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POWERBOX Industrial Line
T15 Series
15W 2:1 Single and Dual Output
DC/DC Converter
Manual

Table of Contents

Introduction

The T15-single series offer 15 watts of output power from a 2.00 x 1.00 x 0.40 inch package. The T15-single series with 2:1 wide input voltage of 9~18VDC, 18~36VDC and 36~75VDC.

DC/DC Converter Features

- Low profile 2.00 x 1.00 x 0.40 inch
- 2:1 wide input voltage range
- 15 watts maximum output
- Input to output isolation 1600VDC
- Operating case temperature range 100°C max.
- Over-current protection
- Output over voltage protection
- ISO 9001 certified manufacturing facilities
- UL60950-1, EN60950-1 and IEC60950-1 licensed
- CE mark meet 2006/95/EC, 93/68/EEC and 2004/108/EC
- RoHS directive compliant

Option

Positive logic and negative logic remote on/off

Output Specifications

Parameters	Model	Min	Typ	Max	Unit
Output voltage (Vin(nom); full load; Ta=25°C)	□□S33	3.267	3.30	3.333	VDC
	□□S05	4.95	5.00	5.05	VDC
	□□S12	11.88	12.00	12.12	VDC
	□□S15	14.85	15.00	15.15	VDC
Line regulation (LL to HL at full load)	All	-0.5		+0.5	%
Load regulation (min to 100% full load)	All	-0.5		+0.5	%
Output ripple and noise (20MHz bandwidth)	All		50	75	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	All		250		mV
Setting time (Vo<10% peak deviation)	All		250		μs
Output current	□□S33	0		4000	mA
	12S05	15		3000	mA
	12S12	0		1250	mA
	12S15	0		1000	mA
	24S05	15		3000	mA
	24S12	0		1250	mA
	24S15	10		1000	mA
	48S05	0		3000	mA
	48S12	10		1250	mA
	48S15	0		1000	mA
Output over voltage protection (zener diode clamp)	□□S33		3.9		VDC
	□□S05		6.2		VDC
	□□S12		15		VDC
	□□S15		18		VDC
Output over current protection	All		150		% of FL
Output short circuit protection	All	Hiccups, automatics recovery			
Output capacitor load	□□S33			10200	μs
	□□S05			7050	μs
	□□S12			1035	μs
	□□S15			705	μs

Input Specifications

Parameters	Model	Min	Typ	Max	Unit
Operating input voltage	12S□□	9	12	18	VDC
	24S□□	18	24	36	VDC
	48S□□	36	48	75	VDC
Input reflected ripple current	All		20		mAp-p
Start up time (nominal input and constant resistive load power up)	All		20	50	mS
Remote on/off					
Negative logic					
DC/DC On	All	0		1.2	VDC
DC/DC Off	All	3.5		12	VDC
Positive logic					
DC/DC On	All	3.5		12	VDC
DC/DC Off	All	0		1.2	VDC
Input voltage					
Continuous	12S□□			18	VDC
	24S□□			36	VDC
	48S□□			75	VDC
Transient (100mS maximum)	12S□□			36	VDC
	24S□□			50	VDC
	48S□□			100	VDC

General Specifications

Parameters	Model	Min	Typ	Max	Unit
Efficiency, test at Vin, nom and full load	12S33		79		%
	12S05		82		%
	12S12		86		%
	12S15		86		%
	24S33		80		%
	24S05		84		%
	24S12		85		%
	24S15		85		%
	48S33		81		%
	48S05		83		%
	48S12		87		%
	48S15		86		%
Isolation resistance	All	10^9			Ω
Isolation capacitance	All			300	pF
Switching frequency	All	450	500	550	kHz
Weight	All		27		g
MTBF MIL-HDBK-217F	All		2.318×10^6		hours
Isolation voltage (1 minute)					
Input to output	All	1600			VDC
Input to case	All	1600			VDC
Output to case	All	1600			VDC
Case material	All	Nickel-coated copper			
Base material	All	Non-conductive black plastic			
Potting material	All	Epoxy (UL94 V-0)			
Dimensions	All	50.8 x 25.4 x 10.2 mm (2.00 x 1.00 x 0.40 inch)			

Environmental Specifications

Parameters	**Model**	**Min**	**Typ**	**Max**	**Unit**
Operating case temperature (with derating)*	All	-40		85	°C
Maximum case temperature	All			100	°C
Storage temperature range	All	-55		105	°C
*Thermal impedance***					
Natural convection	All		12		°C/W
Natural convection with heat-sink	All		10		°C/W
Thermal shock	All	MIL-STD-810F			
Vibration	All	MIL-STD-810F			

*Test condition with vertical direction by natural convection (20LFM)
** Heat-sink is optional and P/N: 7G-0020C-F.

EMC Characteristics

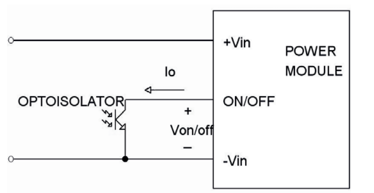
Parameters	**Standard**	**Condition**		**Level**
EMI*	EN55022			Class A
ESD	EN61000-4-2	Air	±8kV	Perf. Criteria A
		Contact	±6kV	
Radiated Immunity	EN61000-4-3		10V/m	Perf. Criteria A
Fast transient**	EN61000-4-4		±2kV	Perf. Criteria A
Surge**	EN61000-4-5		±1kV	Perf. Criteria A
Conducted immunity	EN61000-4-6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

* The T15 series can meet EN55022 Class A with parallel an external capacitor to the input pins.
Recommend: 12VDC input : 6.8μF/50V 1812 MLCC . 24VDC input : 2.2μF/50V 1812 MLCC . 48VDC input: 1.5μF/100V 1812 MLCC.
**An external input filter capacitor is required if the module has to meet EN61000-4-4, EN61000-4-5.
The filter capacitor Powerbox suggest: Nippon chemi-con KY series, 220μF/100V, ESR 48mΩ.

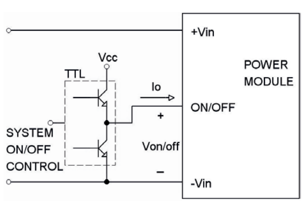
Remote On/Off Control

The Remote 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 -INPUT. The switch can be open collector transistor, FET and Photo-Couple. The switch must be capable of sinking up to 0.5 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 0.5mA.

