TRACO POWER

TEN 20-WIN Series — Application Note

DC/DC Converter 9 to 36Vdc or 18 to 75 Vdc Input
3.3 to 15Vdc Single Outputs and ±5 to ±15Vdc Dual Outputs, 20W

E188913

Complete TEN 20-WIN datasheet can be downloaded at:
http://www.tracopower.com/products/ten20WIN.pdf

Features

- Single output up to 5.5A
  Dual output up to ±2.0A
- 20 watts maximum output power
- 4:1 ultra wide input voltage range of 9-36 and 18-75VDC
- Six-sided continuous shield
- Case grounding
- High efficiency up to 89%
- Low profile: 50.8×25.4×10.2 mm (2.00×1.00×0.40 inch)
- Fixed switching frequency
- RoHS directive compliant
- No minimum load
- Input to output isolation: 1500Vdc for 1 minute
- Operating case temperature range: 105°C max
- Input under-voltage protection
- Output over-voltage protection
- Over-current protection, auto-recovery
- Output short circuit protection
- Remote on/off

Options

- Heat sinks available for extended operation

Applications

- Distributed power architectures
- Computer equipment
- Communications equipment

General Description

The TEN 20-WIN series offer 20 watts of output power from a 50.8×25.4×10.2 mm package with a 4:1 ultra wide input voltage of 9~36VDC, 18~75VDC. The product features 1500VDC of isolation, short circuit and over voltage protection, as well as six sided shielding. All models are particularly suited to telecommunications, industrial, mobile telecom and test equipment applications.

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Absolute Maximum Rating				
Parameter	**Model**	**Min**	**Max**	**Unit**
Input Voltage Continuous Transient (100mS)	 TEN 20-24xx WIN TEN 20-48xx WIN TEN 20-24xx WIN TEN 20-48xx WIN		 40 80 50 100	V_{DC}
Input Voltage Variation (complies with ETS300 132 part 4.4)	All		5	V/mS
Operating Ambient Temperature (with derating)	All	-40	105	°C
Operating Case Temperature	All		105	°C
Storage Temperature	All	-55	125	°C

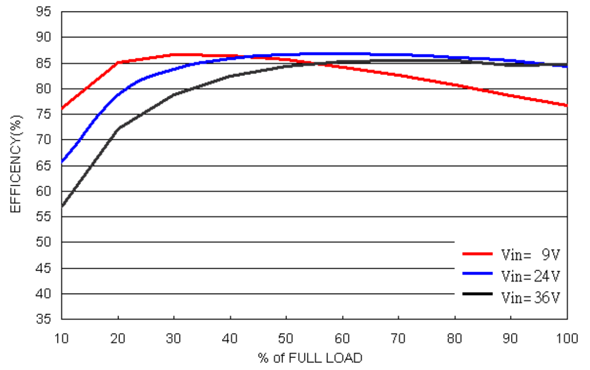
Output Specification					
Parameter	**Model**	**Min**	**Typ**	**Max**	**Unit**
Output Voltage Range ($V_{IN\,nom}$; Full Load; T_A = 25°C)	TEN 20-xx10 WIN TEN 20-xx11 WIN TEN 20-xx12 WIN TEN 20-xx13 WIN TEN 20-xx21 WIN TEN 20-xx22 WIN TEN 20-xx23 WIN	3.267 4.95 11.88 14.85 ±4.95 ±11.88 ±14.85	3.3 5.0 12.0 15.0 ±5.0 ±12.0 ±15.0	3.333 5.05 12.12 15.15 ±5.05 ±12.12 ±15.15	V_{DC}
Output Regulation Line ($V_{IN\,min}$ to $V_{IN\,max}$ at Full Load) Load (0% to 100% of Full Load)	All	 -0.2 -0.5		 +0.2 +0.5	%
Output Ripple & Noise Peak-to-Peak (20MHz bandwidth) (Measured with a 0.1µF/50V MLCC)	TEN 20-xx10 Others single output All dual output			60 75 100	mV_{P-P}
Temperature Coefficient	All	-0.02		+0.02	%/□
Output Voltage Overshoot ($V_{IN\,min}$ to $V_{IN\,max}$; Full Load; T_A = 25°C)	All		0	3	% V_{OUT}
Dynamic Load Response ($V_{IN\,nom}$; T_A = 25°C) Load step change from 75% to 100% or 100 to 75% of Full Load Peak Deviation Setting Time (V_{OUT} < 10% peak deviation)	 All All		 200 250		 mV µS
Output Current	TEN 20-xx10 WIN TEN 20-xx11 WIN TEN 20-xx12 WIN TEN 20-xx13 WIN TEN 20-xx21 WIN TEN 20-xx22 WIN TEN 20-xx23 WIN	0 0 0 0 0 0 0		5500 4000 1670 1330 ±2000 ±833 ±667	mA
Output Over Voltage Protection (Zener diode clamp)	TEN 20-xx10 WIN TEN 20-xx11 WIN TEN 20-xx12 WIN TEN 20-xx13 WIN TEN 20-xx21 WIN TEN 20-xx22 WIN TEN 20-xx23 WIN		3.9 6.2 15 18 6.2 15 18		V_{DC}
Output Over Current Protection	All		150		% FL.
Output Short Circuit Protection	All	Hiccup, automatics recovery			

Input Specification					
Parameter	**Model**	**Min**	**Typ**	**Max**	**Unit**
Operating Input Voltage	TEN 20-24xx WIN	9	24	36	V_{DC}
	TEN 20-48xx WIN	18	48	75	
Input Current	TEN 20-2410 WIN			934	mA
(Maximum value at $V_{IN\,nom}$; Full Load)	TEN 20-2411 WIN			992	
	TEN 20-2412 WIN			1018	
	TEN 20-2413 WIN			1014	
	TEN 20-2421 WIN			992	
	TEN 20-2422 WIN			1004	
	TEN 20-2423 WIN			1005	
	TEN 20-4810 WIN			467	
	TEN 20-4811 WIN			496	
	TEN 20-4812 WIN			503	
	TEN 20-4813 WIN			501	
	TEN 20-4821 WIN			490	
	TEN 20-4822 WIN			496	
	TEN 20-4823 WIN			496	
Input Standby current	TEN 20-2410 WIN		50		mA
(Typical value at $V_{IN\,nom}$; No Load)	TEN 20-2411 WIN		65		
	TEN 20-2412 WIN		22		
	TEN 20-2413 WIN		22		
	TEN 20-2421 WIN		55		
	TEN 20-2422 WIN		30		
	TEN 20-2423 WIN		30		
	TEN 20-4810 WIN		35		
	TEN 20-4811 WIN		35		
	TEN 20-4812 WIN		15		
	TEN 20-4813 WIN		15		
	TEN 20-4821 WIN		35		
	TEN 20-4822 WIN		17		
	TEN 20-4823 WIN		17		
Under Voltage Lockout Turn-on Threshold	TEN 20-24xx WIN		9		V_{DC}
	TEN 20-48xx WIN		18		
Under Voltage Lockout Turn-off Threshold	TEN 20-24xx WIN		7.5		V_{DC}
	TEN 20-48xx WIN		15		
Input reflected ripple current (5 to 20MHz, 12µH source impedance)	All		20		mA_{P-P}
Start Up Time (V_{IN} ,nom and constant resistive load)	All				mS
Power up			20		
Remote On/Off			20		
Remote On/Off Control (The On/Off pin voltage is referenced to $-V_{IN}$)	All				V_{DC}
On/Off pin High Voltage (Remote On)		3		12	
On/Off pin Low Voltage (Remote Off)		0		1.2	
Remote Off input current	All			2.5	mA
Input current of Remote control pin	All	-0.5		0.5	mA

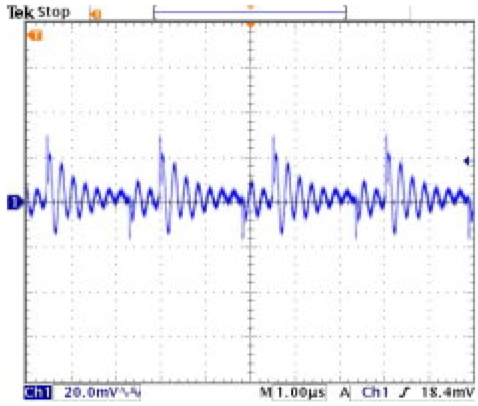
General Specification					
Parameter	**Model**	**Min**	**Typ**	**Max**	**Unit**
Efficiency ($V_{IN\,nom}$; Full Load; T_A = 25°C)	TEN 20-2410 WIN TEN 20-2411 WIN TEN 20-2412 WIN TEN 20-2413 WIN TEN 20-2421 WIN TEN 20-2422 WIN TEN 20-2423 WIN TEN 20-4810 WIN TEN 20-4811 WIN TEN 20-4812 WIN TEN 20-4813 WIN TEN 20-4821 WIN TEN 20-4822 WIN TEN 20-4823 WIN		85 88 86 86 88 87 87 85 88 87 87 89 88 88		%
Isolation voltage (Basic Insulation) Input to Output Input to Case, Output to Case	All	1500 1500			V_{DC}
Isolation resistance	All	1			GΩ
Isolation capacitance	All			1500	pF
Switching Frequency	All		400		KHz
Weight	All		27.0		g
MTBF Bellcore TR-NWT-000332, T_C=40°C MIL-STD-217F	All		1.691×10^6 5.629×10^5		hours

Characteristic Curves

All test conditions are at 25°C.The figures are identical for TEN 20-2410 WIN

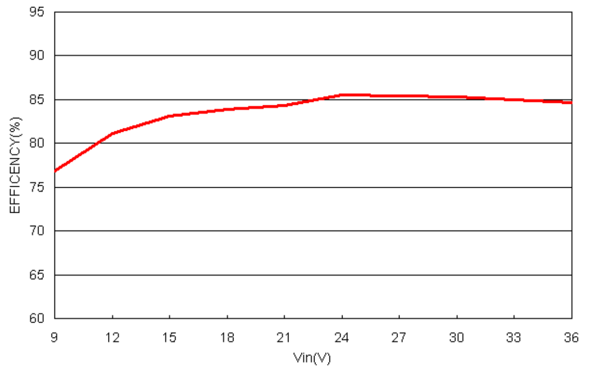


Efficiency versus Output Current

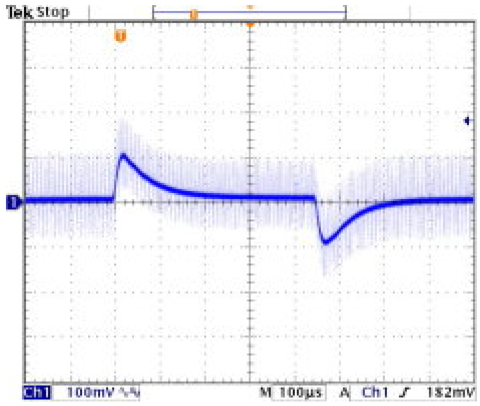


Typical Output Ripple and Noise.

