

50W isolated DC-DC converter
Ultra-wide input and regulated single output



Patent Protection



CB Report RoHS



CSA62368 EN62368 BS EN62368 IEC62368-1
EN50155
EN45545

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°C to +105°C
- 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

The UWTH1D_QB-50W(H/F)R3S series is a high-performance product specifically designed for a variety of railway applications. The output power can reach at 50W. It features wide input voltage of 14-160VDC, which is compatible with nominal input type of 24V, 48V, 72V, 96V and 110V. Meets EN50155 standard for voltage fluctuations. The reinforced high insulation 3000VAC ensures that the system can still be used safely in 5000m high altitude applications. The allowable operating temperature is up to 105°C. It integrates multiple protection functions to ensure the safety and high reliability of the system, with functions of remote control and compensation, output voltage adjustment, etc., which perfectly matches the requirements of line loss and special voltage in the application. It is widely used in vehicle-mounted switches, train control systems and 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.)		
CSA/EN/ BS EN/IEC	UWTH1D12QB-50W(H/F)R3S	110 (14-160)	160	12	4160/0	88/90	3500
	UWTH1D15QB-50W(H/F)R3S			15	3330/0		2200
	UWTH1D24QB-50W(H/F)R3S			24	2080/0	86/88	1000
	UWTH1D28QB-50W(H/F)R3S			28	1790/0		1000
	UWTH1D48QB-50W(H/F)R3S			48	1040/0	88/90	470
	UWTH1D54QB-50W(H/F)R3S			54	930/0		470

Note:

①Use "F/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;

②Exceeding the maximum input voltage may cause permanent damage;

③Efficiency is tested at nominal voltage 48V and full load at +25°C ambient.

Input Specifications

Item	Operating Conditions			Min.	Typ.	Max.	Unit
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	mA	
		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		
Ctrl ^①	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	
UVLO ^②	Operating temperature range, UVLO pin open, module off		10	--	--	VDC	
	Operating temperature range, UVLO pin connect to -Vin, module off		60	--	--		

Note:

①The Ctrl pin voltage is referenced to input -Vin;

②The UVLO pin voltage is referenced to input -Vin, please refer to Fig. 9.

Output Specifications

Item	Operating Conditions	Min.	Typ.	Max.	Unit
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°C	--	--	500	μs
Transient Response Deviation		--	±3	±5	%
Temperature Coefficient	Nominal output voltage, full load	--	--	±0.03	%/°C
Ripple & Noise ^①	20MHz bandwidth, 10%-100% load	--	150	300	mVp-p
Trim		90	--	110	%Vo
Sense		--	--	105	
Over-temperature Protection	Max. Case Temperature	--	115	125	°C
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			

Note:

①The "Tip and barrel method" is used for ripple and noise test, for details please refer to Fig.3.

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	--	--
		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	°C
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°C	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
Altitude ^①		5000m
Low Temperature Start-up and Storage Test		EN60068-1, Ad and Ab

Note: ①When the altitude is above 2000m, the product surface max. temperature must be below 105°C.

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	

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)
Emissions	RE	EN55032	EN55032-11	150kHz-500kHz	79dBuV	(see Fig. 6 for recommended circuit)
				500kHz-30MHz	73dBuV	(see Fig. 6 for recommended circuit)
Immunity	ESD	EN61000-4-2	Contact $\pm 6kV$ /Air $\pm 8kV$			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			
Immunity	EFT	EN61000-4-4	$\pm 2kV$ 5/50ns 5kHz (see Fig. 6 for recommended circuit)			perf. Criteria A
	Surge	EN61000-4-5	line to line $\pm 1kV$ (42Ω , $0.5\mu F$) line to ground $\pm 2kV$ (42Ω , $0.5\mu F$) (see Fig. 6 for recommended circuit) line to line $\pm 1kV$ (2Ω , $18\mu F$) line to ground $\pm 2kV$ (12Ω , $9\mu F$) (see Fig. 6 for recommended circuit)			perf. Criteria A
Immunity	CS	EN61000-4-6	0.15MHz-80MHz 10V r.m.s			perf. Criteria A

