input power off.

Note:

1. If there is no requirement for the hold-up time, no additional capacitor CExt. Cap is required;
2. For the hold-up time of 10ms and 30ms, please refer to table blow;
3. Vq is Start-up voltage.
4.CExt. Cap withstand voltage is greater than≧100V.

Po (W)		50					
Vin (V)		24	36	48	72	96	110
V_o(V)		13.2	19.5	26.9	40.3	53.4	61.1
$C_{Ext.\ Cap}$ (μF)	△t: 10ms	220	220	220	220	220	220
	△t: 30ms	680	680	680	680	680	680

6. Recommended circuit for multi-module parallel redundant design

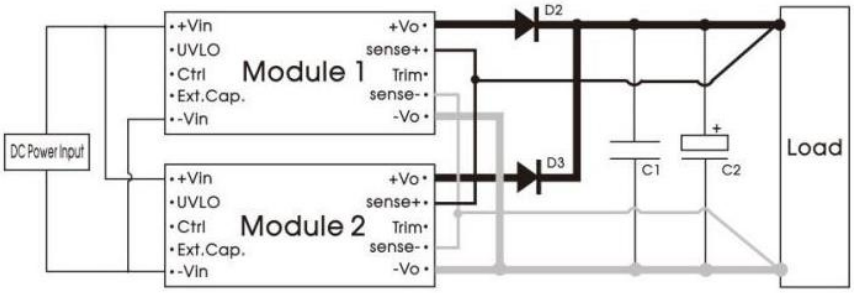


Fig.8

Note:

1. The function of capacitor C1, C2 is filtering. It is used for margin design and cannot be used to increase power;
2. The diodes D2 and D3 are used to protect the power module. In actual use, the user can choose the parameters of the diode or MOSFET according to the output current;
3. Because the output impedance of the two modules is different, the output power of each module cannot be guaranteed to be equal; Pload = P1 + P2 <Pmax (50W).

7. UVLO Function and R_{UVLO} Values

The products with an ultra-wide input voltage range, covering a variety of nominal input voltages. Set the input under-voltage point adjustable function for different input systems, connect a resistor between UVLO pin and -Vin, adjust the under-voltage point of the product by adjusting the resistor value.

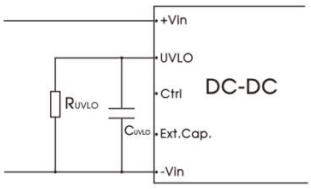


Fig.9

UVLO values for various nominal input voltage and R_{UVLO} table

Nominal input voltage (V)	24	36	48	72	96	110
Starting Voltage (V)	13.2	19.5	26.9	40.3	53.4	61.1
Shutdown Voltage (V)	11.2	16.7	23.3	34.8	46.3	53.1
UVLO setup resistance (KΩ)	open	150	56.1	18.3	5.6	1.5
UVLO setup calculation	100nF/50V/0805					

Calculation formula of R_{UVLO} setup resistance：

$$R_{UVLO} = \frac{182 * c}{182 - c} - 20 \qquad c = \frac{1272.35}{V_{shutdown} - 6.45}$$

Note:

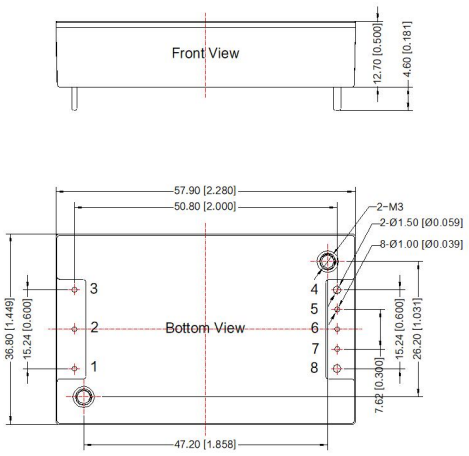
c: self-defined parameter.

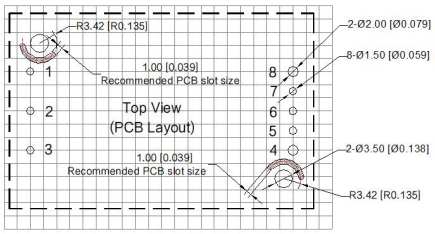
R_{UVLO}(KΩ): UVLO setup resistance.

$V_{shutdown}$: UVLO shutdown voltage.