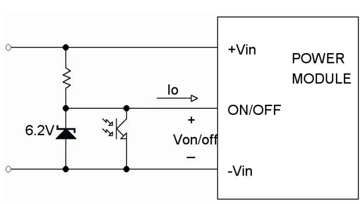
Remote On/Off implementation circuits



Isolated-Closure Remote ON/OFF

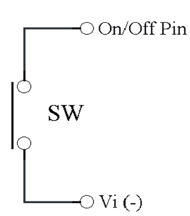


Level Control Using TTL Output

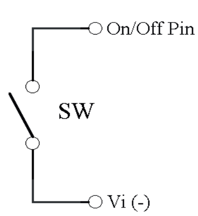


Level Control Using Line Voltage

There is one remote control available, positive logic.
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.



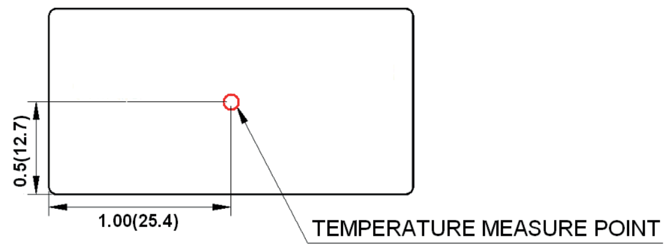
When T15-S module is turned off at Low-level logic



When T15-S module is turned off at High-level logic

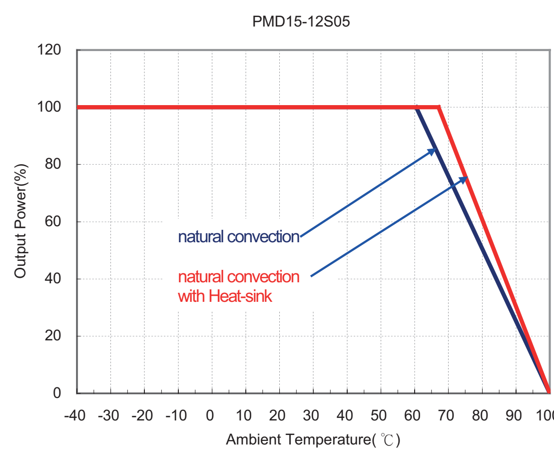
Thermal Consideration

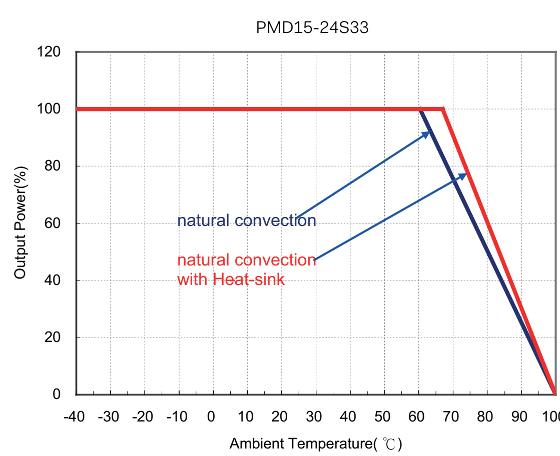
The power module operates in a variety of thermal environments. However, sufficient cooling should be provided to help ensure reliable operation of the unit. Heat is removed by conduction, convection, and radiation to the surrounding Environment. Proper cooling can be verified by measuring the point as the figure below. The temperature at this location should not exceed 100°C. When Operating, adequate cooling must be provided to maintain the test point temperature at or below 100°C. Although the maximum point Temperature of the power modules is 100°C, you can limit this Temperature to a lower value for extremely high reliability.

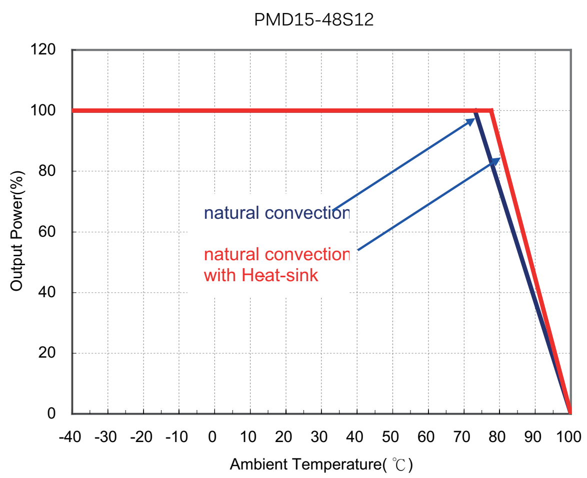


Measurement shown in inch(mm) TOP VIEW

Following are de-rating curve for PMD15-12S05, PMD15-24S33, PMD15-48S12.







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 T1515-S 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 foldback 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.

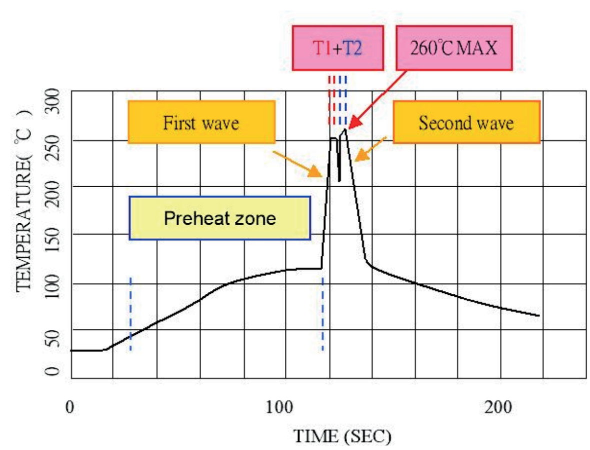
The hiccup operation can be done in various ways. For example, one can start hiccup operation any time an over-current event is detected, or prohibit hiccup during a designated start-up is usually larger than during normal operation and it is easier for an over-current event is detected, or prohibit 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.

Short Circuit Protection

Continuous, hiccup and 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.