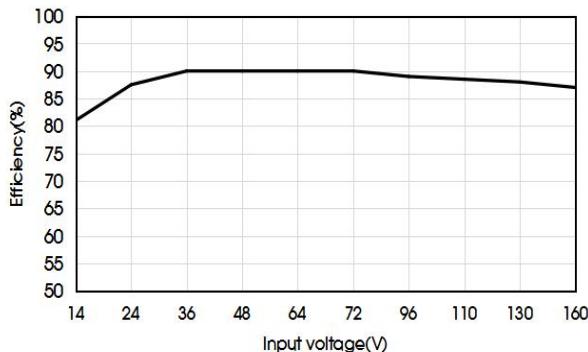
Electromagnetic Compatibility (EMC) (AREMA)

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 230MHz-1GHz	40dBuV/m at 10m 47dBuV/m at 10m	(see Fig. 6 for recommended circuit)
Immunity	ESD	IEC61000-4-2	Contact $\pm 6kV$ /Air $\pm 8kV$		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
Immunity	EFT	IEC61000-4-4	$\pm 2kV$ 5/50ns 5kHz (see Fig. 6 for recommended circuit)		perf. Criteria A
	Surge	IEC61000-4-5	line to line $\pm 2kV$ (2Ω , $18\mu F$) line to ground $\pm 2kV$ (12Ω , $9\mu F$) (see Fig. 6 for recommended circuit)		perf. Criteria A
	CS	IEC61000-4-6	0.15MHz-80MHz 10V r.m.s		perf. Criteria A

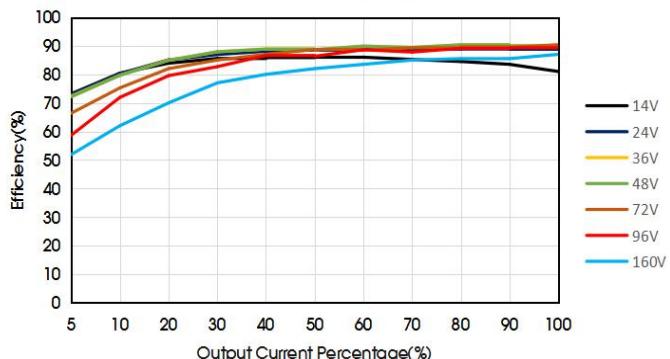
	MS	IEC61000-4-8	60Hz 60Hz	100A/m 300A/m	(see Fig. 6 for recommended circuit) (see Fig. 6 for recommended circuit)	perf. Criteria A
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Typical Performance Curves

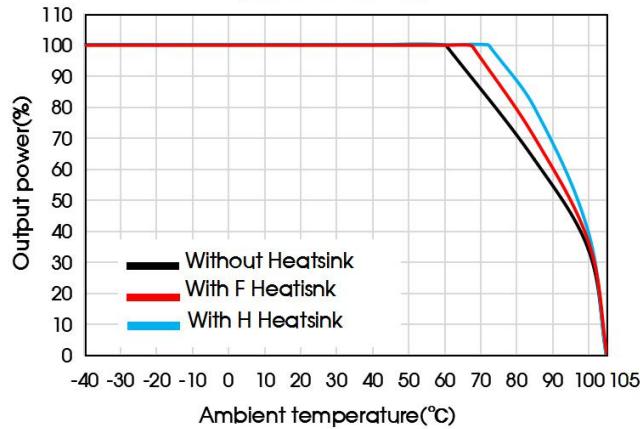
UWTH1D12QB-50WR3S Efficiency Vs Input voltage
(Full load)