Standard Dimensions and Recommended Layout (without heat sink)

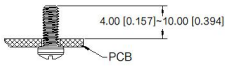
THIRD ANGLE PROJECTION





Note: Grid 2.54*2.54mm

Recommended screw length

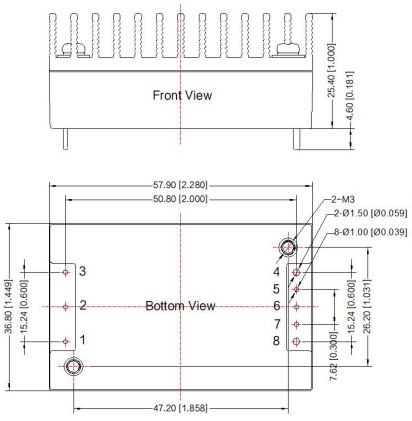


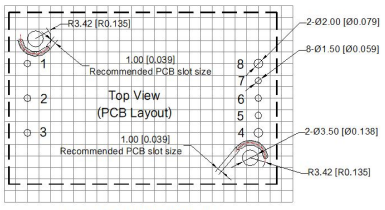
Pin-Out			
Pin	Mark	Pin	Mark
1	+Vin	4	-Vo
2	Ctrl	5	Sense-
3	-Vin	6	Trim
		7	Sense+
		8	+Vo

Note:
Unit: mm[inch]
Pin1,2,3,5,6,7's diameter: 1.00 [0.039]
Pin4,8's diameter: 1.50 [0.059]
Pin diameter tolerances: ± 0.10 [± 0.004]
General tolerances: ± 0.50 [± 0.020]
Mounting hole screwing torque: Max 0.4 N · m

Standard Dimensions and Recommended Layout(with H heat sink)

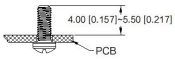
THIRD ANGLE PROJECTION





Note: Grid 2.54*2.54mm

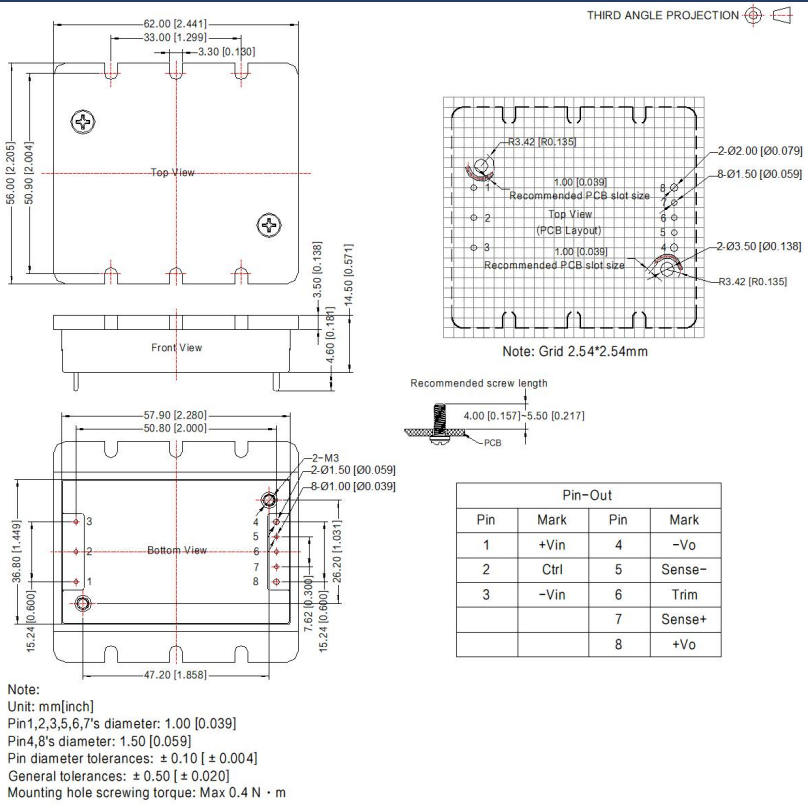
Recommended screw length



Pin-Out			
Pin	Mark	Pin	Mark
1	+Vin	4	-Vo
2	Ctrl	5	Sense-
3	-Vin	6	Trim
		7	Sense+
		8	+Vo

Note:
Unit: mm[inch]
Pin1,2,3,5,6,7's diameter: 1.00 [0.039]
Pin4,8's diameter: 1.50 [0.059]
Pin diameter tolerances: ± 0.10 [± 0.004]
General tolerances: ± 0.50 [± 0.020]
Mounting hole screwing torque: Max 0.4 N · m

Standard Dimensions and Recommended Layout(with F heat sink)



Pin-Out			
Pin	Mark	Pin	Mark
1	+Vin	4	-Vo
2	Ctrl	5	Sense-
3	-Vin	6	Trim
		7	Sense+
		8	+Vo

Note:
Unit: mm[inch]
Pin1,2,3,5,6,7's diameter: 1.00 [0.039]
Pin4,8's diameter: 1.50 [0.059]
Pin diameter tolerances: ± 0.10 [± 0.004]
General tolerances: ± 0.50 [± 0.020]
Mounting hole screwing torque: Max 0.4 N・m

Note:

1. The maximum capacitive load offered were tested at input voltage range and full load;
2. Unless otherwise specified, data in this datasheet should be tested under the conditions of Ta=25℃, humidity<75%RH with nominal input voltage and rated load;
3. All index testing methods in this datasheet are based on our company corporate standards;
4. Product customization is available, please contact below email directly for specific needs;
5. Products are related to laws and regulations: see "Features" and "EMC";
6. Our products shall be classified according to ISO14001 and related environmental laws and regulations, and shall be handled by qualified units.