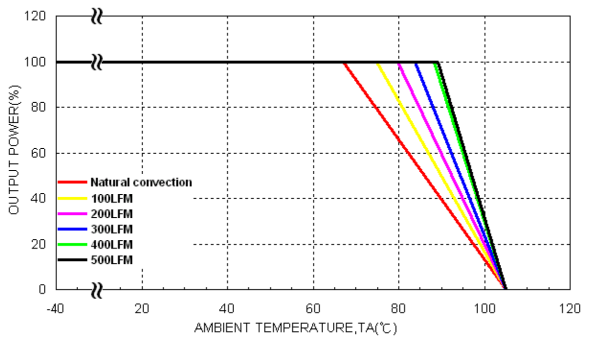
$V_{IN\,nom}$; Full Load



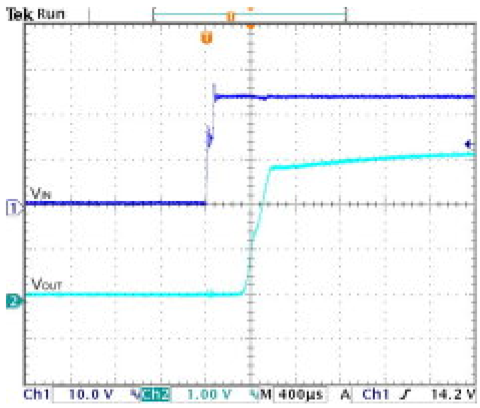
Efficiency versus Input Voltage. Full Load



Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load ; $V_{IN\,nom}$



Derating Output Current versus Ambient Temperature and Airflow $V_{IN\,nom}$

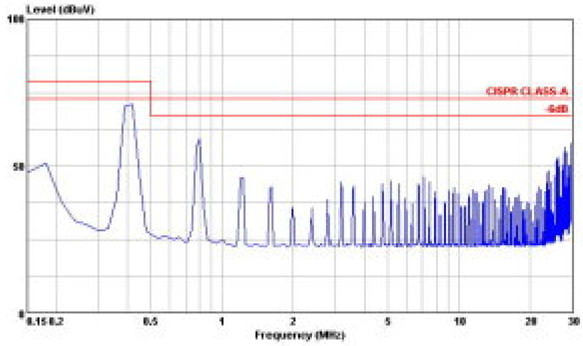


Typical Input Start-Up and Output Rise Characteristic

$V_{IN\,nom}$; Full Load

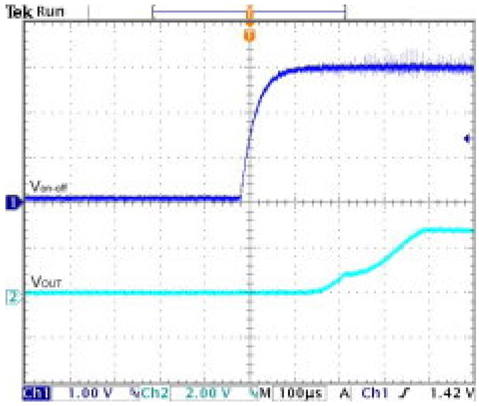
Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-2410 WIN



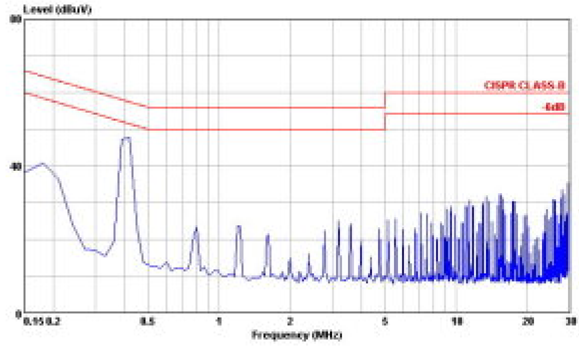
Conduction Emission of EN55022 Class A

$V_{IN\,nom}$; Full Load



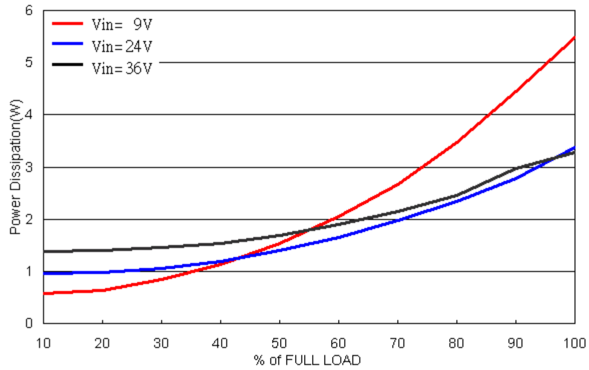
Using ON/OFF Voltage Start-Up and Vo Rise Characteristic

$V_{IN\,nom}$; Full Load



Conduction Emission of EN55022 Class B

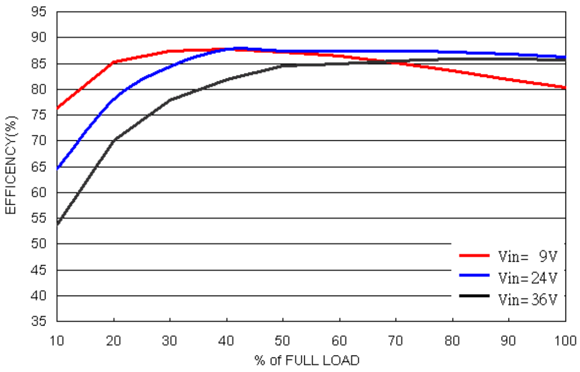
$V_{IN\,nom}$; Full Load



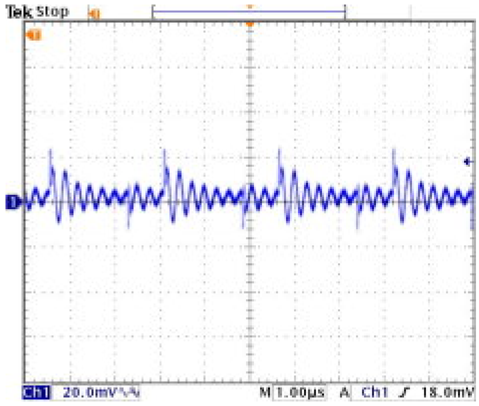
Power Dissipation versus Output Current

Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-2411 WIN

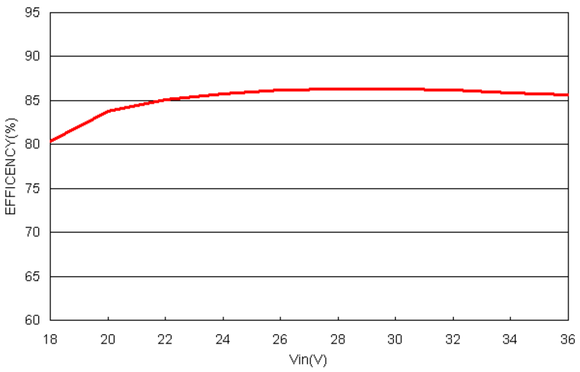


Efficiency versus Output Current

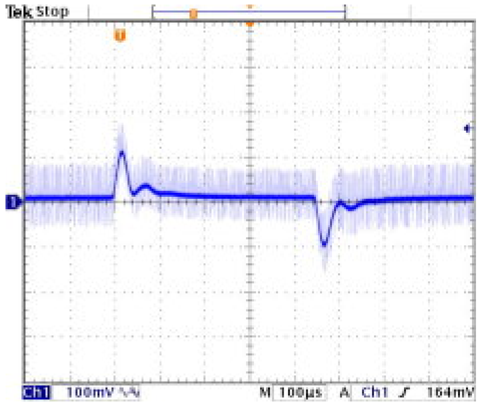


Typical Output Ripple and Noise.

$V_{IN nom}$; Full Load

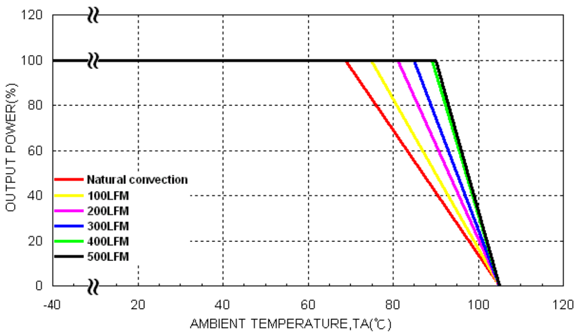


Efficiency versus Input Voltage. Full Load

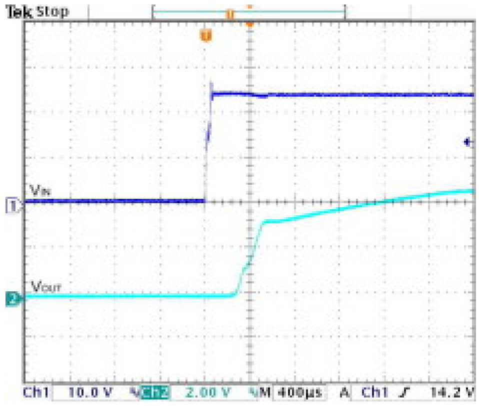


Transient Response to Dynamic Load Change from

100% to 75% to 100% of Full Load ; $V_{IN nom}$



Derating Output Current versus Ambient Temperature and Airflow $V_{IN nom}$

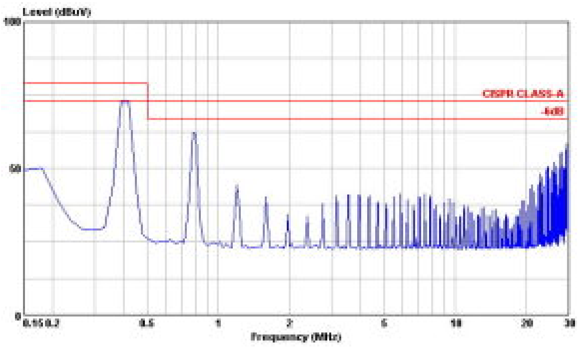


Typical Input Start-Up and Output Rise Characteristic

$V_{IN nom}$; Full Load

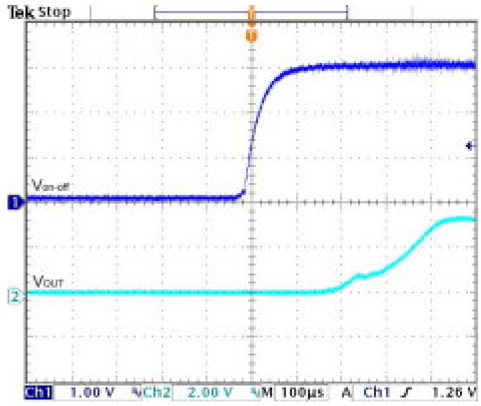
Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-2411 WIN



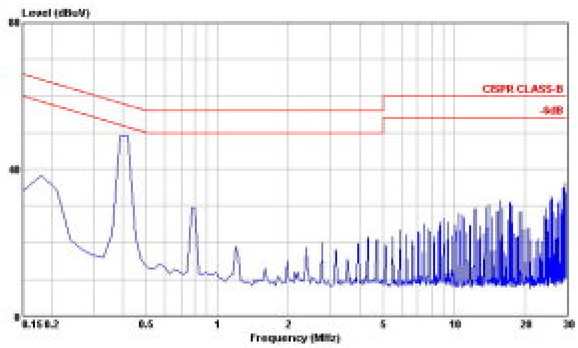
Conduction Emission of EN55022 Class A

$V_{IN\,nom}$; Full Load



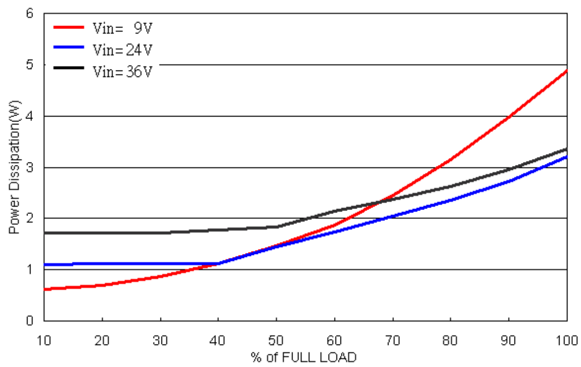
Using ON/OFF Voltage Start-Up and Vo Rise Characteristic

$V_{IN\,nom}$; Full Load



Conduction Emission of EN55022 Class B

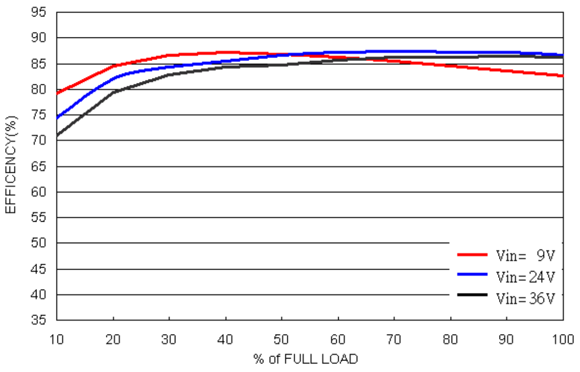
$V_{IN\,nom}$; Full Load



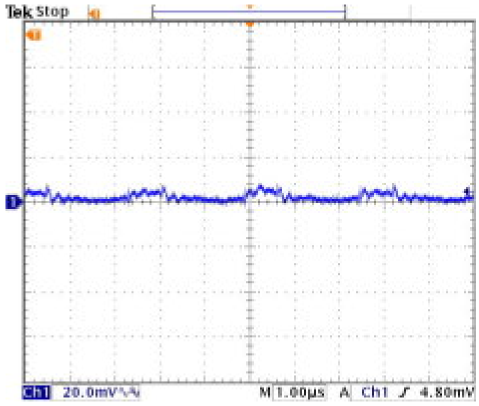
Power Dissipation versus Output Current

Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-2412 WIN

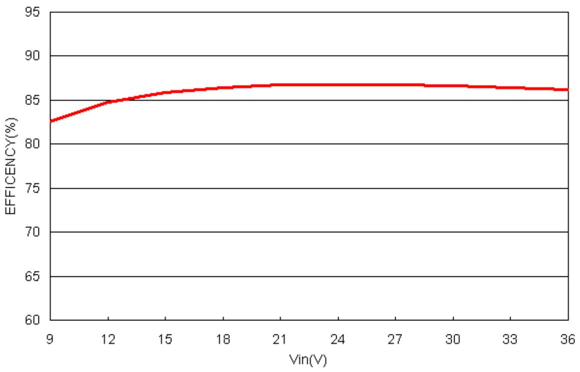


Efficiency versus Output Current

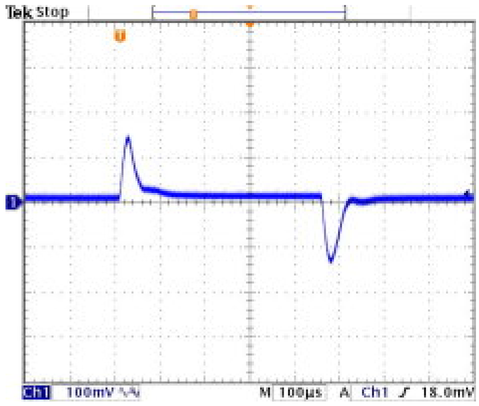


Typical Output Ripple and Noise.