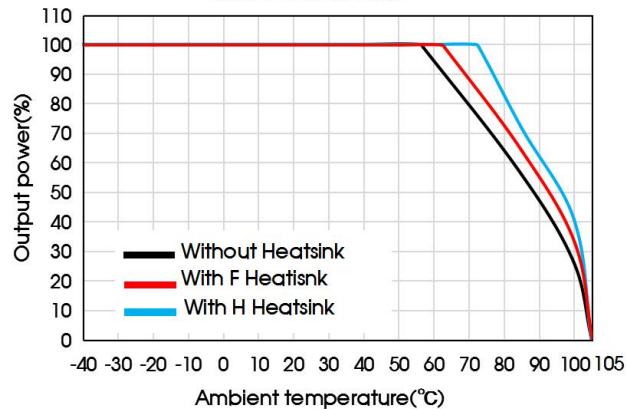
UWTH1D12QB-50WR3S Efficiency Vs Output load



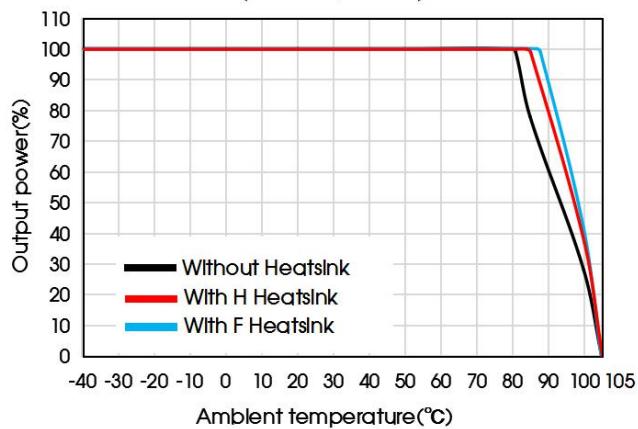
UWTH1D12/15QB-50WR3S Temperature Derating Curves
(Vin=24V, 20LFM)



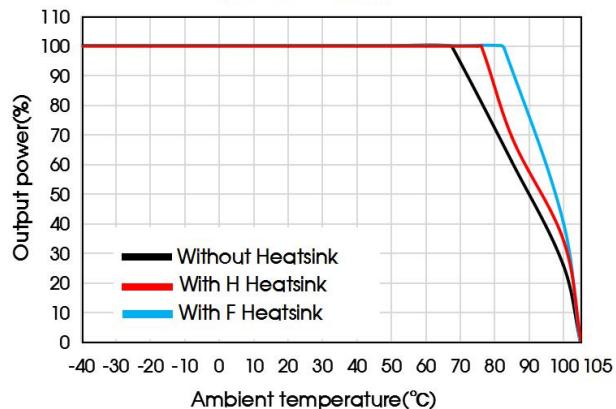
UWTH1D24/28/48/54QB-50WR3S Temperature Derating Curves
(Vin=24V, 20LFM)



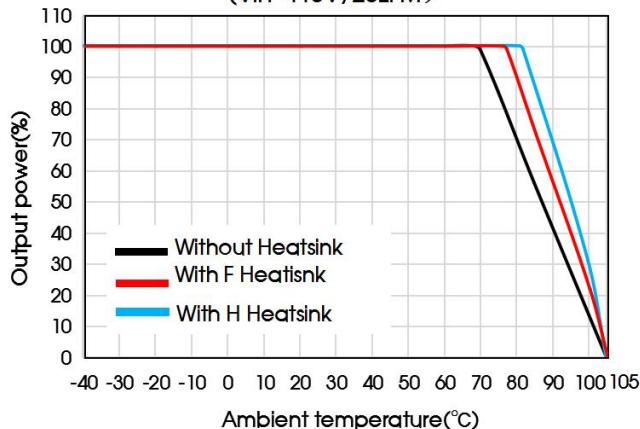
UWTH1D12/15QB-50WR3S Temperature Derating Curves
(Vin=72V, 20LFM)