Soldering and Reflow Considerations

Lead free wave solder profile for T15 DIP type

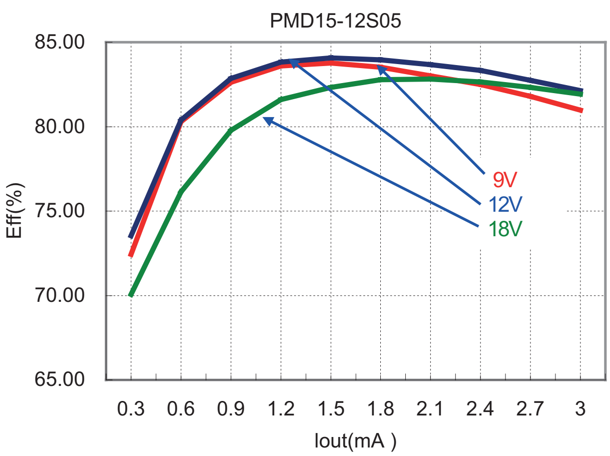


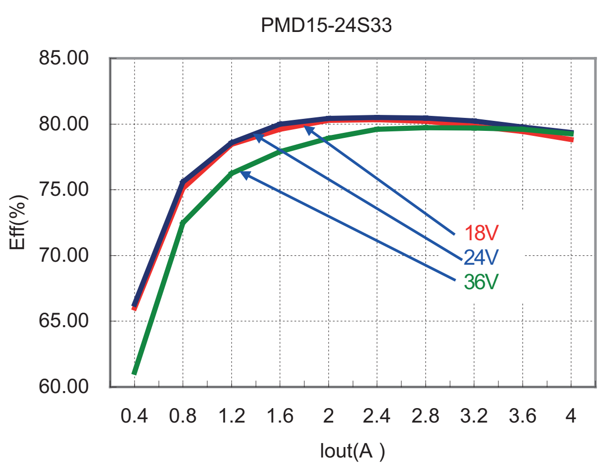
Zone	Reference Parameter
Preheat zone	Rise temp. speed : 3°C / sec max. Preheat temp. : 100~130°C
Actual heating	Peak temp. : 250~260°C Peak time (T1+T2 time) : 4~6 sec

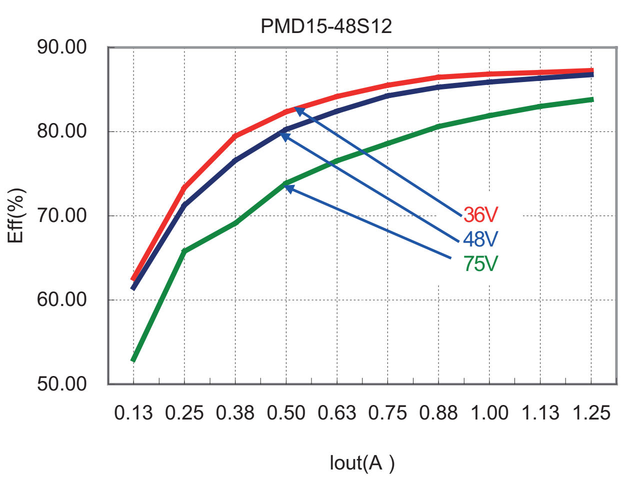
Reference Solder : Sn-Ag-Cu , Sn-Cu
Hand Welding : Soldering iron : Power 90W
Welding Time : 2~4 sec
Temp. : 380~400°C

Efficiency

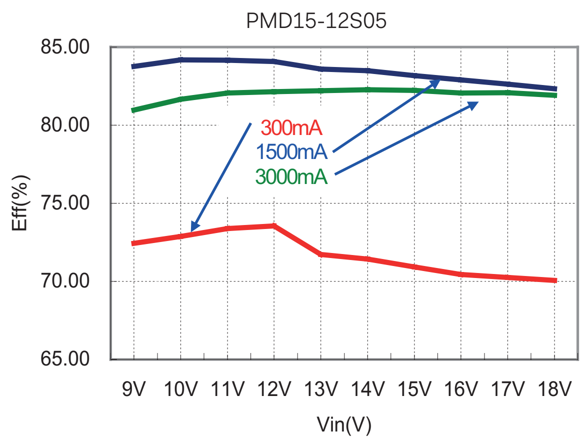
a. Efficiency with load change under different line condition at room temperature

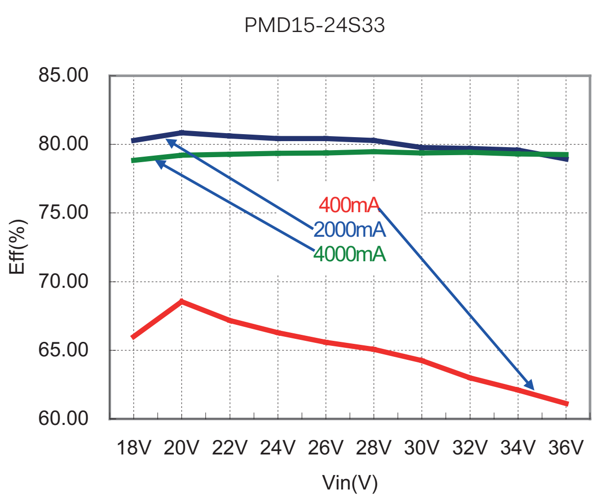


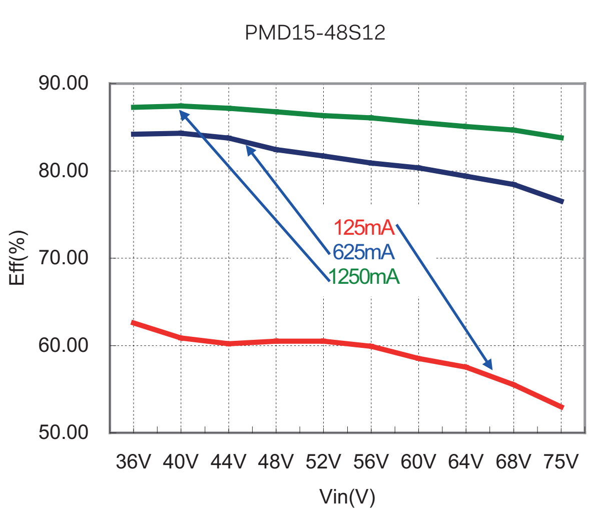




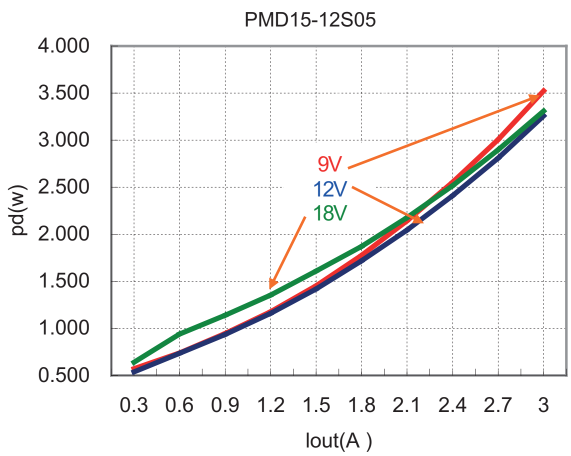
b. Efficiency with line change under different load condition at room temperature

