POWERBOX Industrial Line
PMF20W Series
20W 4:1 Single Output
DC/DC Converter
Manual

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Introduction

PMF20W single output DC/DC converters provide up to 20 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 9~36 VDC and 18~75 VDC, comprehensively protected against over-current, over-voltage and input under-voltage protection conditions, and adjustable output voltage.

DC/DC Converter Features

- 20 Watts maximum output power
- Single output current up to 4.5A
- Industry standard pin-out
- Small size and low profile: 1.0 x 1.0 x 0.39 inch
- High efficiency up to 91%
- 4:1 wide input voltage range
- Six-sided continuous shield
- Meet EN55022 class A without external components
- Fixed switching frequency
- Input to output isolation 1600 VDC
- No minimum load required
- Input under voltage protection
- Output over voltage protection
- Output over current protection
- Output short circuit protection
- Remote on/off control
- Adjustable output voltage
- Compliant to RoHS II & REACH

Output Specifications

Parameters	**Model**	**Min**	**Typ**	**Max**	**Unit**
Output voltage (Vin(nom); full load; Ta=25°C)	□□S3P3W	3.267	3.3	3.333	VDC
	□□S05W	4.95	5	5.05	VDC
	□□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	-0.2		+0.2	%
Load (0% to 100% of full load)	All	-0.2		+0.2	%
Load (10% to 90% of full load)	All	-0.1		+0.1	%
Output ripple and noise					
Peak to peak (20MHz bandwidth)	□□S3P3W				
	□□S05W				
With a 1µF X7R MLCC and a 10µF T/C	□□S12W		75	100	mVp-p
	□□S15W				
With 2 pcs of 6.8µF/50V X7R MLCC	□□S24W				
Voltage adjustability	□□S3P3W	-10		+10	% of Vout
	□□S05W	-10		+10	% of Vout
	□□S12W	-10		+10	% of Vout
	□□S15W	-10		+10	% of Vout
	□□S24W	-10		+20	% of Vout
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	All		350		mV
Setting time (Vo<10% peak deviation)	All		250		µs
Output current	□□S3P3W	0		4500	mA
	□□S05W	0		4000	mA
	□□S12W	0		1670	mA
	□□S15W	0		1330	mA
	□□S24W	0		833	mA
Output capacitance load	□□S3P3W			7000	µF
	□□S05W			5000	µF
	□□S12W			850	µF
	□□S15W			700	µF
	□□S24W			220	µF
Output over voltage protection (voltage clamped)	□□S3P3W	3.7		5.4	VDC
	□□S05W	5.6		7.0	VDC
	□□S12W	13.5		19.6	VDC
	□□S15W	16.8		20.5	VDC
	□□S24W	29.1		32.5	VDC
Output over current protection	All		150		% of FL
Output short circuit protection	All	Continuous, automatics recovery			

Input Specifications

Parameters	Model	Min	Typ	Max	Unit
Operating input voltage					
Continuous	24S□□W	9	24	36	VDC
	48S□□W	18	48	75	VDC
Transient (1sec, max)	24S□□W			50	VDC
	48S□□W			100	VDC
Input standby current (Typ. value at Vin(nom); no load)	24S3P3W		10		mA
	24S05W		10		mA
	24S12W		6		mA
	24S15W		6		mA
	24S24W		10		mA
	48SS3P3W		10		mA
	48S05W		10		mA
	48S12W		4		mA
	48S15W		4		mA
	48S24W		8		mA
Under voltage lockout turn-on threshold	24S□□W			9	VDC
	48S□□W			18	VDC
Under voltage lockout turn-off threshold	24S□□W		8		VDC
	48S□□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)	□□S□□W-A	Open or 3 ~ 15VDC			
On/Off pin low voltage (remote OFF)	□□S□□W-E	Short or 0 ~ 1.2VDC			
Negative logic (standard)					
On/Off pin low voltage (remote ON)	□□S□□ W	Short or 0 ~ 1.2VDC			
On/Off pin high Vvltage (remote OFF)	□□S□□W-C	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)	24S3P3W		89		%
	24S05W		89		%
	24S12W		89		%
	24S15W		89		%
	24S24W		91		%
	48S3P3W		90		%
	48S05W		90		%
	48S12W		89		%
	48S15W		90		%
	48S24W		91		%
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	□□S3P3W	248	275	303	kHz
	□□S05W				kHz
	□□S12W				kHz
	□□S15W	297	330	363	kHz
	□□S24W				kHz
Weight	All		15		g
MTBF MIL-HDBK-217F	All		1.469×10^6		hours
Safety approvals	All	UL60950-1, EN60950-1, IEC60950-1			
Case material	All	Nickel-coated copper			
Base material	All	FR4 PCB			
Potting material	All	Silicone (UL94-V0)			

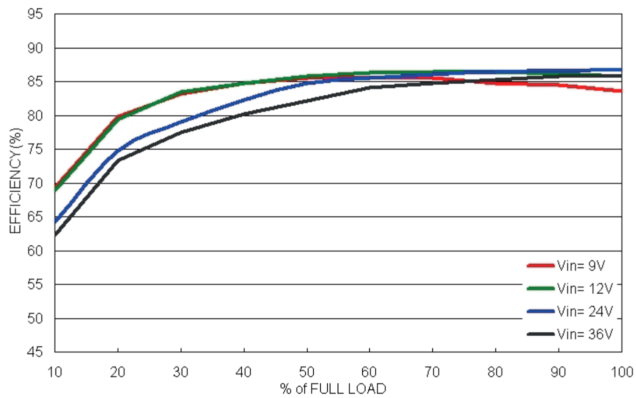
Environmental Specifications

Parameters	Model	Min	Typ	Max	Unit
Operating case temperature					
Without derating	All	-40		60	°C
With derating	All	60		101	°C
Storage temperature	All	-55		125	°C
Max case temperature	All			105	°C
Thermal impedance (natural convection with vertical direction)					
Without heat-sink	All		17.6		°C/W
With heat-sink	All		14.8		°C/W
Relative humidity	All	5		95	% RH
Thermal shock	All	MIL-STD-810F			
Vibration	All	MIL-STD-810F			

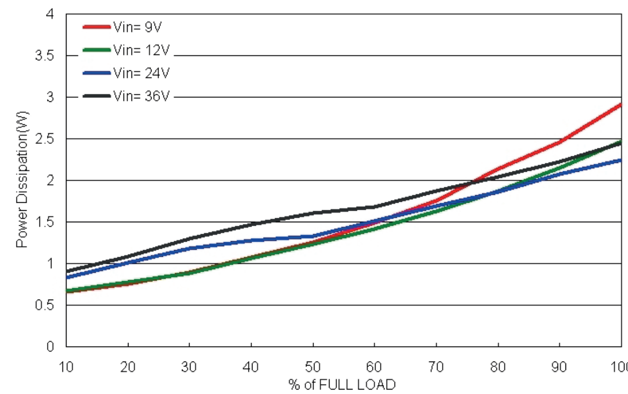
EMC Characteristics

Parameters	Standard	Condition		Level
EMI	EN55022	Module stand-alone		Class A
		With external input filter		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

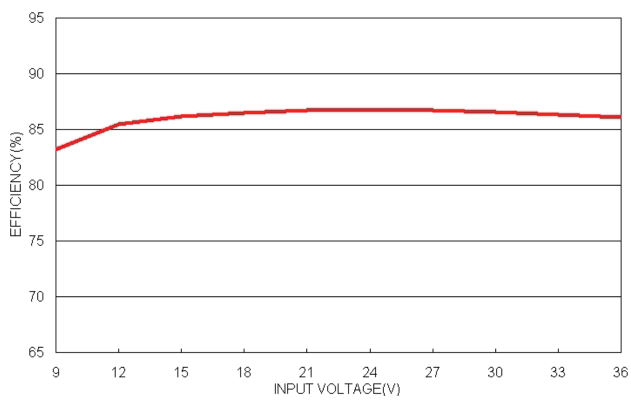
All test conditions are at 25°C.The figures are identical for PMF20-24S3P3W



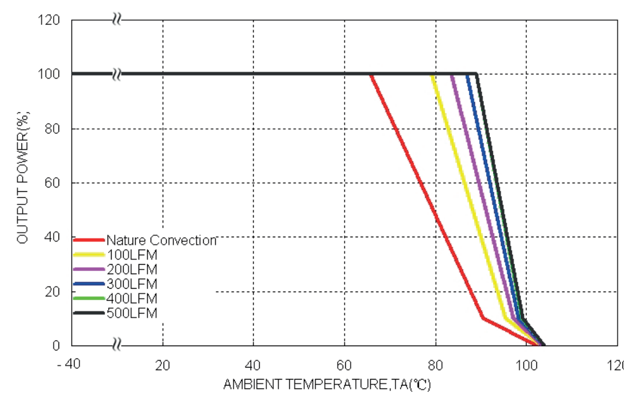
Efficiency versus Output Current



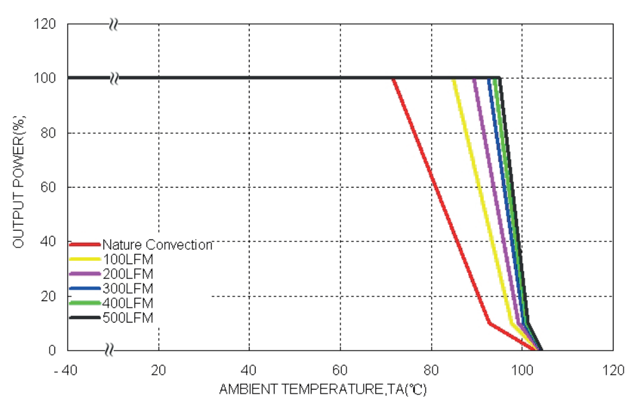
Power Dissipation versus Output Current



Efficiency versus Input Voltage
Full Load

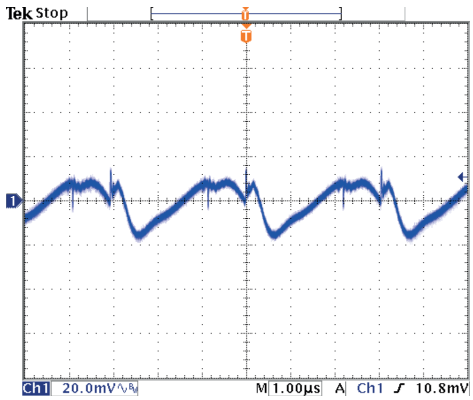


Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

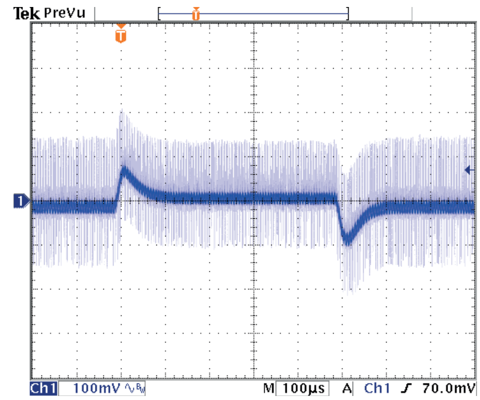


Derating Output Current versus Ambient Temperature with
Heat-sink and Airflow, Vin(nom)

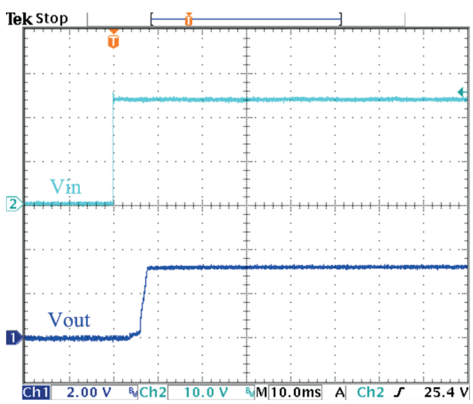
All test conditions are at 25°C.The figures are identical for PMF20-24S3P3W



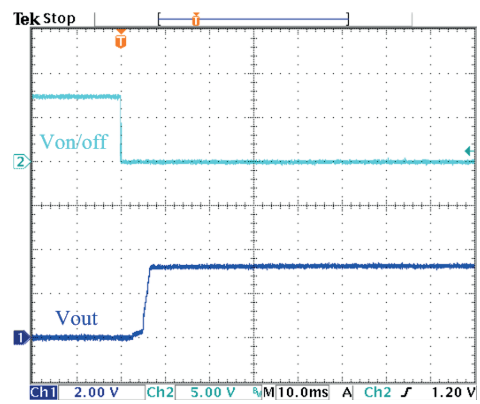
Typical Output Ripple and Noise.
Vin(nom); Full Load



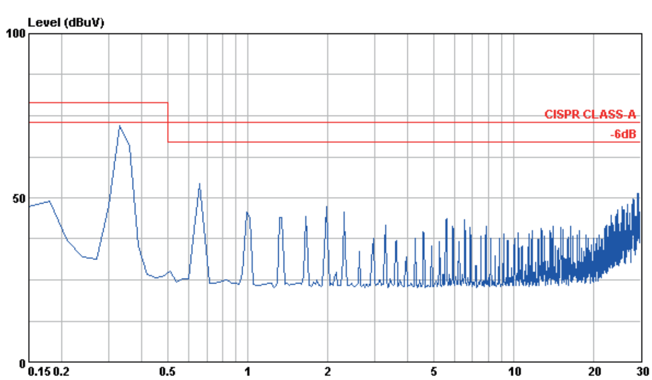
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



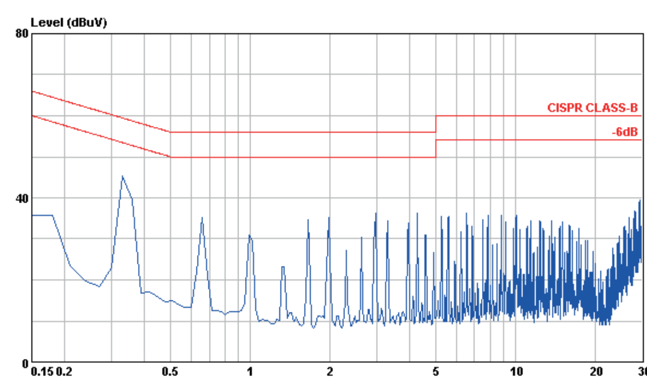
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