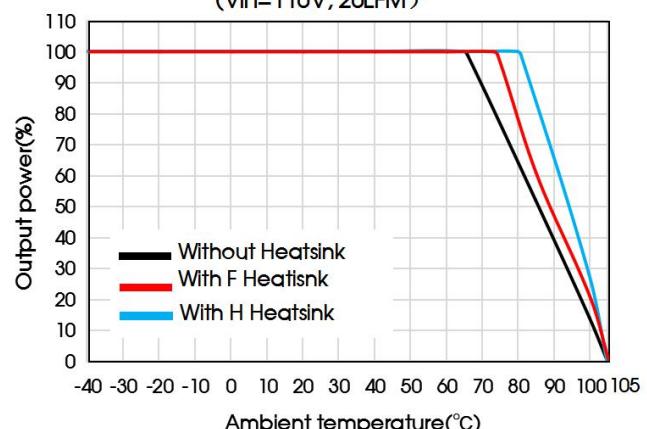
UWTH1D24/28/48/54QB-50WR3S Temperature Derating Curves
(Vin=72V, 20LFM)



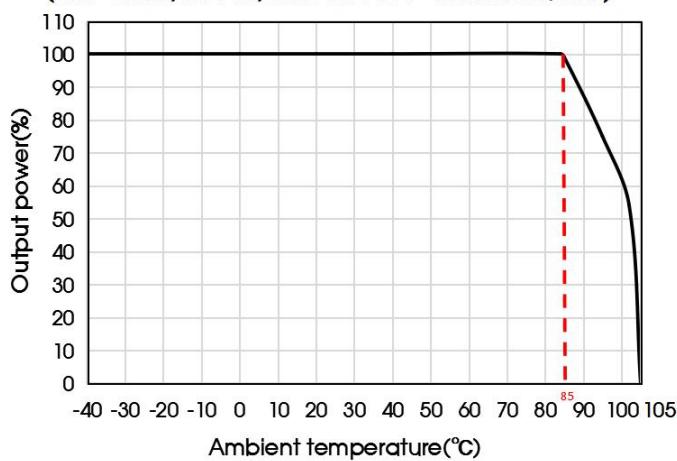
UWTH1D12/15QB-50WR3S Temperature Derating Curves
(Vin=110V, 20LFM)



UWTH1D24/28/48/54QB-50WR3S Temperature Derating Curves
(Vin=110V, 20LFM)



UWTH1D24QB-50WR3S Temperature Derating Curves
(Vin=16.8V, 20LFM, with 182*100*45mm Heatsink)



Remote Sense Application

1. Remote Sense Connection if not used

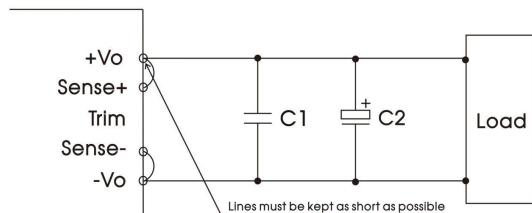


Fig.1

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

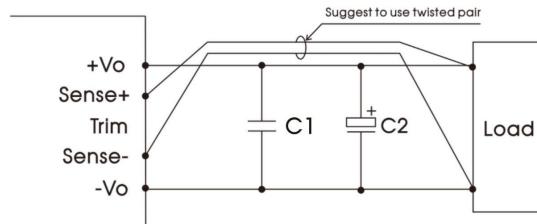


Fig.2

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.