$V_{IN\,nom}$; Full Load

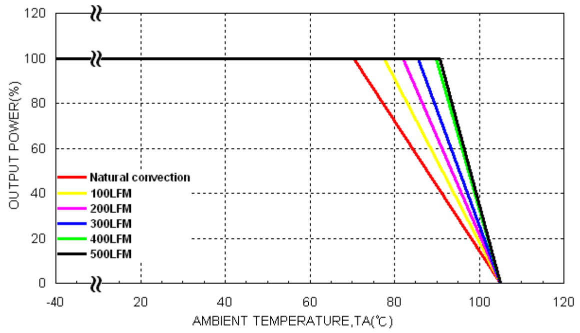


Efficiency versus Input Voltage. Full Load

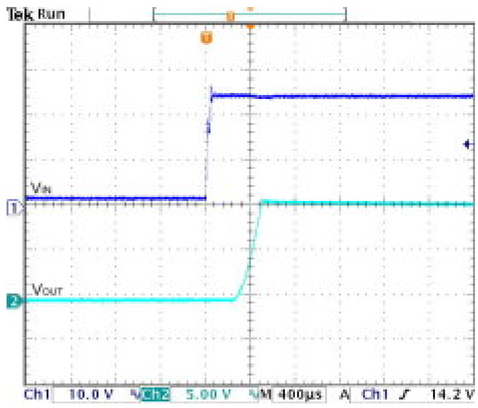


Transient Response to Dynamic Load Change from

100% to 75% to 100% of Full Load ; $V_{IN\,nom}$



Derating Output Current versus Ambient Temperature and Airflow $V_{IN\,nom}$

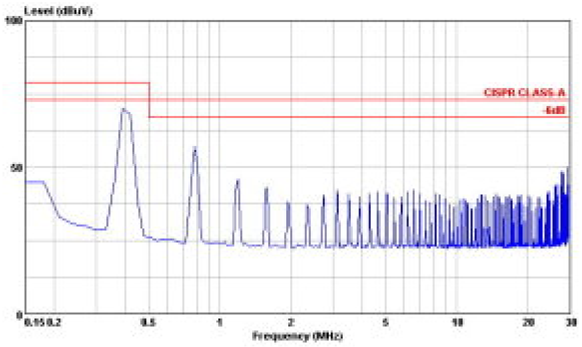


Typical Input Start-Up and Output Rise Characteristic

$V_{IN\,nom}$; Full Load

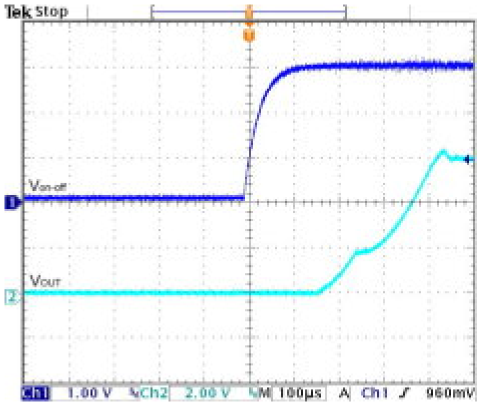
Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-2412 WIN



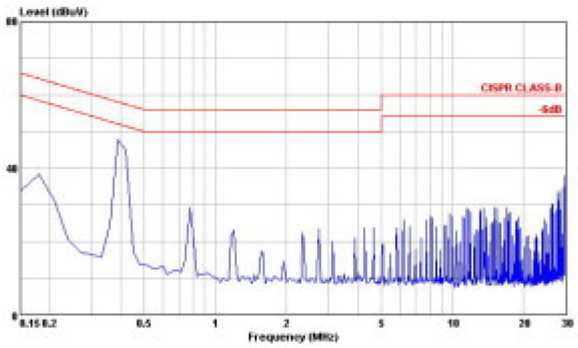
Conduction Emission of EN55022 Class A

$V_{IN\,nom}$; Full Load



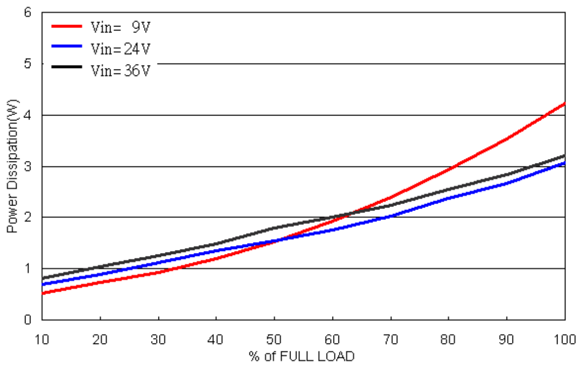
Using ON/OFF Voltage Start-Up and Vo Rise Characteristic

$V_{IN\,nom}$; Full Load



Conduction Emission of EN55022 Class B

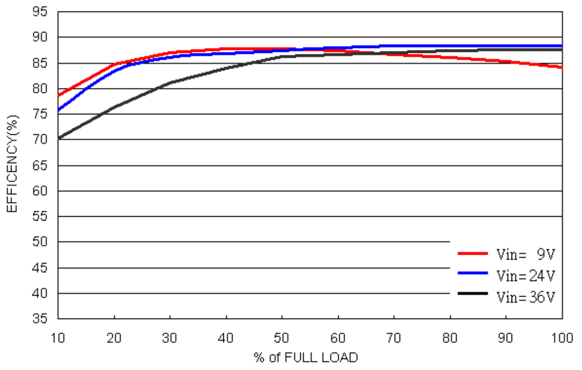
$V_{IN\,nom}$; Full Load



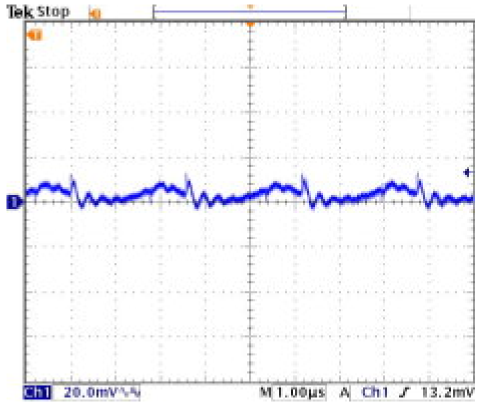
Power Dissipation versus Output Current

Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-2413 WIN

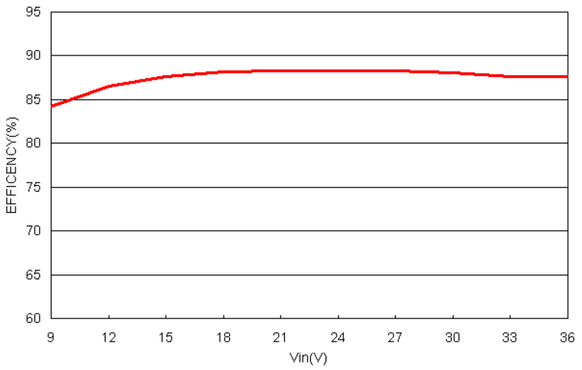


Efficiency versus Output Current

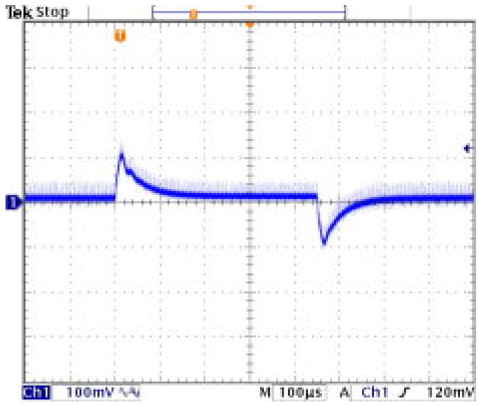


Typical Output Ripple and Noise.

$V_{IN\,nom}$; Full Load

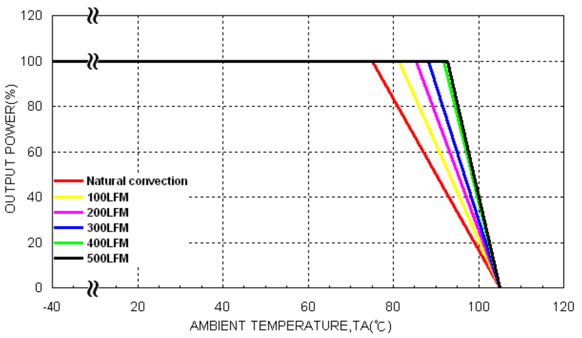


Efficiency versus Input Voltage. Full Load

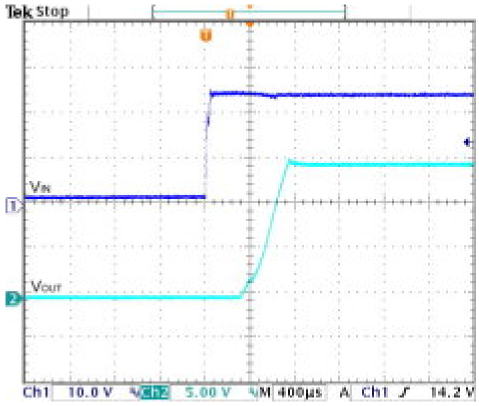


Transient Response to Dynamic Load Change from

100% to 75% to 100% of Full Load ; $V_{IN\,nom}$



Derating Output Current versus Ambient Temperature and Airflow $V_{IN\,nom}$

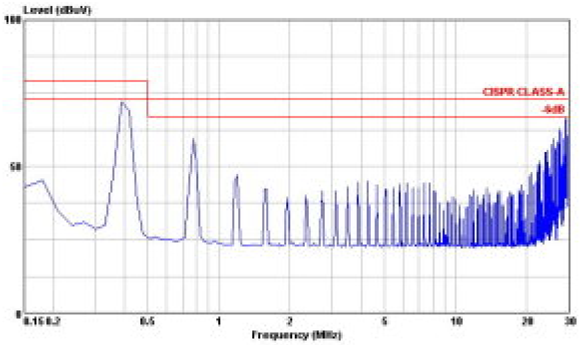


Typical Input Start-Up and Output Rise Characteristic

$V_{IN\,nom}$; Full Load

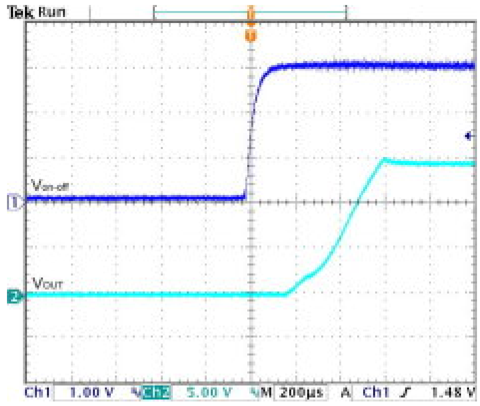
Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-2413 WIN



