P R
B X

POWERBOX Industrial Line
PMF30W Series
30W 4:1 Dual Output
DC/DC Converter
Manual

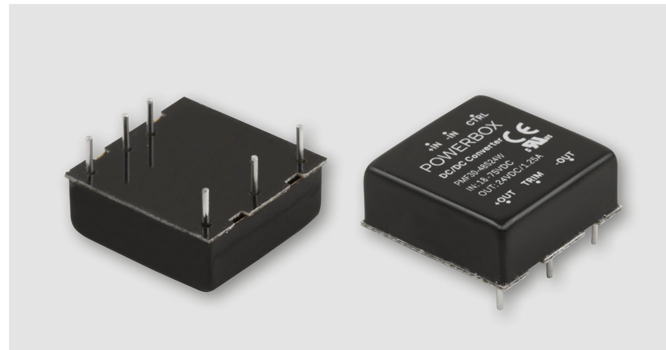


Table of Contents

Introduction

The PMF30W dual output DC/DC converters provide up to 30 watts of output power in an industry standard package and footprint. These units are specifically designed to meet the power needs of low profile. All models feature with 4:1 ultra wide input voltage of 9~36VDC and 18~75VDC, comprehensively protected against over-current, over-voltage, input under-voltage and over temperature protection conditions.

DC/DC Converter Features

- 30 Watts maximum output power
- Ultra low quiscent current
- Dual output current up to ±1.25A
- Small size and low profile: 1.0 x 1.0 x 0.39 inch
- High efficiency up to 92%
- 4:1 ultra wide input voltage range
- Six-sided continuous shield
- Fixed switching frequency
- Input to output isolation 1600 VDC
- Over temperature protection
- No minimum load required
- High power density
- Input under voltage protection
- Output over voltage protection
- Output over current protection
- Output short circuit protection
- Remote on/off control
- Compliant to RoHS II & REACH

Options

- Positive logic remote on/off
- Without on/off control pin
- Heat-sink available for exteneded operation

Output Specifications

Parameters	Model	Min	Typ	Max	Unit
Output voltage (Vin(nom); full load; Ta=25°C)	□□S12W	11.88	12	12.12	VDC
	□□S15W	14.85	15	15.15	VDC
	□□S24W	23.76	24	24.24	VDC
Output regulation					
Line (Vin(min) to Vin(max); full load)	All	-0.5		+0.6	%
Load (0% to 100% of full load)	All	-1.0		+1.0	%
Load (10% to 90% of full load)	All	-0.8		+0.8	%
Output ripple and noise					
Peak to peak (20MHz bandwidth)					
With a 10µF/25V X7R MLCC for each output	□□S12W		60	85	mVp-p
With a 10µF/25V X7R MLCC for each output	□□S15W		60	85	mVp-p
With a 4.7µF/50V X7R MLCC for each output	□□S24W		60	100	mVp-p
Temperature coefficient	All	-0.02		+0.02	%/°C
Output voltage overshoot (Vin(min) to Vin(max) full load; Ta=25°C)	All			5	% of Vout
Dynamic load response (Vin(nom); Ta=25°C)					
Load step change from 75% to 100% or 100 to 75% of full load					
Peak deviation	□□S12W		3		% of Vout
	□□S15W		3		% of Vout
	□□S24W		3		
Setting time (Vo<10% peak deviation)	All		250		µs
Output current	□□S12W	0		±2500	mA
	□□S15W	0		±1000	mA
	□□S24W	0		±625	mA
Output capacitance load	□□S12W			±750	µF
	□□S15W			±500	µF
	□□S24W			±180	µF
Output over voltage protection					
(continuous clamp voltage=|+ Vout| + |- Vout|)	□□S12W	25.5		31.5	VDC
	□□S15W	34		40	VDC
	□□S24W	58.5		64.5	VDC
Output over current protection	All		170		% of FL
Output short circuit protection	All	Continuous, automatics recovery			

Input Specifications

Parameters	Model	Min	Typ	Max	Unit
Operating input voltage					
Continuous	24D☐☐W	9	24	36	VDC
	48D☐☐W	18	48	75	VDC
Transient (1sec, max)	24D☐☐W			50	VDC
	48D☐☐W			100	VDC
Input standby current (Typ. value at Vin(nom); no load)	24D12W		10		mA
	24D15W		10		mA
	24D24W		12		mA
	48D12W		8		mA
	48D15W		8		mA
	48S24W		10		mA
Under voltage lockout turn-on threshold	24D☐☐W			9	VDC
	48D☐☐W			18	VDC
Under voltage lockout turn-off threshold	24D☐☐W		8		VDC
	48D☐☐W		16		VDC
Input reflected ripple current (5 to 20MHz, 12µH source impedance)	All		30		mAp-p
Start up time (Vin(nom) and constant resistive load)					
Power up	All			30	ms
Remote on/off	All			30	ms
Remote ON/OFF control (The Ctrl pin voltage is referred to -INPUT)					
Positive logic (option)					
On/Off pin high voltage (remote ON)	☐☐D☐☐W-A	Open or 3 ~ 15VDC			
On/Off pin low voltage (remote OFF)		Short or 0 ~ 1.2VDC			
Negative logic (standard)					
On/Off pin low voltage (remote ON)	☐☐D☐☐ W	Short or 0 ~ 1.2VDC			
On/Off pin high Vvltage (remote OFF)		Open or 3 ~ 15VDC			
Input current of remote control pin		-0.5		1.0	mA
Remote off state input current			2.0		mA

General Specifications

Parameters	Model	Min	Typ	Max	Unit
Efficiency (Vin(nom), full load; Ta=25°C)	24D12W		89		%
	24D15W		91		%
	24D24W		91		%
	48D12W		91		%
	48D15W		92		%
	48D24W		92		%
Isolation voltage (1 minute)					
Input to output	All	1600			VDC
Input to case, output to case	All	1000			VDC
Isolation resistance (500VDC)	All	1			GΩ
Isolation capacitance	All			1500	pF
Switching frequency	All	297	330	363	kHz
Weight	All		16.5		g
MTBF MIL-HDBK-217F	All		1.259×10^6		hours
Safety approvals	All	UL60950-1, EN60950-1, IEC60950-1			
Case material	All	Copper			
Base material	All	FR4 PCB			
Potting material	All	Silicone (UL94-V0)			

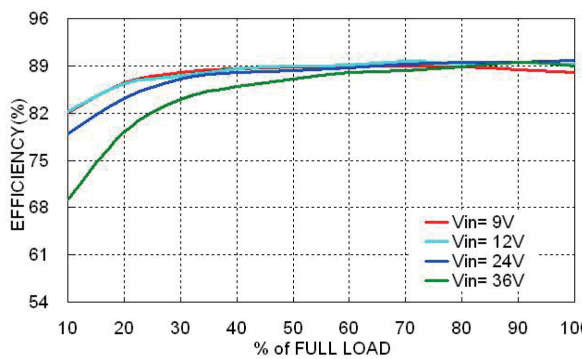
Environmental Specifications

Parameters	Model	Min	Typ	Max	Unit
Operating ambient temperature					
Without derating	All	-40		50	°C
With derating	All	50		100	°C
Storage temperature	All	-55		125	°C
Over temperature protection	All		115		°C
Thermal impedance (natural convection with vertical direction)					
Without heat-sink	All		15.0		°C/W
With heat-sink	All		13.8		°C/W
Relative humidity	All	5		95	% RH
Thermal shock	All	MIL-STD-810F			
Vibration	All	MIL-STD-810F			

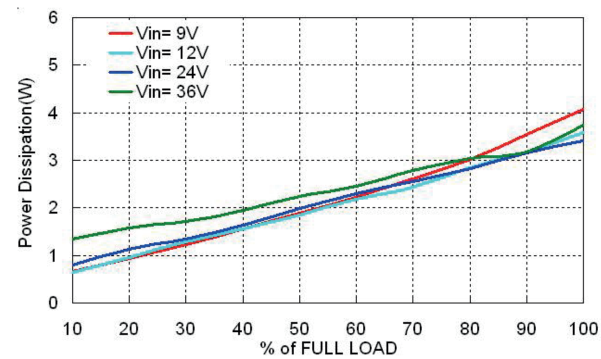
EMC Characteristics

Parameters	Standard	Condition		Level
EMI	EN55022	With external input filter		Class A, Class B
ESD	EN61000-4-2	Air	±8kV	Perf. Criteria A
		Contact	±6kV	
Radiated Immunity	EN61000-4-3		10V/m	Perf. Criteria A
Fast transient	EN61000-4-4		±2kV	Perf. Criteria A
Surge	EN61000-4-5		±2kV	Perf. Criteria A
Conducted immunity	EN61000-4-6		10V r.m.s	Perf. Criteria A
Power frequency magnetic field	EN61000-4-8	100A/m continuous; 1000A/m 1 second		Perf. Criteria A

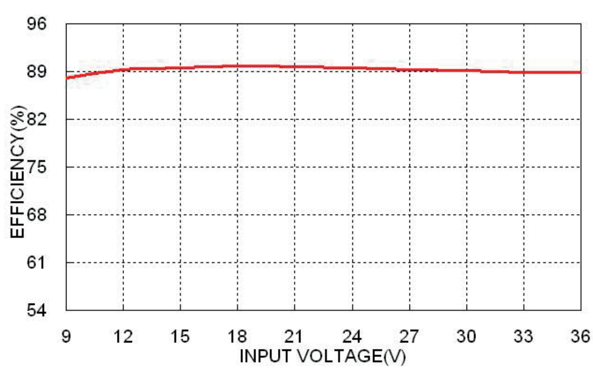
All test conditions are at 25°C.The figures are identical for PMF30-24D12W