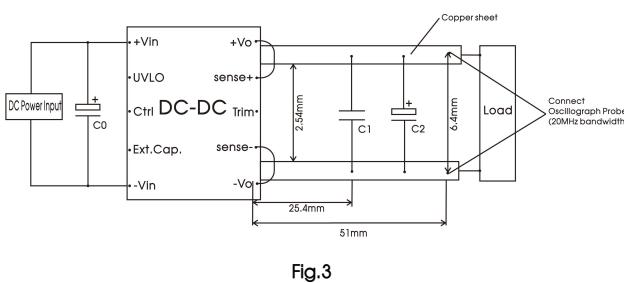


Fig.3

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

2. Typical application

1. Mornsun 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.

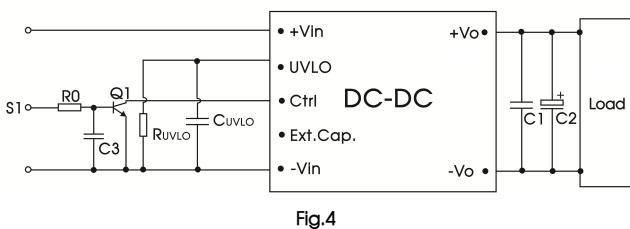
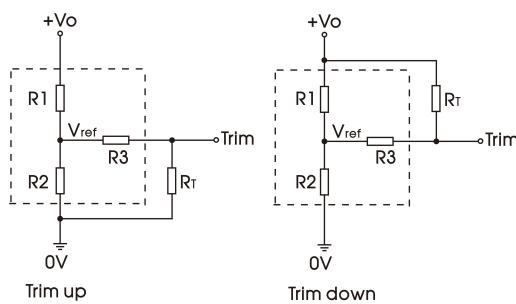


Fig.4

Components	Value	Recommended Component
R0	10K	--
C3	0.1μF	voltage $\geq 25V$
Q1	Ic $\geq 10mA$	voltage $\geq 30V$

Note: S1 pin open, DC-DC ON.

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



Calculation formula of Trim resistance:

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

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

Note:

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

R_T(kΩ): Resistance of Trim.

V_o: Output voltage change.

V_{ref}(VDC): Reference voltage.

Fig.5

Trim resistor connection (dashed line shows internal resistor network)

Vo Res	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	18.2	18.2	18.2	18.2

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

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

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

R_T according to E24≈51 kΩ

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

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

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

R_T according to E24≈4.3k Ω

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.

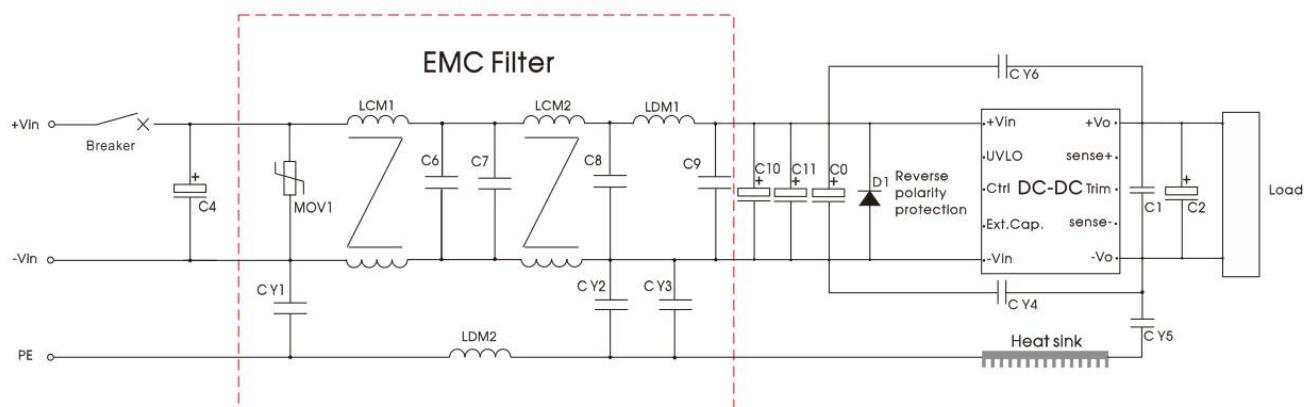


Fig.6

Components Value	C4	C2	C1	CY4, CY5, CY6	D1
Matching Power output voltage					
12V					
24V					
28V	100μF Voltage $\geq 200V$	330μF Voltage $\geq 1.2 \cdot V_o$	1μF Voltage $\geq 1.2 \cdot V_o$	3300 pF /400VAC Y1 safety capacitor	20A Voltage $\geq 200V$
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 ensure a better EMI test margin.					