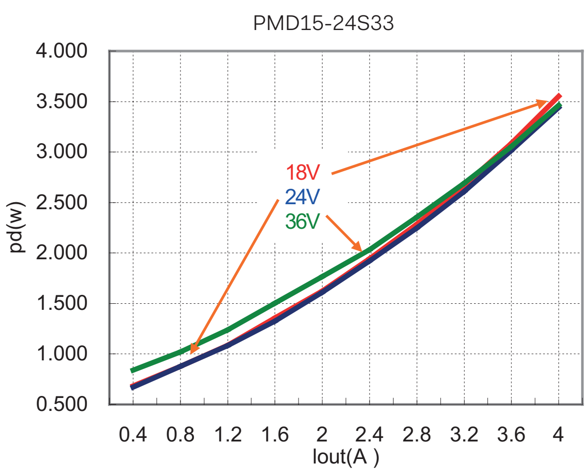


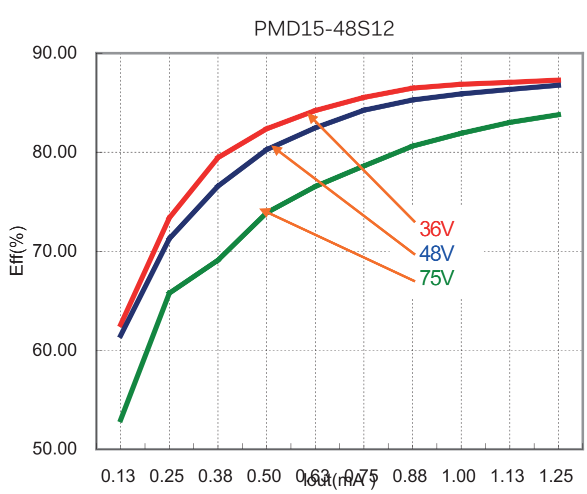




Power dissipation curve

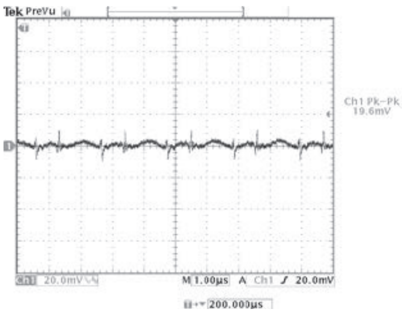






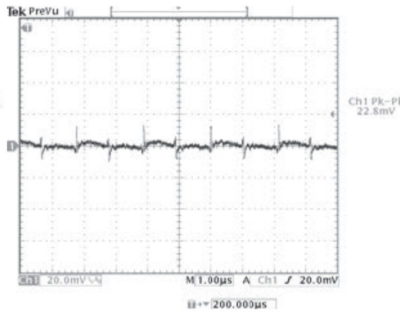
Output ripple & noise

PMD15-12S05



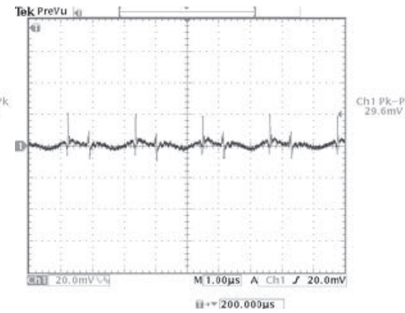
Low Line, Full Load

Output Ripple Noise=19.6mV



Normal Line, Full Load

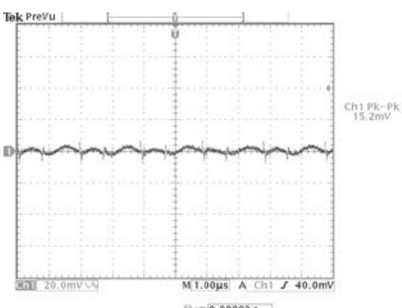
Output Ripple Noise=22.8mV



High Line, Full Load

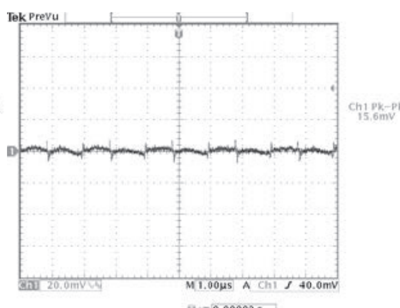
Output Ripple Noise=29.6mV

PMD15-24S33



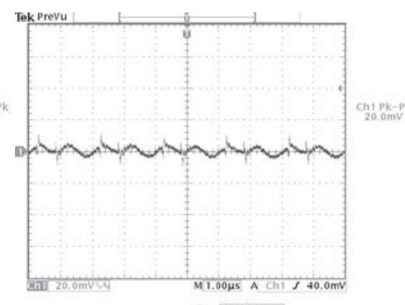
Low Line, Full Load

Output Ripple Noise=15.2mV



Normal Line, Full Load

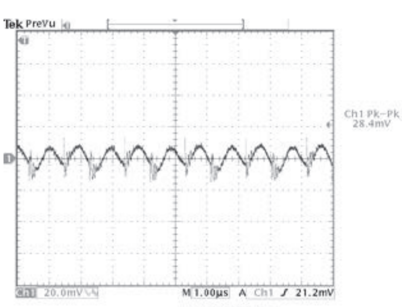
Output Ripple Noise=15.6mV



High Line, Full Load

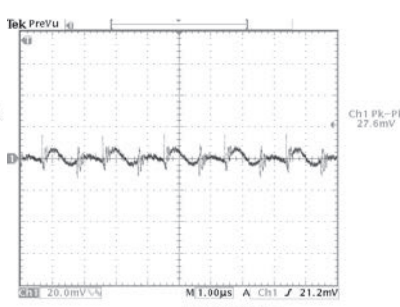
Output Ripple Noise=20.0mV

PMD15-48S12



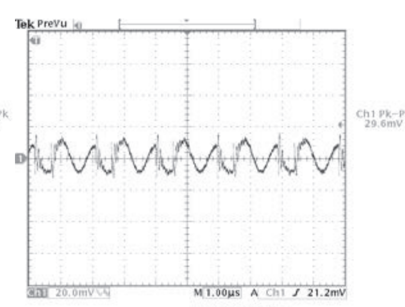
Low Line, Full Load

Output Ripple Noise= 28. 4



Normal Line, Full Load

Output Ripple Noise=27.6mV

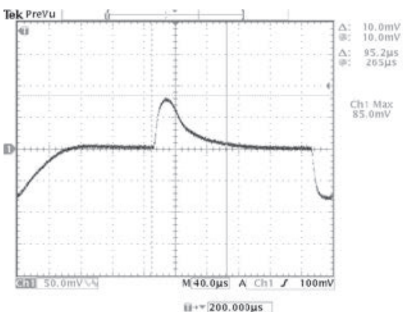


High Line, Full Load

Output Ripple Noise=29.6mV

Transient peak and response

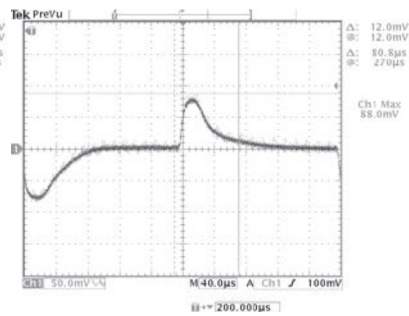
PMD15-12S05



Low Line, Full Load

Transient Peak 85.0mV

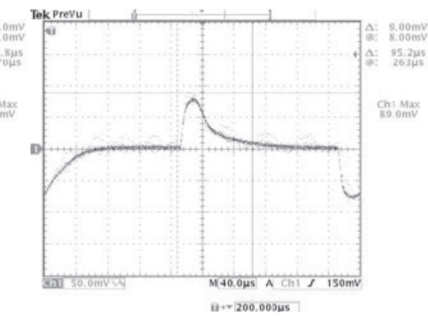
Transient Response 95.2uS



Normal Line, Full Load

Transient Peak 88.0mV

Transient Response 80.8uS

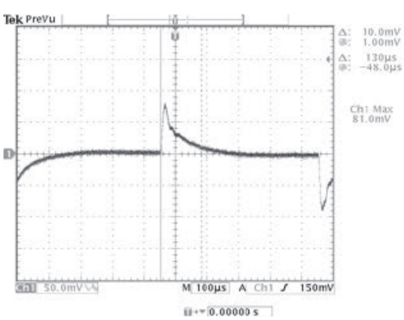


High Line, Full Load

Transient Peak 89.0mV

Transient Response 95.2uS

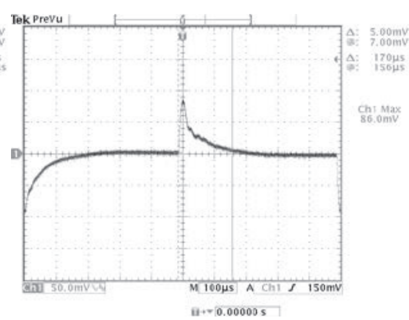
