TF SERIES 24-Pin DIP

Up to 15 Watt DC-DC Converter

FEATURES

- Industry Standard 24-Pin DIP package
- 15Watts Isolated Output
- 4:1 Input Range
- Regulated Outputs
- Up to 90 % Efficiency
- Low No Load Power Consumption
- -40°C to +85°C industrial temperature range
- Negative and positive On/Off logic control, Trim options
- Continuous Short Circuit Protection
- Sense Compensation, Over-temperature protection
- Designed to meet 2004/108/EC
- Safety designed to meet UL60950-1, EN60950-1, and IEC60950-1

PRODUCT OVERVIEW

The TF series offer 15 watts of output power in a 24 pin standard DIP package. These converters have a 4:1 wide input voltage range of 9 to 36 Volts or 18 to 75 Volts. The converter provides precise regulated output voltage ranging from 3.3 to 15 volts. Other output voltages are also available and please contact DATEL if your application requires such modification.

This series features high efficiency up to 90%; 1500Volts of DC of isolation and can operate over the ambient temperature range of –40°C to +85°C. These modules are fully protected against input Under Voltage Lock Out (UVLO), output short circuit and output overvoltage conditions.

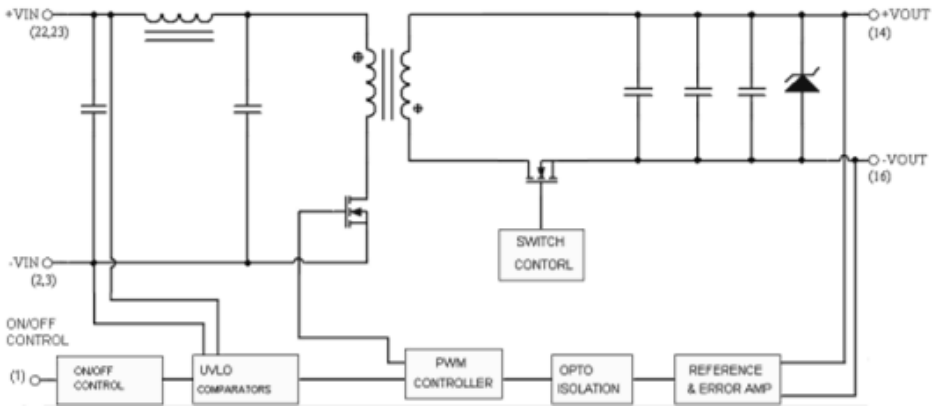
APPLICATIONS:

- Distributed Power Architectures
- Mobile telecommunication
- Industrial applications
- Battery operated equipment

Contact DATEL for other series, Cost saving, lower power, other output voltages, etc.

MODEL NUMBER	INPUT VOLTAGE	OUTPUT VOLTAGE	OUTPUT CURRENT MAX	EFFICIENCY %	LOAD REGULATION	LINE REGULATION
TF22S3.3-4	9-36 VDC	3.3VDC	4 A	88	± 0.5 %	0.2%
TF22S5-3	9-36 VDC	5.0 VDC	3 A	90	± 0.5 %	0.2%
TF22S12-1.25	9-36 VDC	12 VDC	1.25 A	90	± 0.5 %	0.2%
TF22S15-1	9-36 VDC	15 VDC	1 A	90	± 0.5 %	0.2%
TF22D12-0.62	9-36 VDC	±12 VDC	±0.625 A	89	± 1 %	0.5%
TF22D15-0.5	9-36 VDC	±15 VDC	±0.5 A	90	± 1 %	0.5%
TF45S3.3-4	18-75VDC	3.3 VDC	4 A	89	± 0.5 %	0.2%
TF45S5-3	18-75VDC	5 VDC	3 A	90	± 0.5 %	0.2%,
TF45S12-1.25	18-75VDC	12 VDC	1.25 A	90	± 0.5 %	0.2%
TF45S15-1	18-75VDC	15 VDC	1 A	90	± 0.5 %	0.2%
TF45D12-0.62	18-75VDC	±12 VDC	±0.625 A	89.5	± 1 %	0.5%
TF45D15-1	18-75VDC	±15 VDC	±0.5 A	90	± 1 %	0.5%

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

PARAMETER	CONDITIONS	MODEL	Min.	Typical	Max.	Units
Input Voltage						
Continuous	DC	$24V_{in}$ $48V_{in}$	-0.3 -0.3		36 75	Volts
Transient	100ms, DC	$24V_{in}$ $48V_{in}$			50 100	Volts
Operating Ambient Temperature	Derating, Above 65°C	All	-40		+85	°C
Case Temperature		All			+105	°C
Storage Temperature		All	-55		+125	°C
Input / Output Isolation Voltage	1 minute	All			1500	Volts

INPUT CHARACTERISTICS

Note: All specifications are typical at nominal input, full load at 25°C unless otherwise noted

PARAMETER	CONDITIONS	MODEL	Min.	Typical	Max.	Units
Operating Input Voltage		$24V_{in}$	9	24	36	Volts
		$48V_{in}$	18	48	75	
		$48V_{in}$		1		
Maximum Input Current	100% Load, V_{in} =9V	24Vin			1900	mA
	100% Load, V_{in} =18V	48Vin			1000	
No-Load Input Current	V_{in} =Nominal input	TF22S3.3-4		8		mA
		TF22S5-3		8		
		TF22S12-1.25		8		
		TF22S15-1		8		
		TF22D12-0.62		8		
		TF22D15-0.5		8		
		TF45S3.3-4		6		
		TF45S5-3		6		
		TF45S12-1.25		6		
		TF45S15-1		6		
		TF45D12-0.62		6		
		TF45D15-0.5		6		
Off Converter Input Current	Shutdown input idle current	All		4	10	mA
Inrush Current (I^2t)	As per ETS300 132-2	All			0.1	A^2s
Input Reflected-Ripple Current	P-P thru 12µH inductor, 5Hz to 20MHz	All			30	mA

OUTPUT CHARACTERISTIC

PARAMETER	CONDITIONS	MODEL	Min.	Typical	Max.	Units
Output Voltage Set Point	V_{in} =Nominal V_{in} , I_o = I_{o_max}, Tc=25°C	Vo=3.3 Vo=5.0 Vo=12 Vo=15 Vo=±12 Vo=±15	3.2505 4.925 11.82 14.775 11.82 14.775	3.3 5 12 15 12 15	3.3495 5.075 12.18 15.225 12.18 15.225	Volts
Output Voltage Balance	V_{in} =nominal, Io= I_{o_max}, Tc=25°C	Dual			±1.0	%
Output Voltage Regulation						
Line Regulation	V_{in} =High line to Low line Full Load	Single Dual			±0.5 ±1.0	% %
Load Regulation	I_o = Full Load to min. Load	Single Dual			±0.2 ±1.0	% %
Cross Regulation	Load cross variation 10%/100%	Dual			±5	%
Temperature Coefficient	TC=-40°C to + 85°C				±0.03	%/°C
Output Voltage Ripple and Noise	5Hz to 20MHz bandwidth					
Peak-to-Peak	Full Load, 20MHz bandwidth 0.1µF ceramic capacitor	Vo = 3.3V Vo = 5V Vo = 15V Vo = 12V Vo = ±15V Vo = ±12V			75	mV
Operating Output Current Range		Vo=3.3V Vo=5V Vo=12V Vo=15V Vo=±12V Vo=±15V	0 0 0 0 0 0		4000 3000 1250 1000 ±625 ±500	mA
Output DC Current-Limit Inception	Output Voltage=90% $V_{O,\ nominal}$		110	135	160	%
Maximum Output Capacitance	Full load, Resistance	Vo=3.3V Vo=5V Vo=12V Vo=15V Vo=±12V Vo=±15V			4000 3000 1250 1000 625 500	µF

DYNAMIC CHARACTERISTICS

PARAMETER	CONDITIONS	MODEL	Min.	Typical	Max.	Units
Output Voltage Current Transient						
Step Change in Output Current	75% to 100% of I_{o_max} di/dt=0.1A/us	All			±5	%
Setting Time (within 1% $Vo_{nominal}$)		All			250	µs
Turn-On Delay and Rise Time						
Turn-On Delay Time, From On/Off Control	$V_{on/off}$ to 10%V_{o_set}	All		7.5		ms
Turn-On Delay Time, From Input	$V_{in\ \_min}$ to 10%V_{o_set}	All		7.5		ms
Output Voltage Rise Time	10% V_{o_set} to 90% V_{o_set}	All		7.5		ms