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

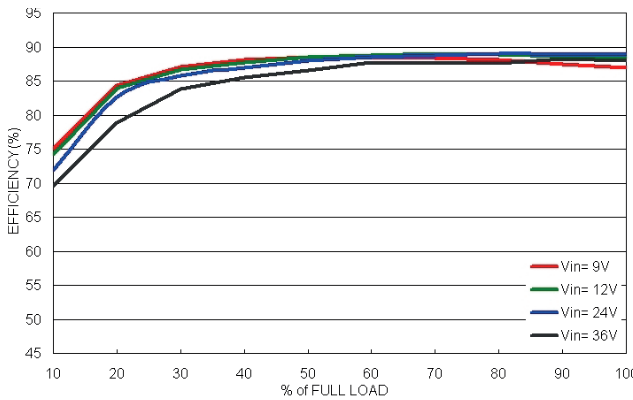


Conduction Emission of EN55022 Class A
Vin(nom); Full Load

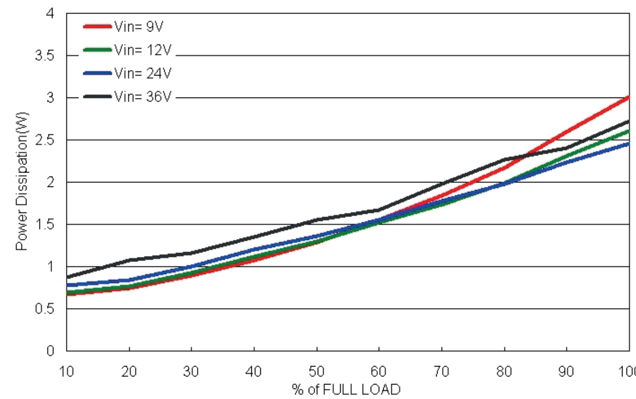


Conduction Emission of EN55022 Class B
Vin(nom); Full Load

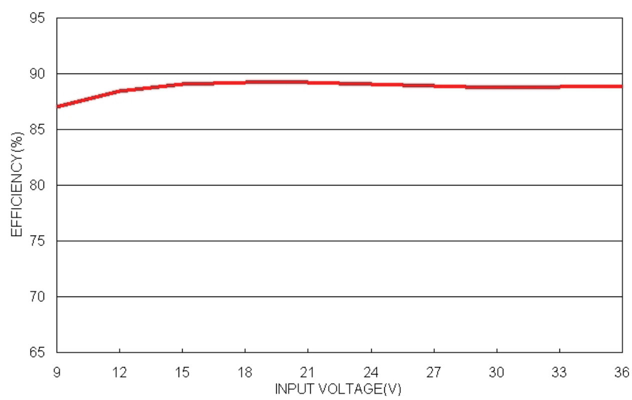
All test conditions are at 25°C.The figures are identical for PMF20-24S05W



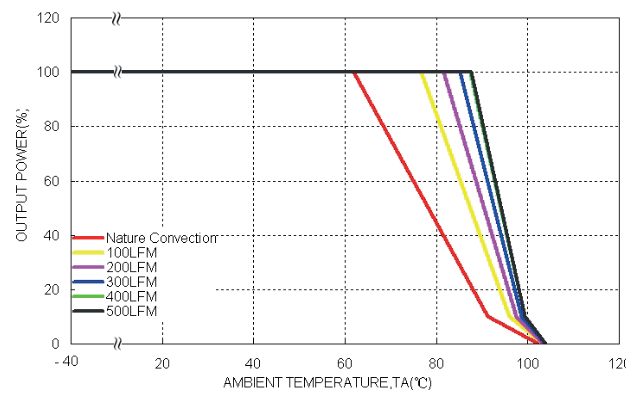
Efficiency versus Output Current



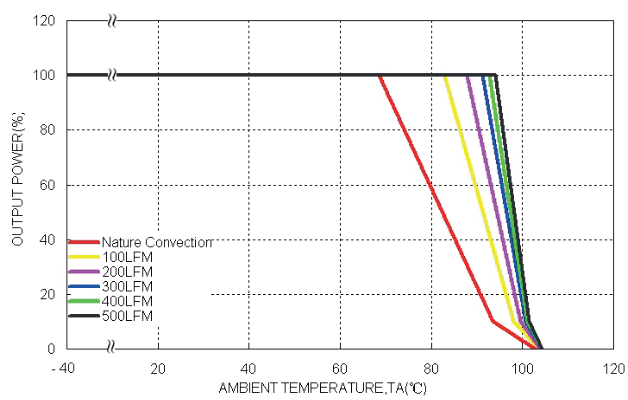
Power Dissipation versus Output Current



Efficiency versus Input Voltage
Full Load

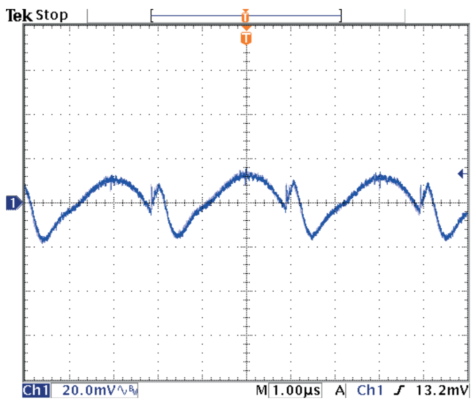


Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

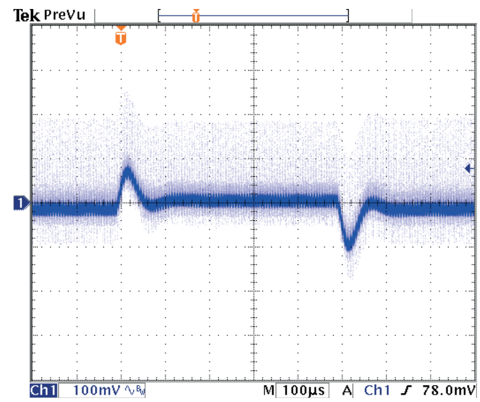


Derating Output Current versus Ambient Temperature with
Heat-sink and Airflow, Vin(nom)

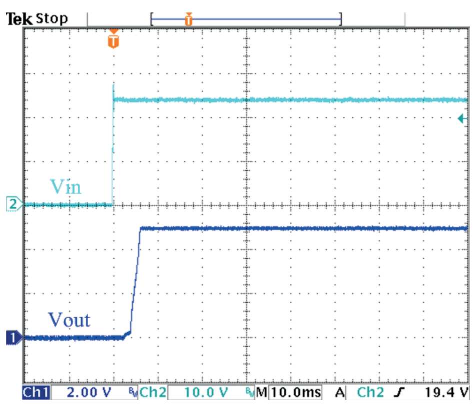
All test conditions are at 25°C.The figures are identical for PMF20-24S05W



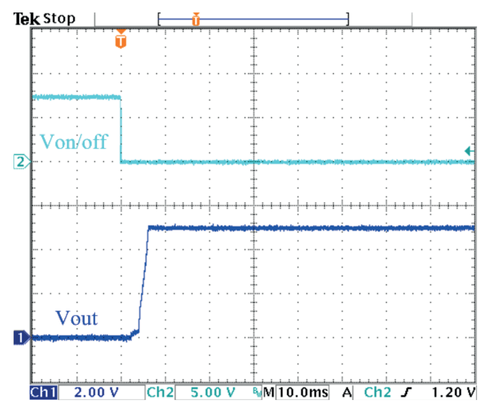
Typical Output Ripple and Noise.
Vin(nom); Full Load



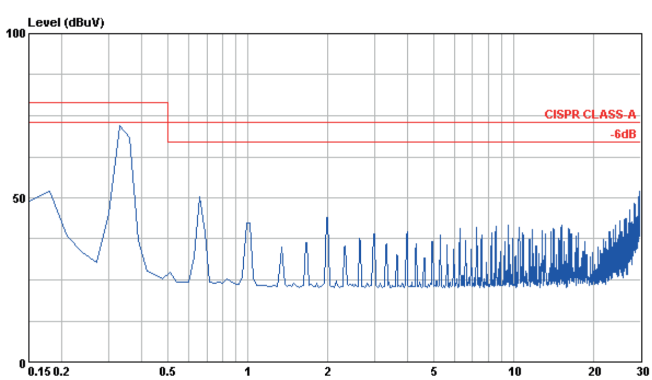
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



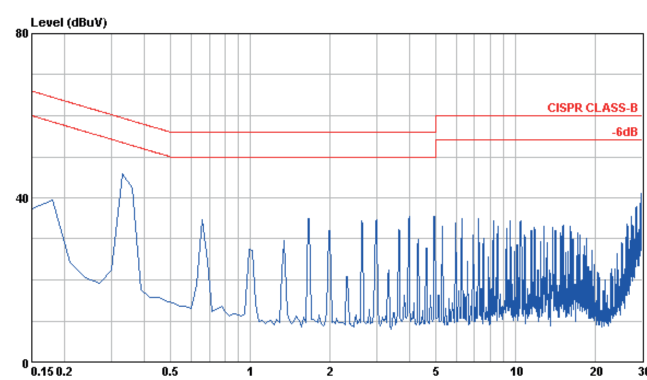
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



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

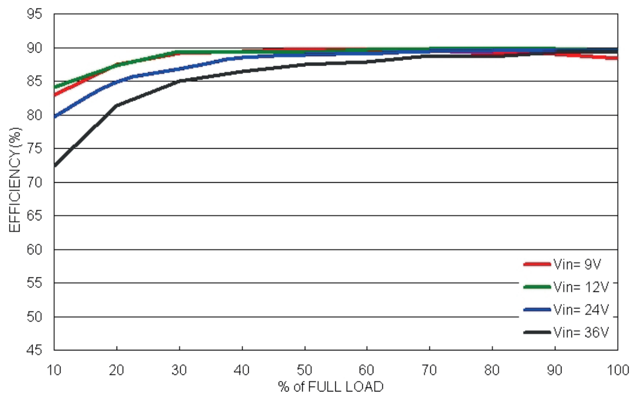


Conduction Emission of EN55022 Class A
Vin(nom); Full Load

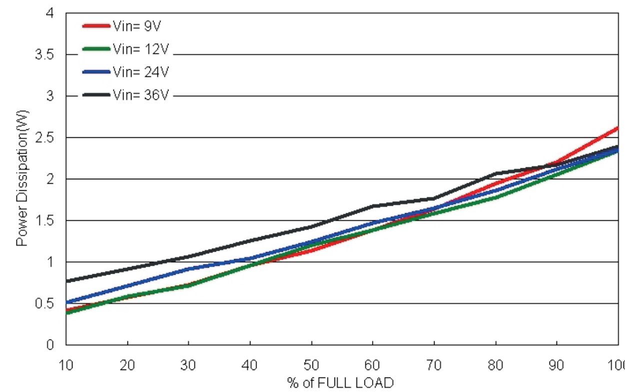


Conduction Emission of EN55022 Class B
Vin(nom); Full Load

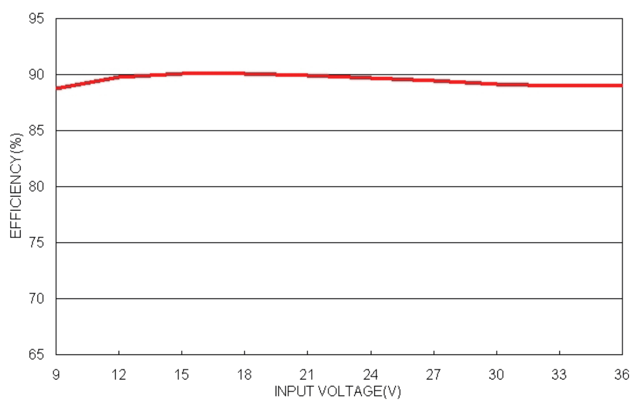
All test conditions are at 25°C.The figures are identical for PMF20-24S12W



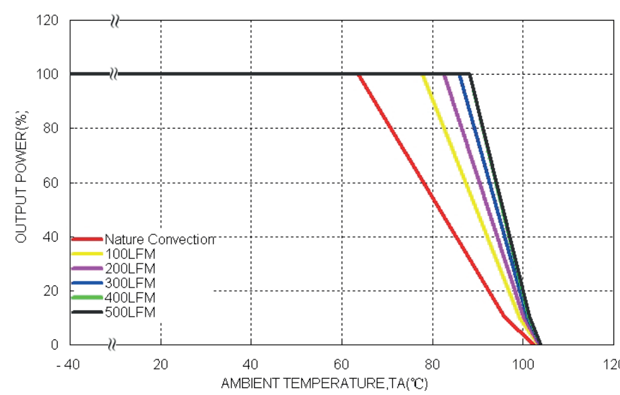
Efficiency versus Output Current



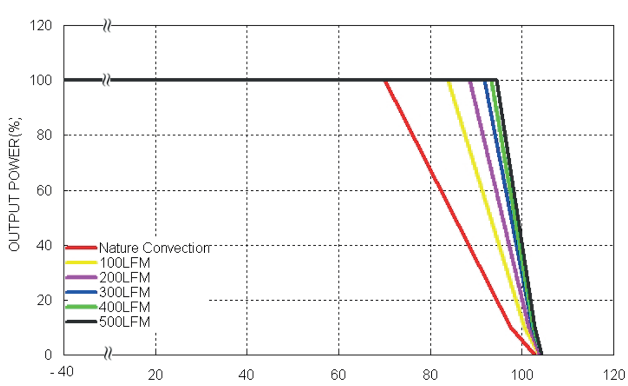
Power Dissipation versus Output Current



Efficiency versus Input Voltage
Full Load

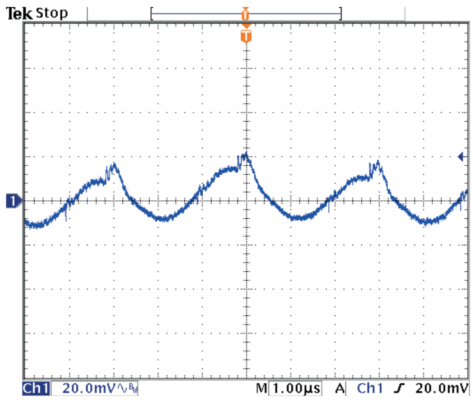


Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

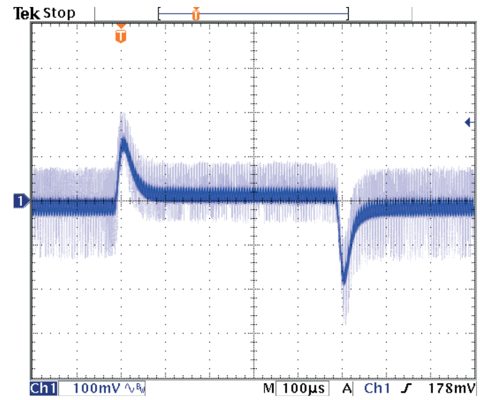


Derating Output Current versus Ambient Temperature with
Heat-sink and Airflow, Vin(nom)