EMC Filter		
Components	Value	Recommended Component
C6	0.1μF	Voltage $\geq 630V$
C8	0.22μF	Voltage $\geq 250V$
C9	2.2μF	Voltage $\geq 250V$
LCM1	$\geq 2mH$	FL2D-A2-202
LCM2	$\geq 4mH$	COMMON MODE, $\geq 4mH$, 35mΩ, -40 to +125°C Ø1.2mmx24Ts
LDM1	0.47μH	Shielding Inductive
LDM2	150μH	Differential MODE, 150μH $\pm 35\%$, 30mΩ , -40 to +125°C Core T10*6*4, Ø0.5mmx25Ts
CY1, CY2	2200 pF /400VAC	Y1 safety capacitor
CY3	1000 pF /400VAC	Y1 safety capacitor
MOV1	7D221K	Varistor

Note: The EMC filter recommended to use MORNSUN P/N: FC-C08D.

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

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 below;
3. Vq is Start-up voltage.

Po (W)	50					
Vin (V)	24	36	48	72	96	110
V _q (V)	13.2	19.5	26.9	40.3	53.4	61.1
C _{Ext. Cap} (μF)	Δt: 10ms	220	220	220	220	220
	Δt: 30ms	680	680	680	680	680

6. Recommended circuit for multi-module parallel redundant design

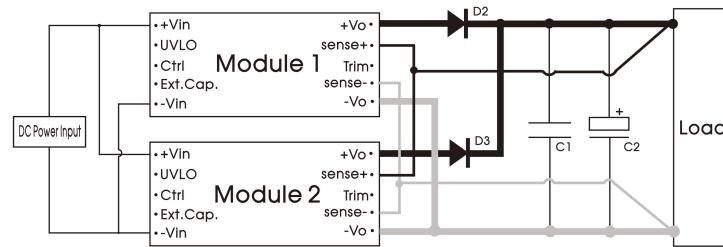


Fig.8

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.

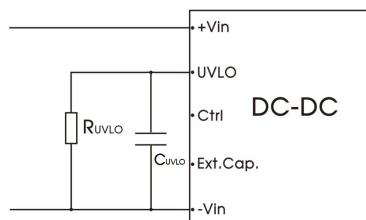


Fig.9

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					

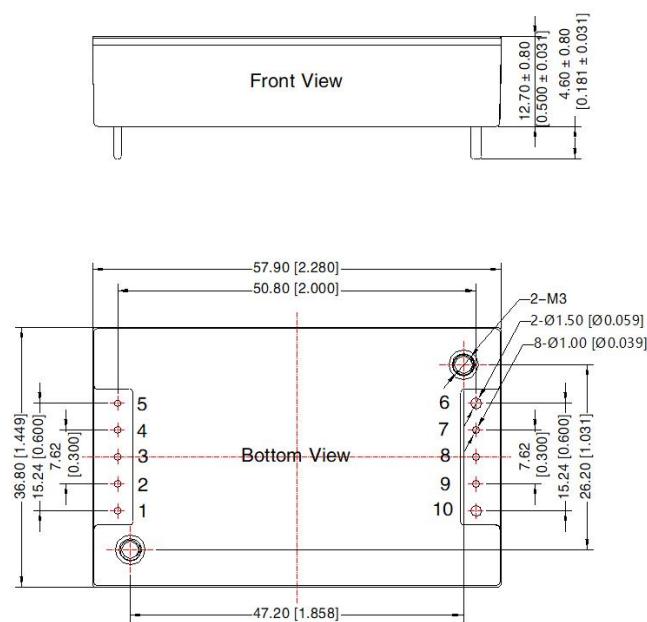
Calculation formula of R_{UVLO} setup resistance :

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

Note:
c: self-defined parameter.
R_{UVLO}(KΩ): UVLO setup resistance.
V_{shutdown}: UVLO shutdown voltage.