FEATURE CHARACTERISTICS

PARAMETER	CONDITIONS	Device	Min.	Typical	Max.	Units
100% Load	V_{in} =12 V_{dc}, I_o = I_{o_max}, Tc=25°C	TF22S3.3-4 TF22S5-3 TF22S12-1.25 TF22S15-1 TF22D12-0.62 TF22D15-0.5		88 90 90 90 89 90		%
	V_{in} =24 V_{dc}, I_o = I_{o_max}, Tc=25°C	TF22S3.3-4 TF22S5-3 TF22S12-1.25 TF22S15-1 TF22D12-0.62 TF22D15-0.5		89 90 90 90 89 90		%
100% Load	V_{in} =24 Vdc, I_o = I_{o_max}, Tc=25°C	TF45S3.3-4 TF45S5-3 TF45S12-1.25 TF45S15-1 TF45D12-0.62 TF45D15-0.5		88 90 90 90 89 89		%
	V_{in} =48 Vdc, I_o = I_{o_max}, Tc=25°C	TF45S3.3-4 TF45S5-3 TF45S12-1.25 TF45S15-1 TF45D12-0.62 TF45D15-0.5		88 90 90 90 89 90		%
ISOLATION CHARACTERISTICS						
Input to Output	1 minutes	All	1500			Volts
Isolation Resistance		All	1000			MΩ
Isolation Capacitance		All		1000		pF
Switching Frequency		All		300		KHz
On/Off Control, Positive Remote On/Off logic						
Logic High (Module On)	$V_{on/off}$ at $I_{on/off}$=0.1µA	All	3.5 or Open Circuit		75	Volts
Logic Low (Module Off)	$V_{on/off}$ at $I_{on/off}$=1.0mA	All			1.2	Volts
On/Off Control, Negative Remote On/Off logic						
Logic High (Module Off)	$V_{on/off}$ at $I_{on/off}$=1.0mA	All	3.5 or Open Circuit		75	Volts
Logic Low (Module On)	$V_{on/off}$ at $I_{on/off}$=0.1uA	All			1.2	Volts
On/Off Current (for both remote on/off logic)	$I_{on/off}$ at $V_{on/off}$=0V	All		0.3	1	mA
Leakage Current (for both remote on/off logic)	Logic High, $V_{on/off}$=15V				30	uA
Off Converter Input Current	Shutdown input idle current	All		2	4	mA
Output Voltage Trim Range	Pout=max rated power	TFXXSXX	-10		+10	%
Output Over Voltage Protection	Zener or TVS Clamp	Vo=3.3V Vo=5.0V Vo=12V Vo=15V Vo=±12V Vo=±15V		3.9 6.2 15 18 ±15 ±18		Volts
MTBF	I_o =100%of I_{o_max};Ta=25℃ per MIL-HDBK-217F	Vo=3.3&5V Others		960 1250		K hours
Weight		All		18		grams

Operating Temperature Range

The TF series of converters operates over the wide ambient temperature range of -40°C to +85°C. Derating for this series starts above the temperature of +65°C. The standard model case temperature should not go over +105°C for normal operation.

Remote On/Off

The TF series allows the user to switch the module on and off electronically with the remote on/off feature. All models are available in "positive logic" versions. The converter turns on if the Remote On/Off pin is high (greater than 3.5 Volts) or open circuit. The converter will turn off when the Remote On/OFF pin is low (Less than 1.2Votls) will turn the converter off. The signal level of the Remote On/Off input is defined with respect to ground. If the Remote On/Off pin is not used, the user should leave the pin open and the converter will be on.

Over Current Protection

All models have internal over current and continuous short circuit protection. The unit operates normally once the fault condition is removed. The converter will go into hiccup mode protection when it reach the current limit condition.

Under Voltage Lock Out (UVLO)

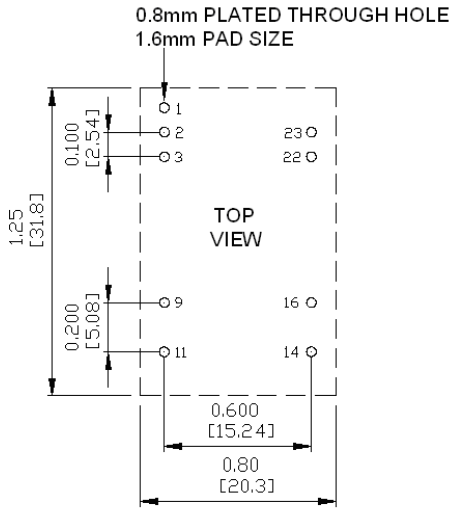
Input under voltage lockout is standard on the TF unit. The unit will shut down when the input voltage drops below the threshold. On the other hand, the unit will operate when the input voltage goes above the upper threshold.

Over Voltage Protection

The over-voltage protection consists of a Zener diode that will limit the output voltage.

Recommended PCB Layout/Footprints and Soldering Information

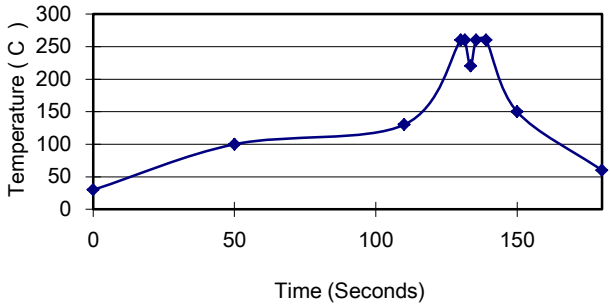
The user must ensure that other components and metal in the vicinity of the converter meet the spacing requirements to which the system is approved. Low resistance and low inductance PCB layout should be used where possible. Proper attention must also be given to low impedance tracks between power module, input and output grounds. The recommended footprints and soldering profiles are shown in the next two figures.



Recommended PCB Layout Footprints

Dimensions are in inches (millimeters)

Lead Free Wave Soldering Profile



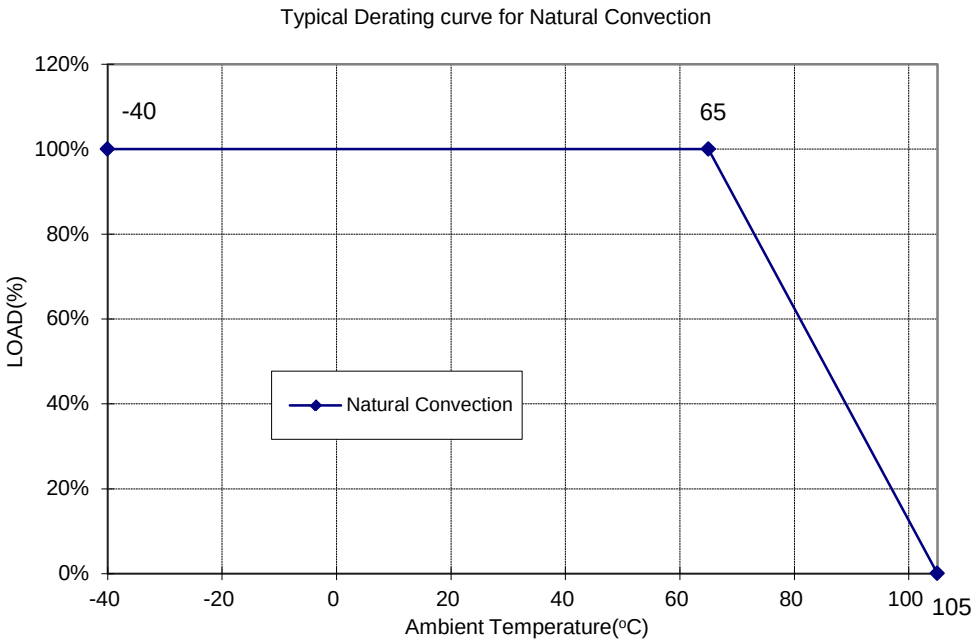
Recommended Wave Soldering Profiles

Note：

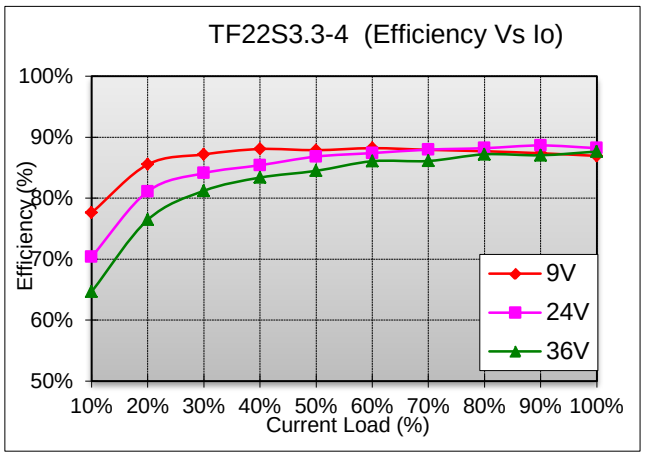
1. Soldering Materials: Sn/Cu/Ni
2. Ramp up rate during preheating: 1.4 °C/Sec (From +50°C to +100°C)
3. Soaking temperature: 0.5 °C/Sec (From +100°C to +130°C), 60 ± 20 seconds
4. Peak temperature: +260°C, above +250°C 3~6 Seconds
5. Ramp up rate during cooling: -10.0 °C/Sec (From +260°C to +150°C)

