TFR RAILWAY SERIES 24-Pin DIP

Up to 10 Watt DC-DC Converter

PRODUCT OVERVIEW

The TFR railway series offer 10 watts of output power in a 24 pin industry-standard DIP package. These converters have ultra-wide input voltage range of 43 to 160 Volts. They provide precise regulated output voltages ranging from 5 to 15 volts. Models are available as single or dual output. Other output voltages are also available and please contact DATEL if your application requires such modification.

This series features high efficiency up to 88%; 3000 Volts 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.

FEATURES

- Industry Standard 24-Pin DIP package
- 10 Watts Isolated Output
- Wide Input Range (43 - 160 Volts)
- Regulated Outputs
- Up to 88 % Efficiency
- Low No-Load Power Consumption
- -40°C to +85°C industrial temperature range
- Remote On/Off logic control
- Over Current Protection
- Continuous Short Circuit Protection
- Sense Compensation, Over-temperature protection
- 3050m Operating Altitude,12000m Transport Altitude
- Designed to meet CE 2014/30/EC
- Fire & Smoke Meets EN45545-2
- Designed to meet Shock & Vibration EN50155 (EN61373) with external circuits
- Safety designed to meet UL60950-1

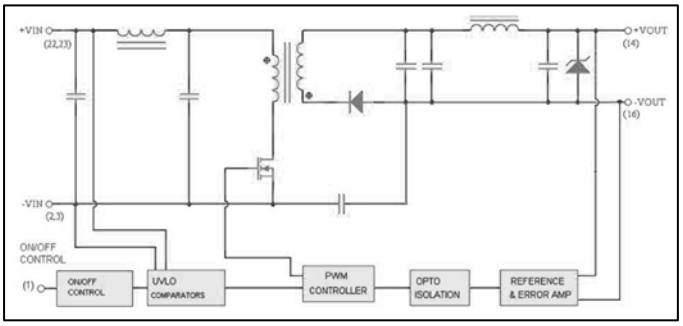
APPLICATIONS:

- Driver Computer System
- Communications System
- Remote & Car Control
- Emergency Start
- Media / Alarms / Horn / Cameras
- Windshield Washer Wipers
- Remote Control / Operation
- Passenger Comfort Systems
- Ticketing / Counting / Tracking Systems
- Doors / Lifts (Including Disabling Facilities)

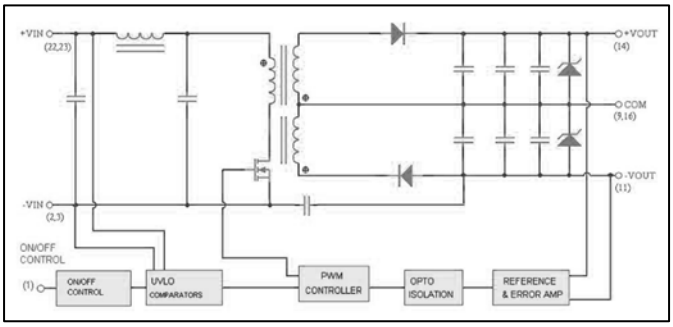
Contact DATEL for other series, Cost saving, lower power, other output voltages, etc.

MODEL NUMBER	INPUT VOLTAGE	OUTPUT VOLTAGE	OUTPUT CURRENT MAX	EFFICIENCY %	LINE REGULATION	OPTION
TFR101S12-0.83	43-160 VDC	12VDC	0.835 A	88	0.2%	N
TFR101S15-0.66	43-160 VDC	15VDC	0.666 A	88	0.2%	N
TFR101D5-1	43-160 VDC	±5VDC	1 A	85	0.2%	N
TFR101D12-0.41	43-160 VDC	±12 VDC	±0.416 A	87	0.2%	N
TFR101D15-0.33	43-160 VDC	±15 VDC	±0.333 A	87	0.2%	N

BLOCK DIAGRAM



Block Diagram for Single Output Models



Block Diagram for Dual Output Models

ABSOLUTE MAXIMUM RATINGS

PARAMETER	CONDITIONS	MODEL	Min.	Typical	Max.	Units
Input Voltage						
Continuous	DC	All	-0.3		160	Volts
Transient	100ms, DC	All			200	Volts
Operating Ambient Temperature	Derating, Above 60°C	All	-40		+85	°C
Case Temperature		All			+100	°C
Storage Temperature		All	-55		+125	°C
Input / Output Isolation Voltage	1 minute, DC Volts	All	3000			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		All	43	110	160	Volts
Maximum Input Current	100% Load, V_{in} = 43V	All		290		mA
No-Load Input Current	V_{in} = 110 Volts	All		6		mA
Input Under Voltage Lockout						
Turn-On Voltage Threshold		All	38.5	40	41.5	VDC
Turn-Off Voltage Threshold		All	36.5	38	39.5	VDC
Lockout Hysteresis Voltage		All		2		VDC
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	Vin = Nominal input, Io = Io max	Vo=±5.0 Vo=12 Vo=15 Vo=±12 Vo=±15	4.95 11.88 14.85 11.88 14.85	5 12 15 12 15	5.05 12.12 15.15 12.12 15.15	
Output Voltage Balance	V_{in} =nominal, Io= I_{o_max}, Tc=25°C	Dual			±2.0	%
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 ±0.2	% %
Cross Regulation	Load cross variation 25%/100%	Dual			±5	%
Temperature Coefficient	Tc=-40°C to + 85°C				±0.02	%/°C
Output Voltage Ripple and Noise	5Hz to 20MHz bandwidth					
Peak-to-Peak	Full Load, 1µF MLCC	Vo=±5.0 Vo=12 Vo=15 Vo=±12 Vo=±15			75 100 100 100 100	mV