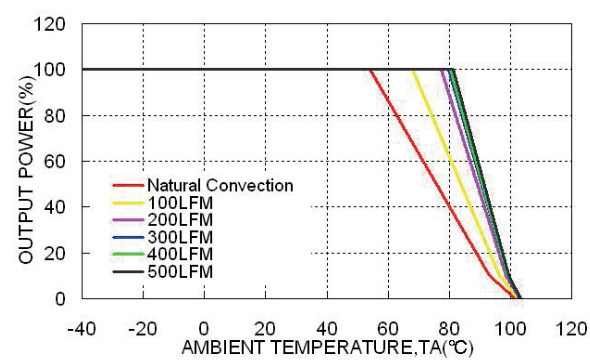
Efficiency versus Output Current



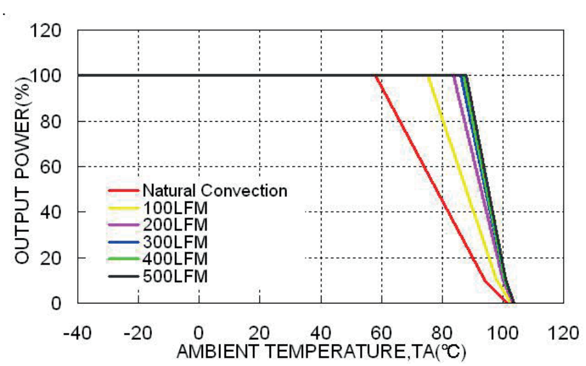
Power Dissipation versus Output Current



Efficiency versus Input Voltage
Full Load

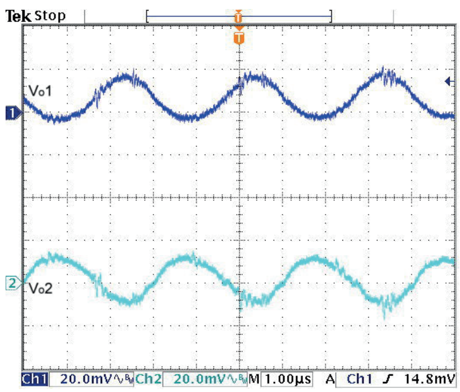


Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

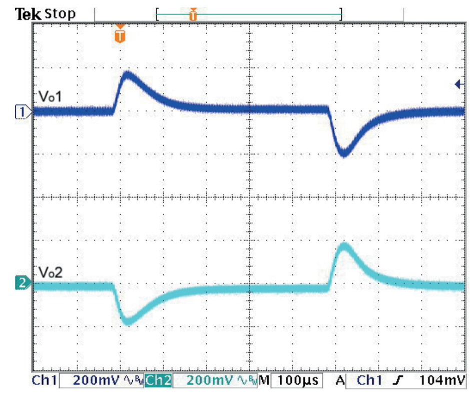


Derating Output Current versus Ambient Temperature with
Heat-sink and Airflow, Vin(nom)

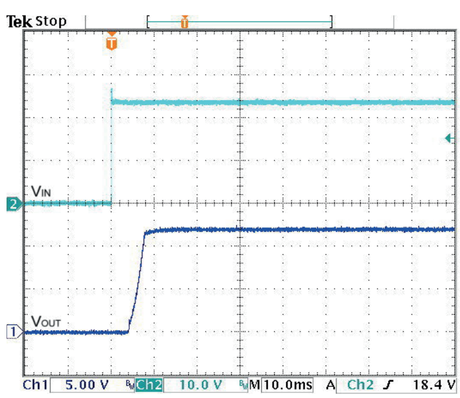
All test conditions are at 25°C.The figures are identical for PMF30-24D12W



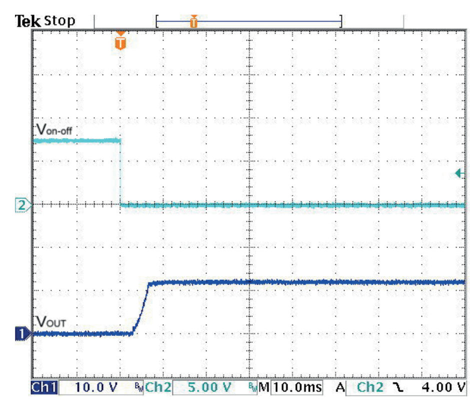
Typical Output Ripple and Noise.
Vin(nom); Full Load



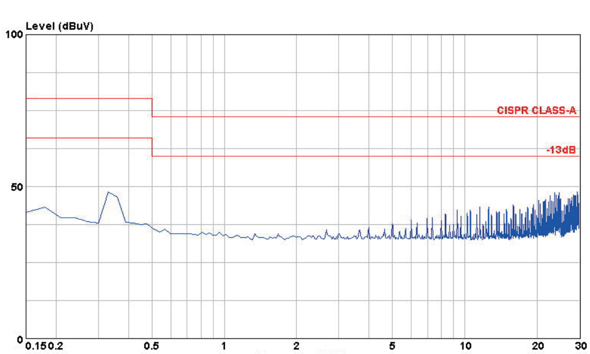
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



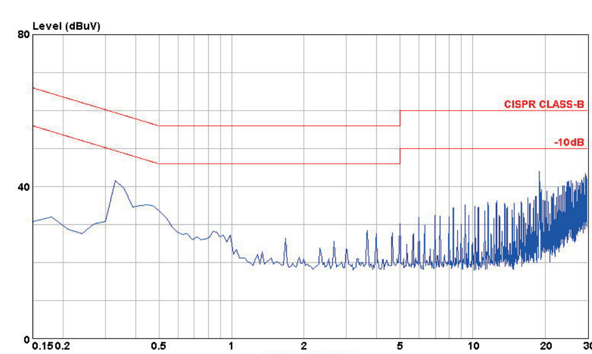
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

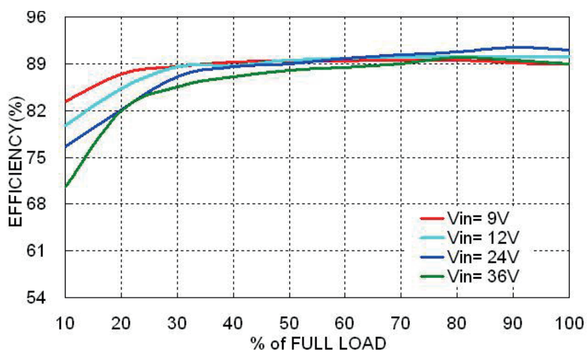


Conduction Emission of EN55022 Class A
Vin(nom); Full Load

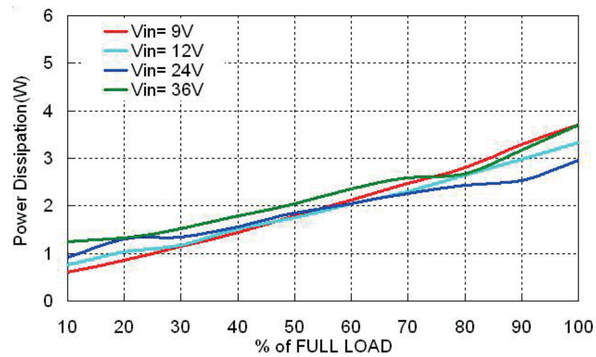


Conduction Emission of EN55022 Class B
Vin(nom); Full Load

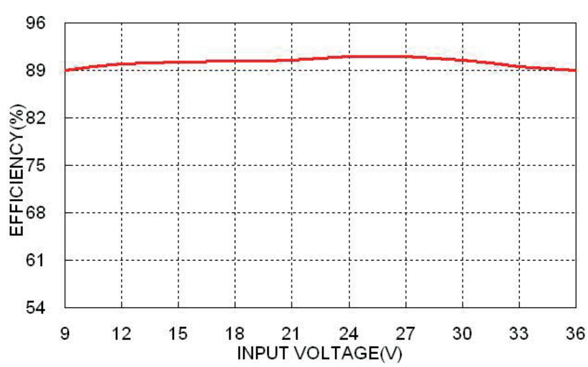
All test conditions are at 25°C.The figures are identical for PMF30-24D15W



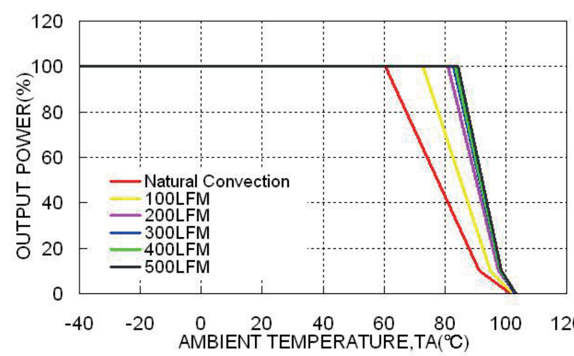
Efficiency versus Output Current



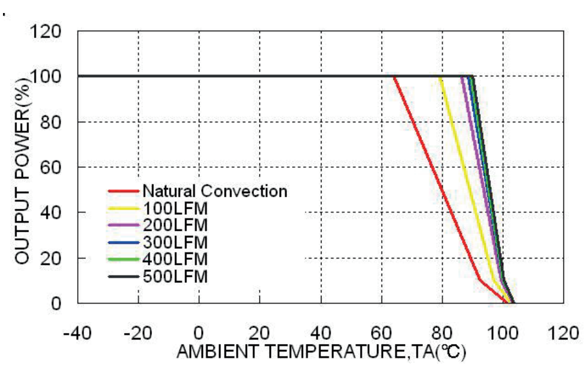
Power Dissipation versus Output Current



Efficiency versus Input Voltage
Full Load

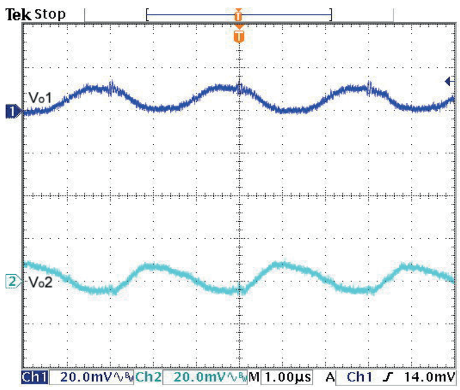


Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

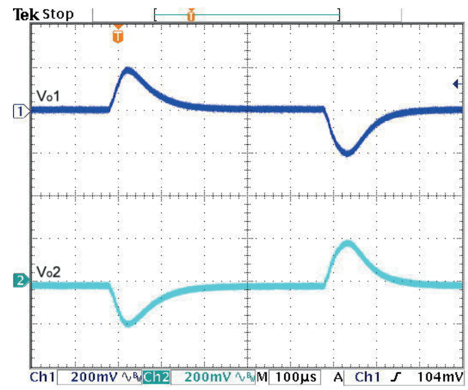


Derating Output Current versus Ambient Temperature with
Heat-sink and Airflow, Vin(nom)