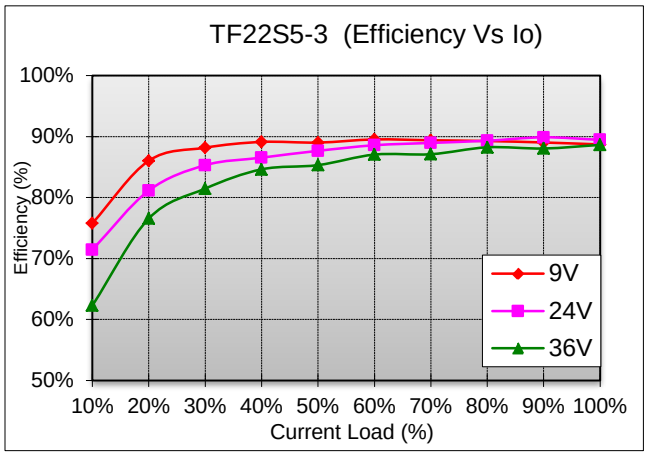
Power De-Rating Curves for TF Series

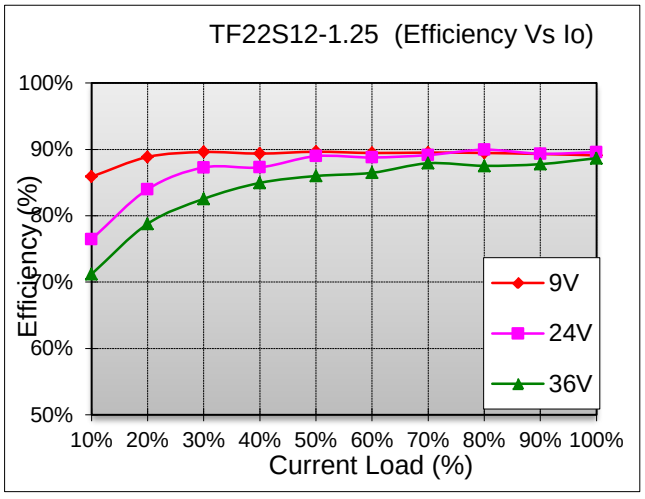
Note that operating ambient temperature range is -40°C to + 85°C with derating above +65°C. Also, the maximum case temperature under any operating condition should not exceed +105°C.