Operating Output Current Range		Vo=±5.0 Vo=12 Vo=15 Vo=±12 Vo=±15	0 0 0 0 0		±1000 835 667 ±417 ±333	mA
Output DC Current-Limit Inception	Output Voltage=90% $V_{O, nominal}$		110	140	170	%
Maximum Output Capacitance	Full load, Resistance	Vo=±5.0 Vo=12 Vo=15 Vo=±12 Vo=±15			1000 835 667 417 333	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		ms
Turn-On Delay Time, From Input	V_{in_min} to 10%V_{o_set}	All		7		ms
Output Voltage Rise Time	10% V_{o_set} to 90% V_{o_set}	Single Dual		8 18		ms

FEATURE CHARACTERISTICS

PARAMETER	CONDITIONS	Device	Min.	Typical	Max.	Units
Efficiency 100% Load	V_{in} = Nominal , I_o = I_{o_max}, Tc=25°C	TFR101S12-0.83 TFR101S15-0.66 TFR101D5-1 TFR101D12-0.41 TFR22D15-0.33		88 88 85 87 87		%
ISOLATION CHARACTERISTICS						
Input to Output	1 minutes	All	3000			Volts
Isolation Resistance		All	1000			MΩ
Isolation Capacitance		All		1000		pF
Switching Frequency		All		240		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		160	Volts
Logic Low (Module Off)	$V_{on/off}$ at $I_{on/off}$=1.0mA	All	0		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		160	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 Over Voltage Protection	Zener or TVS Clamp	Vo=12V Vo=15V Vo=±5V Vo=±12V Vo=±15V		15 18 ±6.2 ±15 ±18		Volts
MTBF	I_o =100%of I_{o_max};Ta=25℃ per MIL-HDBK-217F	All		960		K hours
Weight		All		16		grams
Baseplate Material		Plastic, LCP				
Case Material		Plastic, DAP				
Potting Materials		UL94V-0				
Pin Materials		*Base*: Copper, *Plating*: Nickel with Matte Tin				
Shock / Vibration		MIL-STD-810F / EN61373				
Humidity		95% RH max. Non Condensing				
Altitude		3050m Operating Altitude,12000m Transport Altitude				
Thermal Shock		MIL-STD-810F				
ESD	EN61000-4-2 Level 3: Air ±8kV, Contact ±6kV					
EMI	Meets EN55011, EN55022 & EN50155 with external input filter, EN55032	Class A				
Fast Transient	EN61000-4-4 Level 3: On power input port, ±2kV, external input capacitor required	Perf. Criteria A				
Radiated Immunity	EN61000-4-3 Level 3: 80~1000MHz, 20V/m	Perf. Criteria A				
Surge	EN61000-4-5 Level 4: Line to earth, ±4kV, Line to line, ±2kV	Perf. Criteria A				
Conducted Immunity	EN61000-4-6 Level 3: 0.15~80MHz, 10V	Perf. Criteria A				
Interruptions of Voltage Supply	EN50155 10ms Interruptions	Class S2				
Supply Change Over	EN50155 During a supply break of 30 ms	Class C2				

Operating Temperature Range

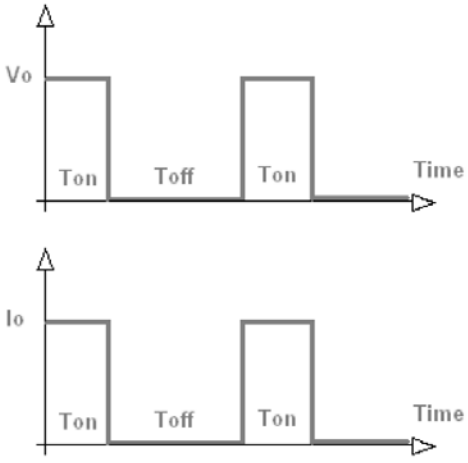
The TFR series of converters operates over the wide ambient temperature range of -40°C to +85°C. Derating for this series starts above the temperature of +60°C. The standard model case temperature should not go over +100°C for normal operation.