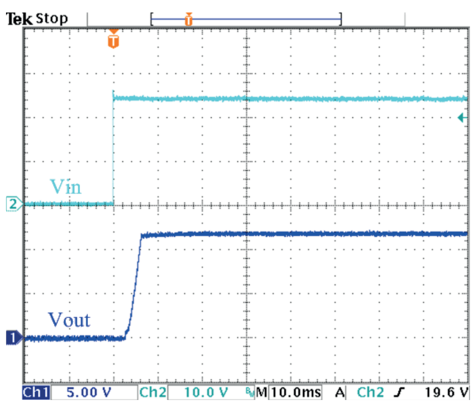
All test conditions are at 25°C.The figures are identical for PMF20-24S12W



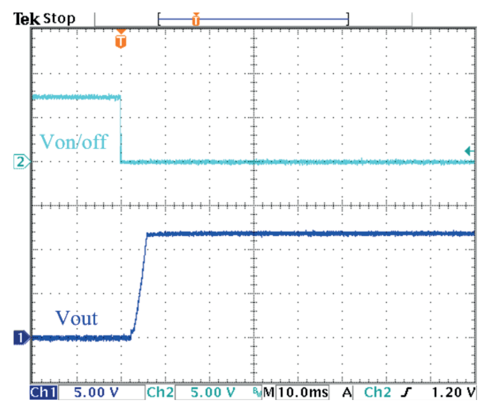
Typical Output Ripple and Noise.
Vin(nom); Full Load



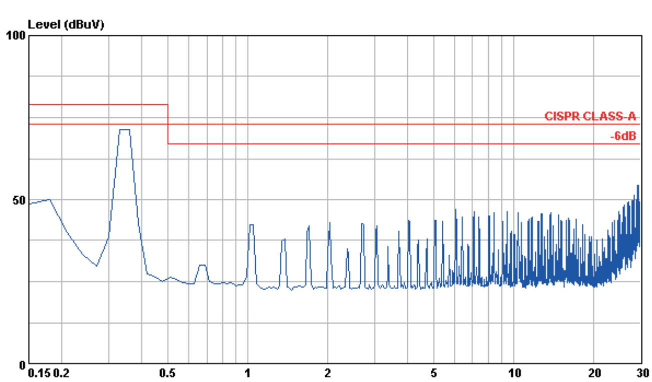
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



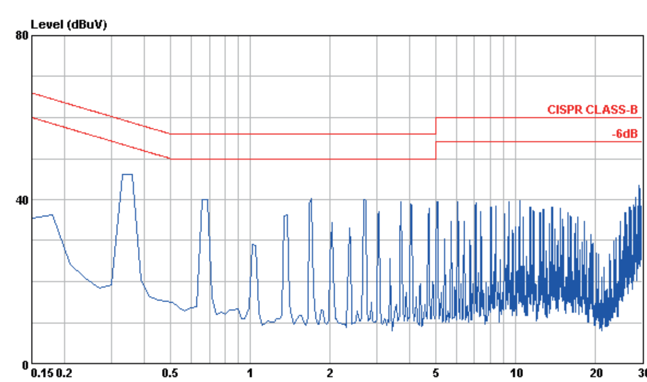
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



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

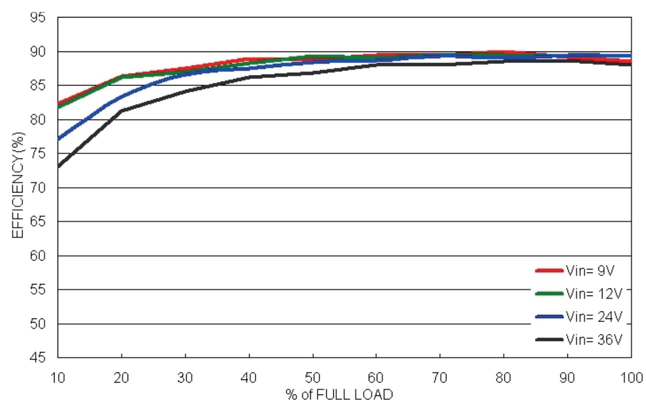


Conduction Emission of EN55022 Class A
Vin(nom); Full Load

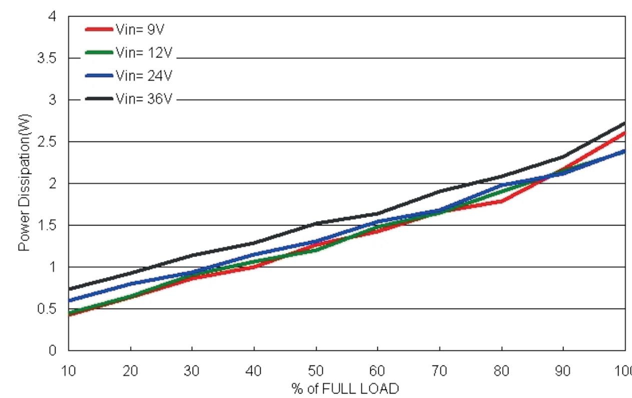


Conduction Emission of EN55022 Class B
Vin(nom); Full Load

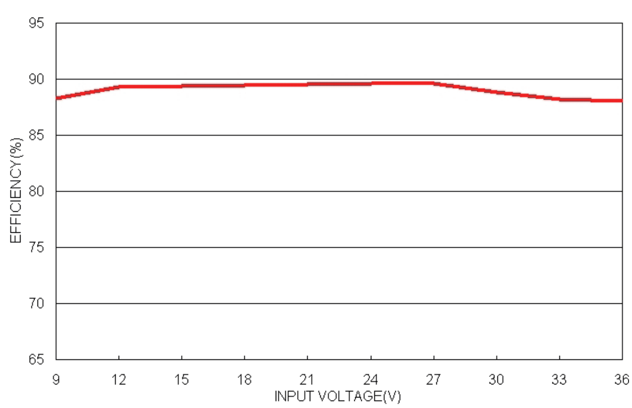
All test conditions are at 25°C.The figures are identical for PMF20-24S15W



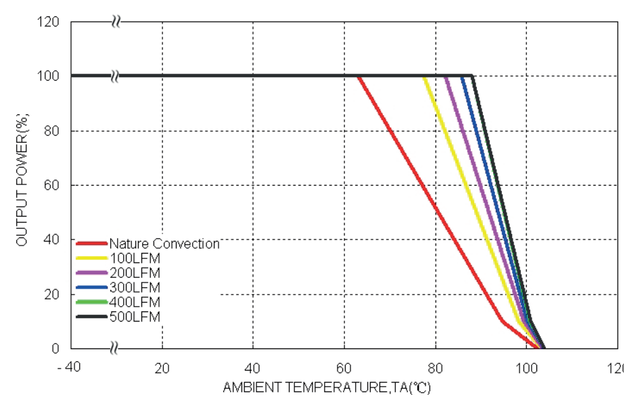
Efficiency versus Output Current



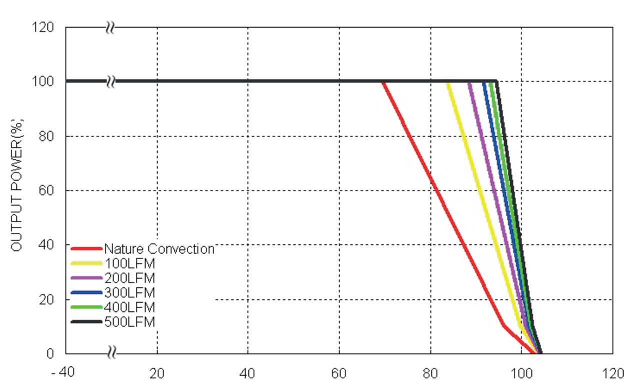
Power Dissipation versus Output Current



Efficiency versus Input Voltage
Full Load

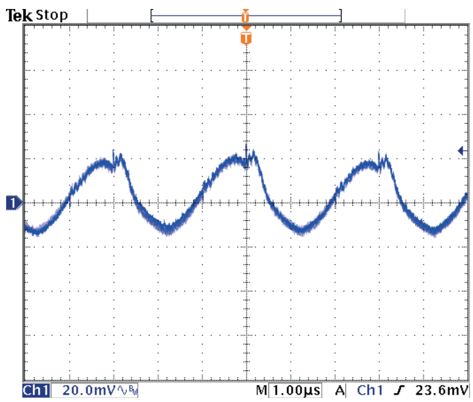


Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

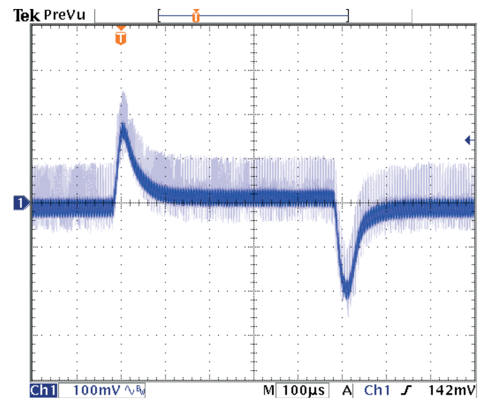


Derating Output Current versus Ambient Temperature with
Heat-sink and Airflow, Vin(nom)

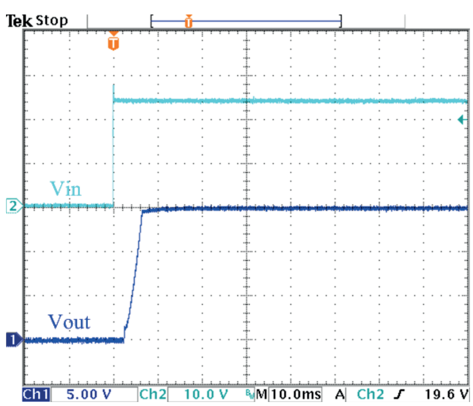
All test conditions are at 25°C.The figures are identical for PMF20-24S15W



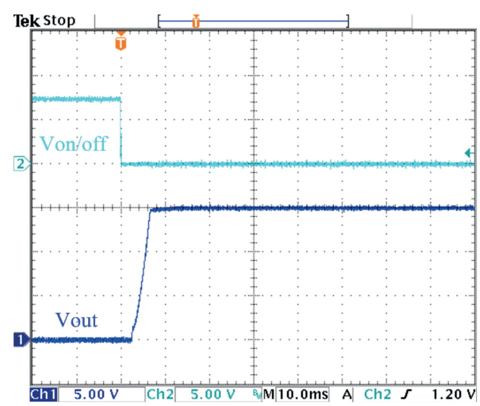
Typical Output Ripple and Noise.
Vin(nom); Full Load



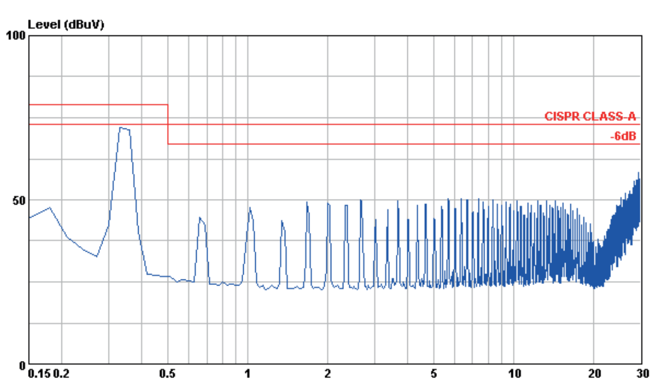
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



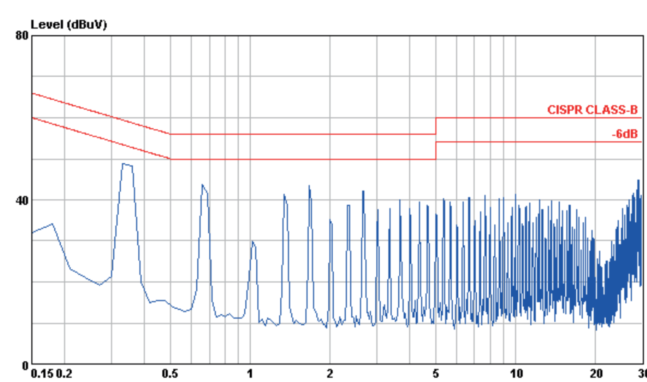
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



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

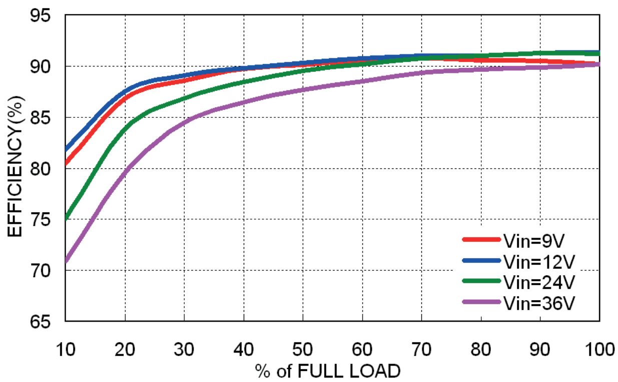


Conduction Emission of EN55022 Class A
Vin(nom); Full Load

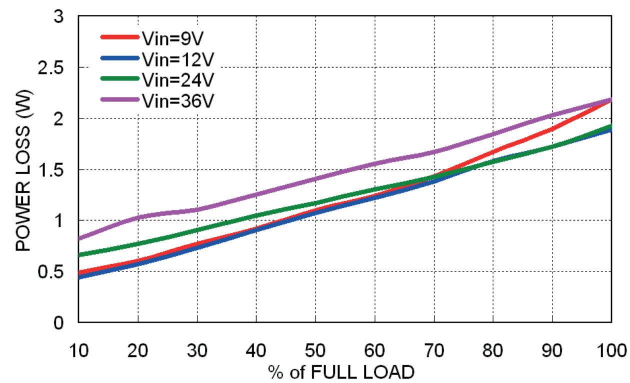


Conduction Emission of EN55022 Class B
Vin(nom); Full Load

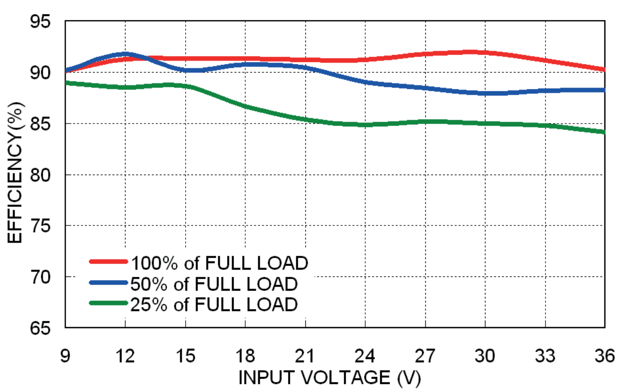
All test conditions are at 25°C.The figures are identical for PMF20-24S24W