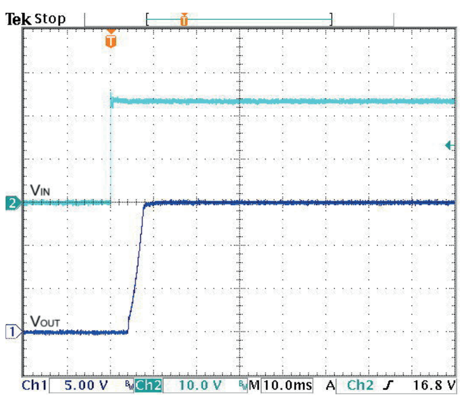
All test conditions are at 25°C.The figures are identical for PMF30-24D15W



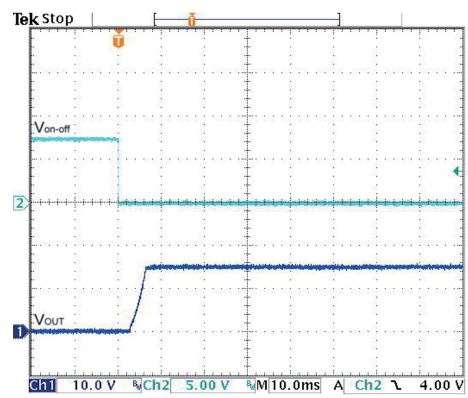
Typical Output Ripple and Noise.
Vin(nom); Full Load



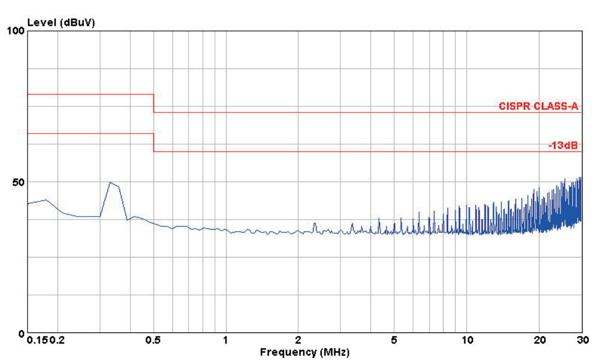
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



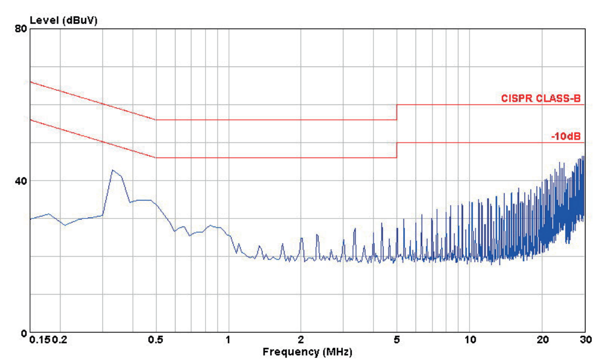
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

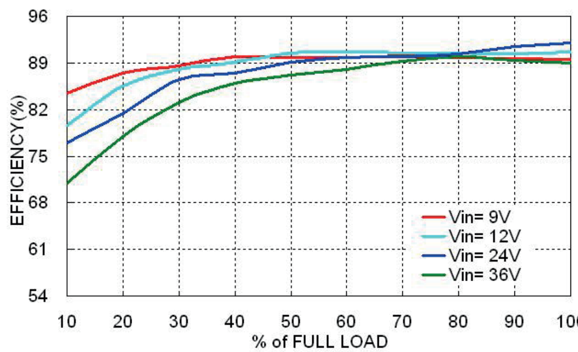


Conduction Emission of EN55022 Class A
Vin(nom); Full Load

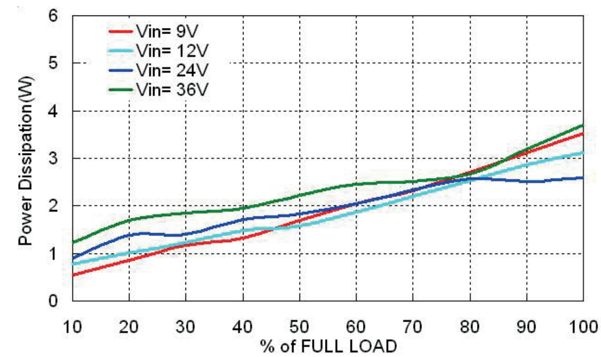


Conduction Emission of EN55022 Class B
Vin(nom); Full Load

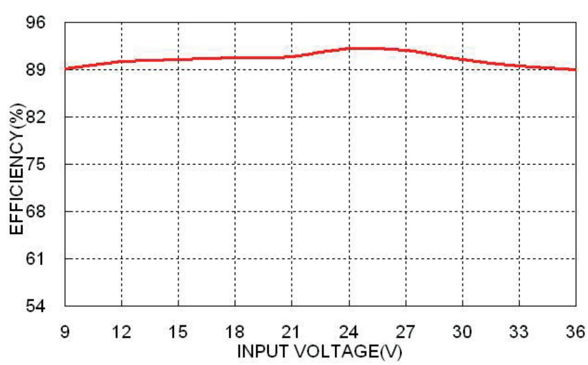
All test conditions are at 25°C.The figures are identical for PMF30-24D24W



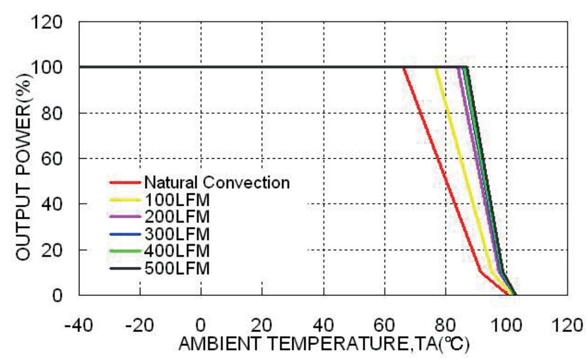
Efficiency versus Output Current



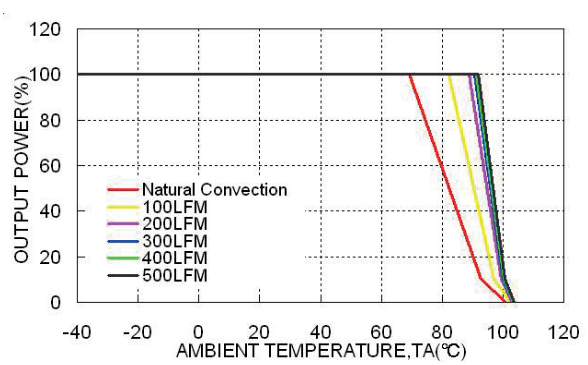
Power Dissipation versus Output Current



Efficiency versus Input Voltage
Full Load

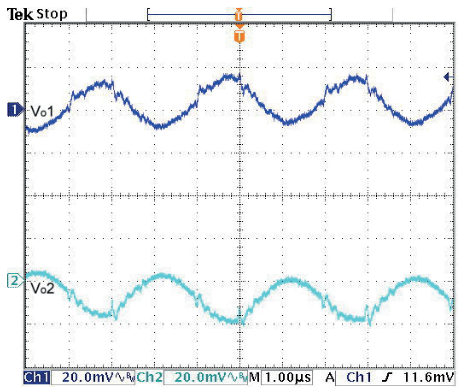


Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

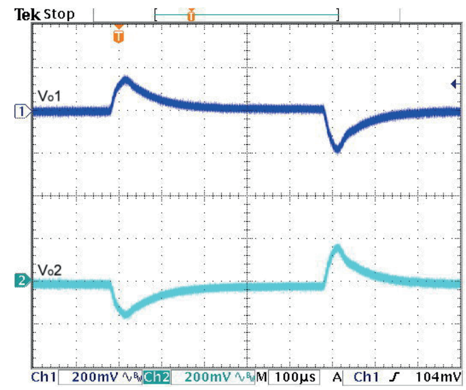


Derating Output Current versus Ambient Temperature with
Heat-sink and Airflow, Vin(nom)

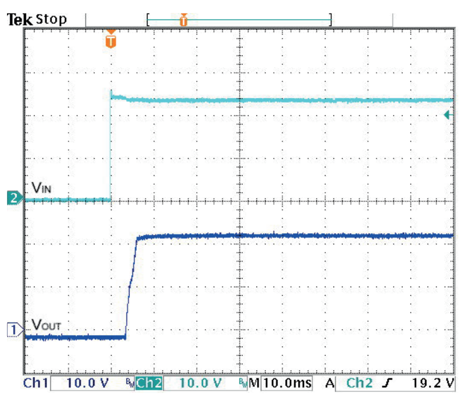
All test conditions are at 25°C.The figures are identical for PMF30-24D24W