PMD15-24S33



Low Line, Full Load

Transient Peak 81.0mV

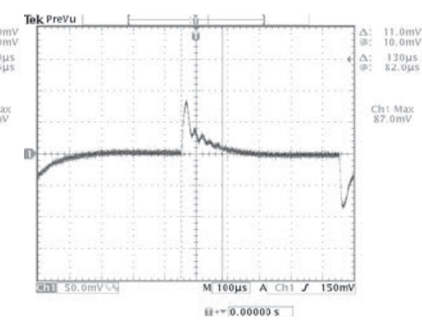
Transient Response130uS



Normal Line, Full Load

Transient Peak 86.0mV

Transient Response 170uS

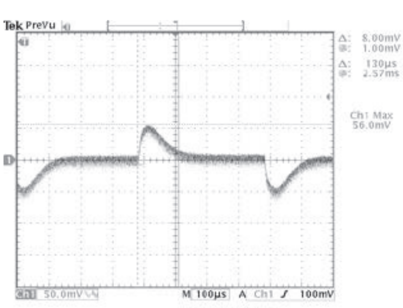


High Line, Full Load

Transient Peak 45.6mV

Transient Response 200uS

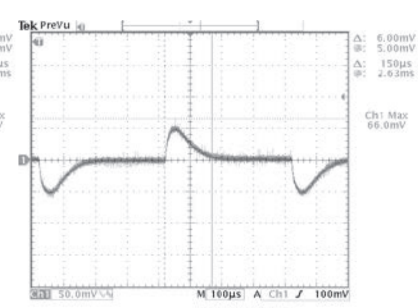
PMD15-48S12



Low Line, Full Load

Transient Peak 56mV

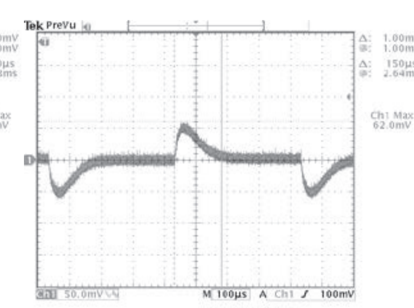
Transient Response130uS



Normal Line, Full Load

Transient Peak 66mV

Transient Response 150uS



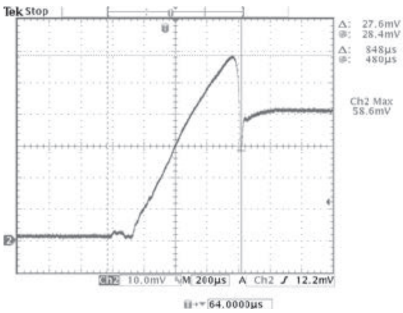
High Line, Full Load

Transient Peak 62mV

Transient Response 150uS

Inrush current

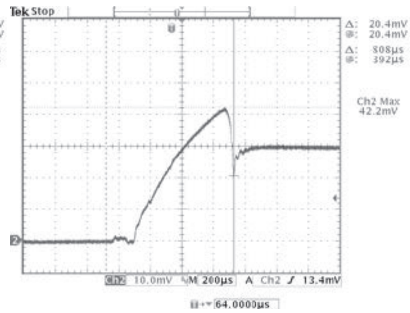
PMD15-12S05



Low Line, Full Load

Inrush current=(58.6/10) X500mA=2930mA

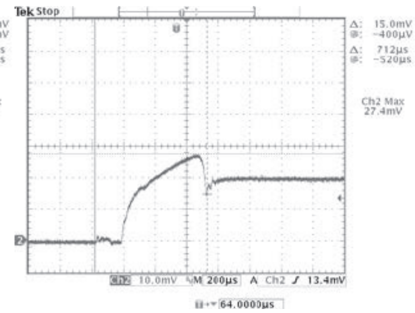
Duration: 848uS



Normal Line, Full Load

Inrush current=(42.2/10) x500mA=2210mA

Duration: 808uS

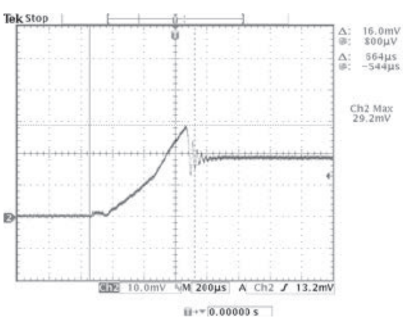


High Line, Full Load

Inrush current=(27.4/10) x500mA=1370mA

Duration: 712uS

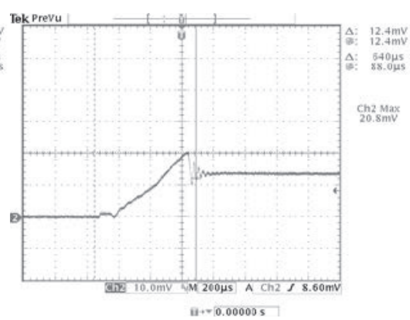
PMD15-24S33



Low Line, Full Load

Inrush current=(29.2/10) X500mA=1460mA

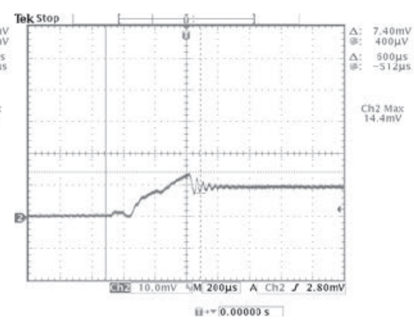
Duration: 664uS



Normal Line, Full Load

Inrush current=(20.8/10) x500mA=1040mA

Duration: 640uS

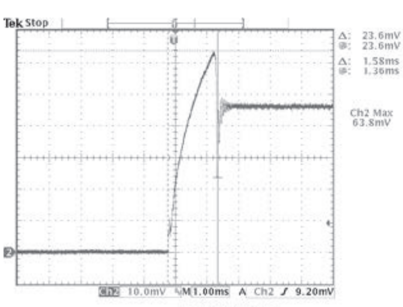


High Line, Full Load

Inrush current=(14.4/10) x500mA=720mA

Duration: 600uS

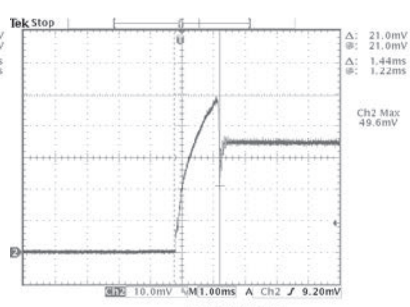