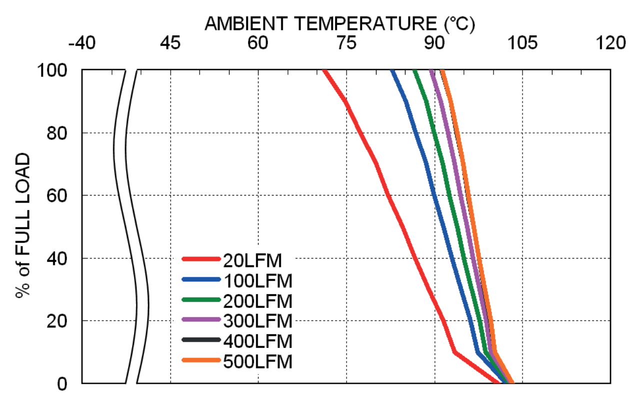
Efficiency versus Output Current



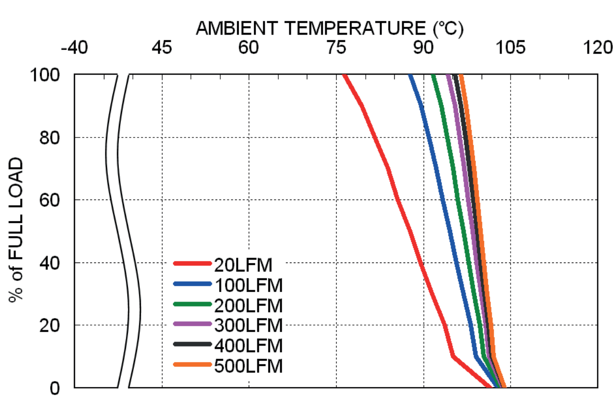
Power Dissipation versus Output Current



Efficiency versus Input Voltage
Full Load

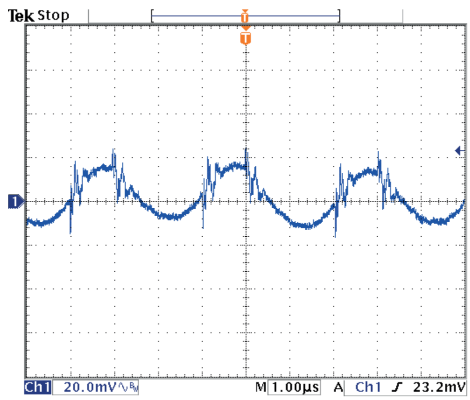


Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

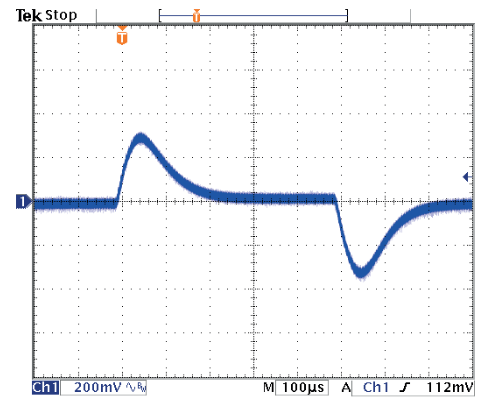


Derating Output Current versus Ambient Temperature with
Heat-sink and Airflow, Vin(nom)

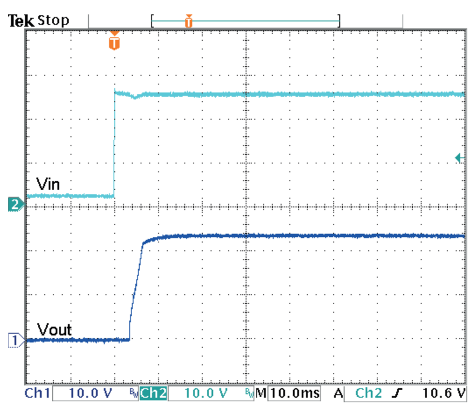
All test conditions are at 25°C.The figures are identical for PMF20-24S24W



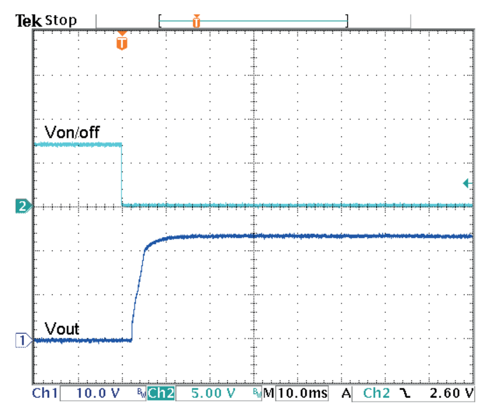
Typical Output Ripple and Noise.
Vin(nom); Full Load



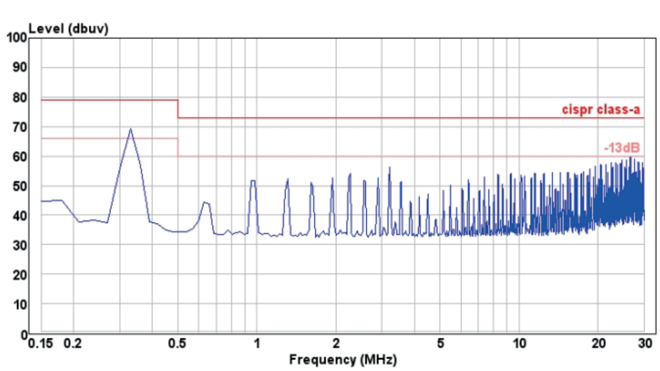
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



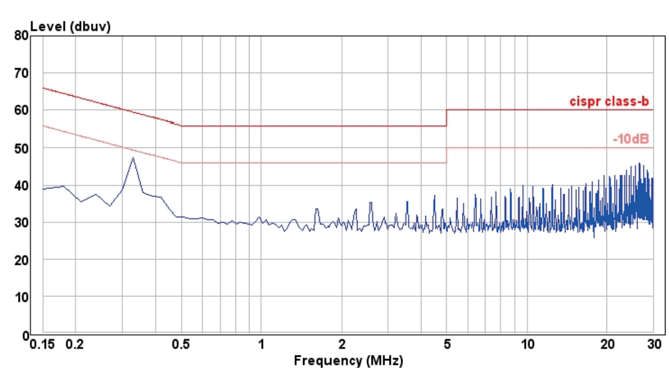
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



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

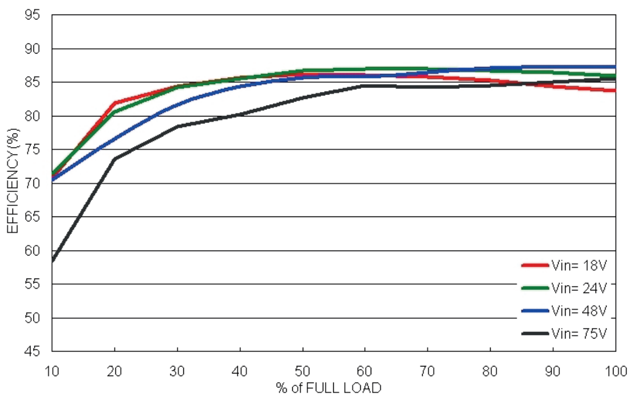


Conduction Emission of EN55022 Class A
Vin(nom); Full Load

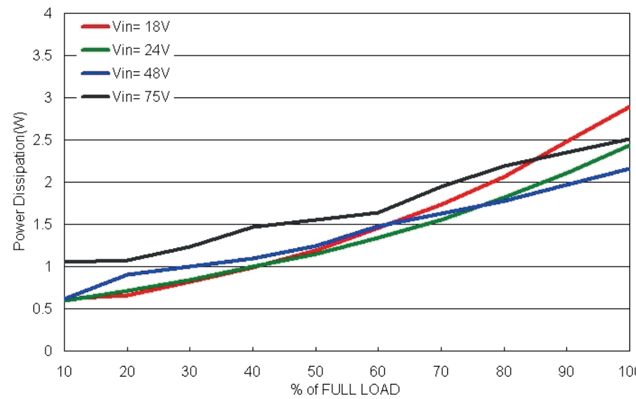


Conduction Emission of EN55022 Class B
Vin(nom); Full Load

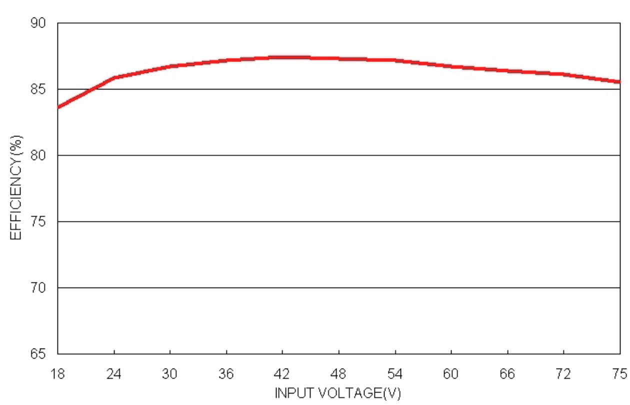
All test conditions are at 25°C.The figures are identical for PMF20-48S3P3W



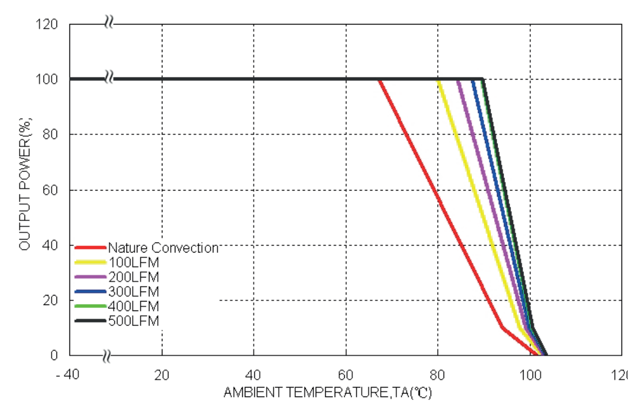
Efficiency versus Output Current



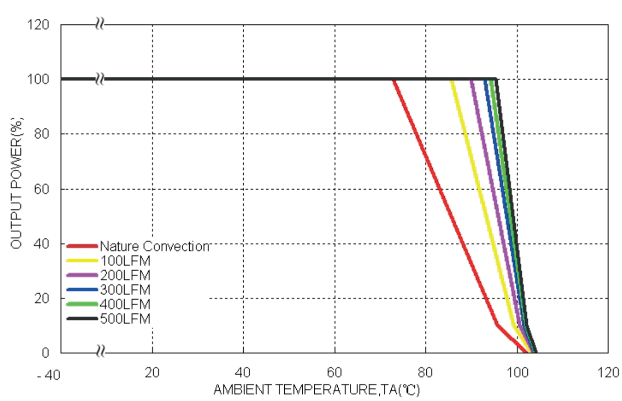
Power Dissipation versus Output Current



Efficiency versus Input Voltage
Full Load

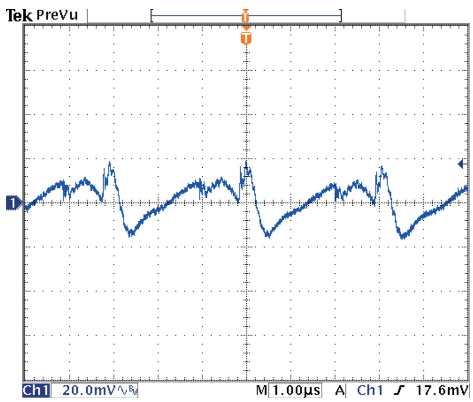


Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

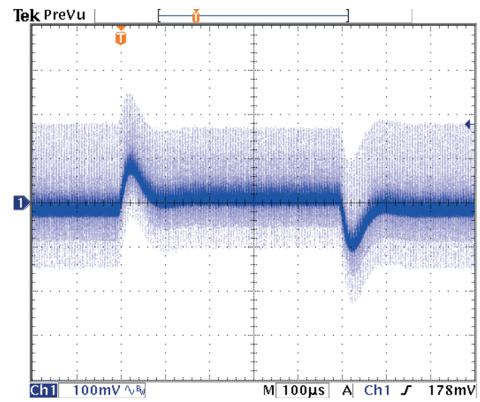


Derating Output Current versus Ambient Temperature with
Heat-sink and Airflow, Vin(nom)

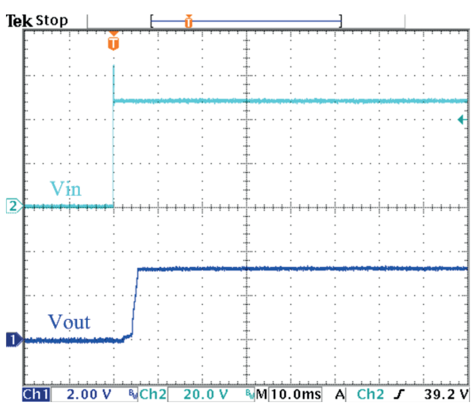
All test conditions are at 25°C.The figures are identical for PMF20-48S3P3W



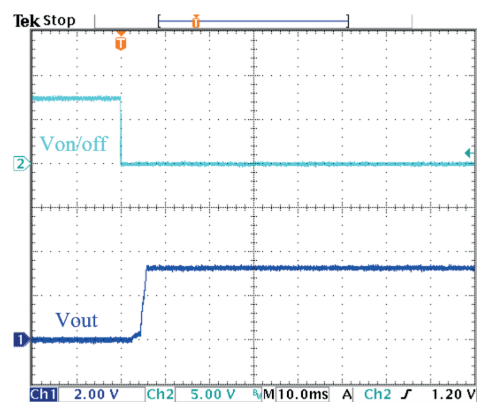
Typical Output Ripple and Noise.
Vin(nom); Full Load



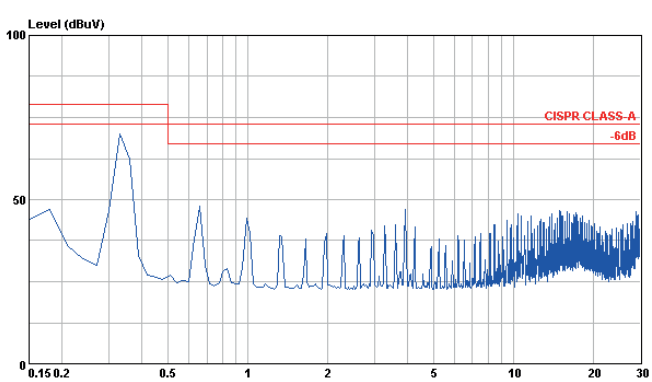
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