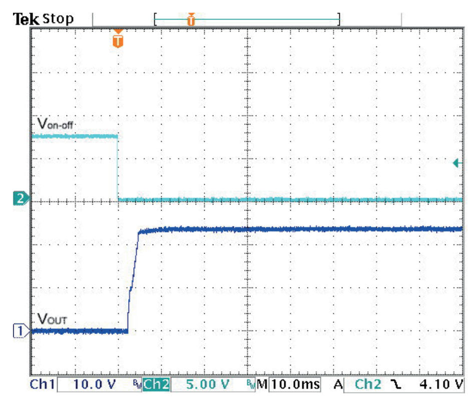
Typical Output Ripple and Noise.
Vin(nom); Full Load



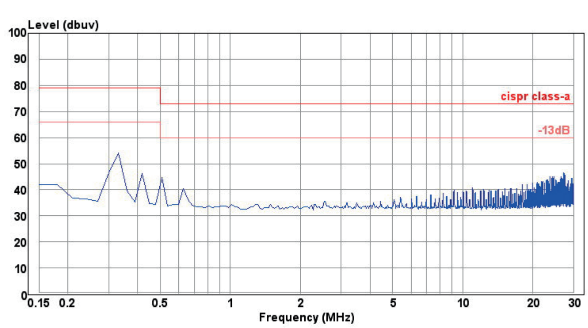
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



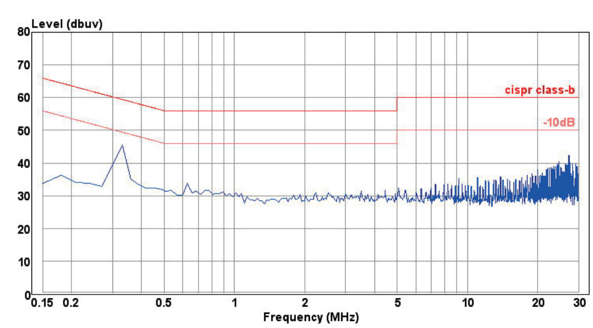
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

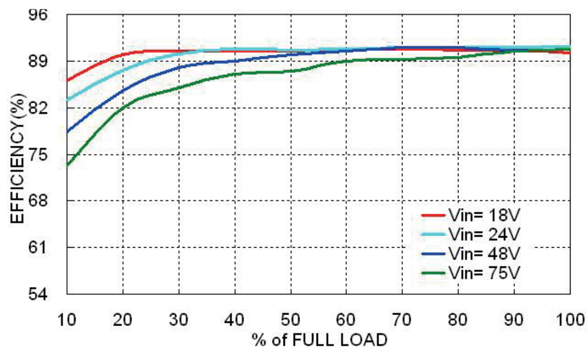


Conduction Emission of EN55022 Class A
Vin(nom); Full Load

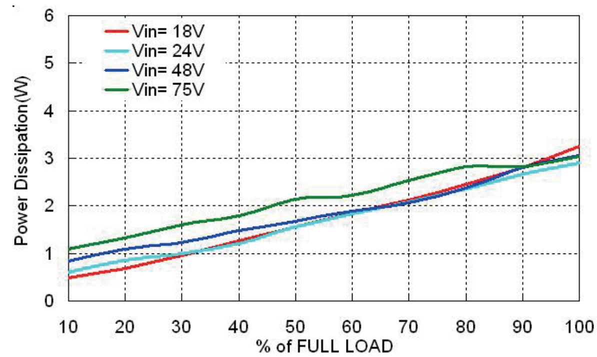


Conduction Emission of EN55022 Class B
Vin(nom); Full Load

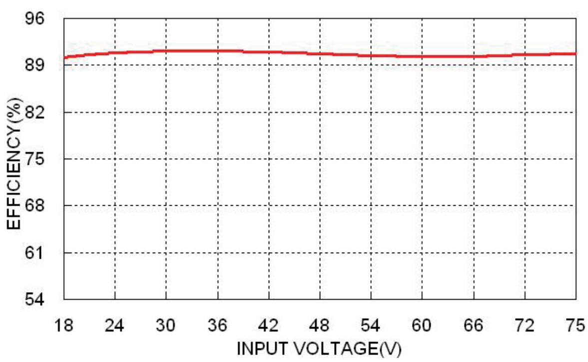
All test conditions are at 25°C.The figures are identical for PMF30-48D12W



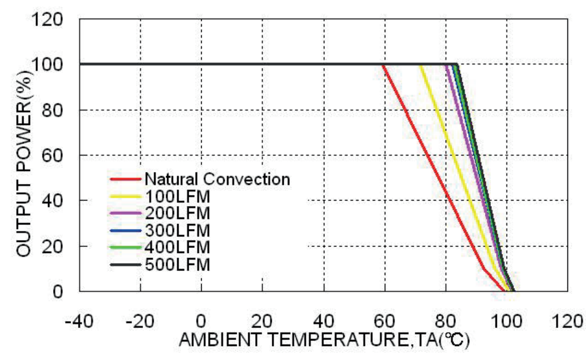
Efficiency versus Output Current



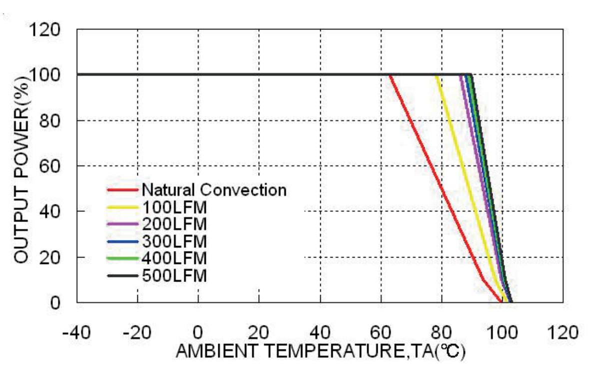
Power Dissipation versus Output Current



Efficiency versus Input Voltage
Full Load

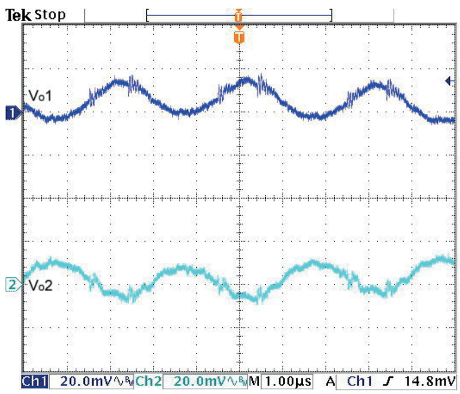


Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

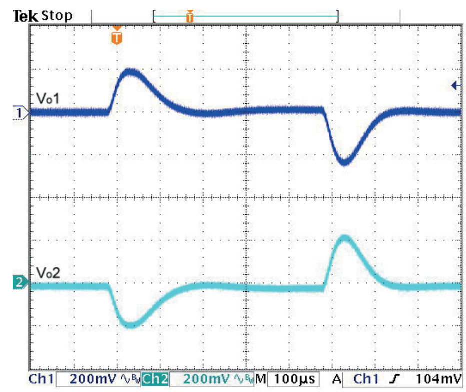


Derating Output Current versus Ambient Temperature with
Heat-sink and Airflow, Vin(nom)

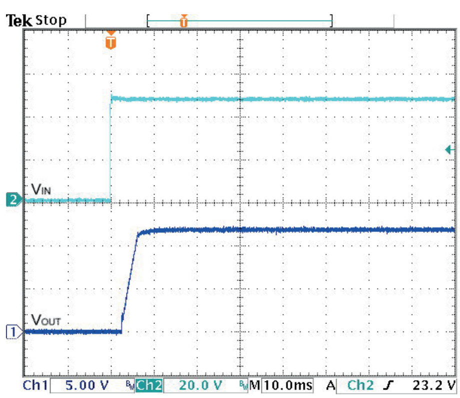
All test conditions are at 25°C.The figures are identical for PMF30-48D12W



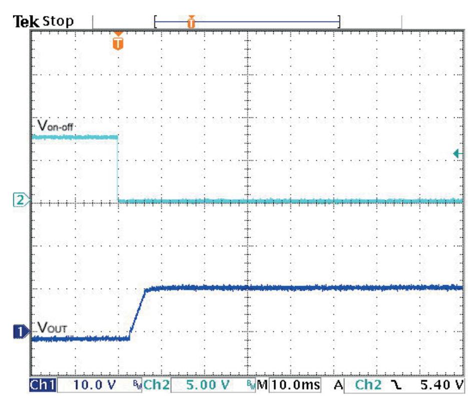
Typical Output Ripple and Noise.
Vin(nom); Full Load



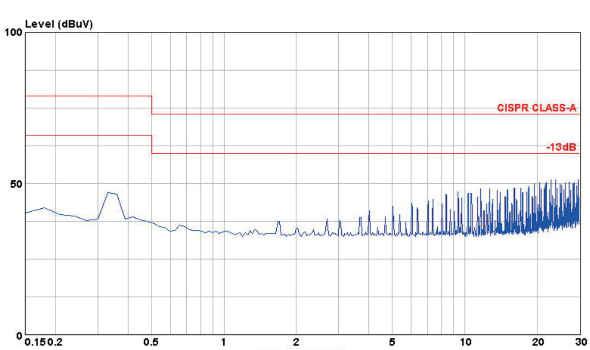
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



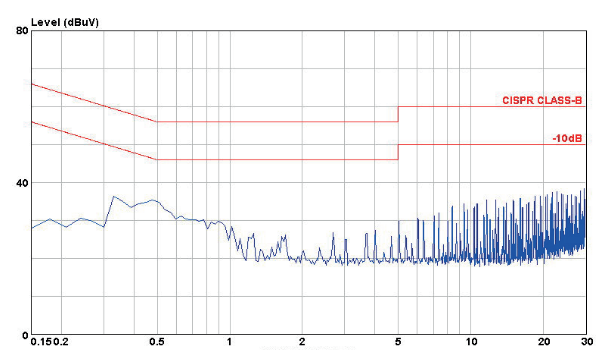
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