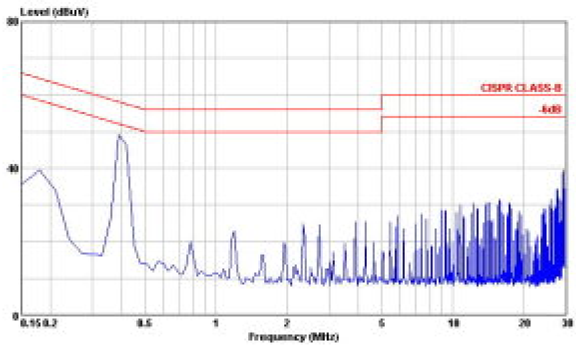
Conduction Emission of EN55022 Class A

$V_{IN\,nom}$; Full Load



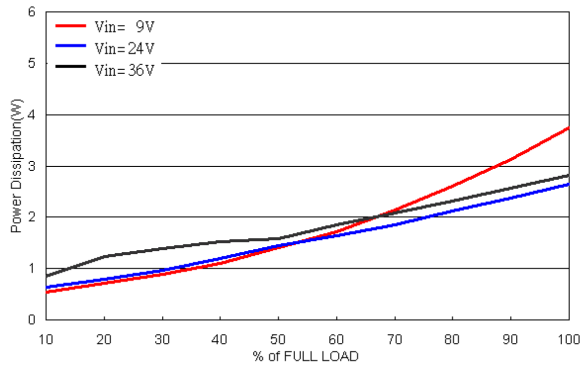
Using ON/OFF Voltage Start-Up and Vo Rise Characteristic

$V_{IN\,nom}$; Full Load



Conduction Emission of EN55022 Class B

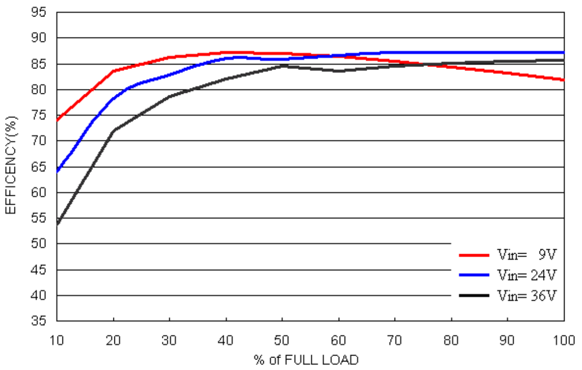
$V_{IN\,nom}$; Full Load



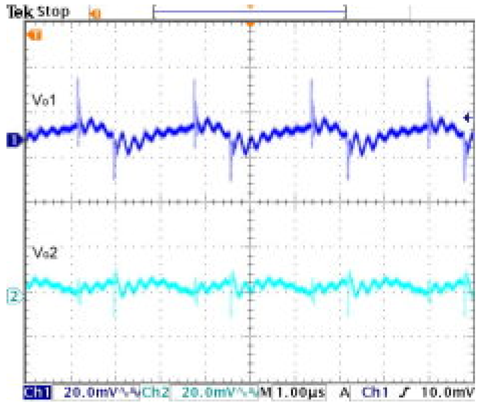
Power Dissipation versus Output Current

Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-2421 WIN

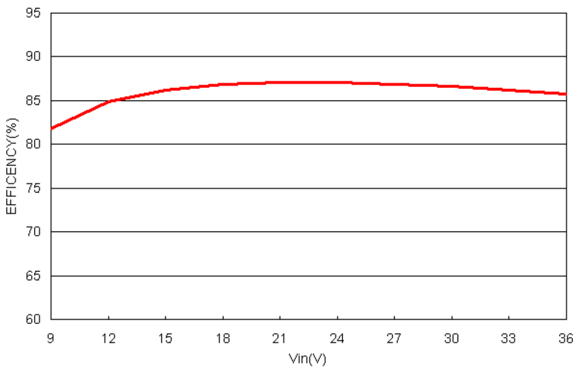


Efficiency versus Output Current

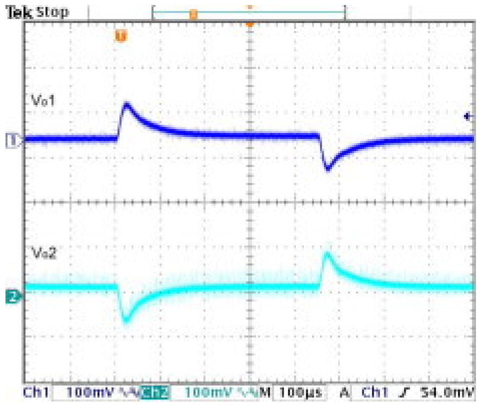


Typical Output Ripple and Noise.

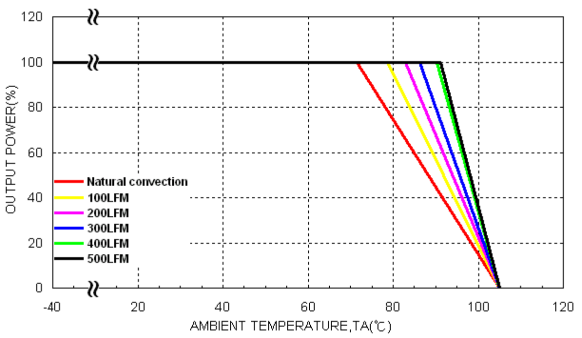
$V_{IN\,nom}$; Full Load



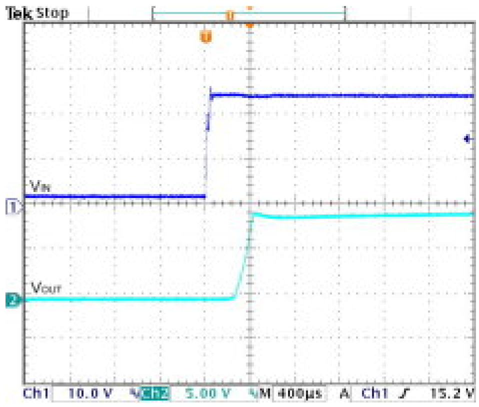
Efficiency versus Input Voltage. Full Load



Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load ; $V_{IN} = V_{IN\,nom}$



Derating Output Current versus Ambient Temperature and Airflow $V_{IN\,nom}$

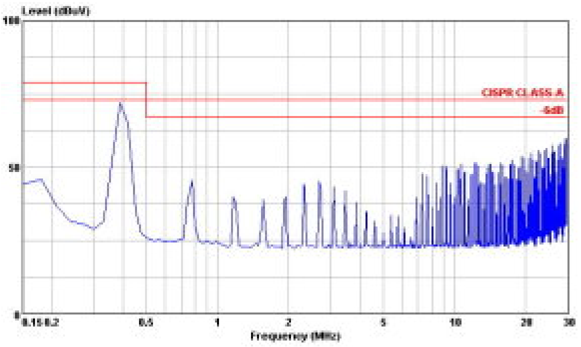


Typical Input Start-Up and Output Rise Characteristic

$V_{IN\,nom}$; Full Load

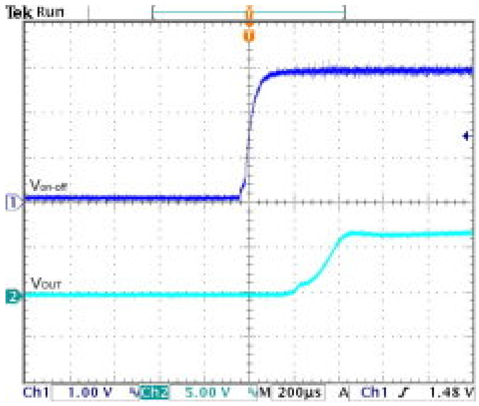
Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-2421 WIN



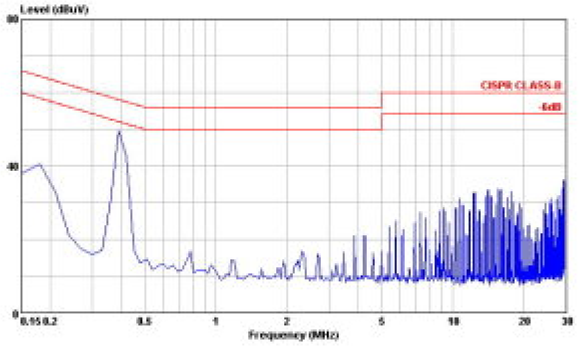
Conduction Emission of EN55022 Class A

$V_{IN\,nom}$; Full Load



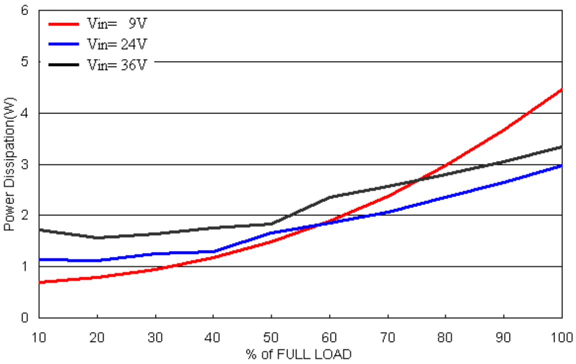
Using ON/OFF Voltage Start-Up and Vo Rise Characteristic

$V_{IN\,nom}$; Full Load



Conduction Emission of EN55022 Class B

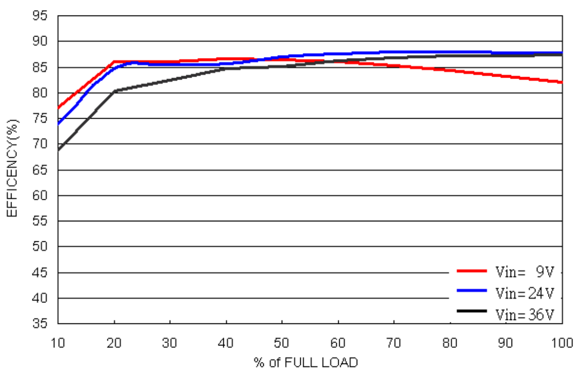
$V_{IN\,nom}$; Full Load



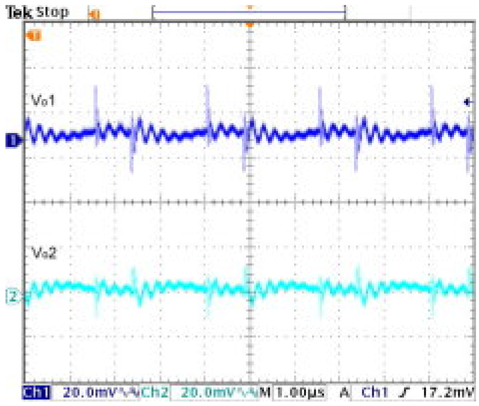
Power Dissipation versus Output Current

Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-2422 WIN

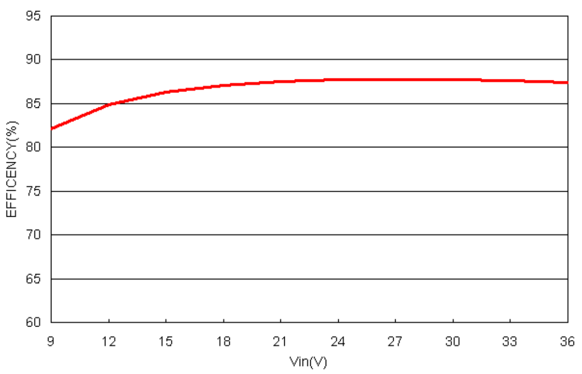


Efficiency versus Output Current

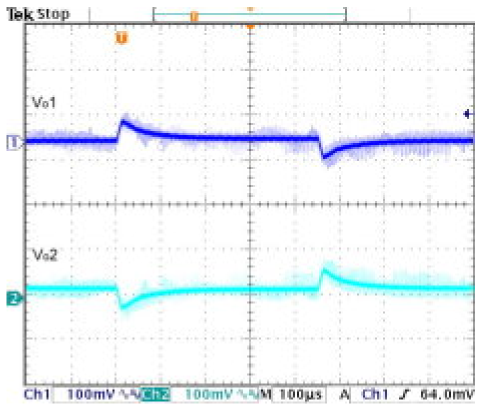


Typical Output Ripple and Noise.