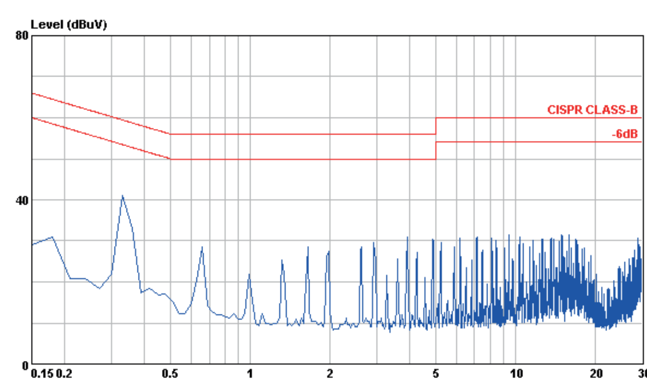
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



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

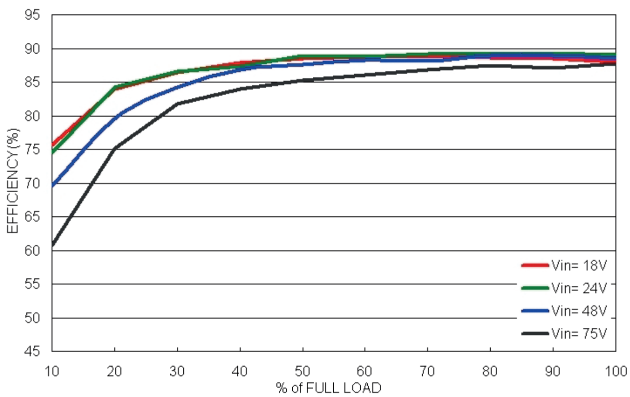


Conduction Emission of EN55022 Class A
Vin(nom); Full Load

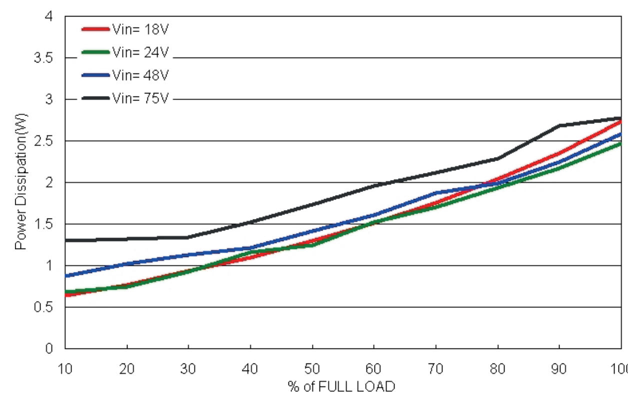


Conduction Emission of EN55022 Class B
Vin(nom); Full Load

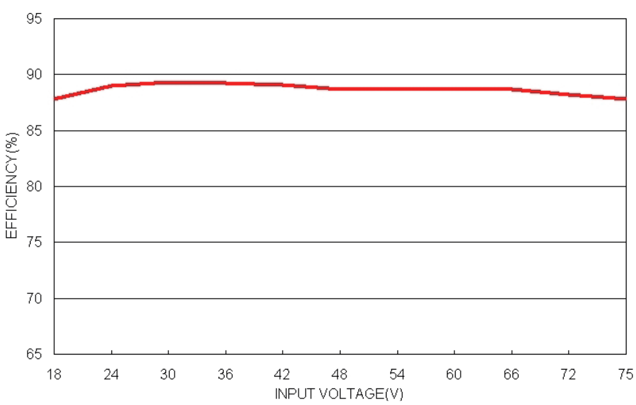
All test conditions are at 25°C.The figures are identical for PMF20-48S05W



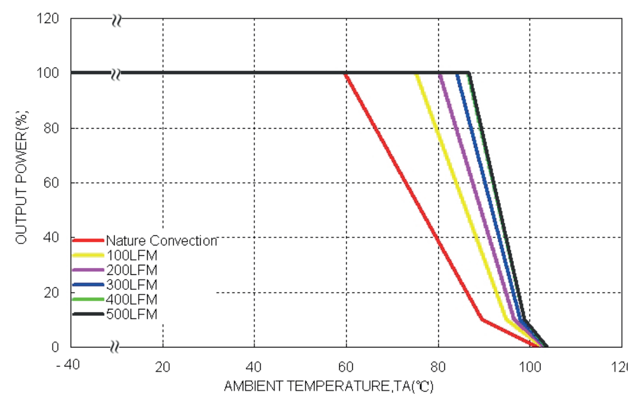
Efficiency versus Output Current



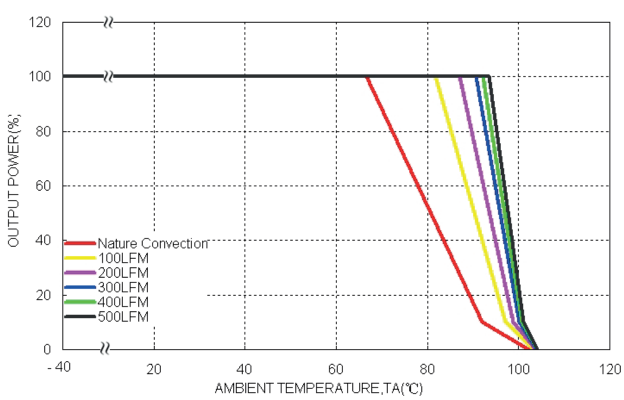
Power Dissipation versus Output Current



Efficiency versus Input Voltage
Full Load

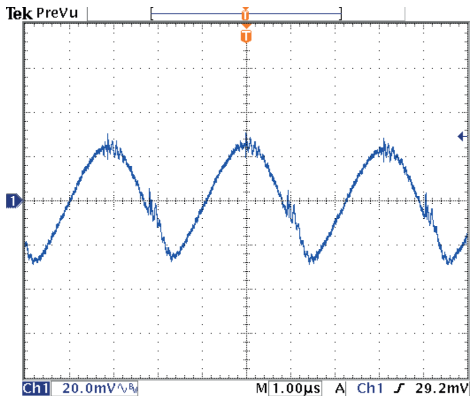


Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

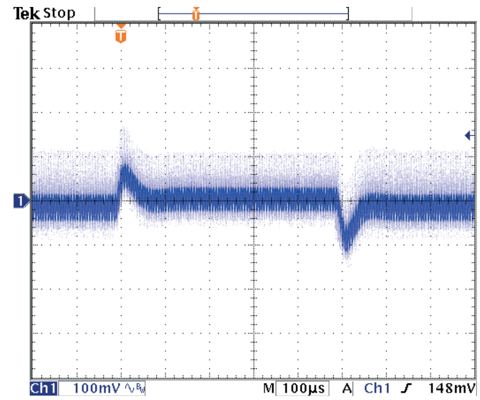


Derating Output Current versus Ambient Temperature with
Heat-sink and Airflow, Vin(nom)

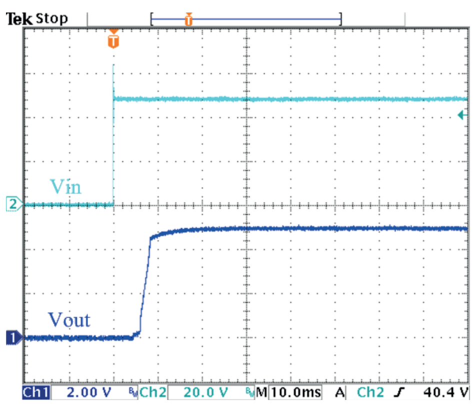
All test conditions are at 25°C.The figures are identical for PMF20-48S05W



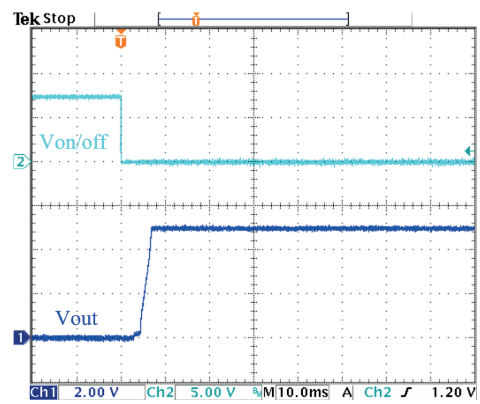
Typical Output Ripple and Noise.
Vin(nom); Full Load



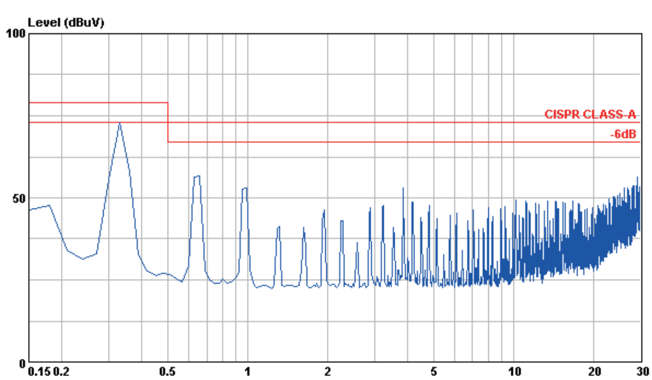
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



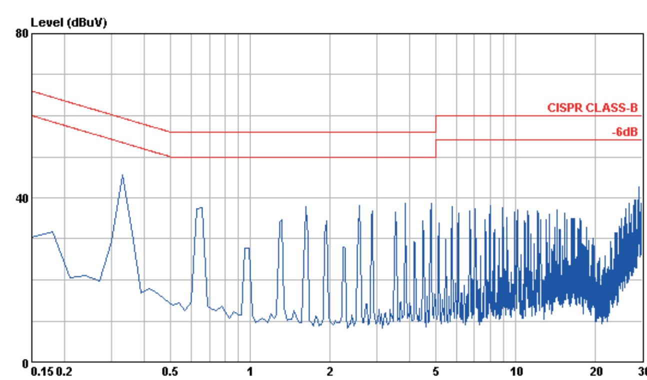
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



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

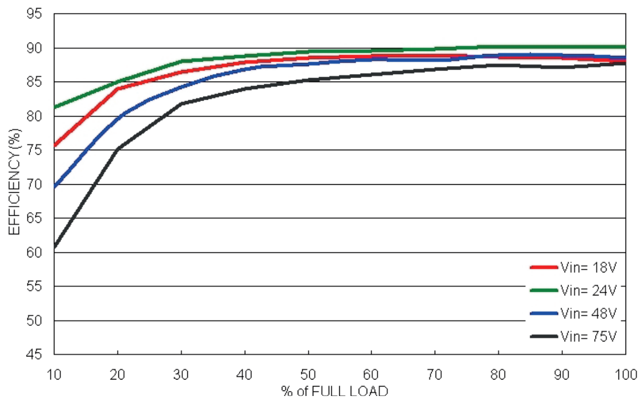


Conduction Emission of EN55022 Class A
Vin(nom); Full Load

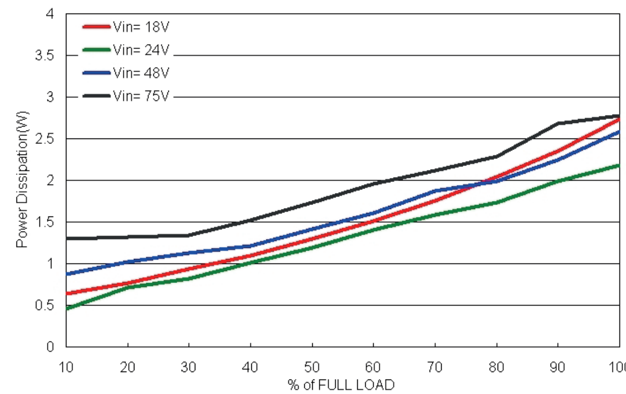


Conduction Emission of EN55022 Class B
Vin(nom); Full Load

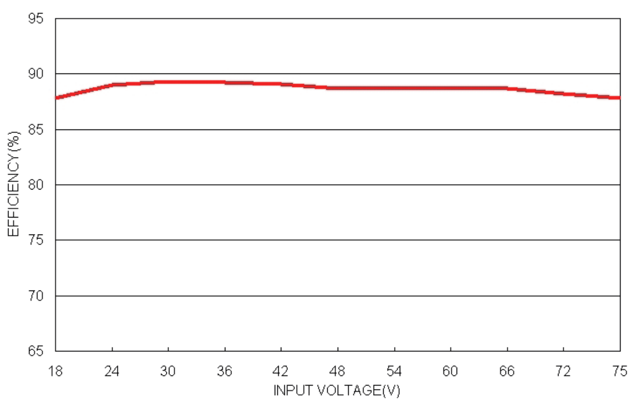
All test conditions are at 25°C.The figures are identical for PMF20-48S12W



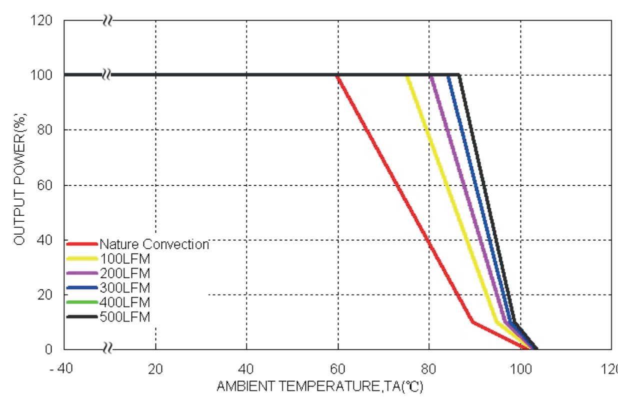
Efficiency versus Output Current



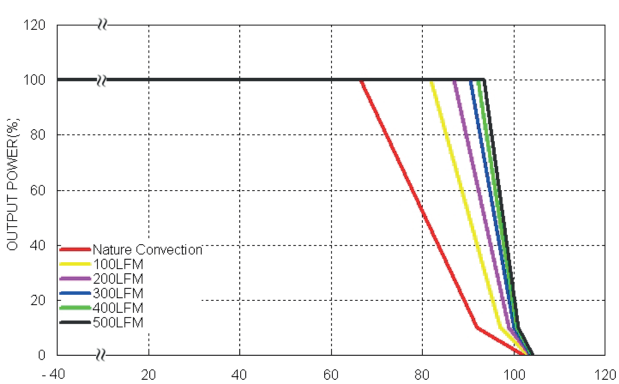
Power Dissipation versus Output Current



Efficiency versus Input Voltage
Full Load

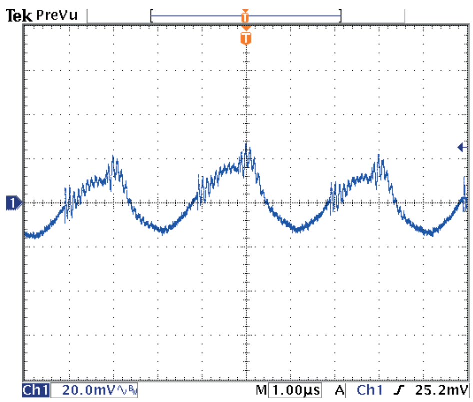


Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

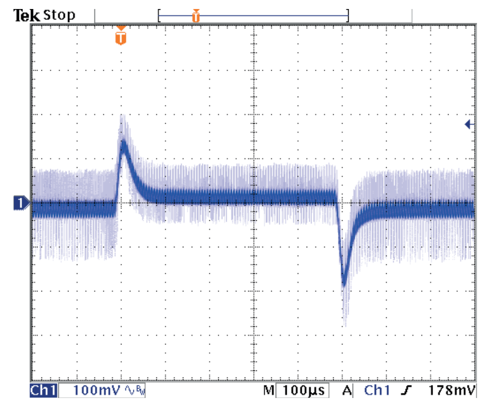


Derating Output Current versus Ambient Temperature with
Heat-sink and Airflow, Vin(nom)