Remote On/Off

The TFR 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. Models with part number option "N" are the "negative logic" remote on/off version. The unit turns off if the remote On/Off pin is high (>3.5Vdc or open circuit). The converter turns on if the on/off pin input is low (0 to<1.2Vdc). Note that the converter is off by default.

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)

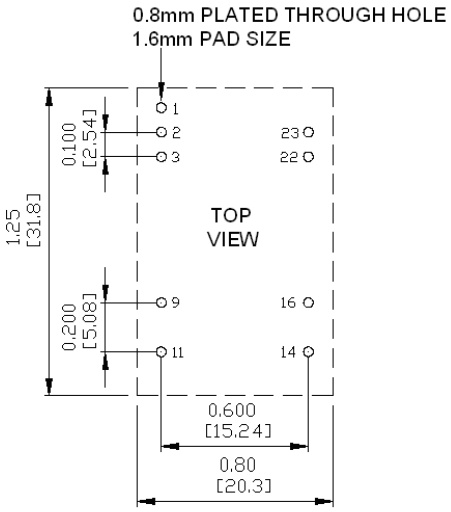
Input under voltage lockout is standard on the TFR unit. The unit will shut down when the input voltage drops below the threshold. On the other hand, the unit will operate when the input voltage goes above the upper threshold.

Over Voltage Protection

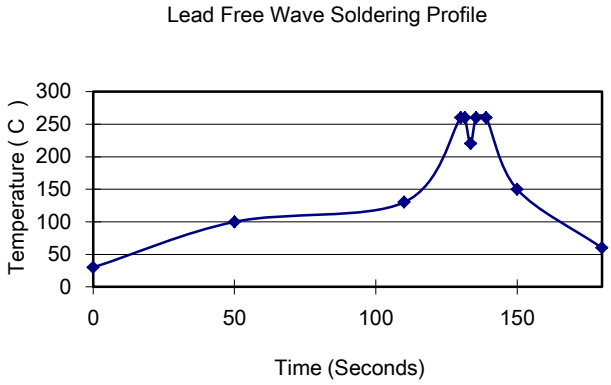
The over-voltage protection consists of a Zener diode that will limit the output voltage.

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 Footprint, Dimensions are in inches (millimeters)