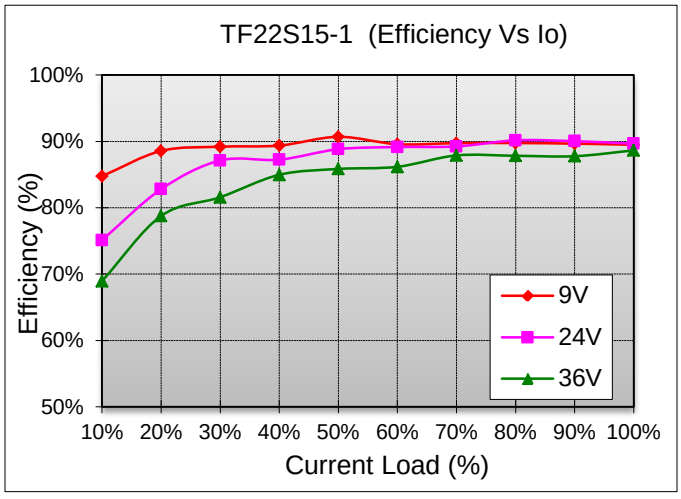


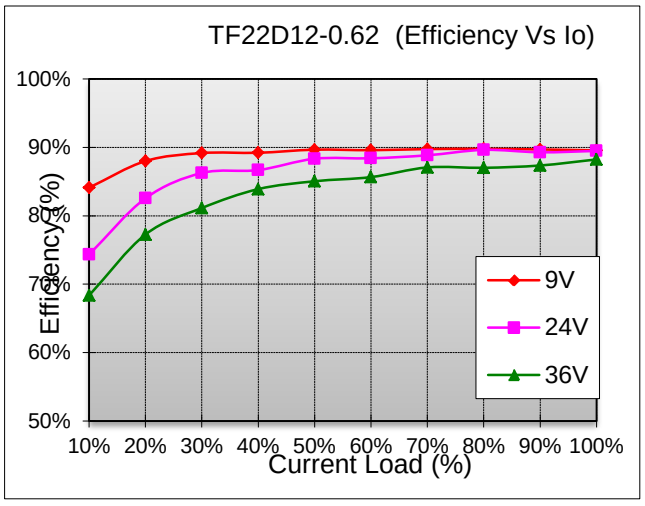
Efficiency vs. Load Curves

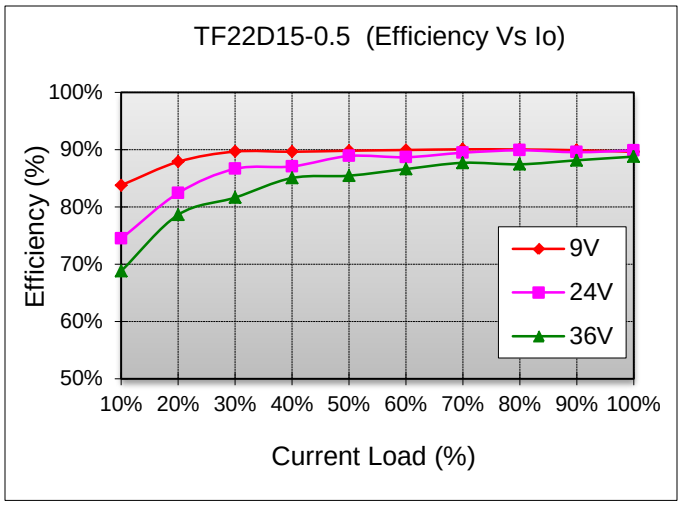




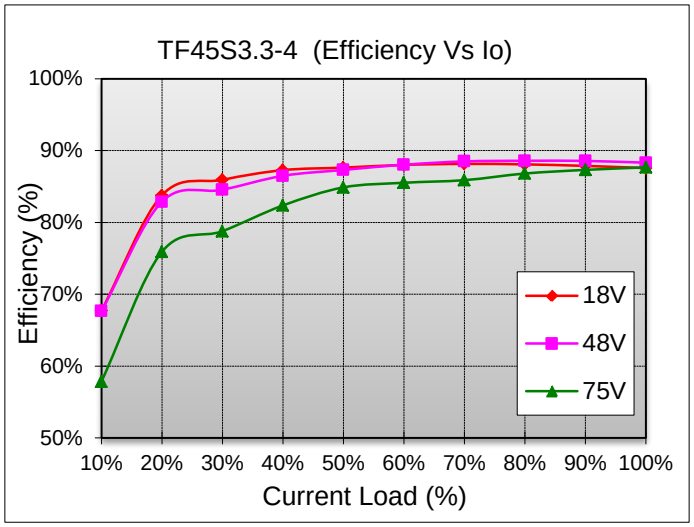


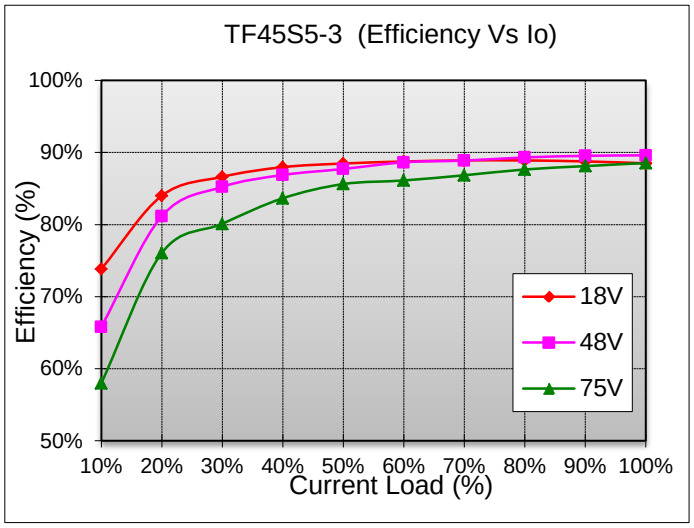


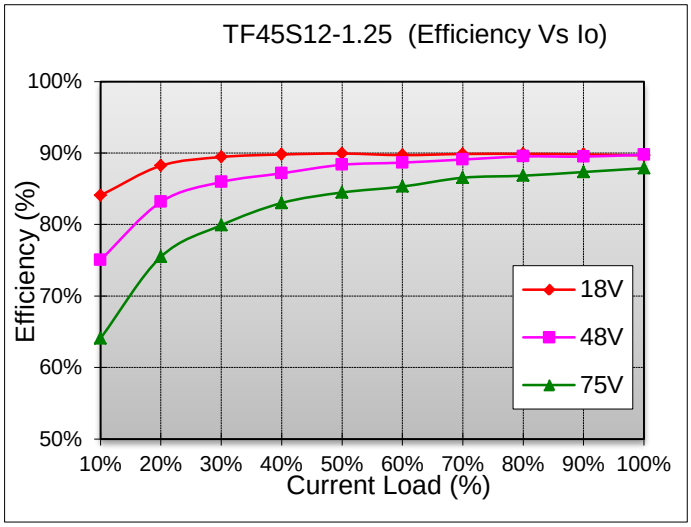


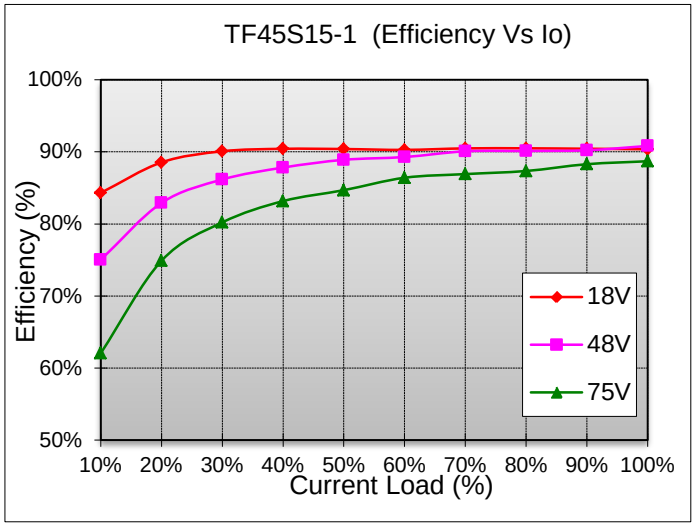


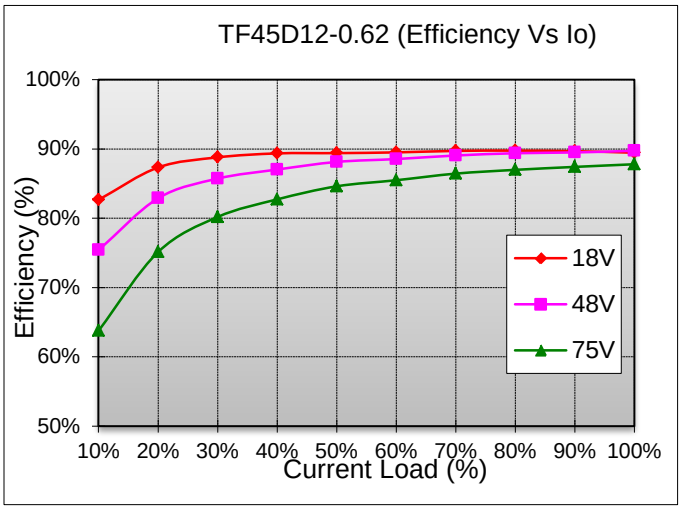
Efficiency vs. Load Curves

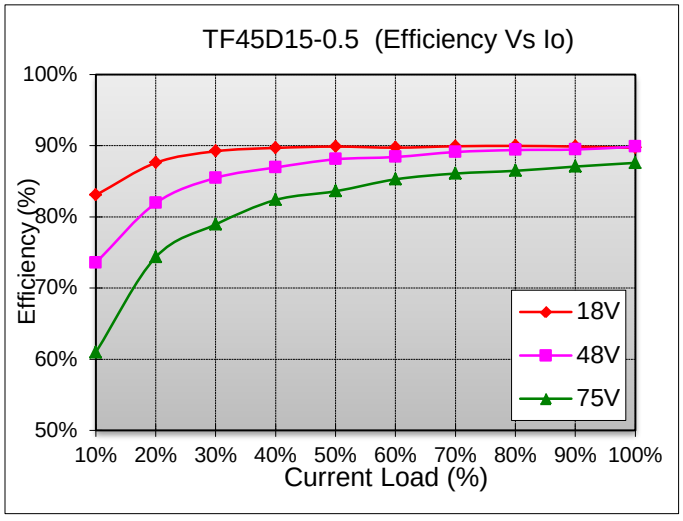






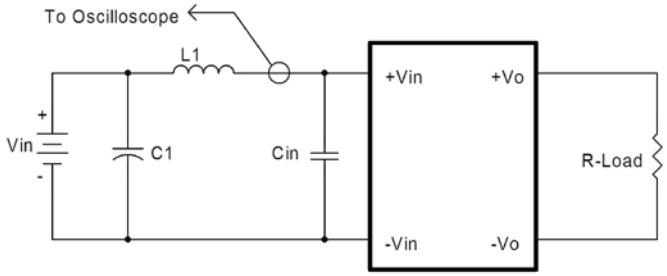






Input Capacitance at the Power Module

In order to avoid problems with loop stability, the converter must be connected to a low impedance AC source and a low inductance source. The input capacitors (Cin) should be placed close to the converter input pins to de-couple distribution inductance. The external input capacitors should have low ESR in order to quiet any ripple. Circuit as shown in the figure below represents typical measurement methods for reflected ripple current. The capacitor C1 and inductor L1 simulate the typical DC source impedance. The input reflected-ripple current is measured by a current probe oscilloscope with a simulated source Inductance (L1).



L1: 1µH
C1: None
Cin: 22µF ESR<0.7ohm @100KHz

Input Reflected-Ripple Test Setup

Test Set-Up

The basic test set-up to measure efficiency, load regulation, line regulation and other parameters is shown in the next figure. When testing the converter under any transient conditions, the user should ensure that the transient response of the source is sufficient to power the equipment under test. Below is the calculation of:

1- Efficiency
2- Load regulation
3- Line regulation

The value of efficiency is defined as:

$$\eta = \frac{V_O \times I_O}{V_{IN} \times I_{IN}} \times 100\%$$

Where

V_O is output voltage,
I_O is output current,
V_{IN} is input voltage,
I_{IN} is input current.

The value of load regulation is defined as:

$$Load.reg = \frac{V_{FL} - V_{NL}}{V_{NL}} \times 100\%$$

Where

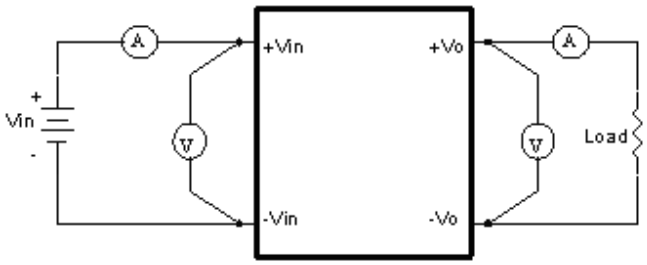
V_{FL} is the output voltage at full load
V_{NL} is the output voltage at 10% load

The value of line regulation is defined as:

$$Line.reg = \frac{V_{HL} - V_{LL}}{V_{LL}} \times 100\%$$

Where

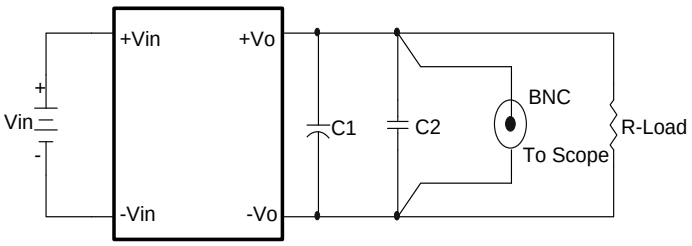
V_{HL} is the output voltage of maximum input voltage at full load.
V_{LL} is the output voltage of minimum input voltage at full load.