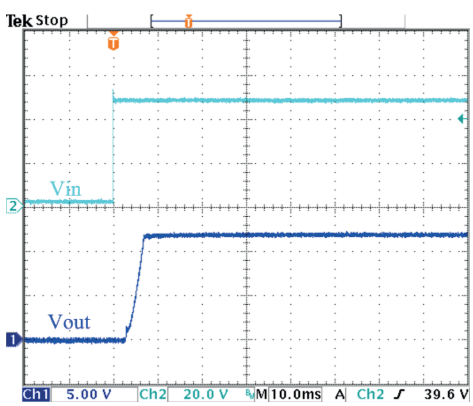
All test conditions are at 25°C.The figures are identical for PMF20-48S12W



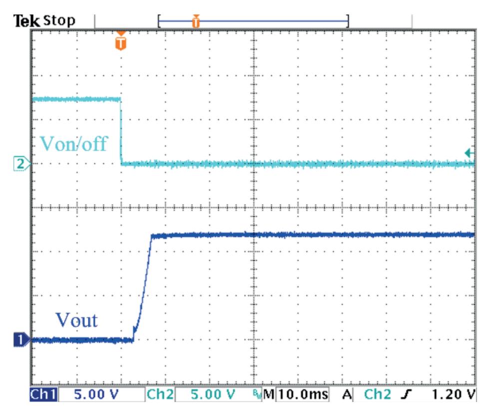
Typical Output Ripple and Noise.
Vin(nom); Full Load



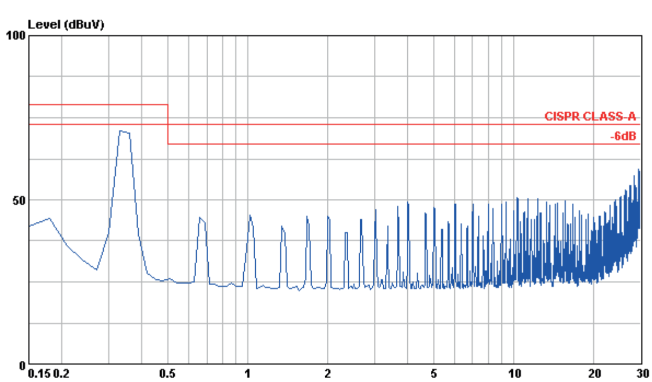
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



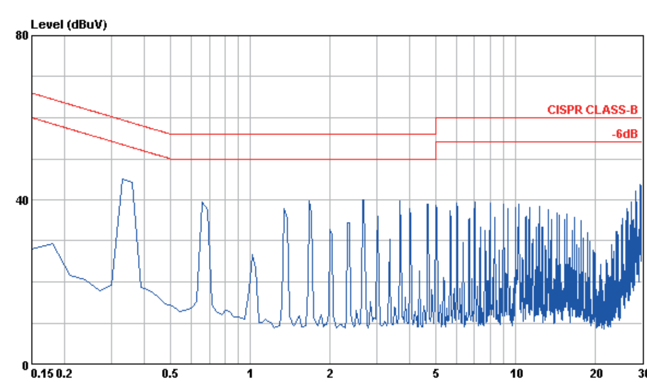
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



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

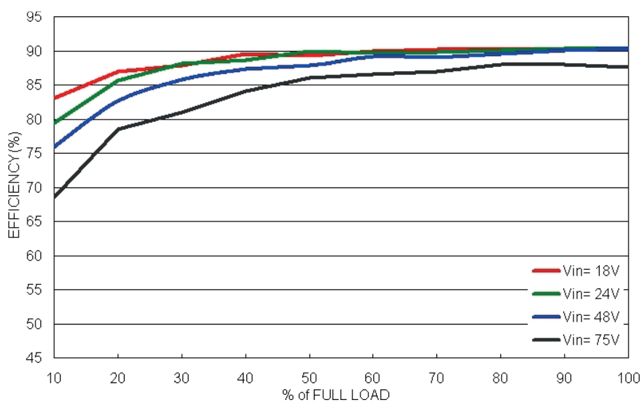


Conduction Emission of EN55022 Class A
Vin(nom); Full Load

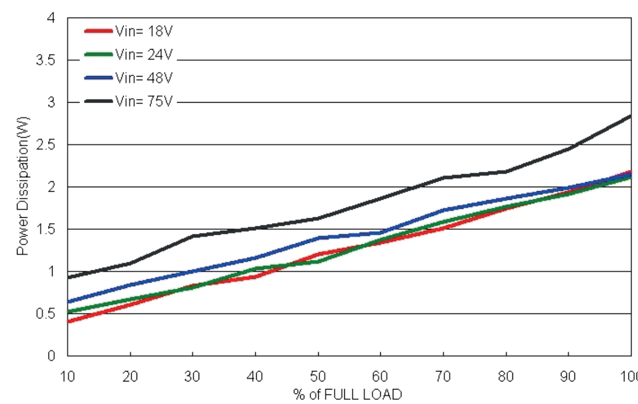


Conduction Emission of EN55022 Class B
Vin(nom); Full Load

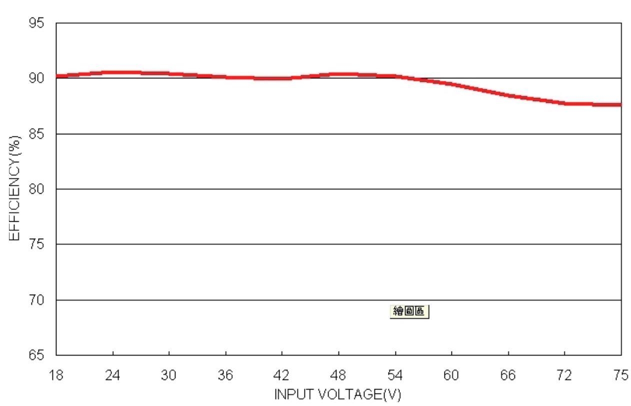
All test conditions are at 25°C.The figures are identical for PMF20-48S15W



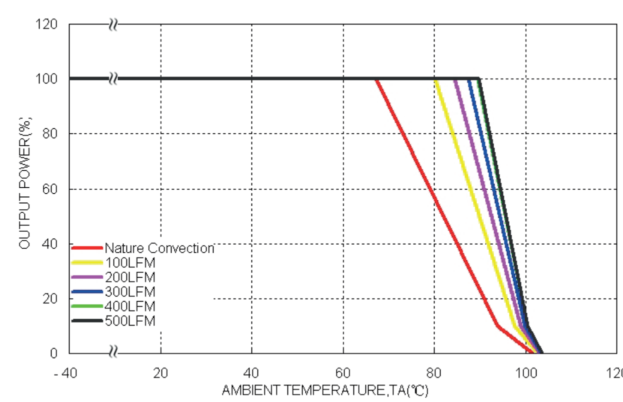
Efficiency versus Output Current



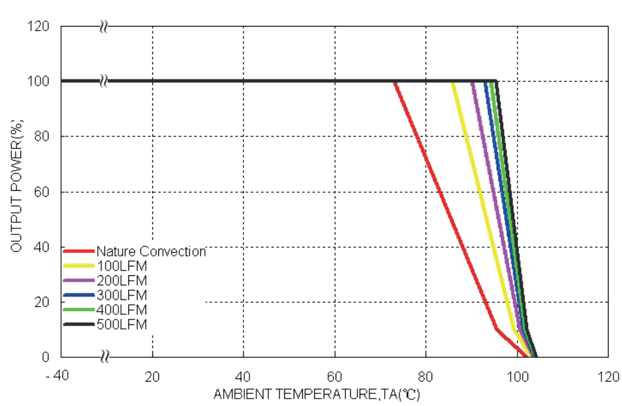
Power Dissipation versus Output Current



Efficiency versus Input Voltage
Full Load

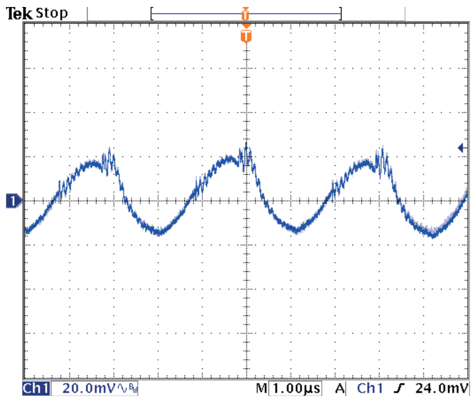


Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

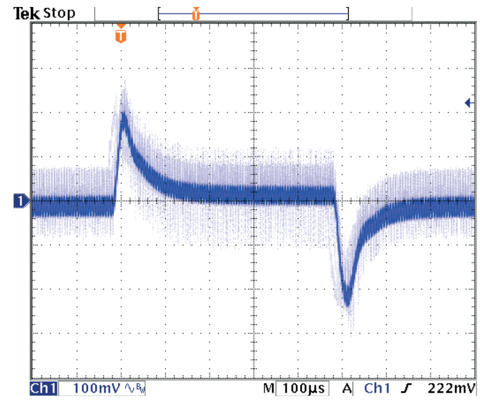


Derating Output Current versus Ambient Temperature with
Heat-sink and Airflow, Vin(nom)

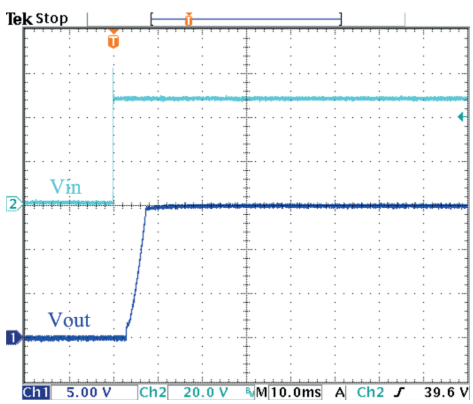
All test conditions are at 25°C.The figures are identical for PMF20-48S15W



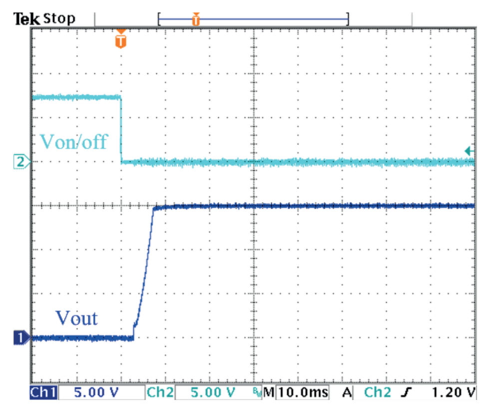
Typical Output Ripple and Noise.
Vin(nom); Full Load



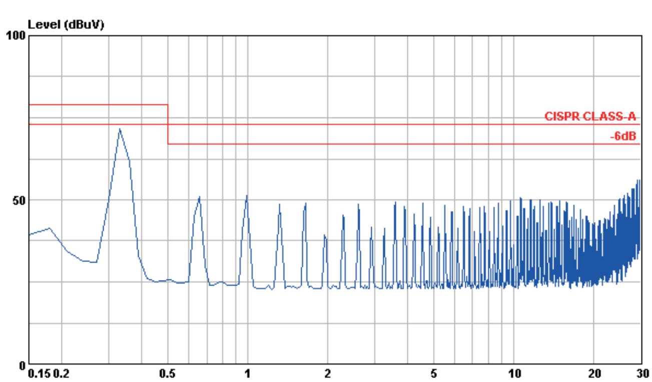
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



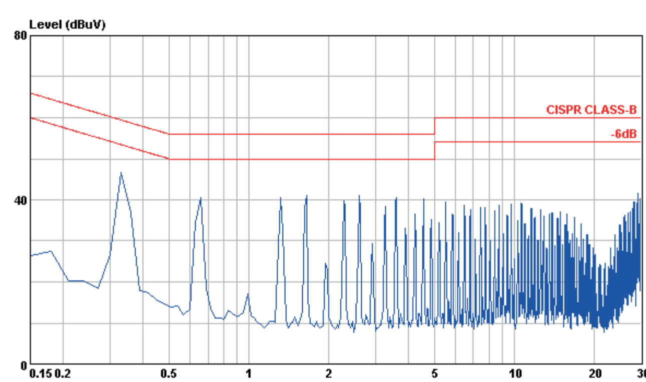
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