$V_{IN nom}$; Full Load

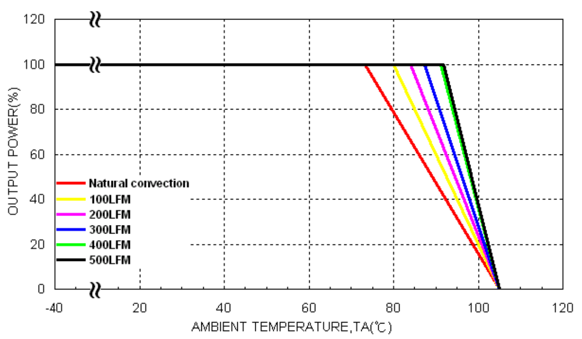


Efficiency versus Input Voltage. Full Load

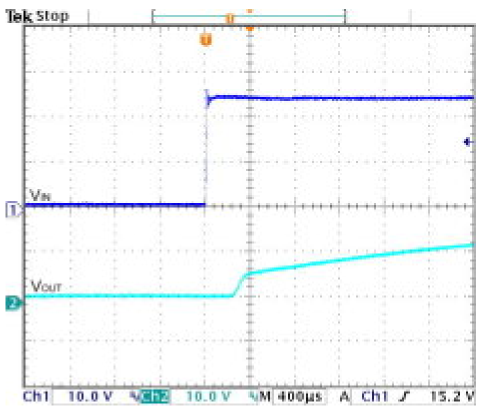


Transient Response to Dynamic Load Change from

100% to 75% to 100% of Full Load ; $V_{IN nom}$



Derating Output Current versus Ambient Temperature and Airflow $V_{IN nom}$

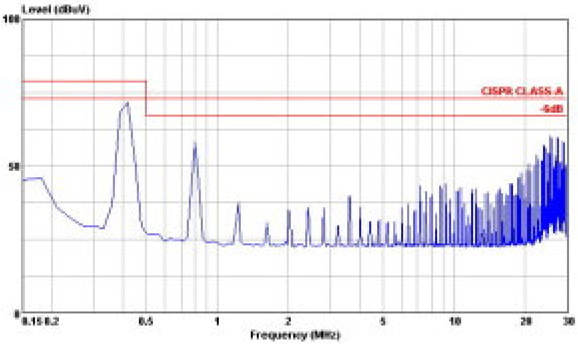


Typical Input Start-Up and Output Rise Characteristic

$V_{IN nom}$; Full Load

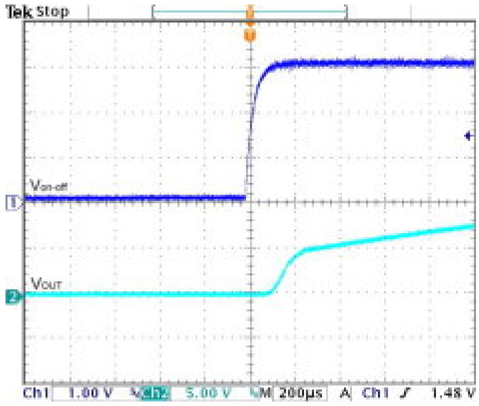
Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-2422 WIN



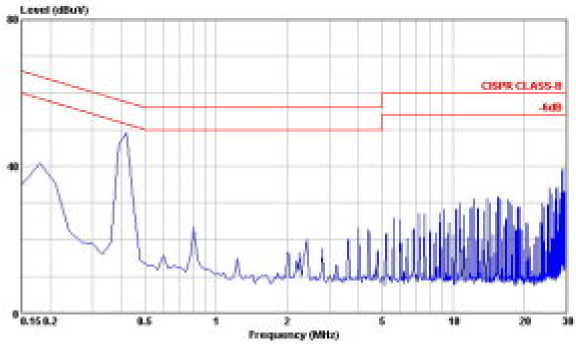
Conduction Emission of EN55022 Class A

$V_{IN\,nom}$; Full Load



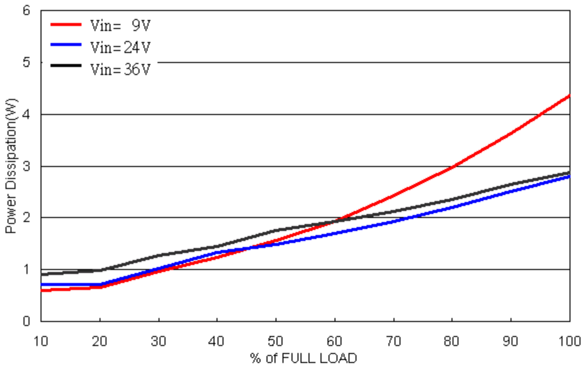
Using ON/OFF Voltage Start-Up and Vo Rise Characteristic

$V_{IN\,nom}$; Full Load



Conduction Emission of EN55022 Class B

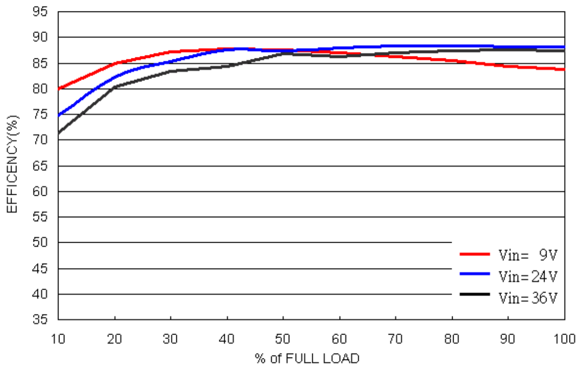
$V_{IN\,nom}$; Full Load



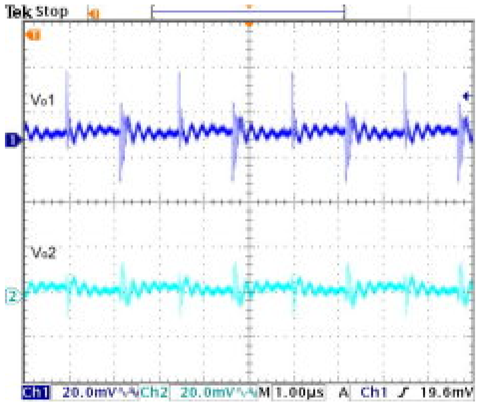
Power Dissipation versus Output Current

Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-2423 WIN

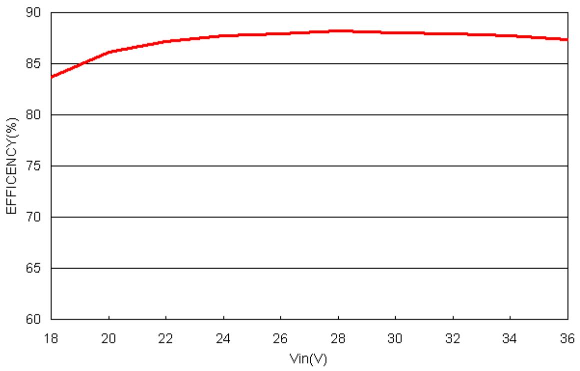


Efficiency versus Output Current

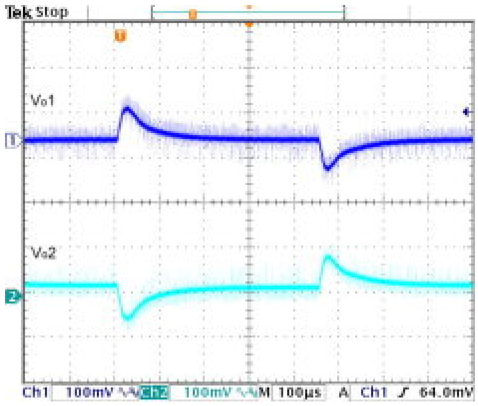


Typical Output Ripple and Noise.

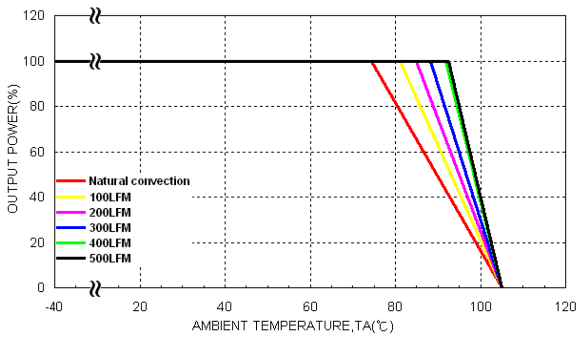
$V_{IN\,nom}$; Full Load



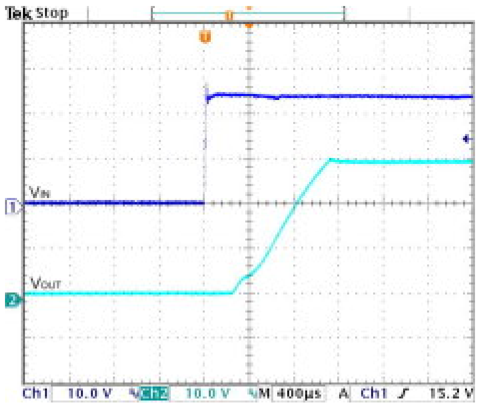
Efficiency versus Input Voltage. Full Load



Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load ; $V_{IN\,nom}$



Derating Output Current versus Ambient Temperature and Airflow $V_{IN\,nom}$

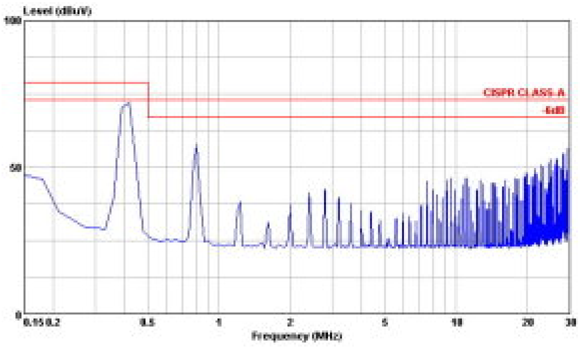


Typical Input Start-Up and Output Rise Characteristic

$V_{IN\,nom}$; Full Load

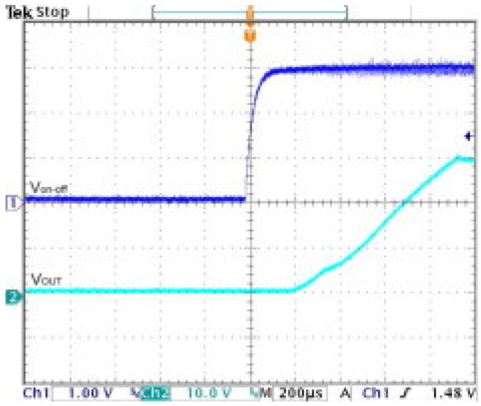
Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-2423 WIN



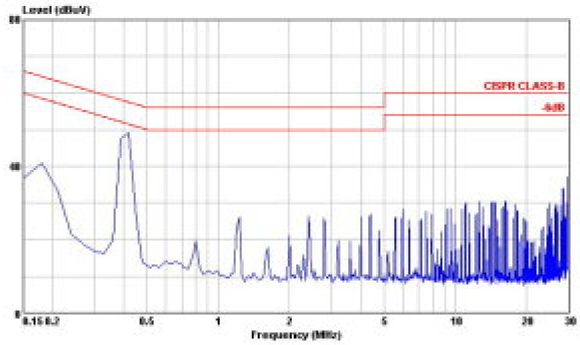
Conduction Emission of EN55022 Class A

$V_{IN\,nom}$; Full Load



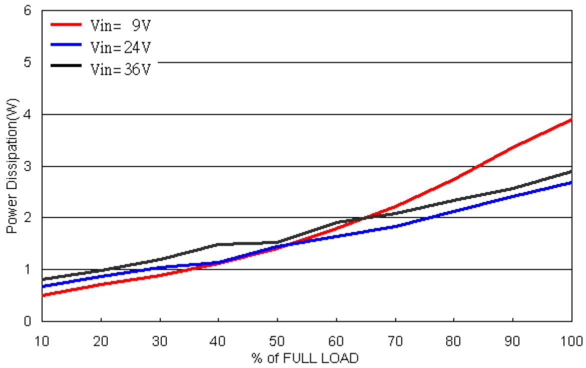
Using ON/OFF Voltage Start-Up and Vo Rise Characteristic