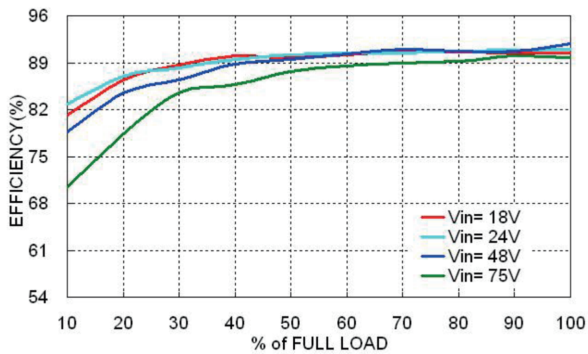


Conduction Emission of EN55022 Class A
Vin(nom); Full Load

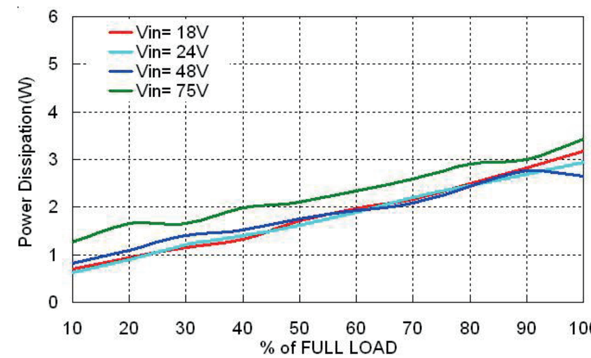


Conduction Emission of EN55022 Class B
Vin(nom); Full Load

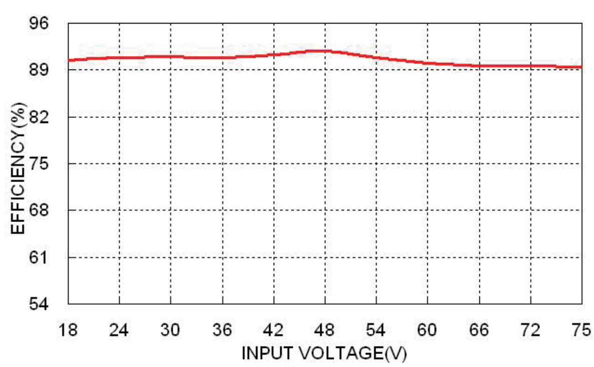
All test conditions are at 25°C.The figures are identical for PMF30-48D15W



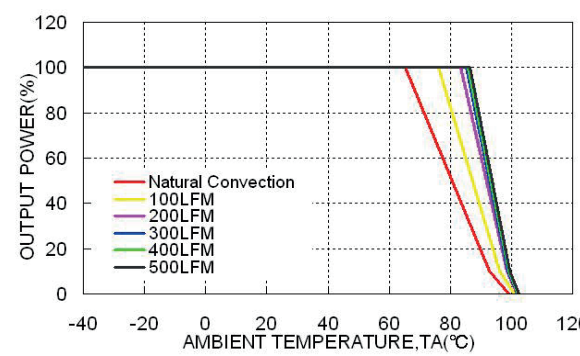
Efficiency versus Output Current



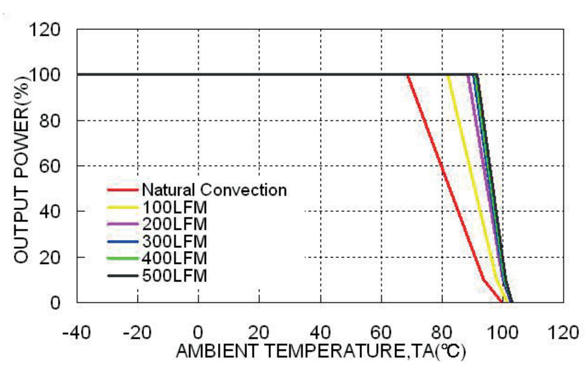
Power Dissipation versus Output Current



Efficiency versus Input Voltage
Full Load

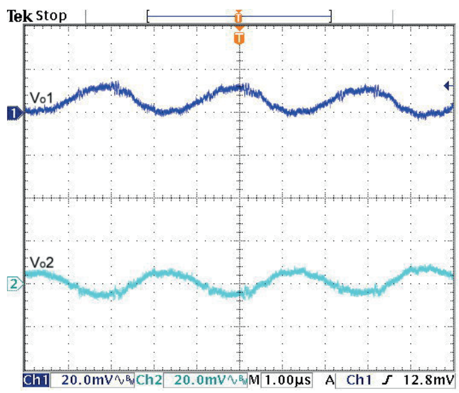


Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

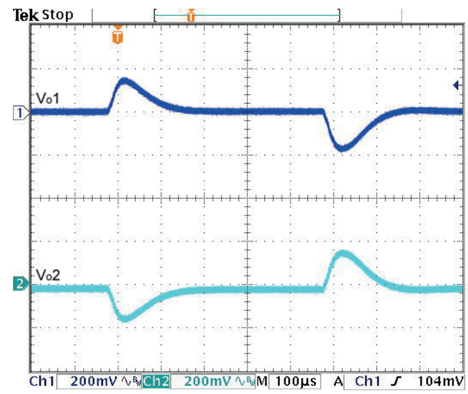


Derating Output Current versus Ambient Temperature with
Heat-sink and Airflow, Vin(nom)

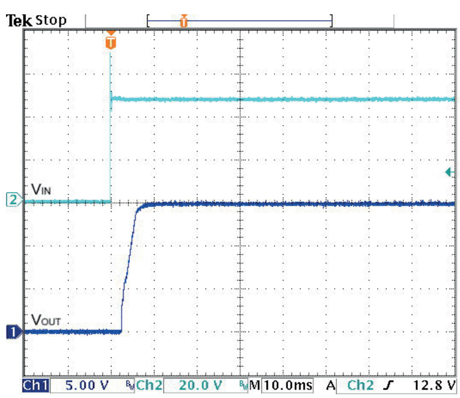
All test conditions are at 25°C.The figures are identical for PMF30-48D15W



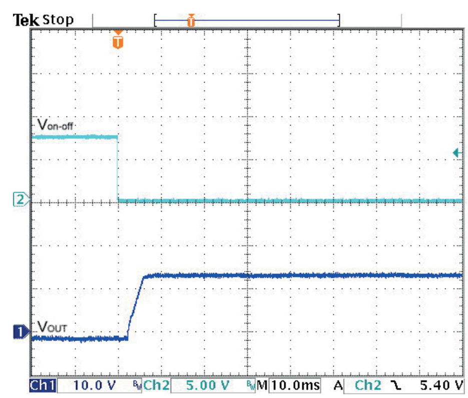
Typical Output Ripple and Noise.
Vin(nom); Full Load



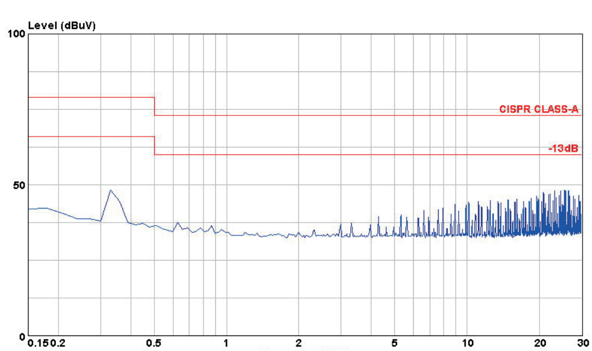
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



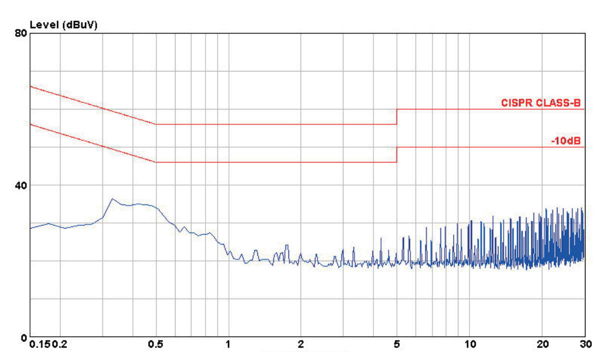
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load

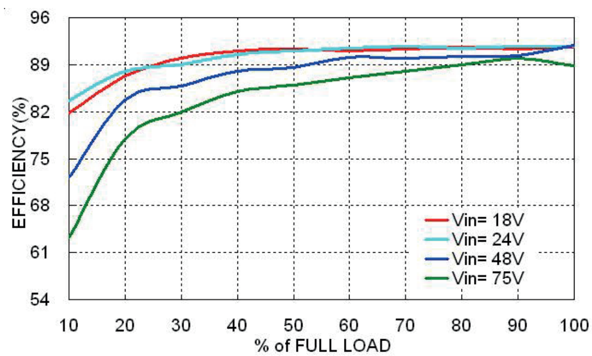


Conduction Emission of EN55022 Class A
Vin(nom); Full Load

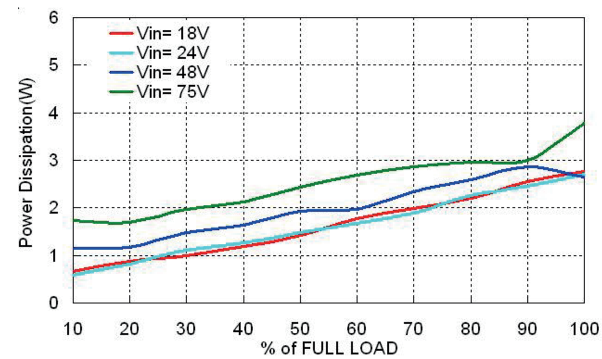


Conduction Emission of EN55022 Class B
Vin(nom); Full Load

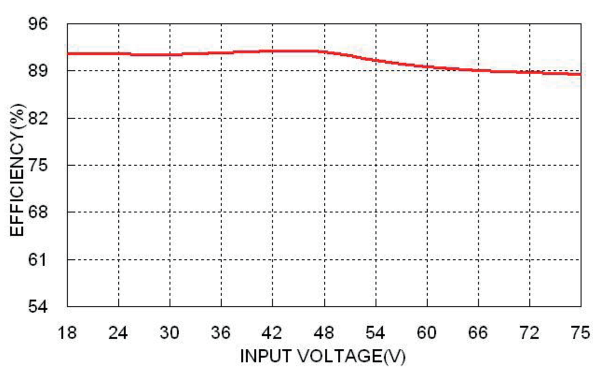
All test conditions are at 25°C.The figures are identical for PMF30-48D24W