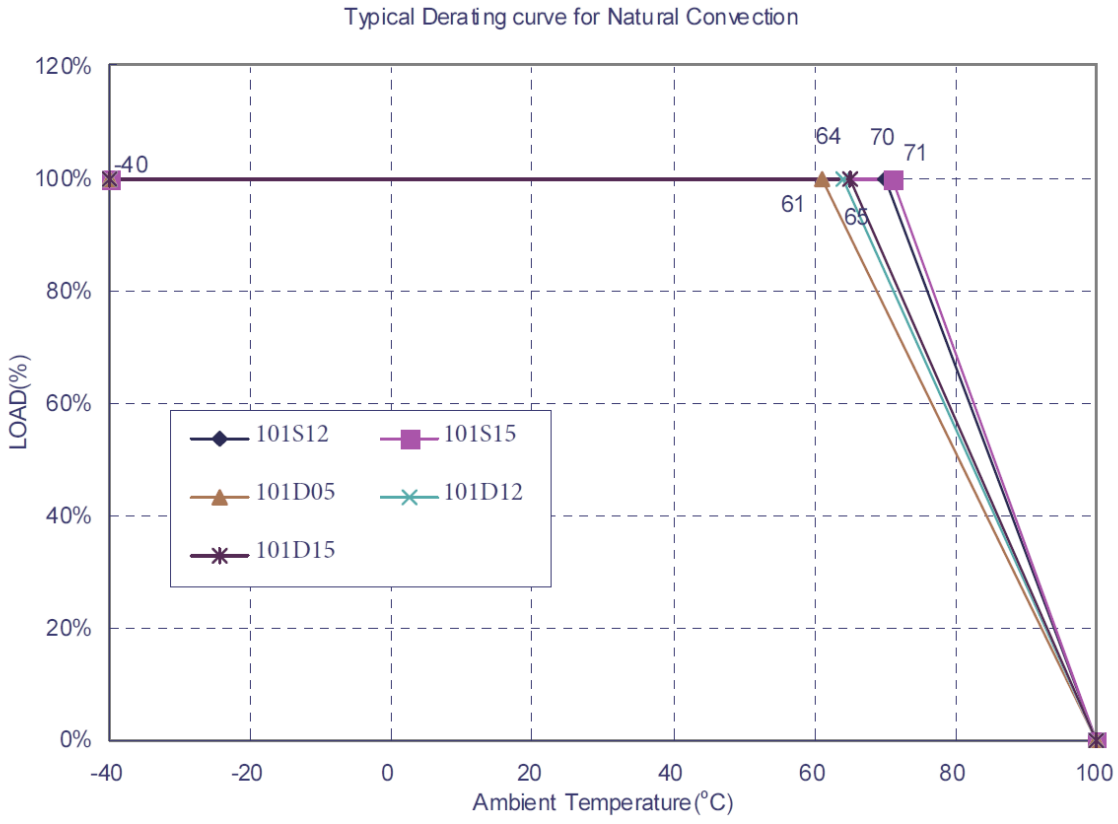
Recommended Wave Soldering Profiles

Note：

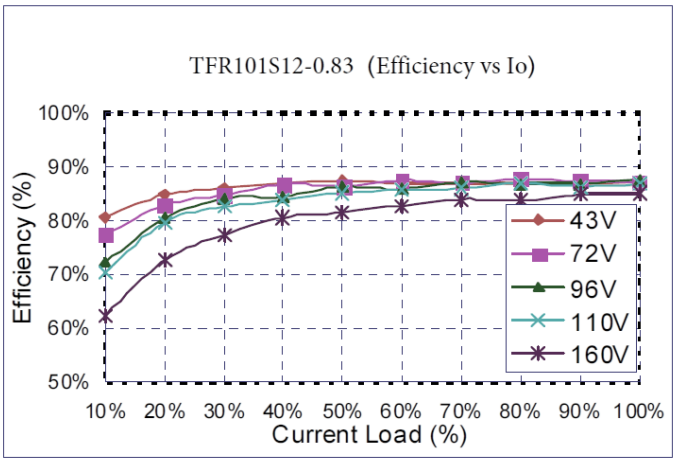
1. Soldering Materials: Sn/Cu/Ni
2. Ramp up rate during preheating: 1.4 °C/Sec (From +50°C to +100°C)
3. Soaking temperature: 0.5 °C/Sec (From +100°C to +130°C), 60 ± 20 seconds
4. Peak temperature: +260°C, above +250°C 3~6 Seconds
5. Ramp up rate during cooling: -10.0 °C/Sec (From +260°C to +150°C)

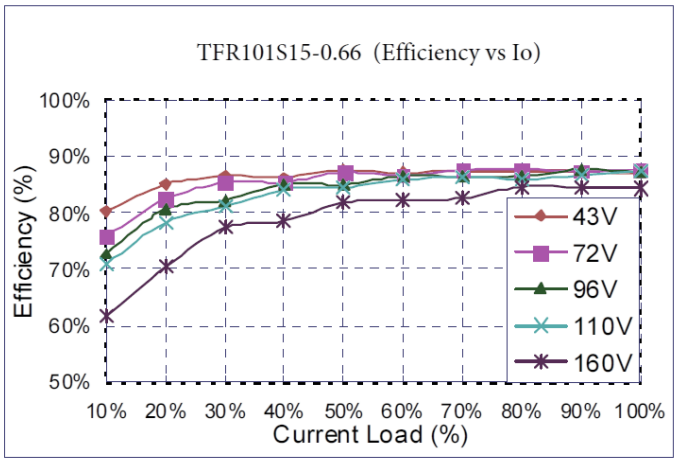
Power De-Rating Curves for TFR Series

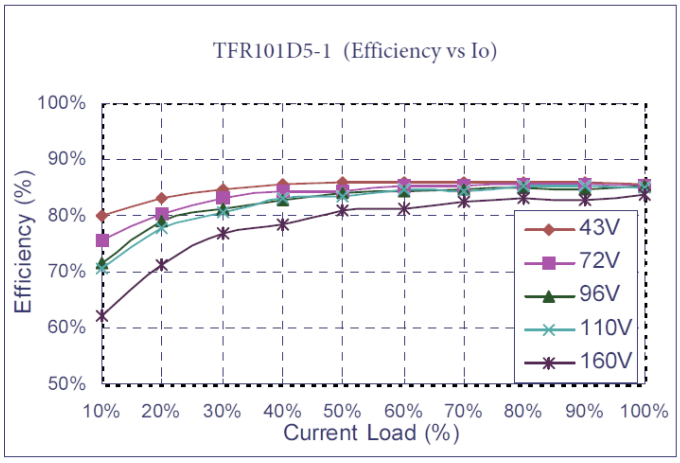
Note that operating ambient temperature range is -40°C to + 85°C with derating above +60°C. Also, the maximum case temperature under any operating condition should not exceed +100°C.