$V_{IN\,nom}$; Full Load



Conduction Emission of EN55022 Class B

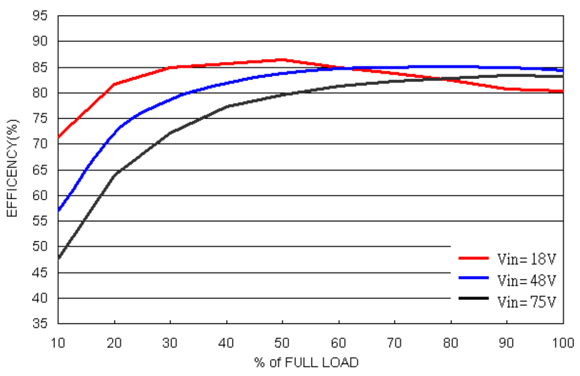
$V_{IN\,nom}$; Full Load



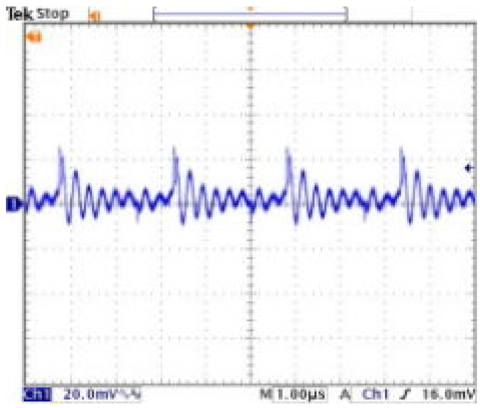
Power Dissipation versus Output Current

Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-4810 WIN

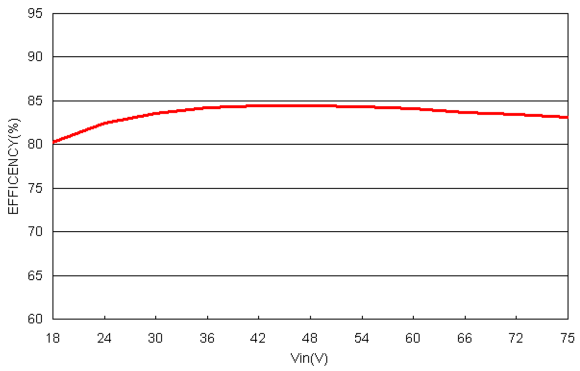


Efficiency versus Output Current

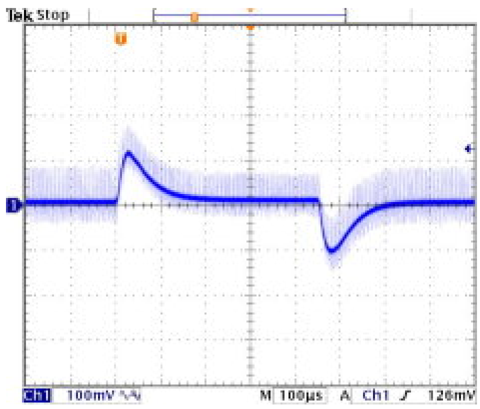


Typical Output Ripple and Noise.

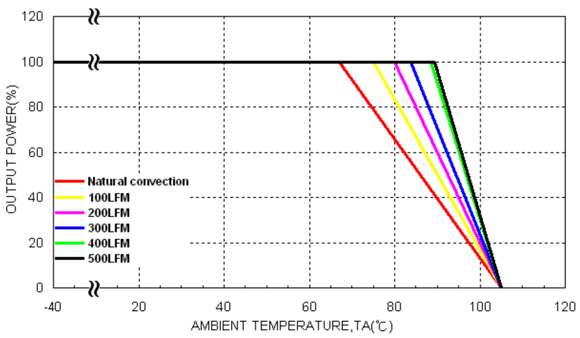
$V_{IN\,nom}$; Full Load



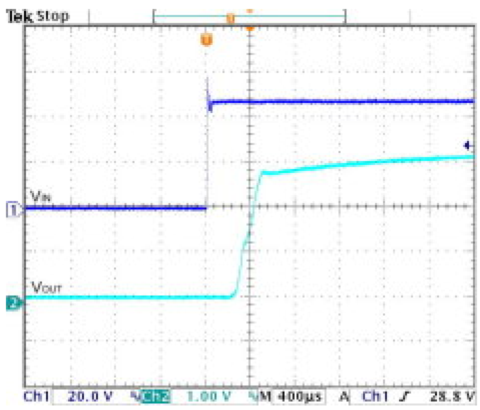
Efficiency versus Input Voltage. Full Load



Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load ; $V_{IN\,nom}$



Derating Output Current versus Ambient Temperature and Airflow $V_{IN\,nom}$

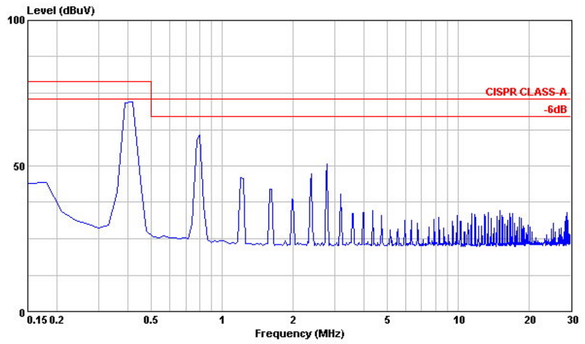


Typical Input Start-Up and Output Rise Characteristic

$V_{IN\,nom}$; Full Load

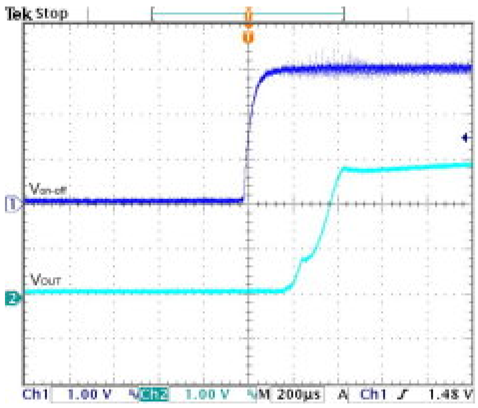
Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-4810 WIN



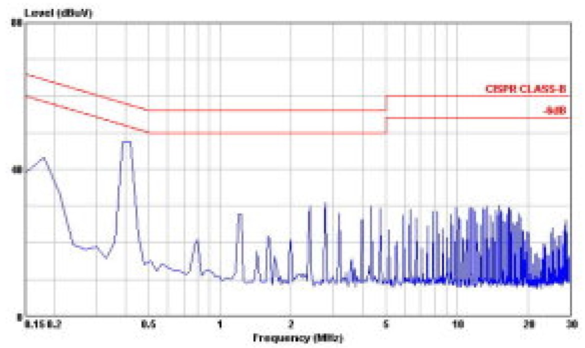
Conduction Emission of EN55022 Class A

$V_{IN\,nom}$; Full Load



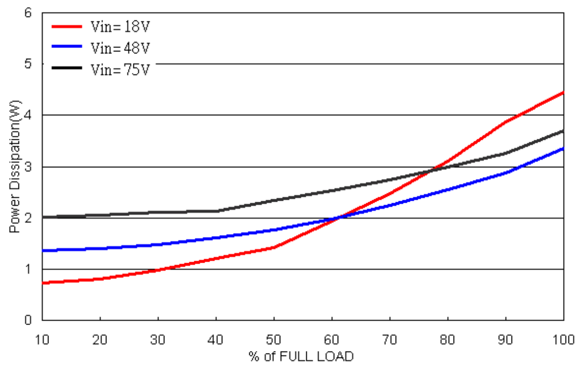
Using ON/OFF Voltage Start-Up and Vo Rise Characteristic

$V_{IN\,nom}$; Full Load



Conduction Emission of EN55022 Class B

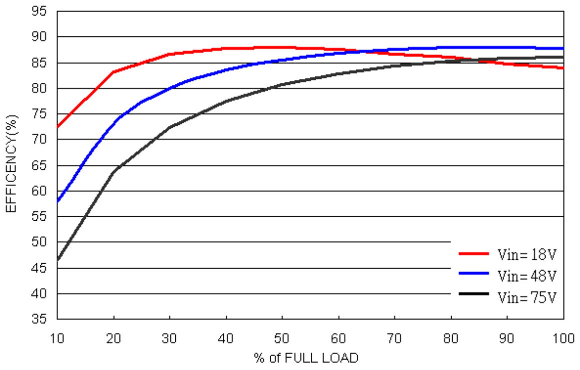
$V_{IN\,nom}$; Full Load



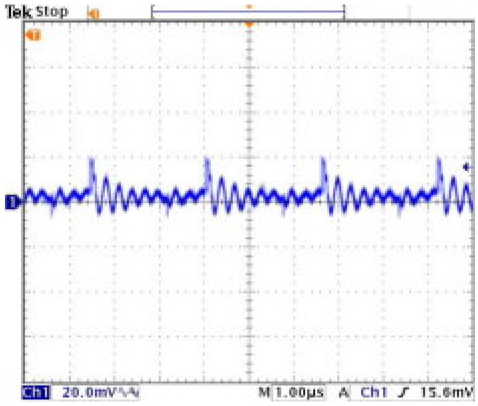
Power Dissipation versus Output Current

Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-4811 WIN

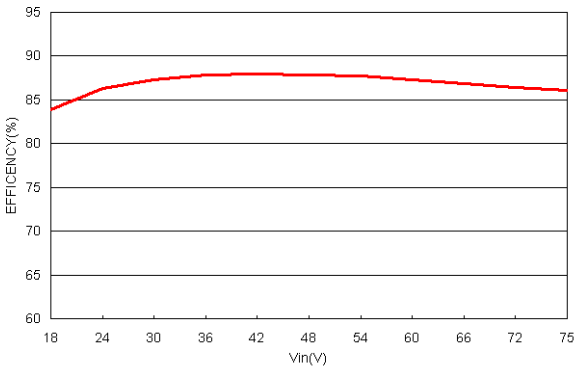


Efficiency versus Output Current

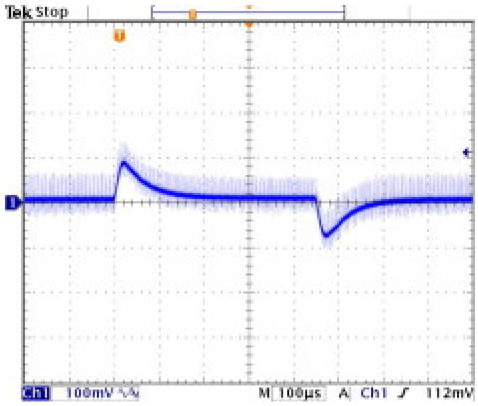


Typical Output Ripple and Noise.