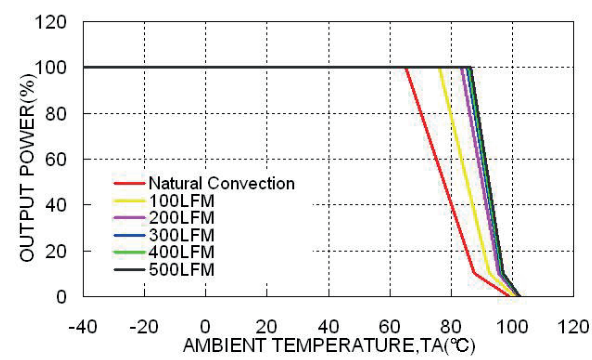
Efficiency versus Output Current



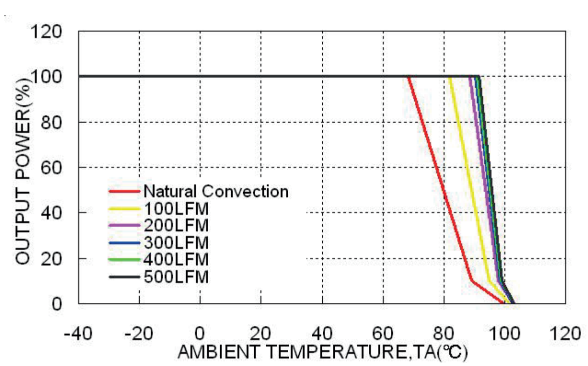
Power Dissipation versus Output Current



Efficiency versus Input Voltage
Full Load

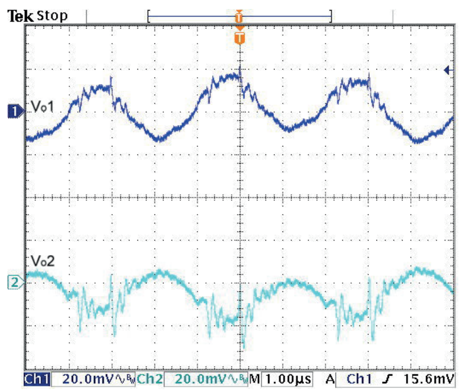


Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

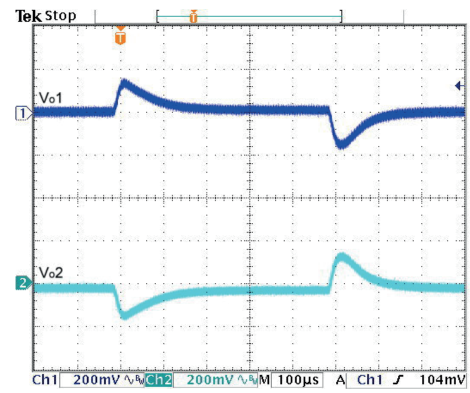


Derating Output Current versus Ambient Temperature with
Heat-sink and Airflow, Vin(nom)

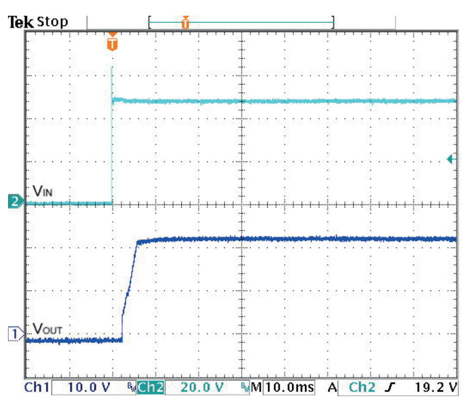
All test conditions are at 25°C.The figures are identical for PMF30-48D24W



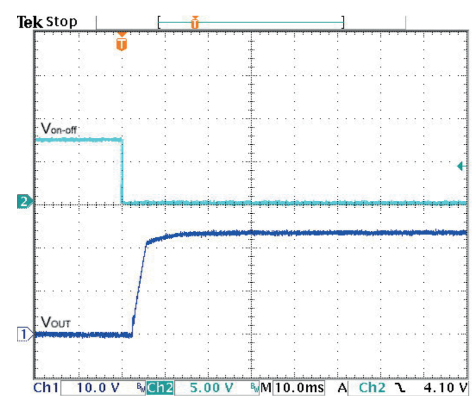
Typical Output Ripple and Noise.
Vin(nom); Full Load



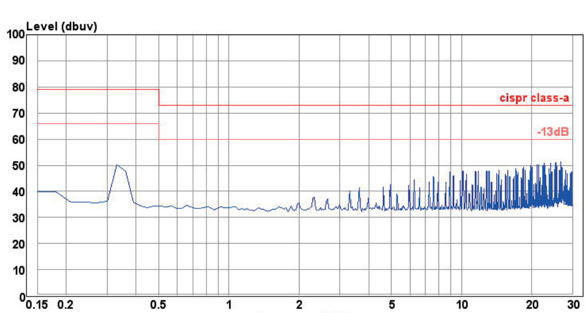
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



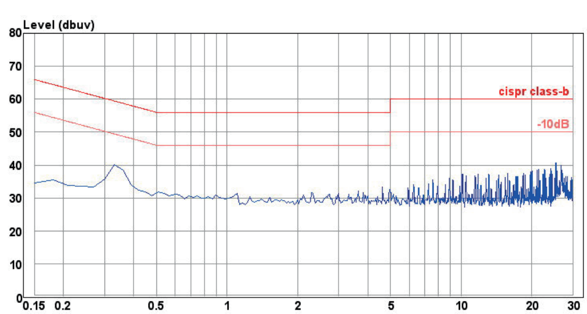
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



Using ON/OFF Voltage Start-Up and Output Rise Characteristic
Vin(nom); Full Load



Conduction Emission of EN55022 Class A
Vin(nom); Full Load



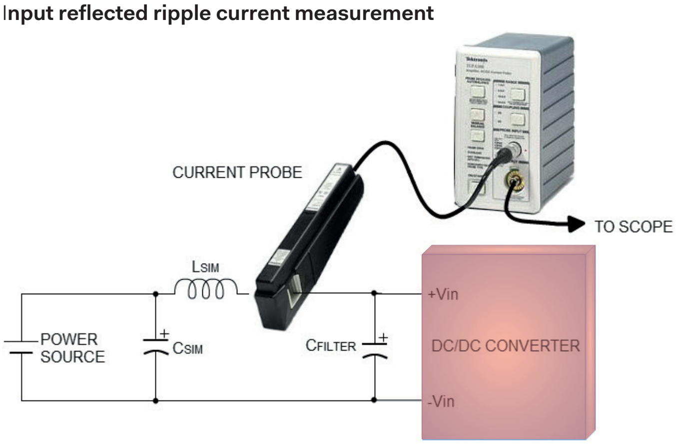
Conduction Emission of EN55022 Class B
Vin(nom); Full Load

Input Source Impedance

The power modules operate as specifications without external components, assuming that the source voltage has a very low impedance and reasonable input voltage regulation. Highly inductive source impedances can affect the stability of the power module.

Install CSIM and LSIM to simulate the impedance of power source. External capacitors CFILTER serve primarily as energy-storage elements, minimizing line voltage variations caused by transient IR drops in conductors from backplane to the DC/DC. The capacitor must as close as possible to the input terminals of the power module for lower impedance. For the input reflected-ripple current measurement configuration is shown as below:

Input reflected ripple current measurement



PMF30-□□S□□W

Component	Value	Voltage	Reference
L_{SIM}	12µH	----	Inductor
C_{SIM} C_{FILTER}	10µF	100V	Nippon chemi-con KY-series

Output Over Current Protection

When excessive output currents occur in the system, circuit protection is required on all power supplies. Normally, overload current is maintained at approximately 170 percent of rated current for PMF30W dual output series.

Hiccup-mode is a method of operation in a power supply whose purpose is to protect the power supply from being damaged during an over-current fault condition. It also enables the power supply to restart when the fault is removed. There are other ways of protecting the power supply when it is over-loaded, such as the maximum current limiting or current fold-back methods.
One of the problems resulting from over current is that excessive heat may be generated in power devices; especially MOSFET and Schottky diodes and the temperature of those devices may exceed their specified limits. A protection mechanism has to be used to prevent those power devices from being damaged.

The operation of hiccup is as follows. When the current sense circuit sees an over-current event, the controller shuts off the power supply for a given time and then tries to start up the power supply again. If the over-load condition has been removed, the power supply will start up and operate normally; otherwise, the controller will see another over-current event and shut off the power supply again, repeating the previous cycle. Hiccup operation has none of the drawbacks of the other two protection methods, although its circuit is more complicated because it requires a timing circuit. The excess heat due to overload lasts for only a short duration in the hiccup cycle, hence the junction temperature of the power devices is much lower.

The hiccup operation can be done in various ways. For example, one can start hiccup operation any time an over-current event is detected; or prohibit hiccup during a designated start-up is usually larger than during normal operation and it is easier for an over-current event is detected; or prohibit hiccup during a designated start-up interval (usually a few milliseconds). The reason for the latter operation is that during start-up, the power supply needs to provide extra current to charge up the output capacitor. Thus the current demand during start-up is usually larger than during normal operation and it is easier for an over-current event to occur. If the power supply starts to hiccup once there is an over-current, it might never start up successfully. Hiccup mode protection will give the best protection for a power supply against over current situations, since it will limit the average current to the load at a low level, so reducing power dissipation and case temperature in the power devices.