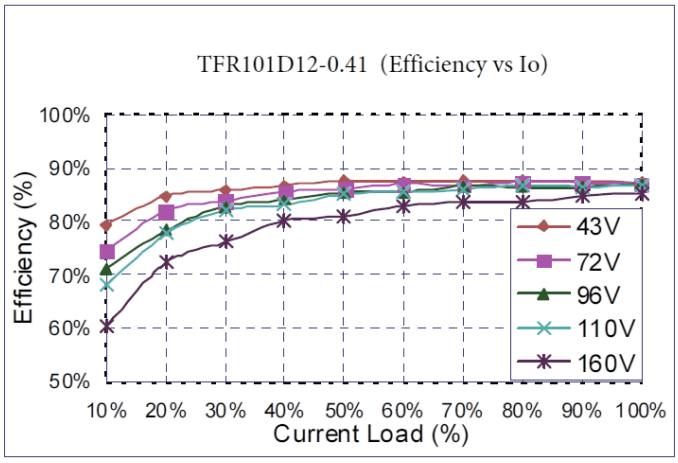


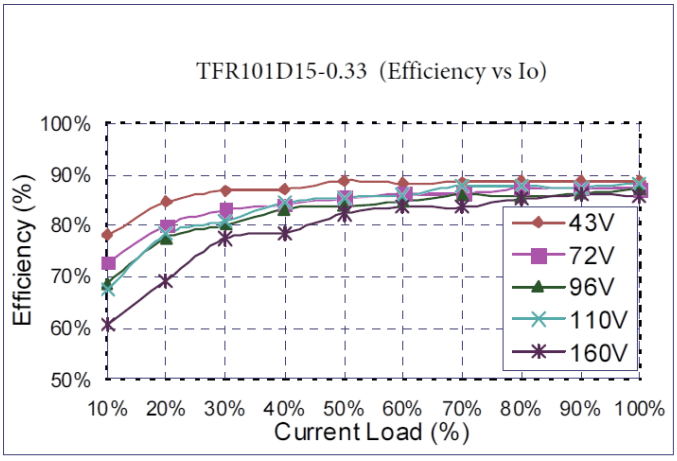
Efficiency vs. Load Curves





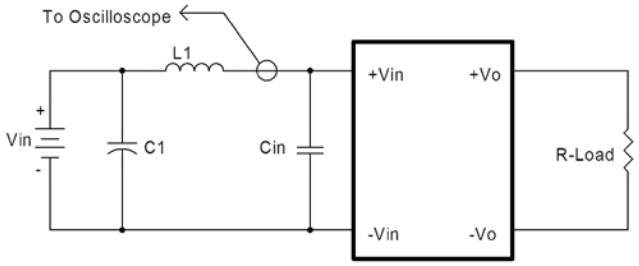






Input Capacitance at the Power Module

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:

$$\eta = \frac{Vo \times Io}{V_{IN} \times I_{IN}} \times 100\%$$

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

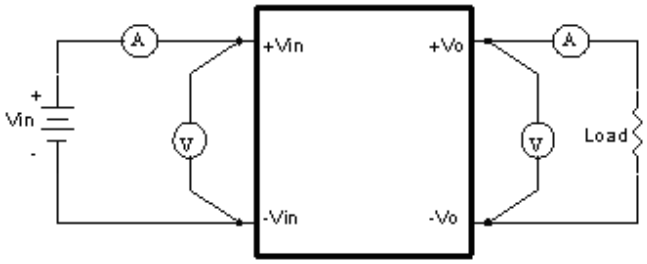
V_{FL} is the output voltage at full load
V_{NL} is the output voltage at 10% load

The value of line regulation is defined as:

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

Where

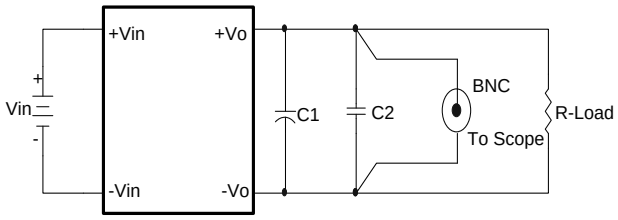
V_{HL} is the output voltage of maximum input voltage at full load.
V_{LL} is the output voltage of minimum input voltage at full load.



TFR Series Test Setup

Output Ripple and Noise Measurement

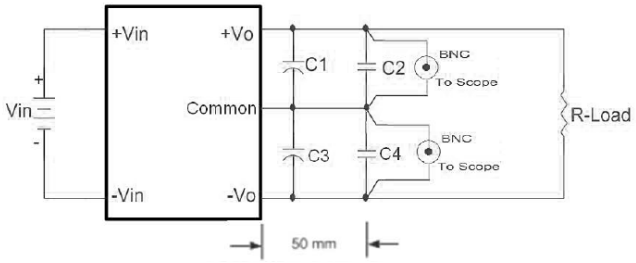
The test set-up for noise and ripple measurements is shown in the figure below. A coaxial cable was used to prevent impedance mismatch reflections disturbing the noise readings at higher frequencies. Measurements are taken with output appropriately loaded and all ripple/noise specifications are from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



Note:

C1: None
C2: 0.1uF Ceramic capacitor

Output Voltage Ripple and Noise Measurement Set-Up for Single Output Model

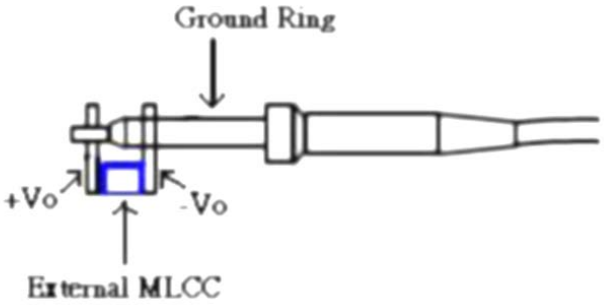


C1: None
C2: 0.1uF Ceramic capacitor

Output Voltage Ripple and Noise Measurement Set-Up for Dual Output Model

The conventional ground clip on an oscilloscope probe should never be used in this kind of measurement. This clip, when placed in a field of radiated high frequency energy, acts as an antenna or inductive pickup loop, creating an extraneous voltage that is not part of the output noise of the converter.

Another method is shown in below, in case of coaxial-cable/BNC is not available. The noise pickup is eliminated by pressing scope probe ground ring directly against the -Vout terminal while the tip contacts the +Vout terminal. This makes the shortest possible connection across the output terminals.

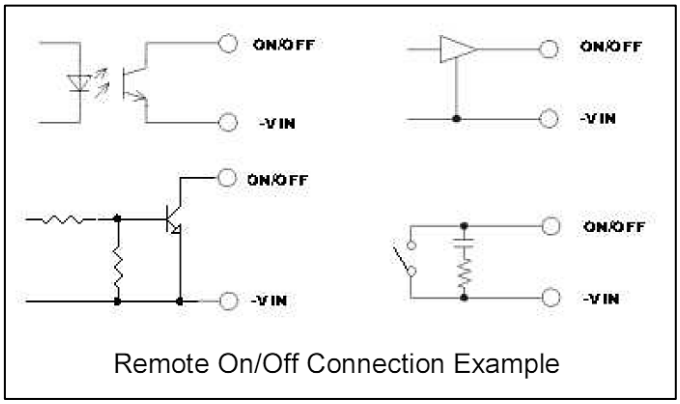


Output Capacitance

The TFR 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.

Remote On/Off circuit

The converter Remote On/Off circuit is built-in on the input side. The ground pin of input side Remote On/Off circuit is –Vin pin. For Connection examples see below:

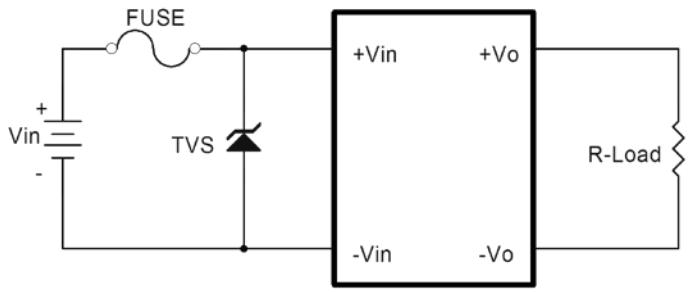


Remote On/Off Connection Example

SAFETY and EMC

Input Fusing and Safety Considerations

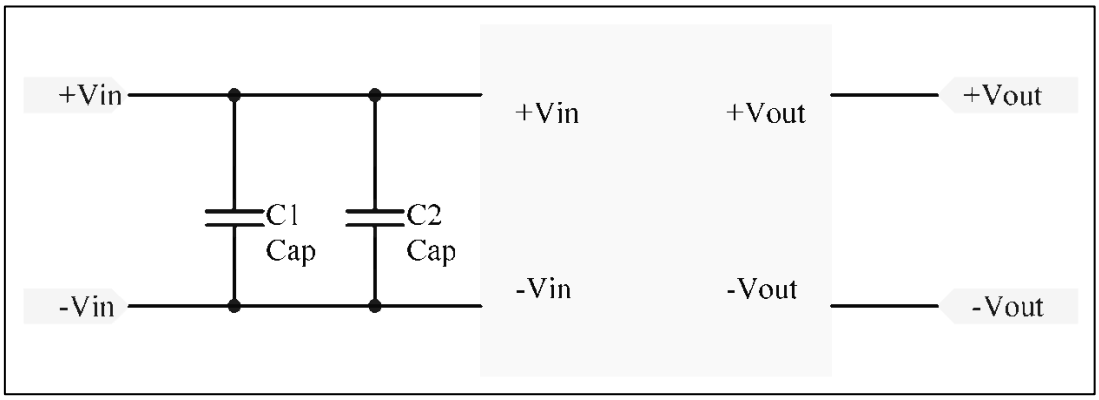
The TFR series converters have not an internal fuse. In order to achieve maximum safety and system protection, always use an input line fuse and DATEL recommend a fast acting fuse 0.5A for all models of this series. The circuit shown below is recommended using a Transient Voltage Suppressor diode across the input terminal to protect the unit against surge or spike voltage and input reverse voltage.