TF Series Test Setup

Output Ripple and Noise Measurement

The test set-up for noise and ripple measurements is shown in the figure below. A coaxial cable was used to prevent impedance mismatch reflections disturbing the noise readings at higher frequencies. Measurements are taken with output appropriately loaded and all ripple/noise specifications are from D.C. to 20MHz Band Width.



Note: C1: None
C2: 0.1uF Ceramic capacitor

Output Voltage Ripple and Noise Measurement Set-Up

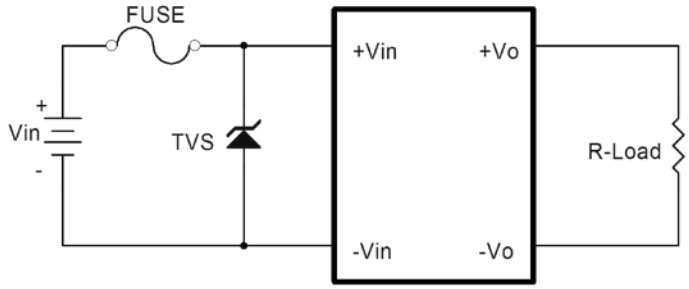
Output Capacitance

The TF series converters provide unconditional stability with or without external capacitors. For good transient response low ESR output capacitors should be located close to the point of load. These series converters are designed to work with load capacitance to see technical specifications.

SAFETY and EMC

Input Fusing and Safety Considerations

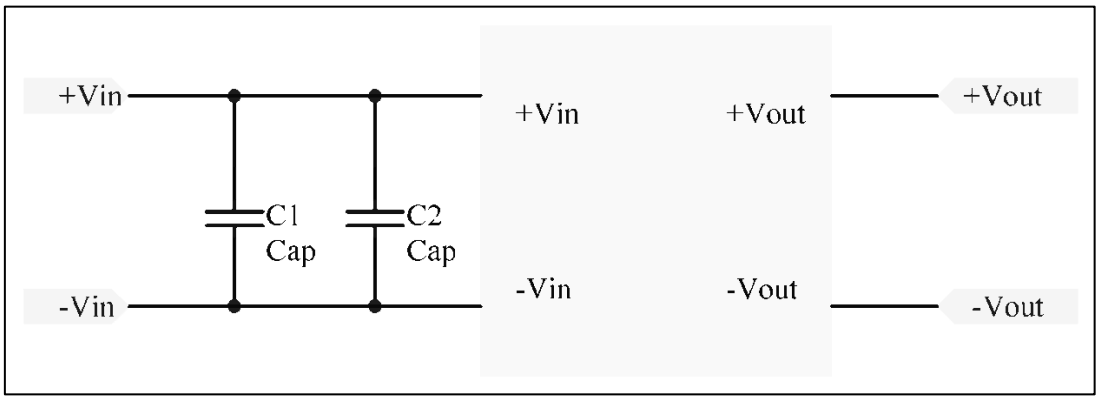
The TF series converters have not an internal fuse. However, to achieve maximum safety and system protection, always use an input line fuse. We recommended a time delay fuse 4A for 24Vin models and 2A for 48Vin modules. Figure10 circuit is recommended by a Transient Voltage Suppressor diode across the input terminal to protect the unit against surge or spike voltage and input reverse voltage.



Input Protection

EMC Considerations

(1) EMI Test standard: EN55022 Class A Conducted Emission
Test Condition: Input Voltage: Nominal, Output Load: Full Load

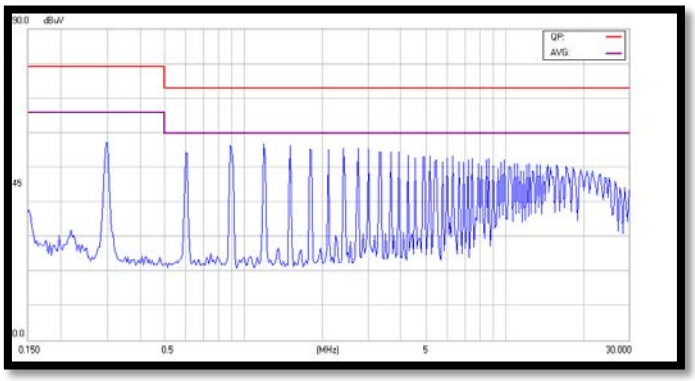


Connection circuit for conducted EMI testing

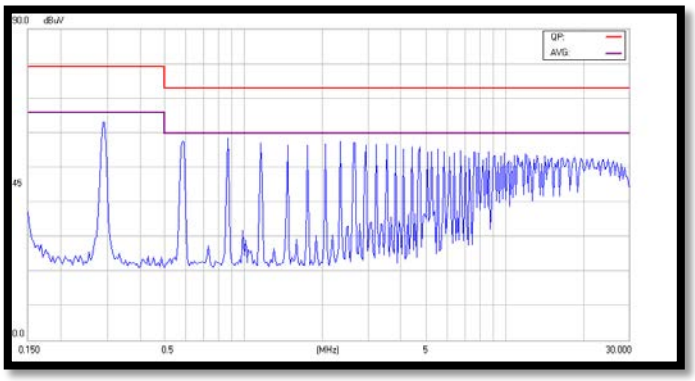
EN55022 class A					
Model No.	**C1**	**C2**	**Model No.**	**C1**	**C2**
TF22S3.3-4	None	None	TF45S3.3-4	None	None
TF22S5-3	None	None	TF45S5-3	None	None
TF22S12-1.25	None	None	TF45S12-1.25	None	None
TF22S15-1	None	None	TF45S15-1	None	None
TF22D12-0.62	None	None	TF45D12-0.62	None	None
TF22D15-0.5	None	None	TF45D15-1	None	None

Note: All of capacitors are ceramic capacitors and 1812 size.

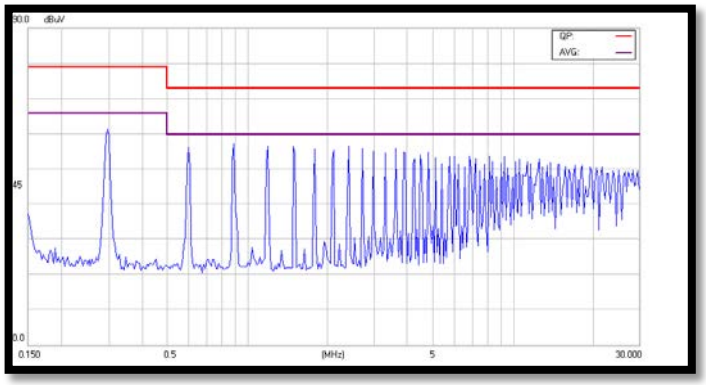
EMI and conducted noise meet EN55022 Class A