PMD15-48S12



Low Line, Full Load

Inrush current=(63.8/10) X100mA=638mA

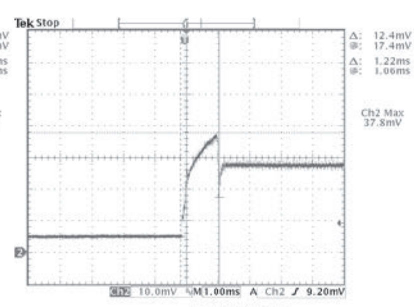
Duration: 1.58mS



Normal Line, Full Load

Inrush current=(49.6/10) x100mA=496mA

Duration: 1.44mS



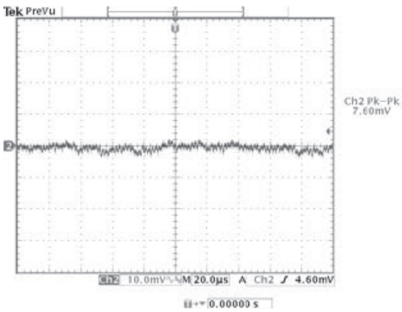
High Line, Full Load

Inrush current=(37.8/10) x100mA=378mA

Duration: 1.22mS

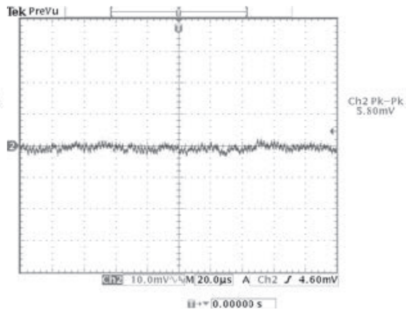
Input ripple current

PMD15-12S05



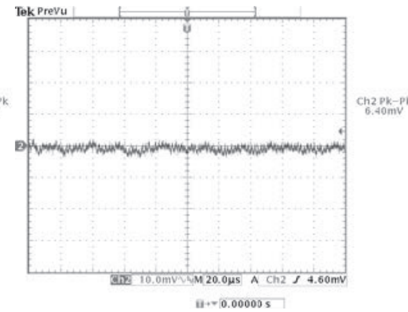
Low Line, Full Load

Ripple current=(7.6/10) x5=3.8mA



Normal Line, Full Load

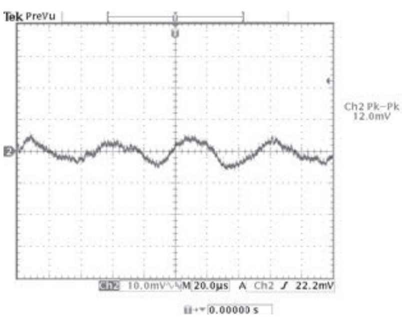
Ripple current=(5.8/10) x5=2.9mA



High Line, Full Load

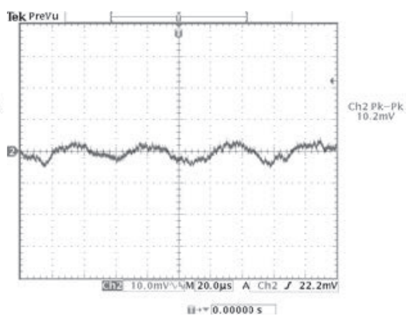
Ripple current=(6.4/10) x5=3.2mA

PMD15-24S33



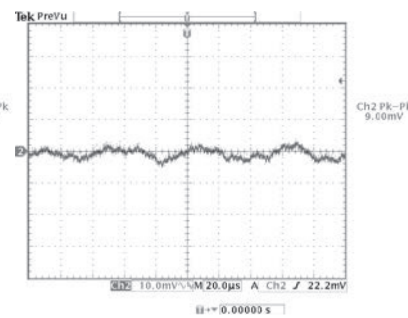
Low Line, Full Load

Ripple current=(12/10) x5=6.0mA



Normal Line, Full Load

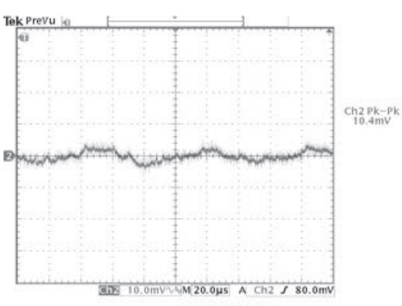
Ripple current=(10.2/10) x5=5.1mA



High Line, Full Load

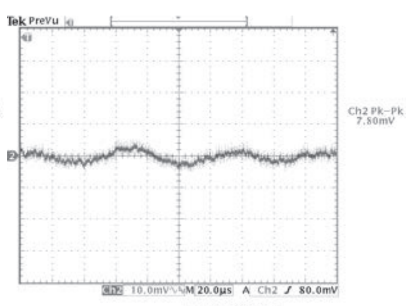
Ripple current=(9/10) x5=4.5mA

PMD15-48S12



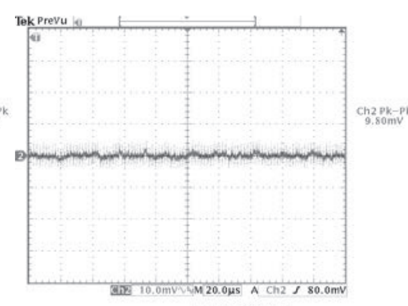
Low Line, Full Load

Ripple current=(10.4/10) x5=5.2mA



Normal Line, Full Load

Ripple current=(7.8/10) x5=3.9mA

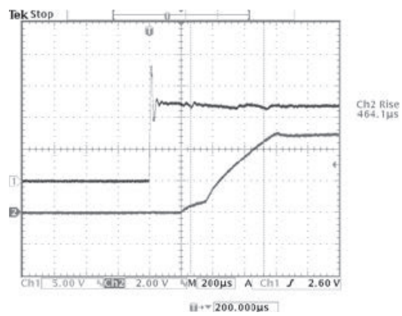


High Line, Full Load

Ripple current=(9.8/10) x5=4.9mA

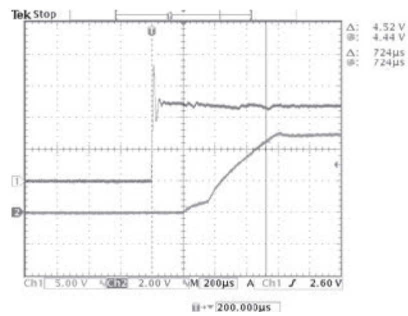
Delay time and rise time

PMD15-12S05



Normal Line, Full Load

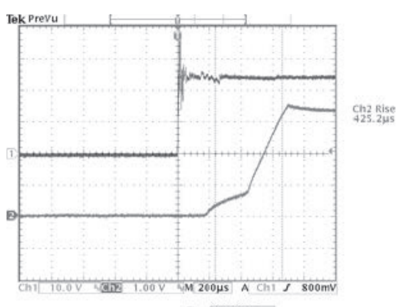
Rise Time=464.1uS



Normal Line, Full Load