Output Short Circuitry Protection

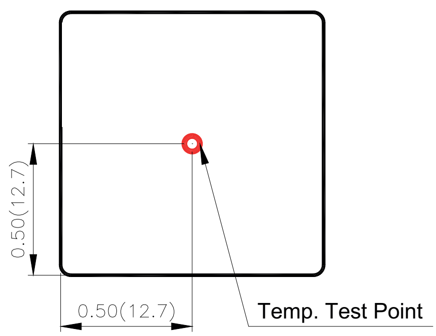
Continuous, auto-recovery mode. During short circuit, converter still shut down. The average current during this condition will be very low and the device can be safety in this condition.

Output Over Voltage Protection

The output over-voltage protection consists of Zener diode that monitors the output voltage on the feedback loop. If the voltage on the output terminals exceeds the over-voltage protection threshold, then the Zener diode will send a current signal to the control IC to limiting the output voltage.

Thermal Consideration

The power module operates in a variety of thermal environments. However, sufficient cooling should be provided to help ensure reliable operation of the unit. Heat is removed by conduction, convection, and radiation to the surrounding environment. Proper cooling can be verified by measuring the point as the figure below. The temperature at this location should not exceed 105°C. When operating, adequate cooling must be provided to maintain the test point temperature at or below 105°C. Although the maximum point temperature of the power modules is 105°C, you can limit this temperature to a lower value for extremely high reliability.

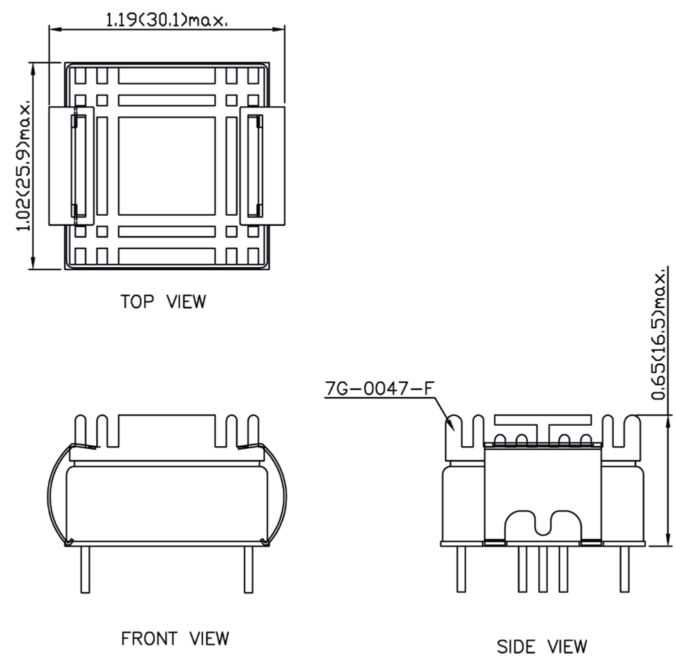


Measurement shown in inch (mm)

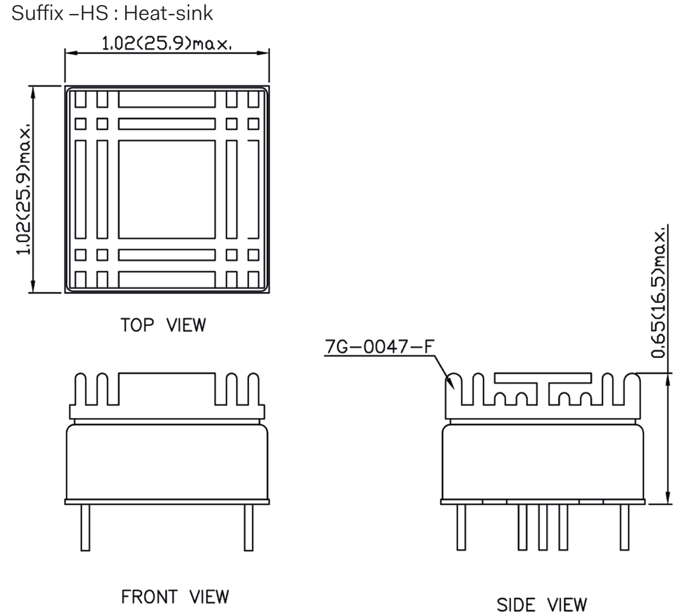
Heat-Sink Considerations

Equip heat-sink for lower temperature and higher reliability of the module. There are two types for choosing.

Suffix – HC : Heat-sink + Clamp



Suffix –HS : Heat-sink

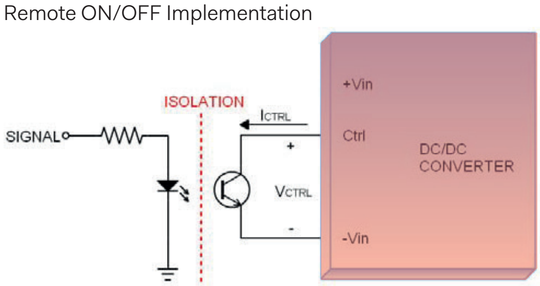


All dimensions in inch (mm)

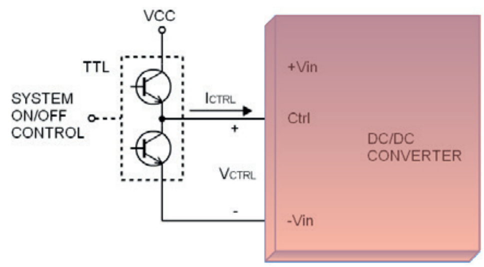
Remote On/Off Control

The Ctrl Pin is controlled DC/DC power module to turn on and off, the user must use a switch to control the logic voltage high or low level of the pin referenced to -Vin. The switch can be open collector transistor, FET and Photo-Coupler. The switch must be capable of sinking up to 1 mA at low-level logic voltage. High-level logic of the Ctrl pin signal maximum voltage is allowable leakage current of the switch at 12V is 0.5 mA.

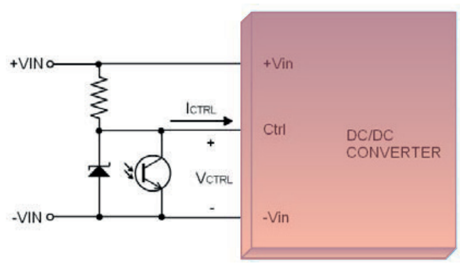
Remote ON/OFF Implementation



Isolated-Closure Remote ON/OFF



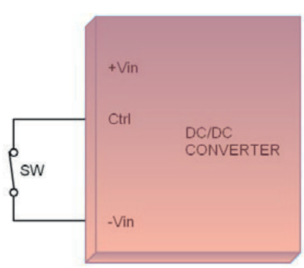
Level Control Using TTL Output



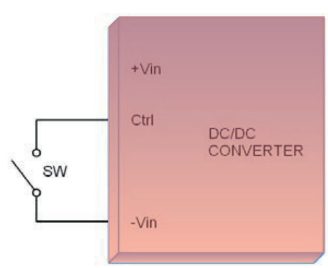
Level Control Using Line Voltage

There are two remote control options available, positive logic and negative logic.

a. The positive logic structure turned on of the DC/DC module when the Ctrl pin is at high-level logic and low-level logic is turned off it.

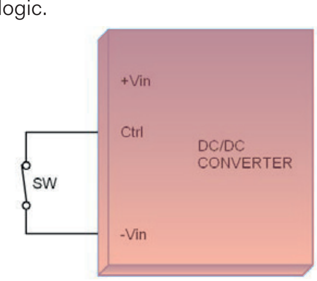


When PMF30W module is turned off
at Low-level logic

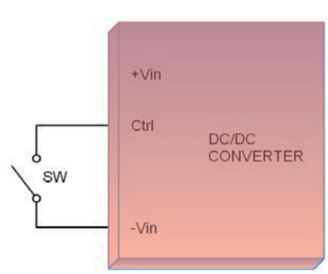


When PMF30W module is turned on
at High-level logic

b. The negative logic structure turned on of the DC/DC module when the Ctrl pin is at low-level logic and turned off when at high-level logic.



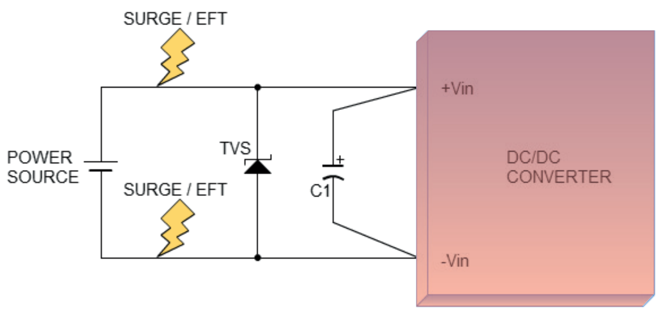
When PMF30W module is turned on
at Low-level logic



When PMF30W module is turned off
at High-level logic

EMS Considerations

The PMF30 series can meet Fast Transient EN61000-4-4 and Surge EN61000-4-5 performance criteria A with external components connected to the input terminals of the module. Please see the following schematics as below.