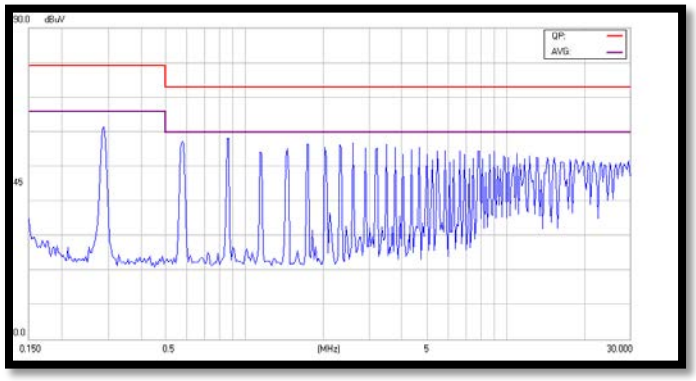
Conducted Class A of TF22S3.3-4



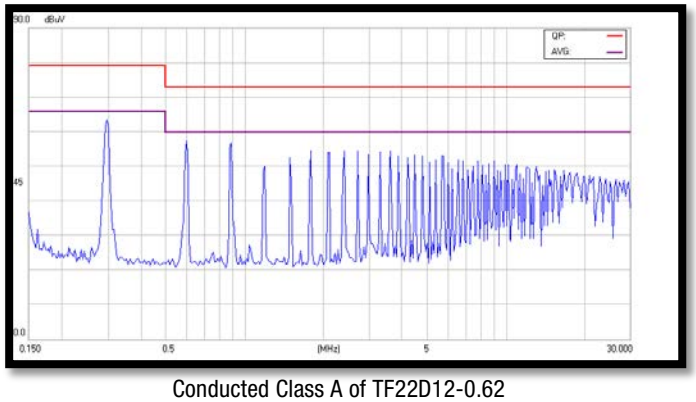
Conducted Class A of TF22S5-3



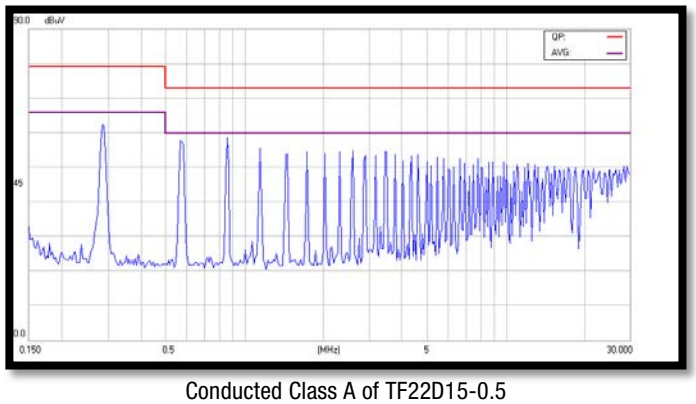
Conducted Class A of TF22S12-1.25



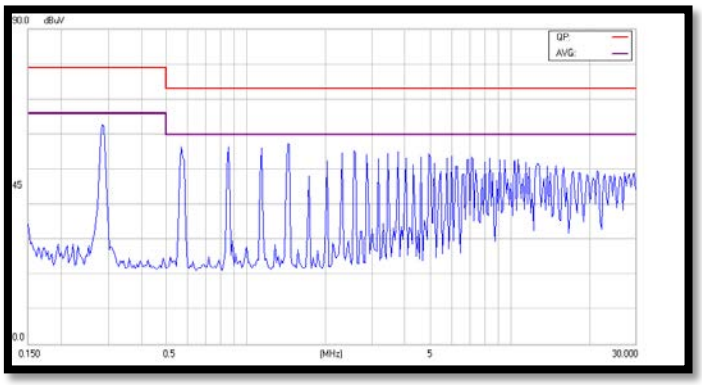
Conducted Class A TF22S15-1



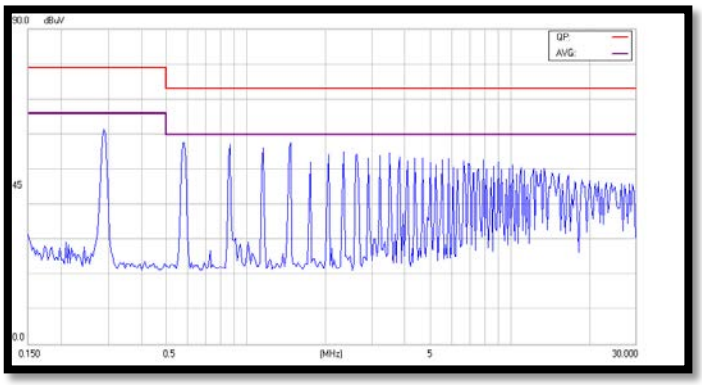
Conducted Class A of TF22D12-0.62



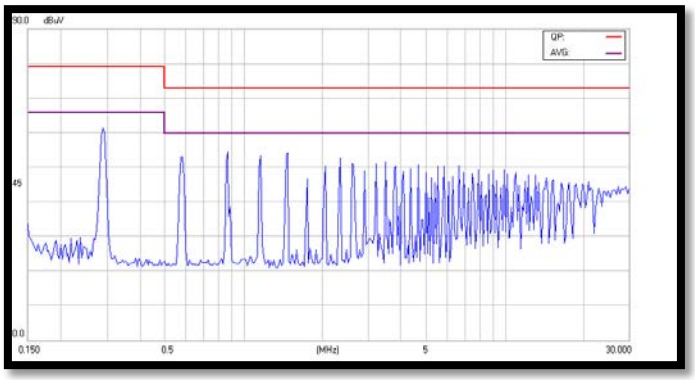
Conducted Class A of TF22D15-0.5



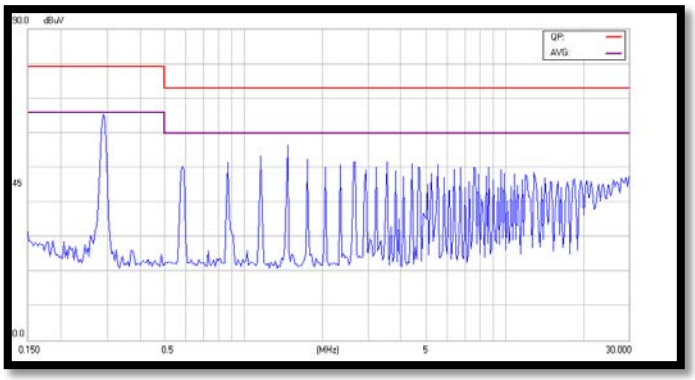
Conducted Class A of TF45S3.3-4



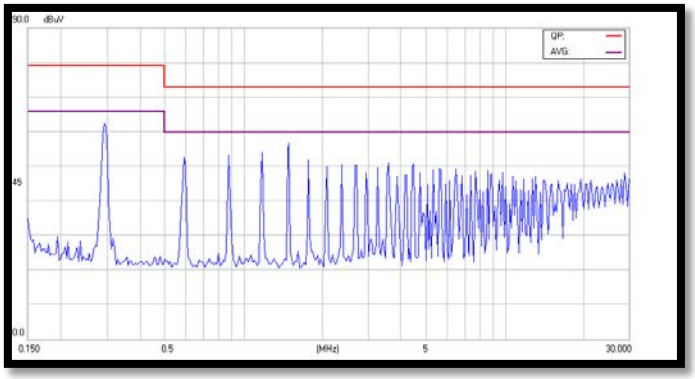
Conducted Class A of TF45S5-3



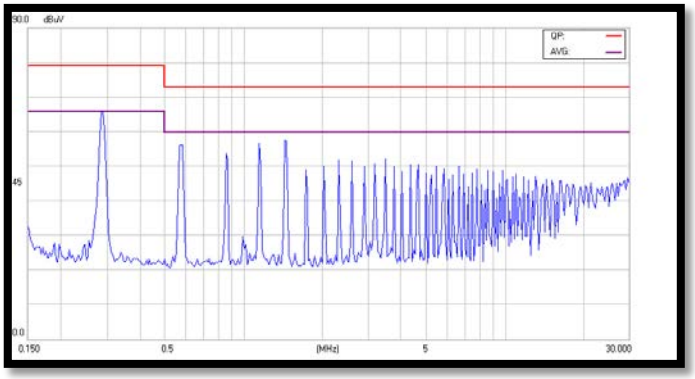
Conducted Class A of TF45S12-1.25



Conducted Class A of TF45-S15-1

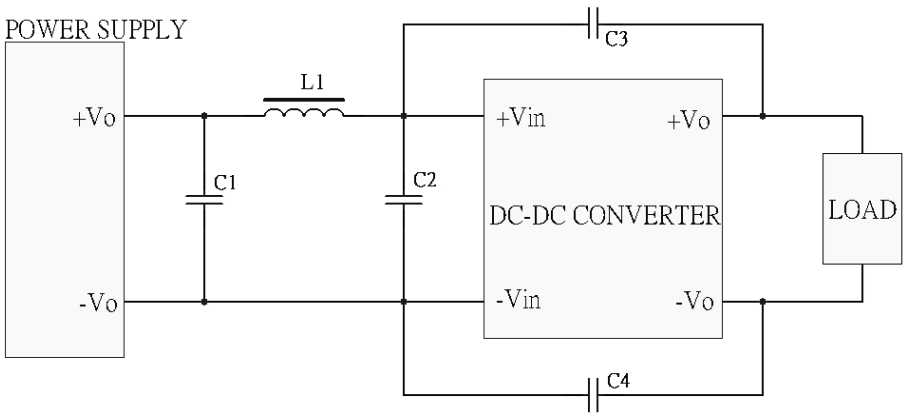


Conducted Class A of TF45D12-0.62



Conducted Class A of TF45D15-0.5

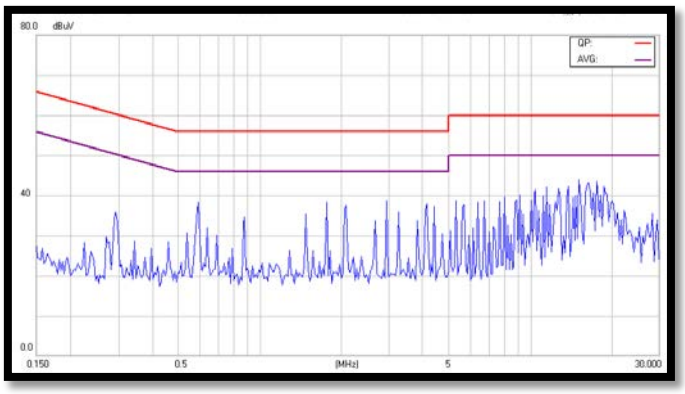
(2) EMI Test standard: EN55022 Class B Conducted Emission
Test Condition: Input Voltage: Nominal, Output Load: Full Load