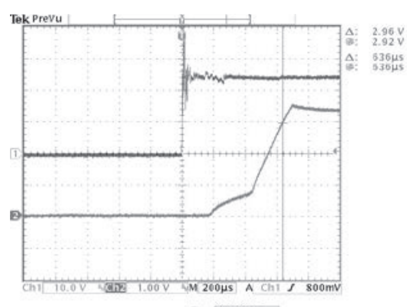
Delay Time= 724uS

PMD15-24S33



Normal Line, Full Load

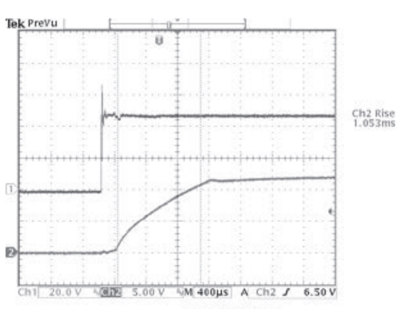
Rise Time=425.2uS



Normal Line, Full Load

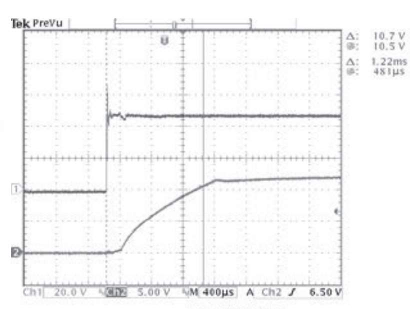
Delay Time= 636uS

PMD15-48S12



Normal Line, Full Load

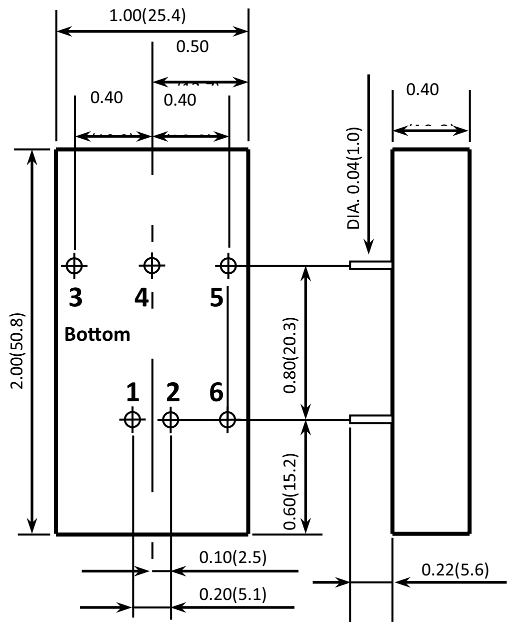
Rise Time=1.053mS



Normal Line, Full Load

Delay Time= 1.22mS

Mechanical Drawing



1. All dimensions in Inch (mm)
2. Pin pitch tolerance ±0.0014(0.35)
3. Tolerance : x.xx±0.02 (x.x±0.5)

Pin Connection

Pin	Define
1	+ Input
2	- Input
3	+ Output
4	No Pin
5	- Output
6	CTRL (Option)

Safety and Installation Instruction

Isolation consideration

The T15 series features 1.6k Volt DC isolation from input to output, input to case, and output to case. The input to output resistance is greater than 109 ohms. Nevertheless, if the system using the power module needs to receive safety agency approval, certain rules must be followed in the design of the system using the model. In particular, all of the creepage and clearance requirements of the end-use safety requirement must be observed. These documents include UL-60950-1, EN60950-1 and CSA 22.2-960, although specific applications may have other or additional requirements.

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 a 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 safety agencies require a slow-blow fuse with maximum rating of 6.3 A. Based on the information provided in this data sheet on inrush energy and maximum dc input current, the same type of fuse with lower rating can be used. Refer to the fuse manufacturer's data for further information.