Input Protection

EMC Considerations

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

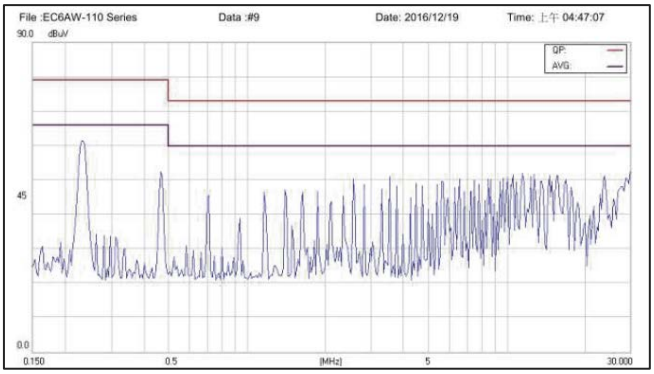


Connection circuit for conducted EMI testing

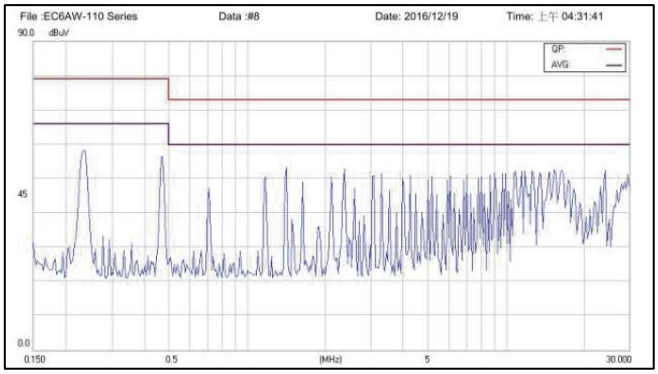
Model No.	C1	C2
TFR101S12-0.83	1µF/250V	1µF/250V
TFR101S15-0.66	1µF/250V	1µF/250V
TFR101D5-1	1µF/250V	1µF/250V
TFR101D12-0.41	1µF/250V	1µF/250V
TFR101D15-0.33	1µF/250V	1µF/250V

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

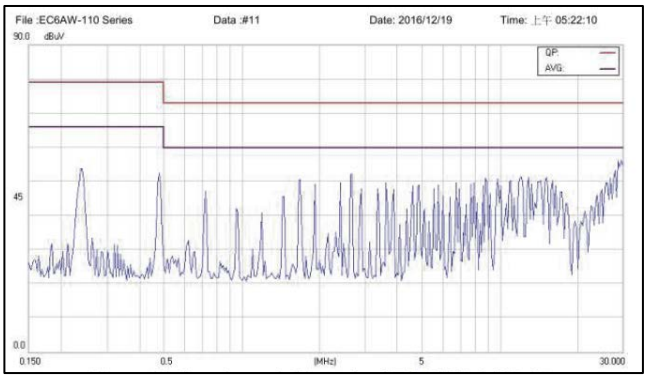
EMI and conducted noise meet EN55022 Class A