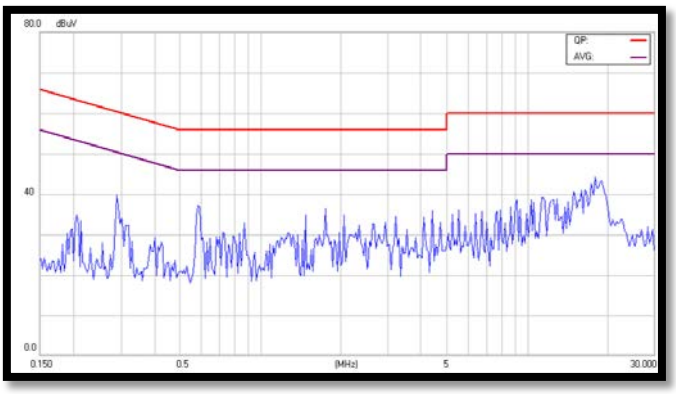
EN55022 class B					
Model No.	**C1**	**C2**	**C3**	**C4**	**L1**
TF22S3.3-4	6.8μF/50V	6.8μF/50V	1000pF/2KV	1000pF/2KV	3.3μH
TF22S5-3	6.8μF/50V	6.8μF/50V	1000pF/2KV	1000pF/2KV	3.3μH
TF22S12-1.25	6.8μF/50V	6.8μF/50V	1000pF/2KV	1000pF/2KV	3.3μH
TF22S15-1	6.8μF/50V	6.8μF/50V	1000pF/2KV	1000pF/2KV	3.3μH
TF22D12-0.62	6.8μF/50V	6.8μF/50V	1000pF/2KV	1000pF/2KV	3.3μH
TF22D15-0.5	6.8μF/50V	6.8μF/50V	1000pF/2KV	1000pF/2KV	3.3μH
TF45S3.3-4	2.2μF/100V	6.8μF/50V	1500pF/2KV	1500pF/2KV	3.3μH
TF45S5-3	2.2μF/100V	6.8μF/50V	1500pF/2KV	1500pF/2KV	3.3μH
TF45S12-1.25	2.2μF/100V	6.8μF/50V	1500pF/2KV	1500pF/2KV	3.3μH
TF45S15-1	2.2μF/100V	6.8μF/50V	1500pF/2KV	1500pF/2KV	3.3μH
TF45D12-0.62	2.2μF/100V	6.8μF/50V	1500pF/2KV	1500pF/2KV	3.3μH
TF45D15-0.5	2.2μF/100V	6.8μF/50V	1500pF/2KV	1500pF/2KV	3.3μH

Note: C1, C2 of capacitors are ceramic capacitors 1812 size and C3, C4 of capacitors are ceramic capacitors 1206 size

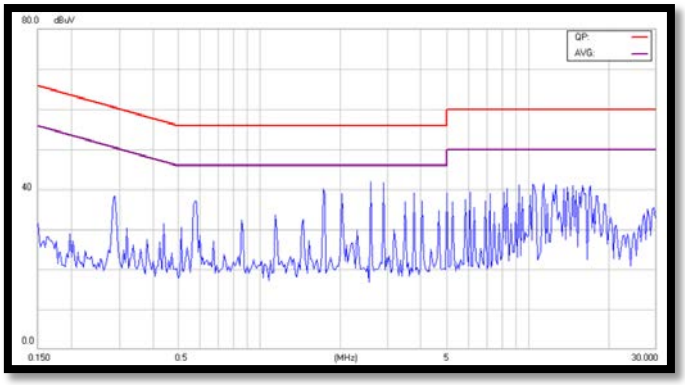
EMI and conducted noise meet EN55022 Class A