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

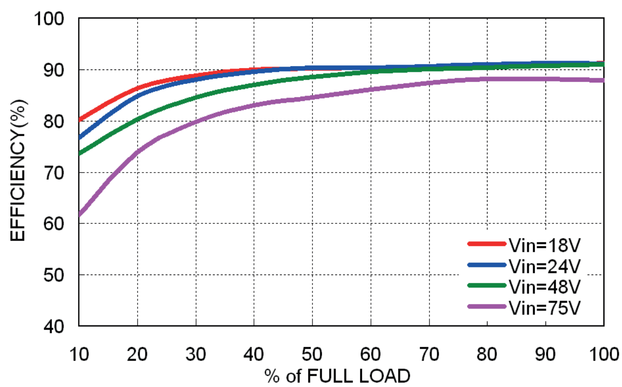


Conduction Emission of EN55022 Class A
Vin(nom); Full Load

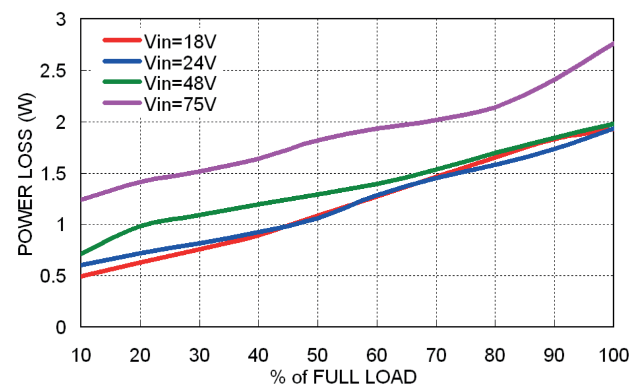


Conduction Emission of EN55022 Class B
Vin(nom); Full Load

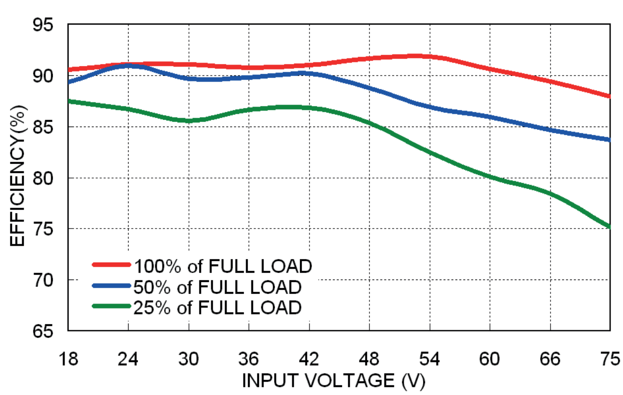
All test conditions are at 25°C.The figures are identical for PMF20-48S24W



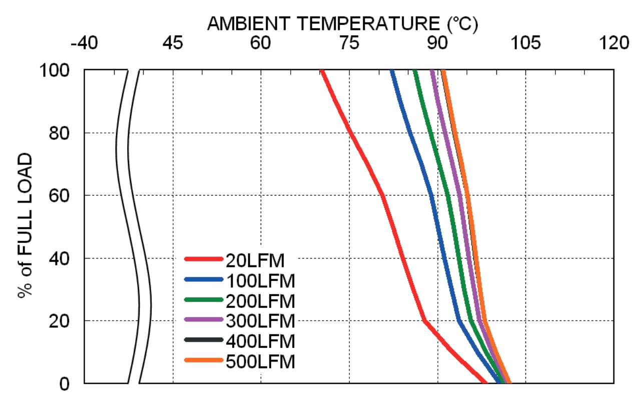
Efficiency versus Output Current



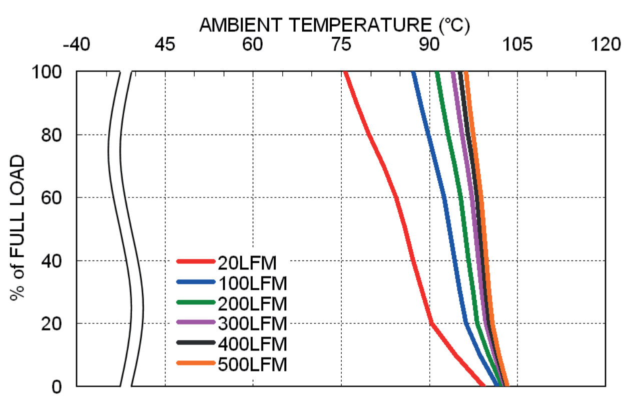
Power Dissipation versus Output Current



Efficiency versus Input Voltage
Full Load

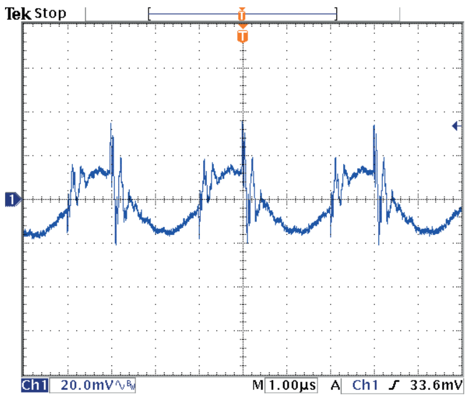


Derating Output Current versus Ambient Temperature and Airflow
Vin(nom)

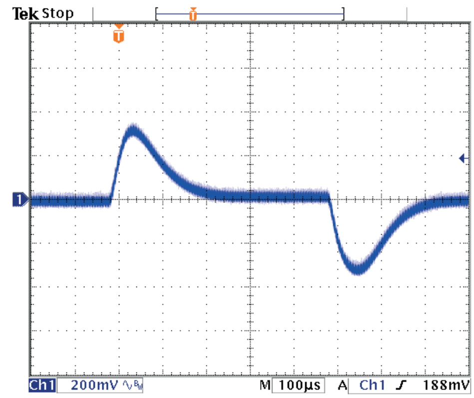


Derating Output Current versus Ambient Temperature with
Heat-sink and Airflow, Vin(nom)

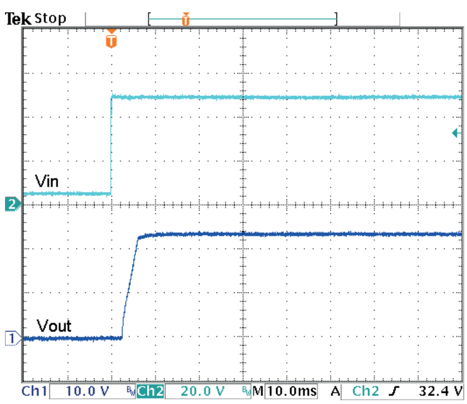
All test conditions are at 25°C.The figures are identical for PMF20-48S24W



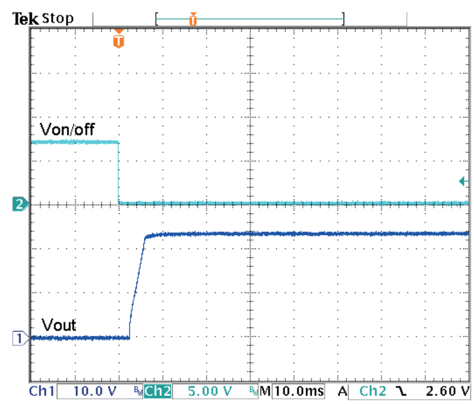
Typical Output Ripple and Noise.
Vin(nom); Full Load



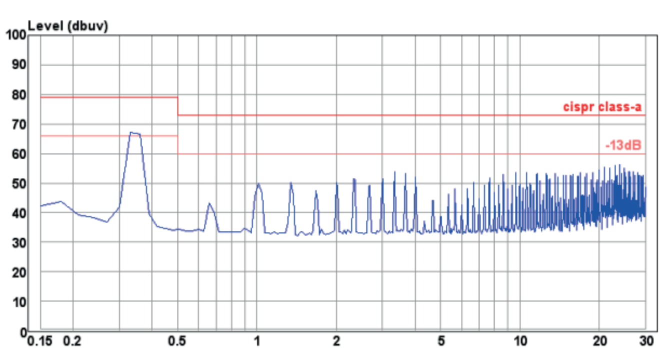
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; Vin(nom)



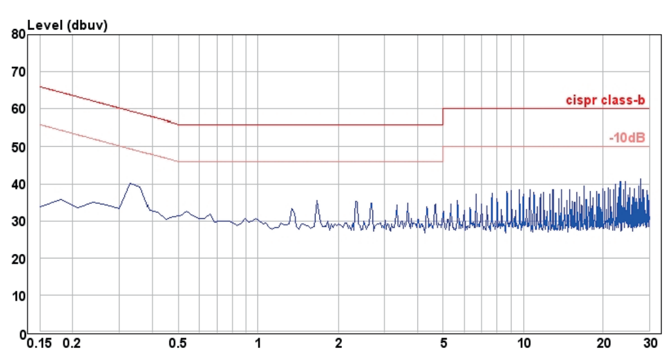
Typical Input Start-Up and Output Rise Characteristic
Vin(nom); Full Load



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



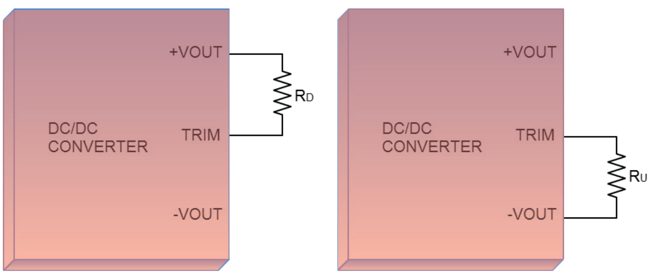
Conduction Emission of EN55022 Class A
Vin(nom); Full Load



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

Output Voltage Adjustment

Output voltage set point adjustment allows the user to increase or decrease the output voltage set point of the module. This is accomplished by connecting an external resistor between the TRIM pin and either the +OUTPUT or -OUTPUT pins. With an external resistor between the TRIM and -OUTPUT pin, the output voltage set point increases. With an external resistor between the TRIM and +OUTPUT pin, the output voltage set point decreases. The external TRIM resistor needs to be at least 1/16W of rated power.



Trim up equation

$$R_U = \left[\frac{G \times L}{(V_{O,up} - L - K)} - H\right]\Omega$$

Trim down equation

$$R_D = \left[\frac{(V_{o,down} - L) \times G}{(V_o - V_{o,down})} - H\right]\Omega$$

Trim constants

Module	**G**	**H**	**K**	**L**
PMF20-□□S3P3W	5110	2050	0.8	2.5
PMF20-□□S05W	5110	2050	2.5	2.5
PMF20-□□S12W	10000	5110	9.5	2.5
PMF20-□□S15W	10000	5110	12.5	2.5
PMF20-□□S24W	56000	13000	21.5	2.5

Output voltage adjustment configurations

PMF20-□□S3P3W		**Trim-Up**									
Trim-Up	(%)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Vout	(V)	3.333	3.366	3.399	3.432	3.465	3.498	3.531	3.564	3.597	3.630
RU	(kΩ)	385.071	191.511	126.990	94.730	75.374	62.470	53.253	46.340	40.963	36.662

PMF20-□□S3P3W		**Trim-Down**									
Trim-Down	(%)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Vout	(V)	3.267	3.234	3.201	3.168	3.135	3.102	3.069	3.036	3.003	2.970
RD	(kΩ)	116.719	54.779	34.133	23.810	17.616	13.486	10.537	8.325	6.604	5.228

PMF20-□□S05W		**Trim-Up**									
Trim-Up	(%)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Vout	(V)	5.050	5.100	5.150	5.200	5.250	5.300	5.350	5.400	5.450	5.500
RU	(kΩ)	253.450	125.700	83.117	61.825	49.050	40.533	34.450	29.888	26.339	23.500

PMF20-□□S05W		**Trim-Down**									
Trim-Down	(%)	1	2	3	4	5	6	7	8	9	10
Vout	(V)	4.950	4.900	4.850	4.800	4.750	4.700	4.650	4.600	4.550	4.500
RD	(kΩ)	248.340	120.590	78.007	56.715	43.940	35.423	29.340	24.778	21.229	18.390

PMF20-□□S12W		**Trim-Up**									
Trim-Up	(%)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Vout	(V)	12.120	12.240	12.360	12.480	12.600	12.720	12.840	12.960	13.080	13.200
RU	(kΩ)	203.223	99.057	64.334	46.973	36.557	29.612	24.652	20.932	18.038	15.723

PMF20-□□S12W		**Trim-Down**									
Trim-Down	(%)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Vout	(V)	11.880	11.760	11.640	11.520	11.400	11.280	11.160	11.040	10.920	10.800
RD	(kΩ)	776.557	380.723	248.779	182.807	143.223	116.834	97.985	83.848	72.853	64.057

PMF20-□□S15W		**Trim-Up**									
Trim-Up	(%)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Vout	(V)	15.150	15.300	15.450	15.600	15.750	15.900	16.050	16.200	16.350	16.500
RU	(kΩ)	161.557	78.223	50.446	36.557	28.223	22.668	18.700	15.723	13.409	11.557

PMF20-□□S15W		**Trim-Down**									
Trim-Down	(%)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Vout	(V)	14.850	14.700	14.550	14.400	14.250	14.100	13.950	13.800	13.650	13.500
RD	(kΩ)	818.223	401.557	262.668	193.223	151.557	123.779	103.938	89.057	77.483	68.223

PMF20-□□S24W		**Trim-Up**									
Trim-Up	(%)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Vout	(V)	24.240	24.480	24.720	24.960	25.200	25.440	25.680	25.920	26.160	26.400
RU	(kΩ)	570.333	278.667	181.444	132.833	13.667	84.222	70.333	59.917	51.815	45.333

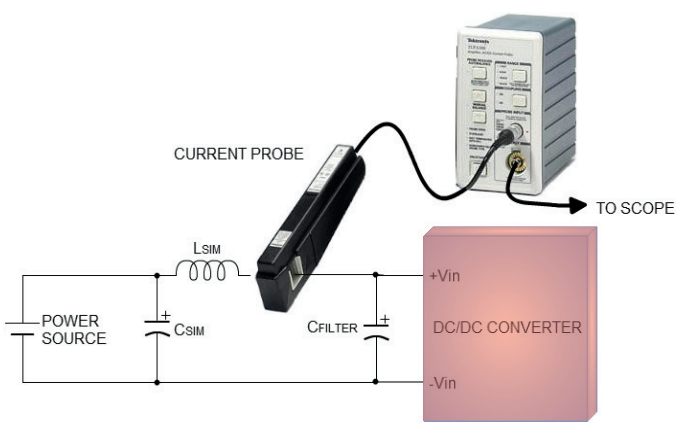
PMF20-□□S24W		**Trim-Up**									
Trim-Up	(%)	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Vout	(V)	26.640	26.880	27.120	27.360	27.600	27.840	28.080	28.320	28.560	28.800
RU	(kΩ)	40.030	35.611	31.872	28.667	25.889	23.458	21.314	19.407	17.702	16.167

PMF20-□□S24W		**Trim-Down**									
Trim-Down	(%)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Vout	(V)	23.760	23.520	23.280	23.040	22.800	22.560	22.320	22.080	21.840	21.600
RD	(kΩ)	4947.667	2439.333	1603.222	1185.167	934.333	767.111	647.667	558.083	488.407	432.667

Input Source Impedance

The power module should be connected to a low impedance input source. Highly inductive source impedance can affect the stability of the power module. Install CSIM and LSIM to simulate the impedance of power source. External input 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 Refleced Ripple Current Measurement Setup



PMF20-□□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 150 percent of rated current for PMF20W single 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 overload 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

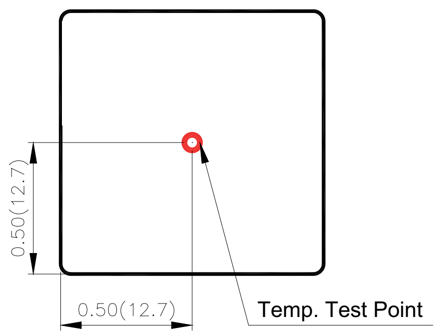
Continuous, auto-recovery mode. During short circuit, converter still shut down. The average current during this condition will be very low and the device can be safety in this condition.