8. For additional information please refer to DC-DC converter application notes on www.mornsun-power.com

Dimensions and Recommended Layout (without heat sink)



Note:

Unit: mm[inch]

Pin1, 2, 3, 4, 5, 7, 8, 9's diameter: 1.00 [0.039]

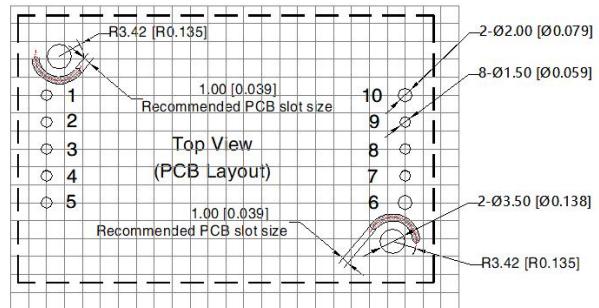
Pin6, 10's diameter: 1.50 [0.059]

Pin diameter tolerances: ± 0.10 [± 0.004]

General tolerances: ± 0.50 [± 0.020]

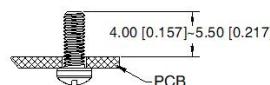
Mounting hole screwing torque: Max 0.4 N · m

THIRD ANGLE PROJECTION



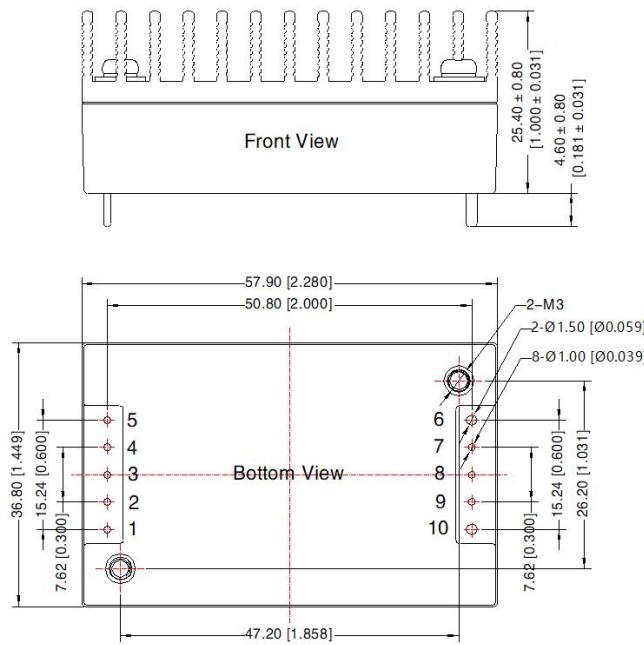
Note: Grid 2.54*2.54mm

Recommended screw length



Pin-Out			
Pin	Mark	Pin	Mark
1	+Vin	6	-Vo
2	UVLO	7	Sense-
3	Ctrl	8	Trim
4	Ext. Cap.	9	Sense+
5	-Vin	10	+Vo

Dimensions and Recommended Layout (with H heat sink)



Note:

Unit: mm[inch]

Pin1, 2, 3, 4, 5, 7, 8, 9's diameter: 1.00 [0.039]

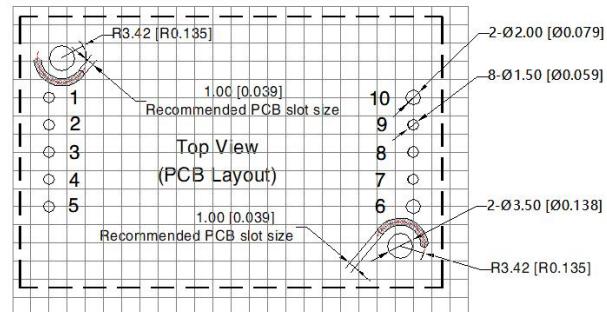
Pin6, 10's diameter: 1.50 [0.059]

Pin diameter tolerances: ± 0.10 [± 0.004]

General tolerances: ± 0.50 [± 0.020]

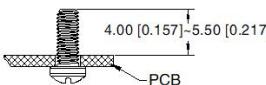
Mounting hole screwing torque: Max 0.4 N · m