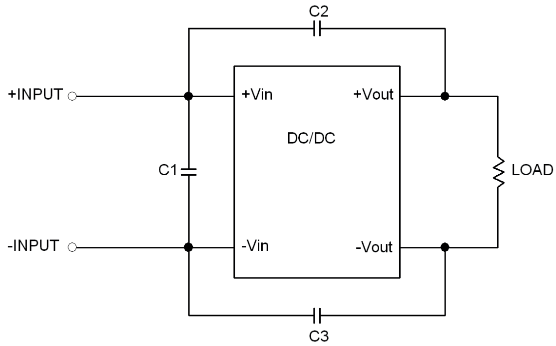
Minimum Load Requirement

10%(of full load) minimum load required. The 10% minimum load requirement is in order to meet all performance specifications. The T15 Series does not properly maintain regulation and operate with no load condition. The output voltage drops off about 10%.

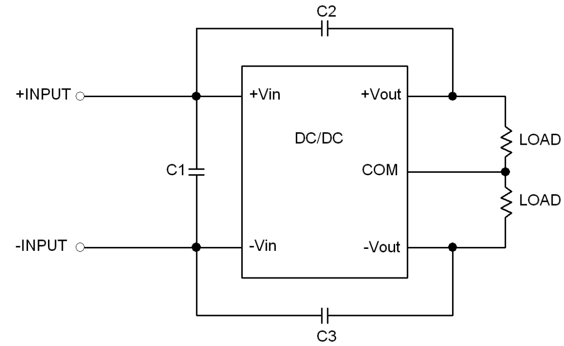
MTBF and Reliability

The MTBF of T15-S series of DC/DC converters has been calculated using MIL-HDBK-217F, Ta = 25°C, FULL LOAD. The resulting figure for MTBF is 2.318× 10^6 hours.

Recommended external EMI filter for EN55022 Class A



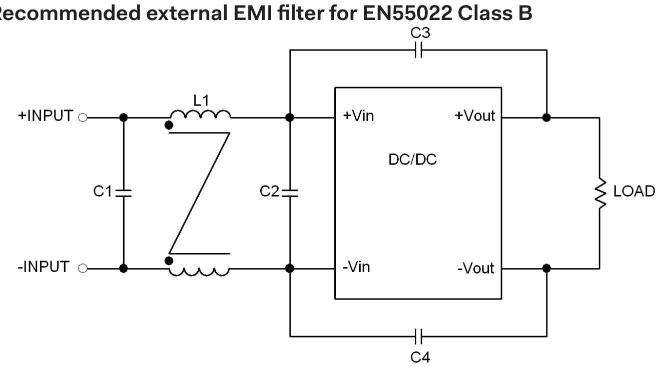
Single Output



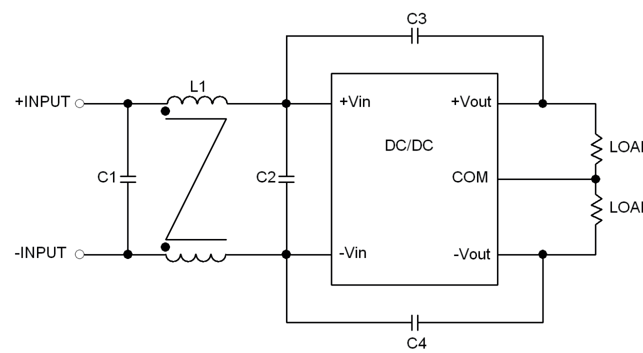
Dual Output

Model	C1	C2	C3
PME15-12□□□	6.8μF/50V 1812 MLCC	1000pF/2kV 1808 MLCC	1000pF/2kV 1808 MLCC
PME15-24□□□	2.2μF/50V 1812 MLCC	1000pF/2kV 1808 MLCC	1000pF/2kV 1808 MLCC
PME15-48□□□	1.5μF/100V 1812 MLCC	1000pF/2kV 1808 MLCC	1000pF/2kV 1808 MLCC

Recommended external EMI filter for EN55022 Class B



Single Output



Dual Output

Model	C1	C2	C3, C4	L1
PME15-12□□□	4.7μF/50V 1812 MLCC	N/A	1000pF/2kV 1808 MLCC	325μH Common Shoke PMT-050
PME15-24□□□	3.3μF/50V 1812 MLCC	N/A	1000pF/2kV 1808 MLCC	325μH Common Shoke PMT-050
PME15-48□□□	2.2μF/100V 1812 MLCC	2.2μF/100V 1812 MLCC	1000pF/2kV 1808 MLCC	325μH Common Shoke PMT-050