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.

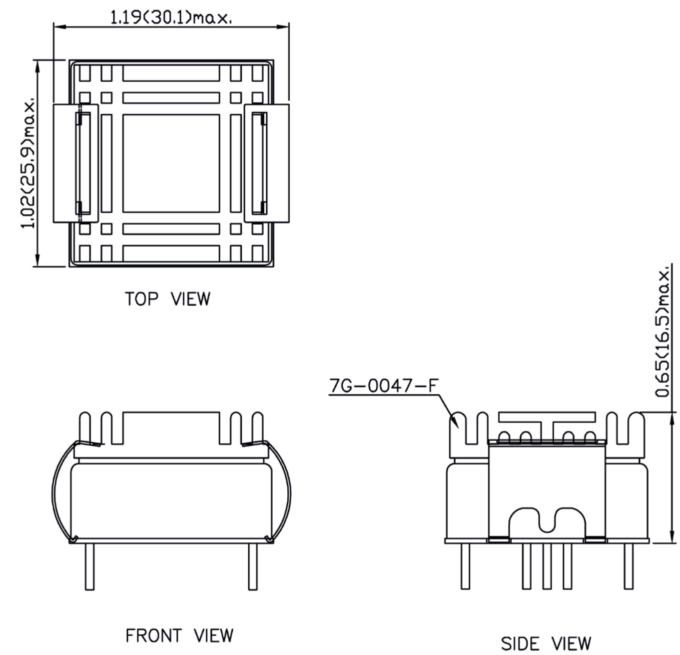


Measurement shown in inch (mm)

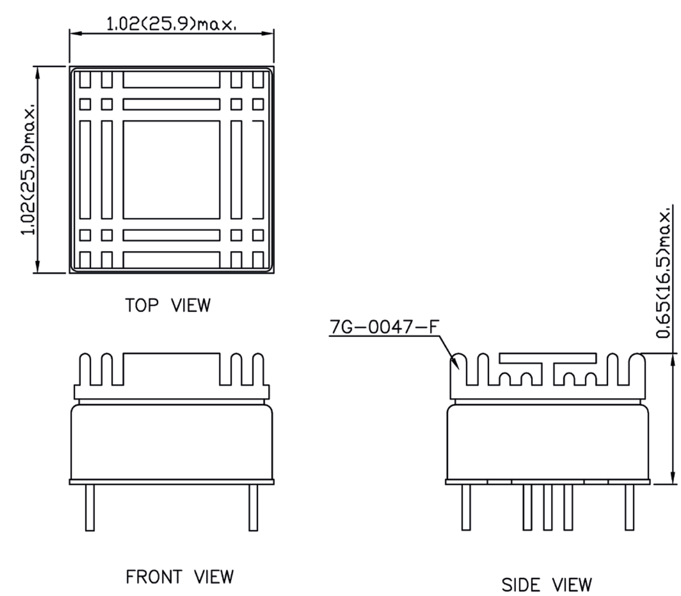
Heat-Sink Considerations

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

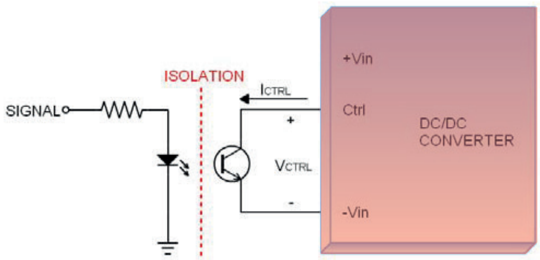


All dimensions in inch (mm)

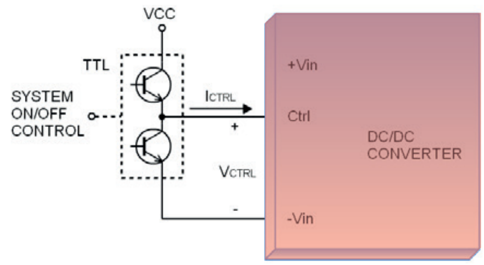
Remote On/Off Control

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.

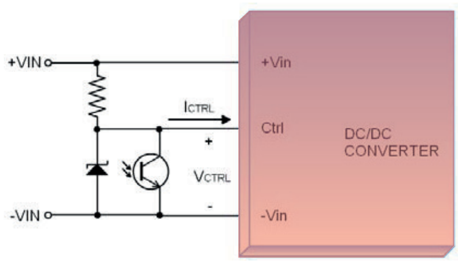
Remote ON/OFF Implementation



Isolated-Closure Remote ON/OFF



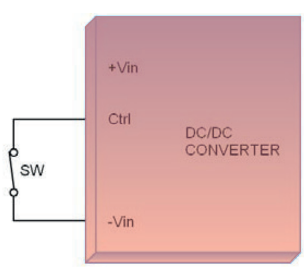
Level Control Using TTL Output



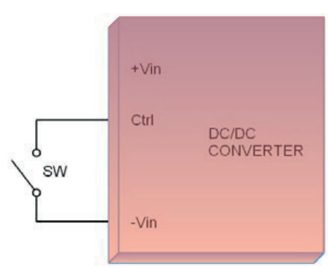
Level Control Using Line Voltage

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.

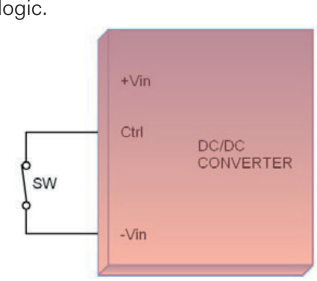


When PMF20W module is turned off
at Low-level logic

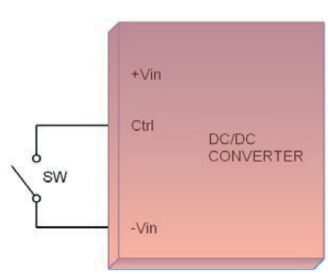


When PMF20W module is turned on
at High-level logic

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.



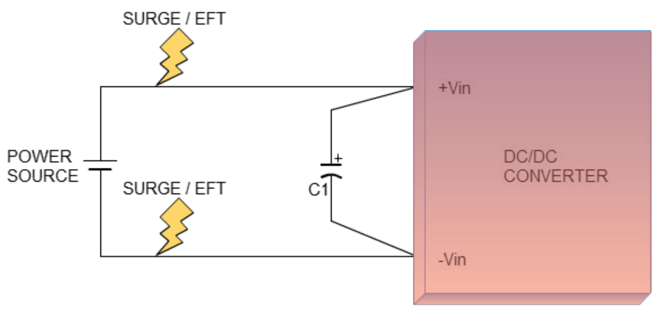
When PMF20W module is turned on
at Low-level logic



When PMF20W module is turned off
at High-level logic

EMS Considerations

The PMF20 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.

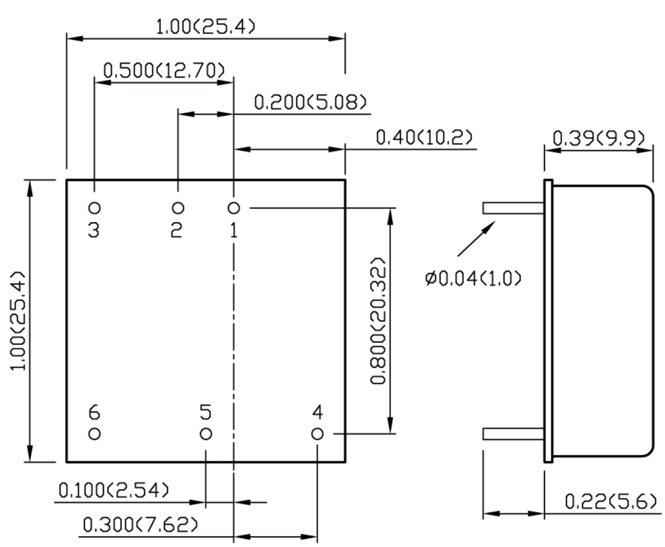


Surge/Fast Transient

PMF20-□□S□□W

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

Mechanical Data



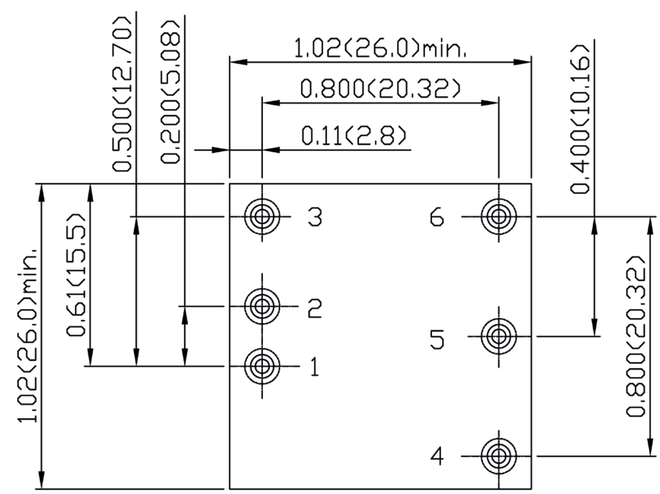
BOTTOM VIEW

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

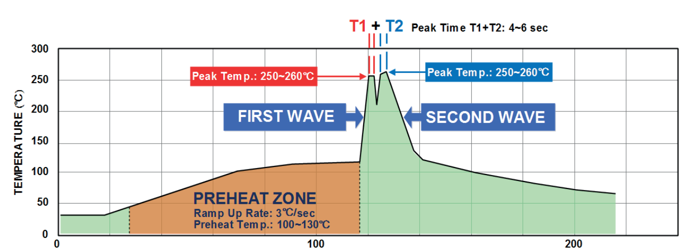
Recommended Pad Layout



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

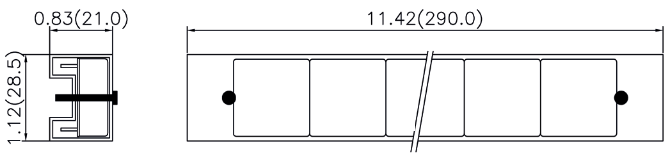
Lead free wave solder profile



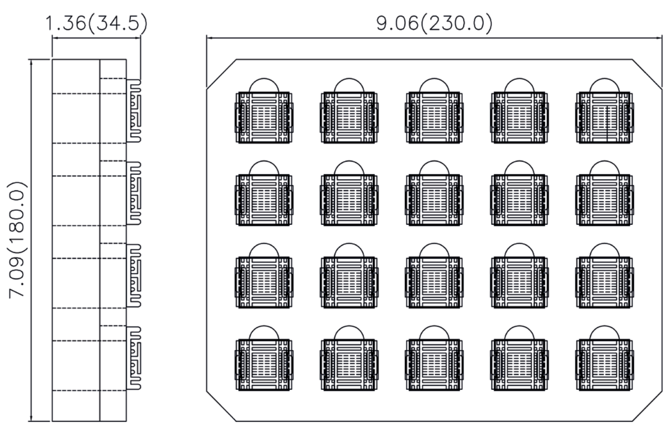
Reference Solder: Sn-Ag-Cu: Sn-Cu
Hand Welding (Reference):
Soldering iron: Power 150W
Welding Time: 3~6 sec
Temp: 410~430°C

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
PMF20-24S□□W	4	Slow-Blow
PMF20-48S□□W	2	Slow-Blow

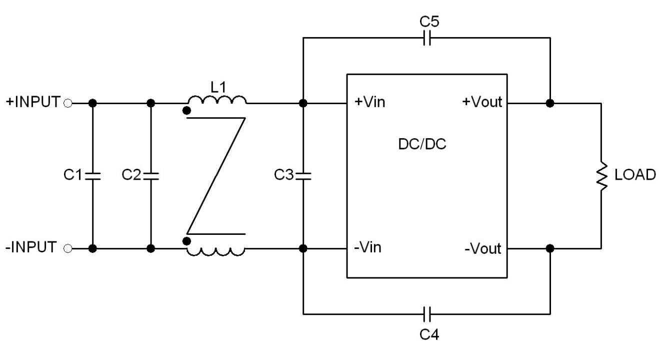
Based on the information provided in this application note on Inrush energy and maximum DC input current at low Vin. If customer have another used condition and need more information, please contact Powerbox.

MTBF and Reliability

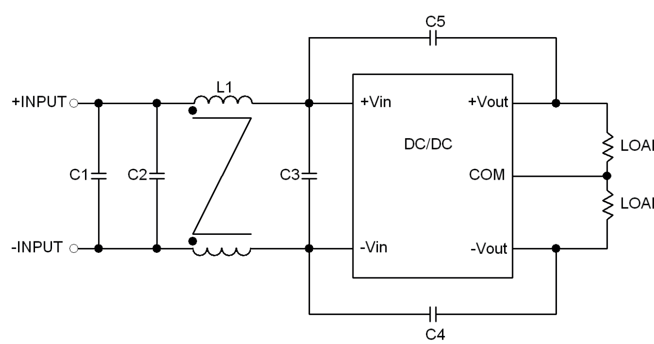
The MTBF of PMF20W SINGLE-SERIES of DC/DC converters has been calculated using MIL-HDBK 217F NOTICE2 FULL LOAD, Operating Temperature at 25°C. The resulting figure for MTBF is 1.469x10^6 hours.

The series modules can meet EN55022 A without external filter

Recommended external EMI filter for EN55022 Class B



Single Output



Dual Output

Model	C1	C2	C3	C4, C5	L1
PMF20-24□□□W	4.7µF/50V 1812 MLCC	N/A	N/A	470pF/2kV 1808 MLCC	325µH Common Choke PMT-050
PMF20-48□□□W	2.2µF/100V 1812 MLCC	2.2µF/100V 1812 MLCC	2.2µF/100V 1812 MLCC	1000pF/2kV 1808 MLCC	325µH Common Choke PMT-050