$V_{IN\,nom}$; Full Load

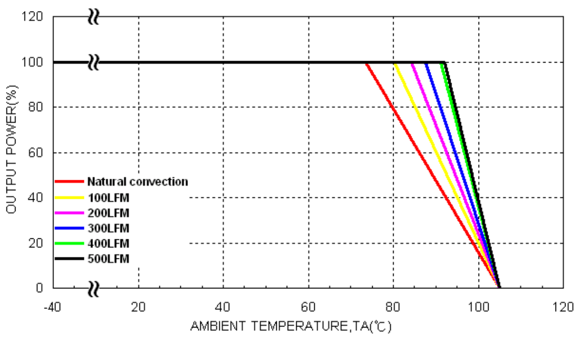


Efficiency versus Input Voltage. Full Load

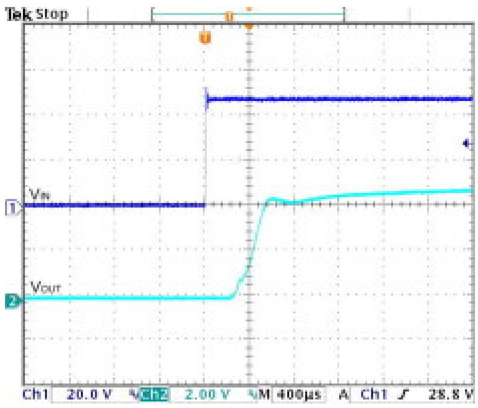


Transient Response to Dynamic Load Change from

100% to 75% to 100% of Full Load ; $V_{IN\,nom}$



Derating Output Current versus Ambient Temperature and Airflow $V_{IN\,nom}$

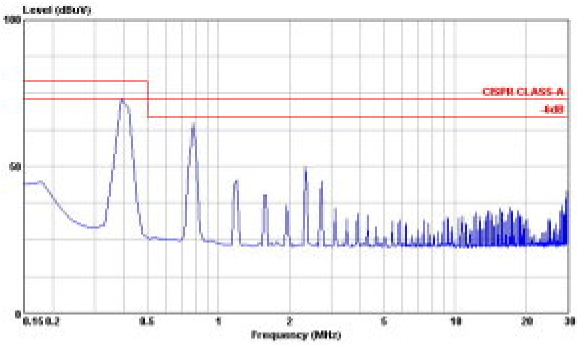


Typical Input Start-Up and Output Rise Characteristic

$V_{IN\,nom}$; Full Load

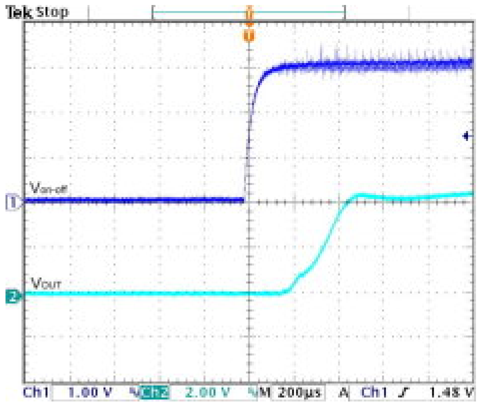
Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-4811 WIN



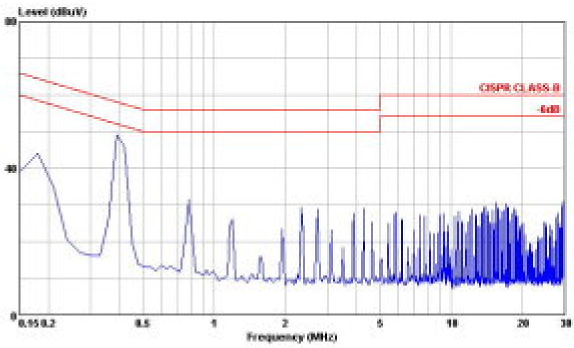
Conduction Emission of EN55022 Class A

$V_{IN\,nom}$; Full Load



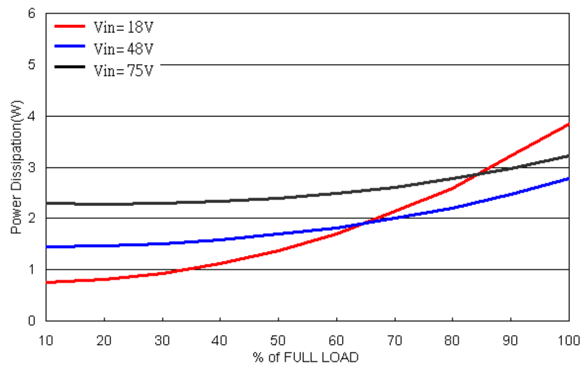
Using ON/OFF Voltage Start-Up and Vo Rise Characteristic

$V_{IN\,nom}$; Full Load



Conduction Emission of EN55022 Class B

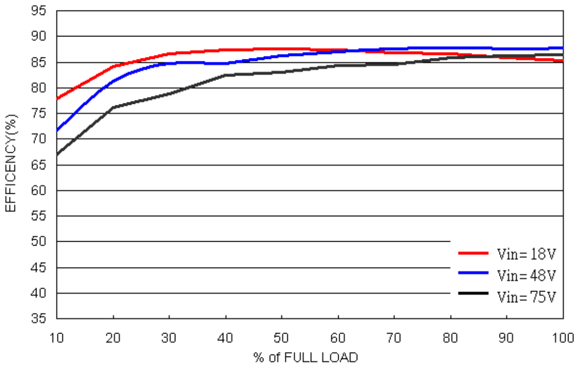
$V_{IN\,nom}$; Full Load



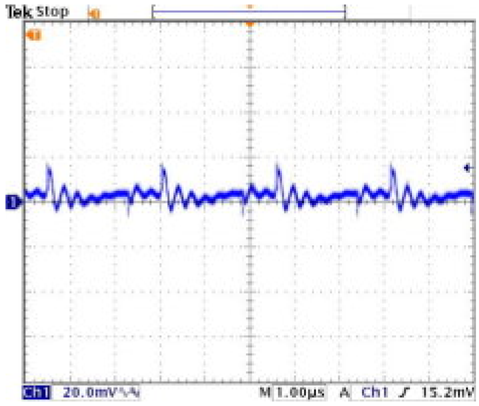
Power Dissipation versus Output Current

Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-4812 WIN

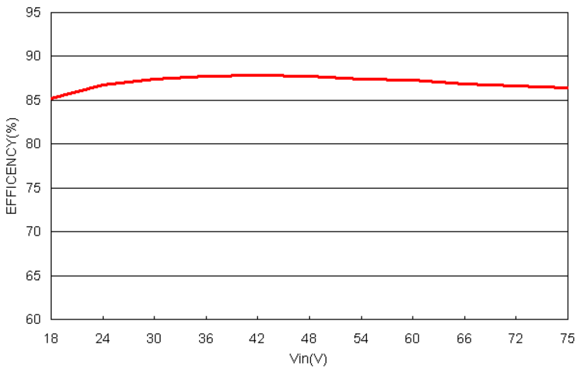


Efficiency versus Output Current

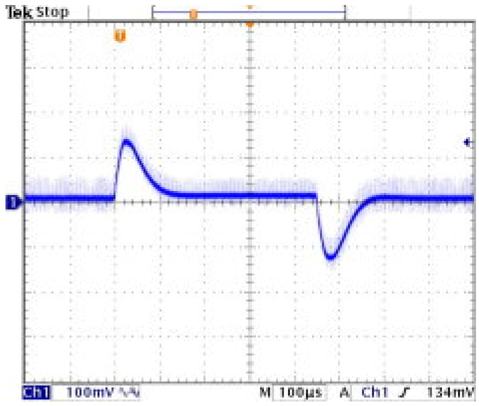


Typical Output Ripple and Noise.

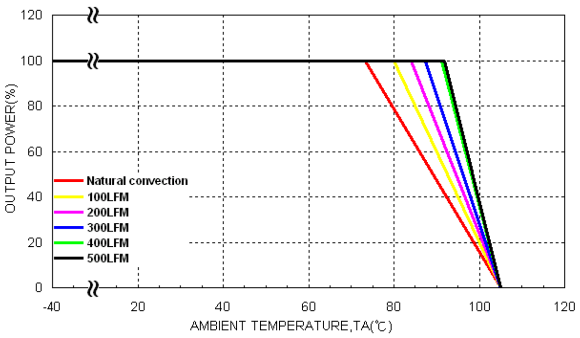
$V_{IN\,nom}$; Full Load



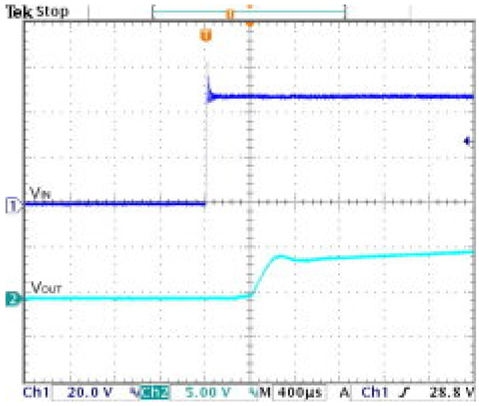
Efficiency versus Input Voltage. Full Load



Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load ; $V_{IN\,nom}$



Derating Output Current versus Ambient Temperature and Airflow $V_{IN\,nom}$

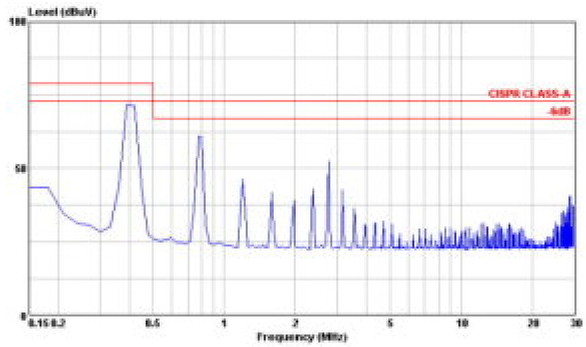


Typical Input Start-Up and Output Rise Characteristic

$V_{IN\,nom}$; Full Load

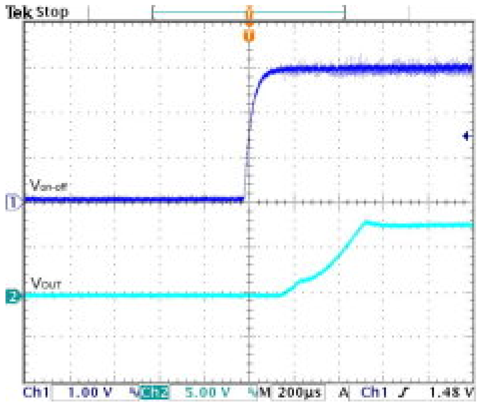
Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-4812 WIN



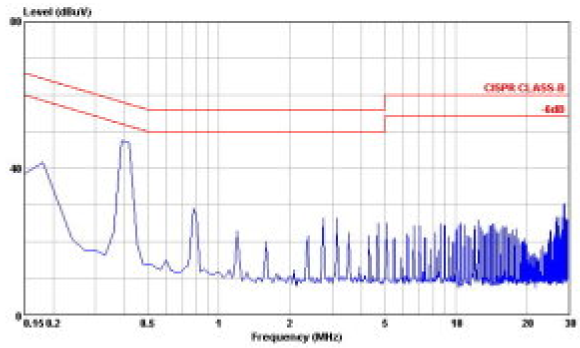
Conduction Emission of EN55022 Class A

$V_{IN\,nom}$; Full Load



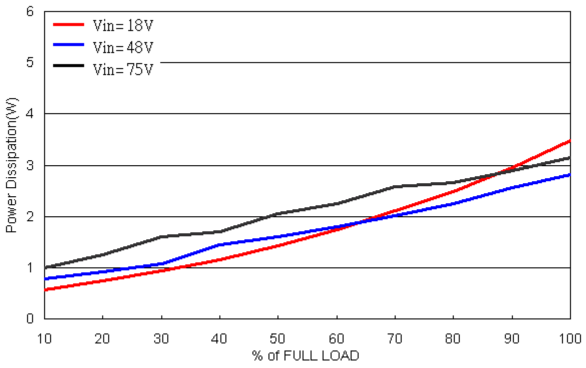
Using ON/OFF Voltage Start-Up and Vo Rise Characteristic

$V_{IN\,nom}$; Full Load



Conduction Emission of EN55022 Class B

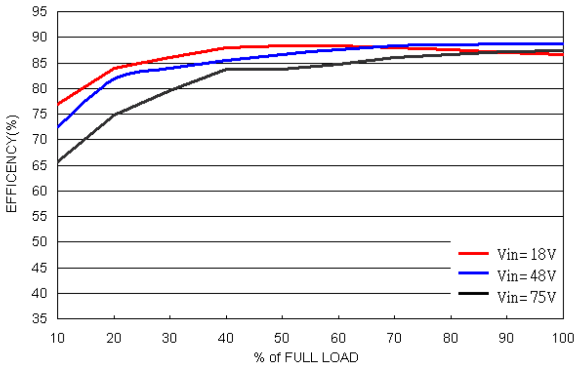
$V_{IN\,nom}$; Full Load



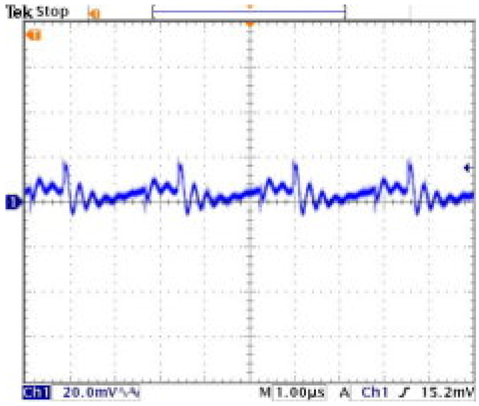
Power Dissipation versus Output Current

Characteristic Curves (Continued)