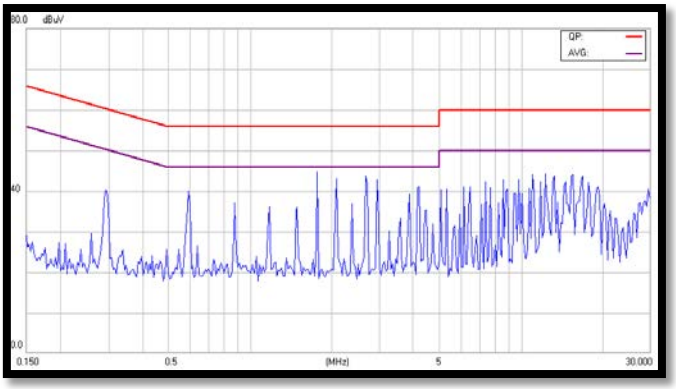
Class A test conducted for TF22S3.3-4



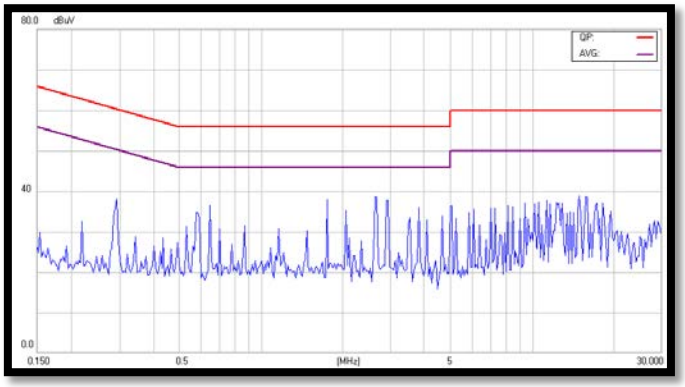
Class B test conducted for TF22S5-3



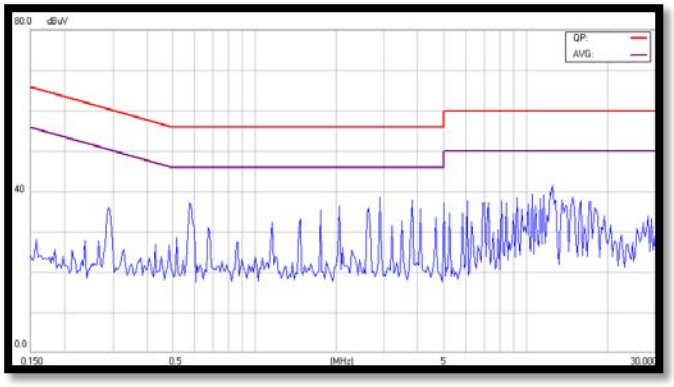
Class B test conducted for TF22S12-1.25



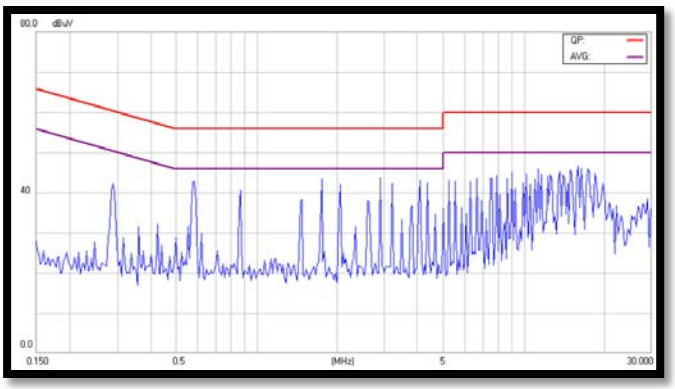
Class B test conducted for TF22S15-1



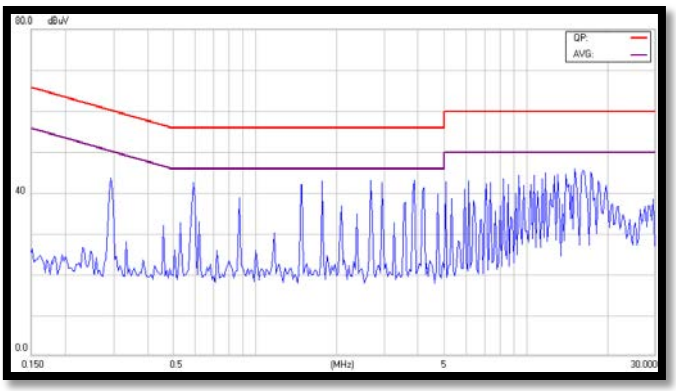
Class B test conducted for TF22D12-0.62



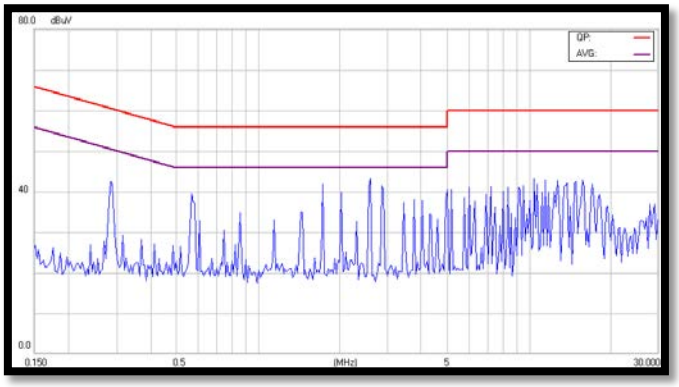
Class B test conducted for TF22D15-0.5



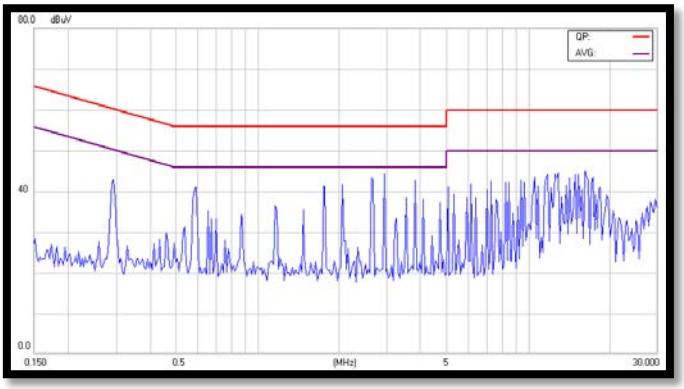
Class B test conducted for TF45S3.3-4



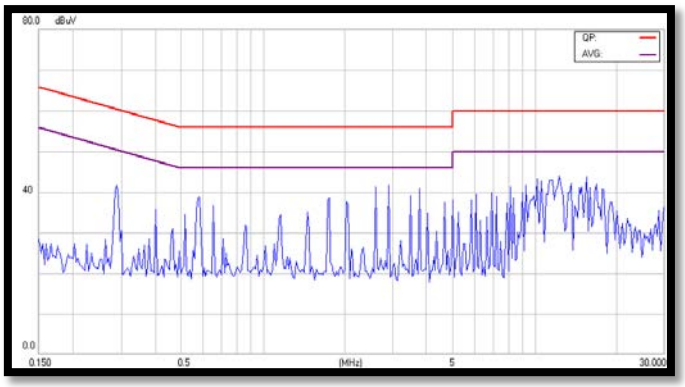
Class B test conducted for TF45S5-3



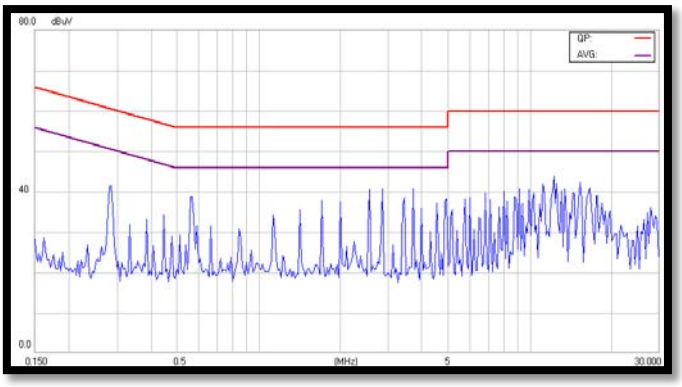
Class B test conducted for TF45S12-1.25



Class B test conducted for TF45S15-1



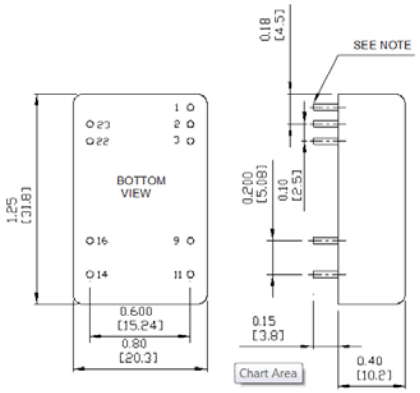
Class B test conducted for TF45D12-0.62



Class B test conducted for TF45D15-0.5

MECHANICAL SPECIFICATIONS

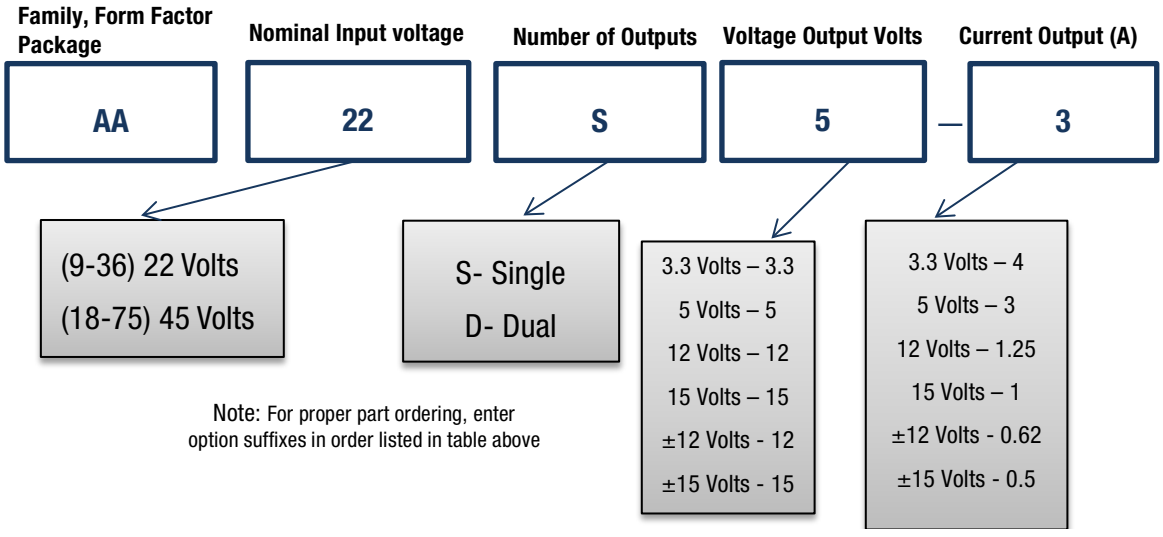
Note: All dimensions are in millimeters (inches). Tolerance: x.xx ±0.02 in. (0.5mm), x.xxx ±0.010 in. (0.25 mm) unless otherwise noted



PIN CONNECTIONS

PIN CONNECTIONS					
PIN	SINGLE OUTPUT	DUAL OUTPUTS	PIN	SINGLE OUTPUT	DUAL OUTPUTS
1	Remote	Remote	13	No Pin	No Pin
2	- V Input	- V Input	14	+ V Output	+ V Output
3	- V Input	- V Input	15	No Pin	No Pin
4,5	No Pin	No Pin	16	-V Output	Common
9	No Pin	Common	20,21	No Pin	No Pin
10	No Pin	No Pin	22	+ V Input	+ V Input
11	No Connection	-V output	23	+ V Input	+ V Input
12	No Pin	No Pin	24	No Pin	No Pin

PART NUMBER ORDERING INFORMATION



Note: For proper part ordering, enter option suffixes in order listed in table above