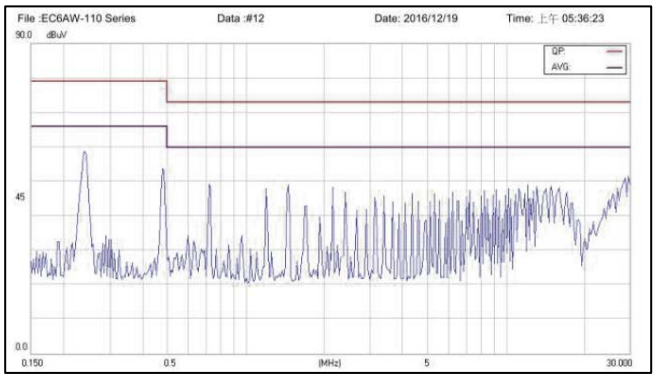
Conducted Class A of TFR101S12-0.83



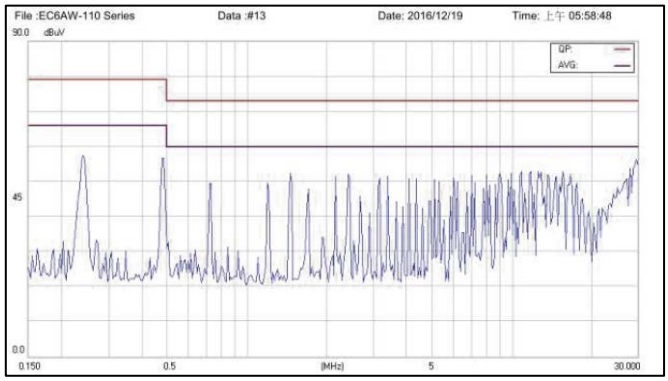
Conducted Class A of TFR101S15-0.66



Conducted Class A of TFR101D5-1

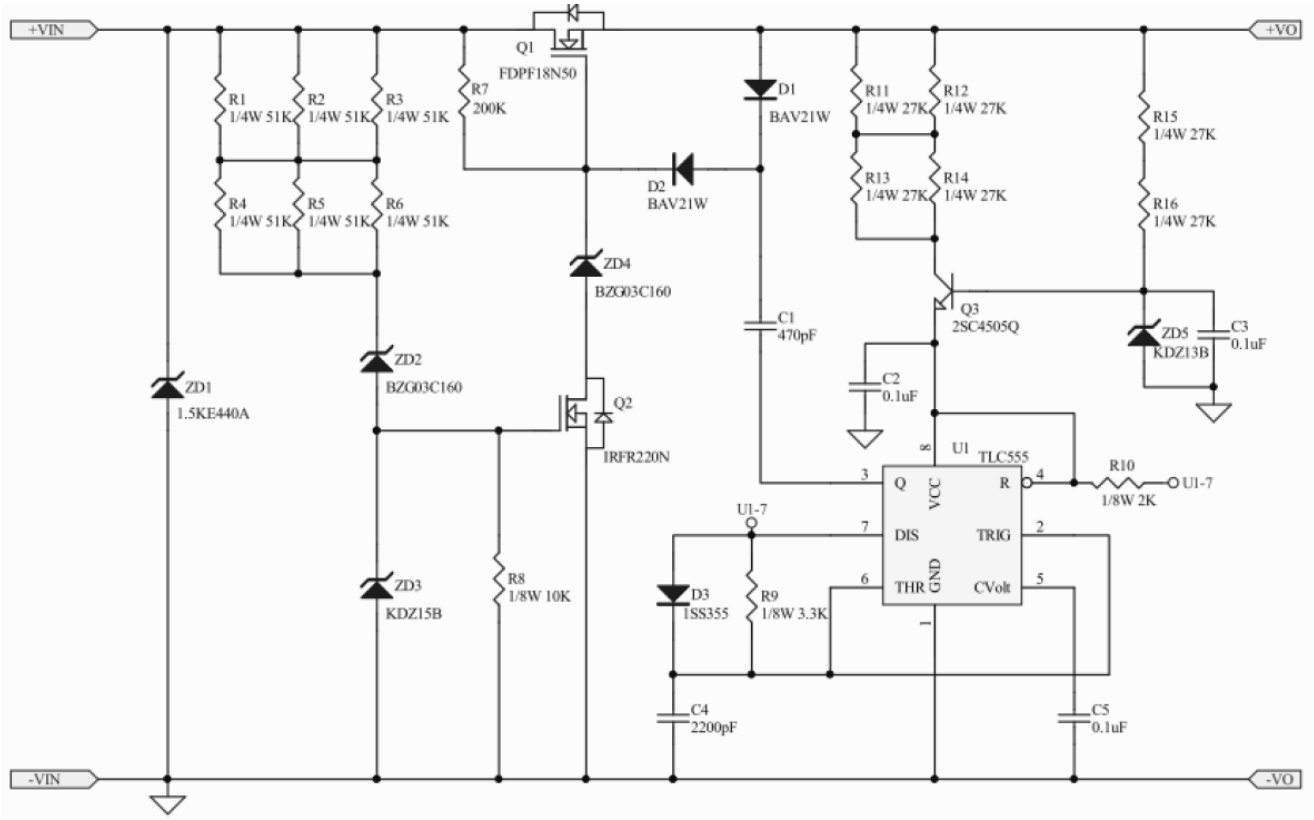


Conducted Class A TFR101D12-0.41



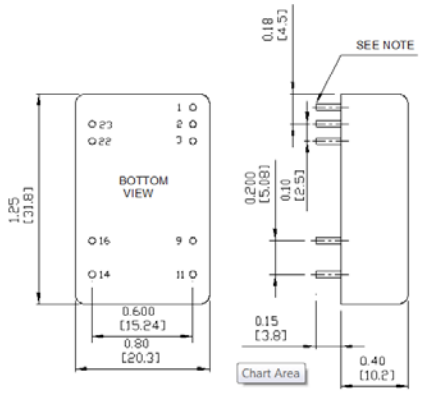
Conducted Class A of TFR101D15-0.33

Suggested Configuration for RIA12 Surge Test



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	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

Family, Form Factor Package	Nominal Input voltage	Number of Outputs	Voltage Output Volts	Current Output (A)	Option
TFR	101	D	5	3	N
	(43-160) 101 Volts	S- Single D- Dual	12 Volts – 12 15 Volts – 15 ±5 Volts – ±5 ±12 Volts - ±12 ±15 Volts - ±15	12 Volts – 0.83 15 Volts – 0.66 ±5 Volts – ±1 ±12 Volts - ±0.41 ±15 Volts - ±0.33	None- Positive Logic N - Negative Logic

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

11 Cabot Boulevard, Suite 200, Mansfield, MA 02048 USA
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