THIRD ANGLE PROJECTION



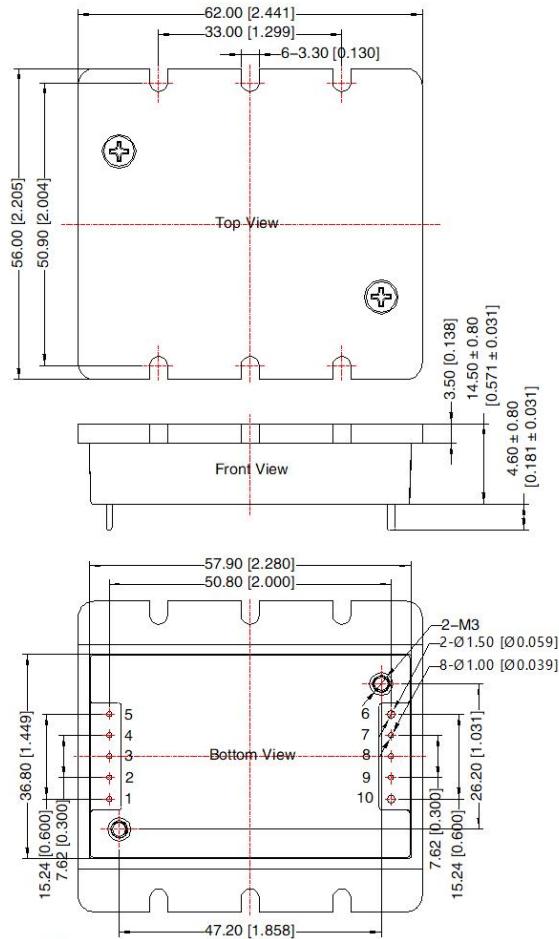
Note: Grid 2.54*2.54mm

Recommended screw length

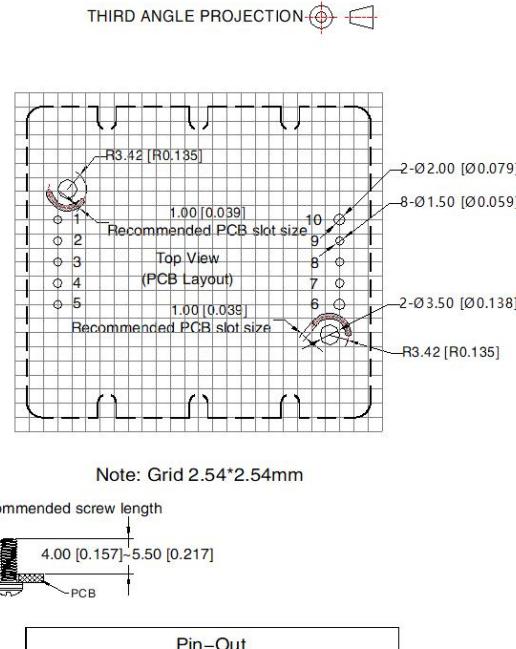


Pin-Out			
Pin	Mark	Pin	Mark
1	+Vin	6	-Vo
2	UVLO	7	Sense-
3	Ctrl	8	Trim
4	Ext. Cap.	9	Sense+
5	-Vin	10	+Vo

Dimensions and Recommended Layout (with F heat sink)



Note:
Unit: mm[inch]
Pin1, 2, 3, 4, 5, 7, 8, 9's diameter: 1.00 [0.039]
Pin6, 10'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



Pin-Out			
Pin	Mark	Pin	Mark
1	+Vin	6	-Vo
2	UVLO	7	Sense-
3	Ctrl	8	Trim
4	Ext. Cap.	9	Sense+
5	-Vin	10	+Vo

Note:

1. For additional information on Product Packaging please refer to www.mornsun-power.com. Packaging bag number: 58010113(UWTH1DxxQB-50WR3S); 58220017(UWTH1DxxQB-50WHR3S); 58200069(UWTH1DxxQB-50WFR3S);
2. The maximum capacitive load offered were tested at input voltage range and full load;
3. Unless otherwise specified, data in this datasheet should be tested under the conditions of $T_a=25^\circ\text{C}$, humidity<75%RH with nominal input voltage and rated load;
4. All index testing methods in this datasheet are based on our company corporate standards;
5. Product customization is available, please contact below email directly for specific needs;
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.

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