Surge/Fast Transient

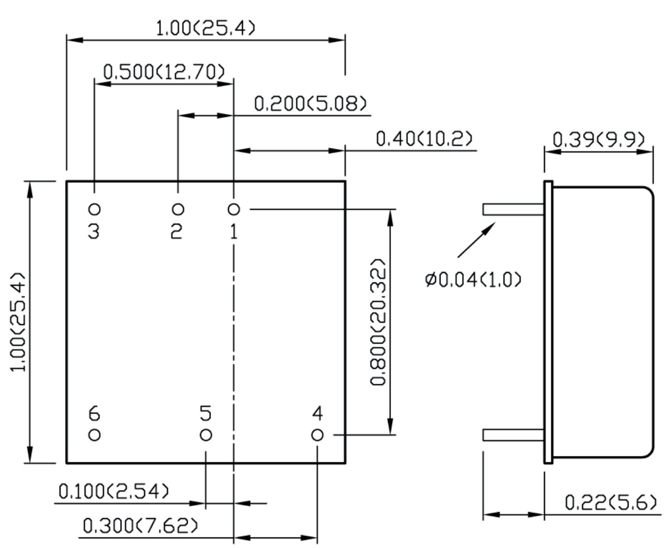
PMF30-24D□□W

Component	Value	Voltage	Reference
C1	220µF	100V	Nippon chemi-con KY-series
TVS	3000W (peak pulse power)	58V	Littelfuse,SMDJ58A

PMF30-48D□□W

Component	Value	Voltage	Reference
C1	220µF	100V	Nippon chemi-con KY-series

Mechanical Data



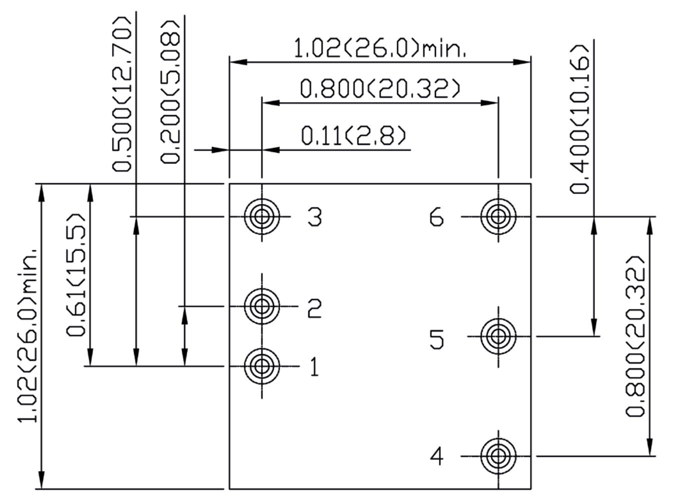
BOTTOM VIEW

1. All dimensions in inch (mm)
2. Tolerance: X.XX±0.02 (X.X±0.5)
   X.XXX±0.01 (X.XX±0.25)
3. Pin pitch tolerance ±0.01(0.25)
4. Pin dimension tolerance ±0.004 (0.1)

Pin Connection

Pin	Define
1	+Vin
2	-Vin
3	Ctrl
4	+Vout
5	Trim
6	-Vout

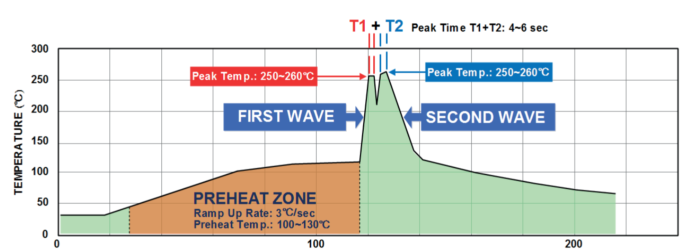
Recommended Pad Layout



All dimensions in inch(mm)
Pad size(lead free recommended)
Through hole:ø0.051(ø1.30)
Top view pad:ø0.064(ø1.63)
Bottom view pad:ø0.102(ø2.60)

Soldering Considerations

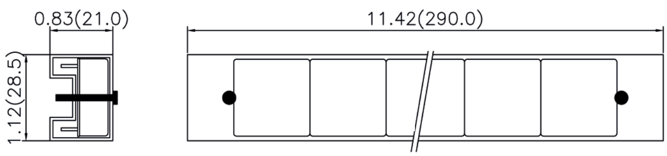
Lead free wave solder profile



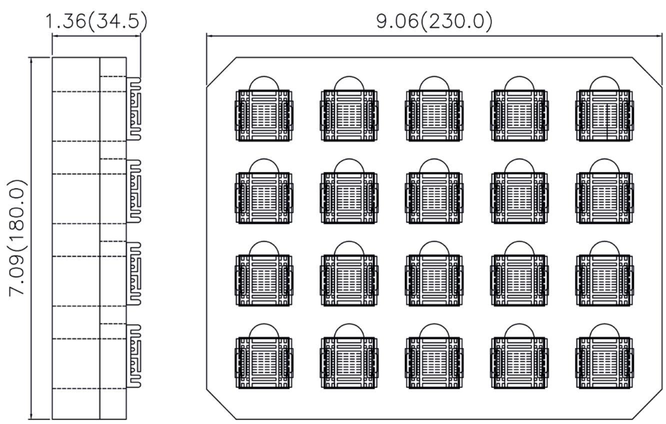
Reference Solder: Sn-Ag-Cu: Sn-Cu
Hand Welding (Reference):
Soldering iron: Power 150W
Welding Time: 3~6 sec
Temp: 410~430°C

Packing Information

Tube



Tray



Model Type	Packing Material	Quantity
Without Heat-sink	Tube	10 PCS / Tube
With Heat-sink	Tray	20 PCS / Tray

Safety and Installation Instruction

Fusing Consideration

Caution: This power module is not internally fused. An input line fuse must always be used. This encapsulated power module can be used in a wide variety of applications, ranging from simple stand-alone operation to an integrated part of sophisticated power architecture. To maximum flexibility, internal fusing is not included; however, to achieve maximum safety and system protection, always use an input line fuse. The input line fuse suggest as below:

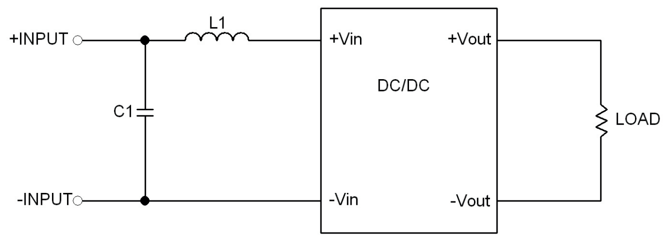
Model	Fuse Rating	Fuse Type
PMF30-24D□□W	6	Slow-Blow
PMF30-48D□□W	3	Slow-Blow

Based on the information provided in this application note on Inrush energy and maximum DC input current at low Vin. If customer have another used condition and need more information, please contact Powerbox.

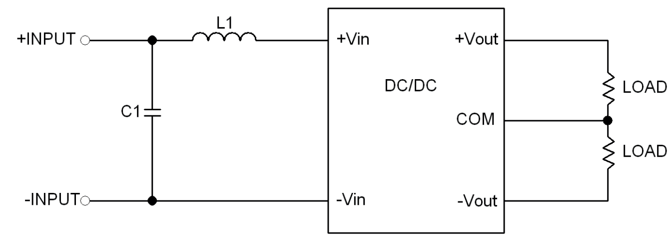
MTBF and Reliability

The MTBF of PMF30W DUAL-SERIES of DC/DC converters has been calculated using MIL-HDBK 217F at Tc=70°C FULL LOAD. The resulting figure for MTBF is 1.259×10^6 hours.

Recommended external EMI filter for EN55022 Class A



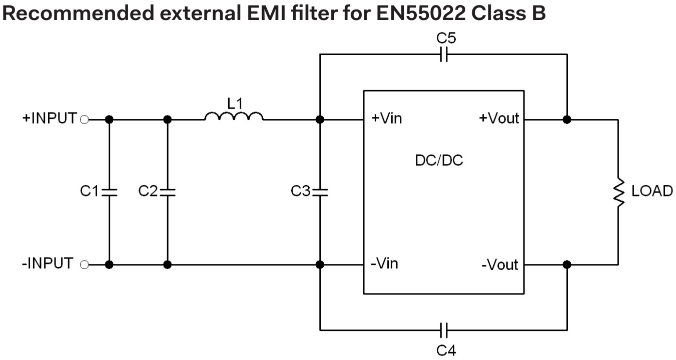
Single Output



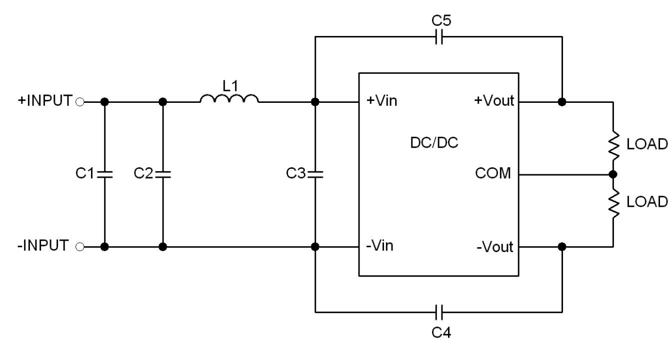
Dual Output

Model	C1	L1
PMF30-24□□□W	4.7µF/50V 1812 MLCC	2.2µH 11A 0.012Ω 0705 SMD Inductor, PMT-097
PMF30-48□□□W	4.7µF/100V 1812 MLCC	10µH 2.6A 0.04Ω 0705 SMD Inductor, PMT-070

Recommended external EMI filter for EN55022 Class B



Single Output



Dual Output

Model	C1	C2	C3	C4, C5	L1
PMF30-24□□□W	4.7µF/50V 1812 MLCC	4.7µF/50V 1812 MLCC	4.7µF/50V 1812 MLCC	1000pF/2kV 1206 MLCC	2.2µH 11A 0.012Ω 0705 SMD Inductor, PMT-097
PMF30-48□□□W	2.2µF/100V 1812 MLCC	2.2µF/100V 1812 MLCC	2.2µF/100V 1812 MLCC	1000pF/2kV 1808 MLCC	10µH 2.6A 0.04Ω 0705 SMD Inductor, PMT-070