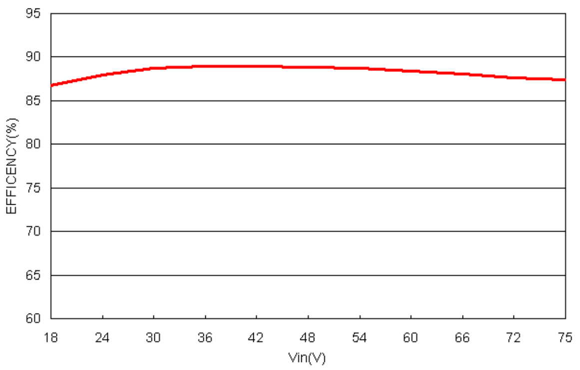
All test conditions are at 25°C.The figures are identical for TEN 20-4813 WIN



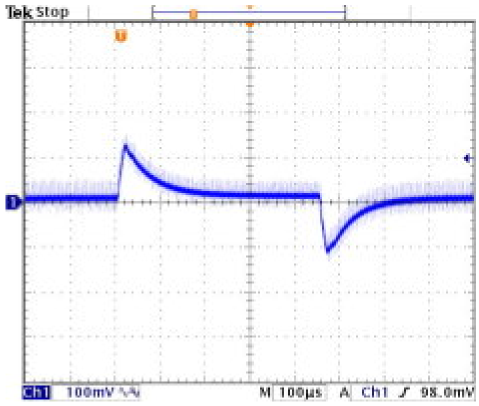
Efficiency versus Output Current



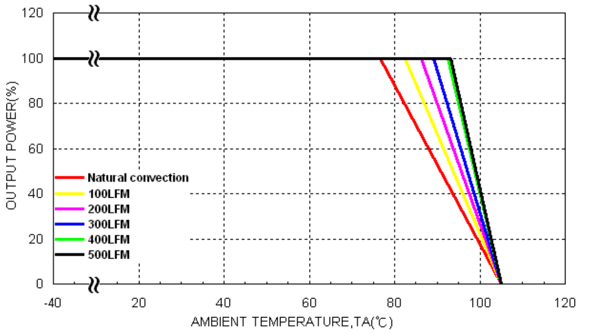
Typical Output Ripple and Noise. $V_{IN\,nom}$; Full Load



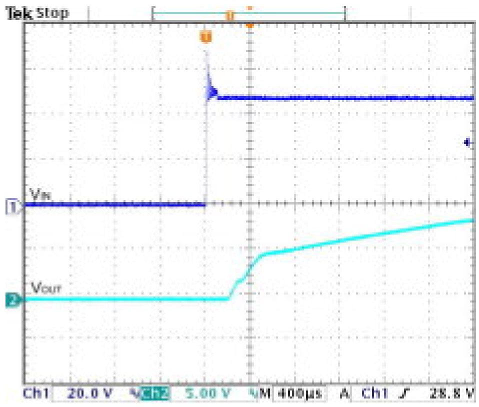
Efficiency versus Input Voltage. Full Load



Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load ; $V_{IN\,nom}$



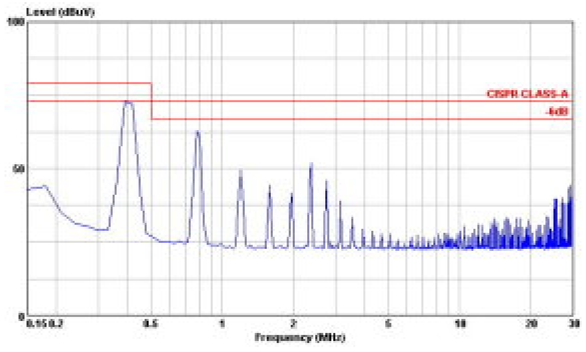
Derating Output Current versus Ambient Temperature and Airflow $V_{IN\,nom}$



Typical Input Start-Up and Output Rise Characteristic $V_{IN\,nom}$; Full Load

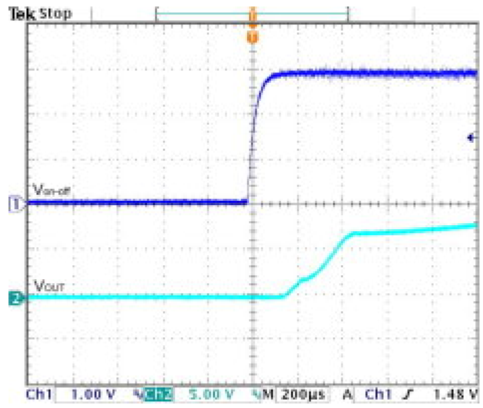
Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-4813 WIN



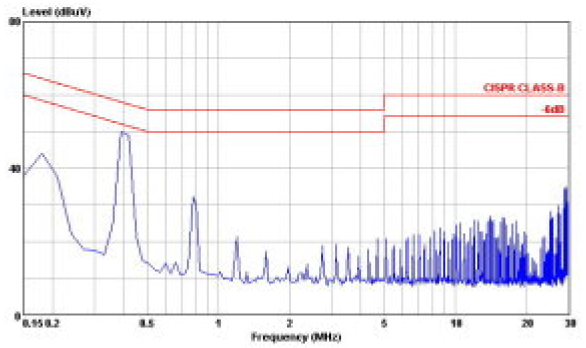
Conduction Emission of EN55022 Class A

$V_{IN\,nom}$; Full Load



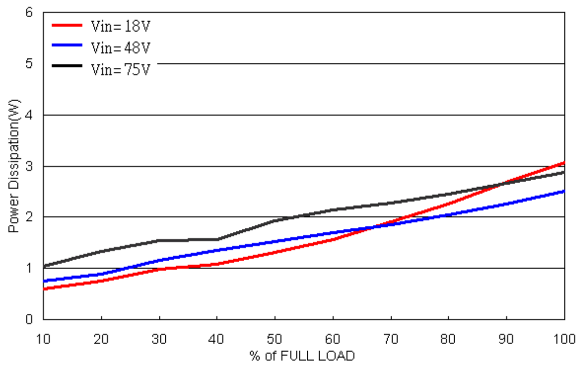
Using ON/OFF Voltage Start-Up and Vo Rise Characteristic

$V_{IN\,nom}$; Full Load



Conduction Emission of EN55022 Class B

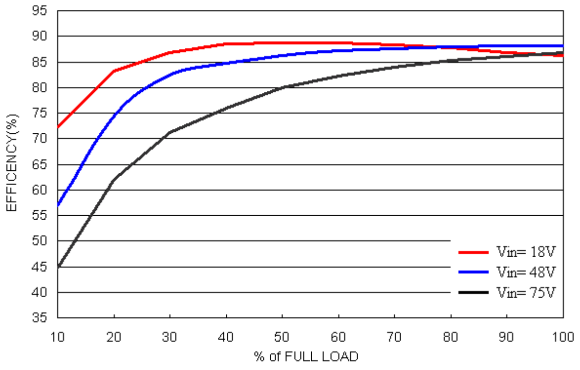
$V_{IN\,nom}$; Full Load



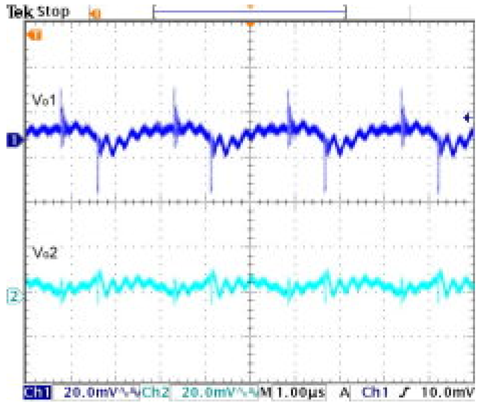
Power Dissipation versus Output Current

Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-4821 WIN

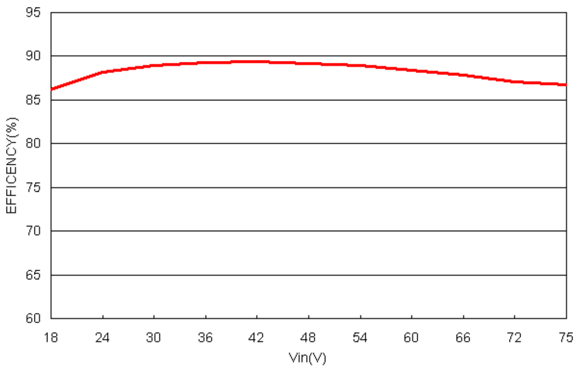


Efficiency versus Output Current

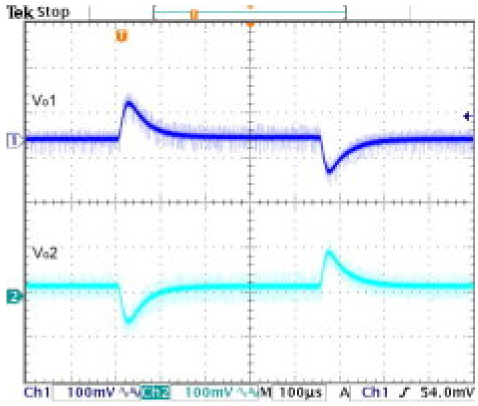


Typical Output Ripple and Noise.

$V_{IN\,nom}$; Full Load

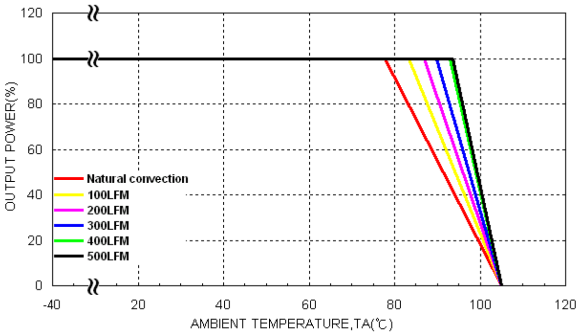


Efficiency versus Input Voltage. Full Load

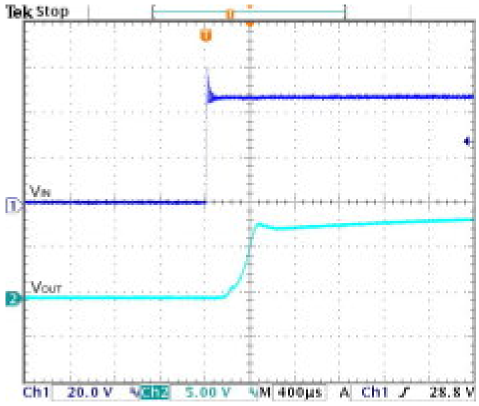


Transient Response to Dynamic Load Change from

100% to 75% to 100% of Full Load ; $V_{IN\,nom}$



Derating Output Current versus Ambient Temperature and Airflow $V_{IN\,nom}$

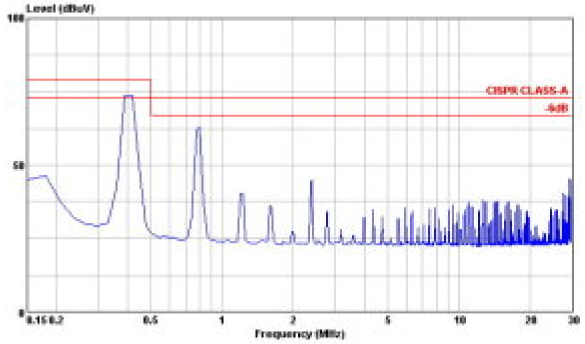


Typical Input Start-Up and Output Rise Characteristic

$V_{IN\,nom}$; Full Load

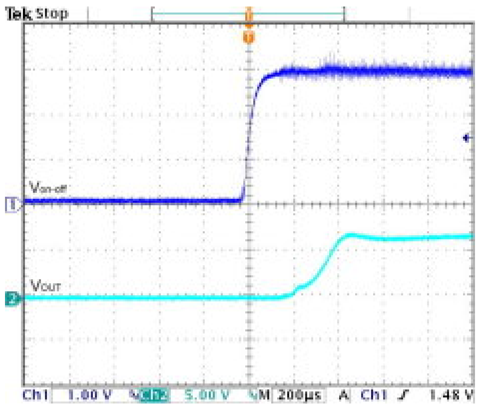
Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-4821 WIN



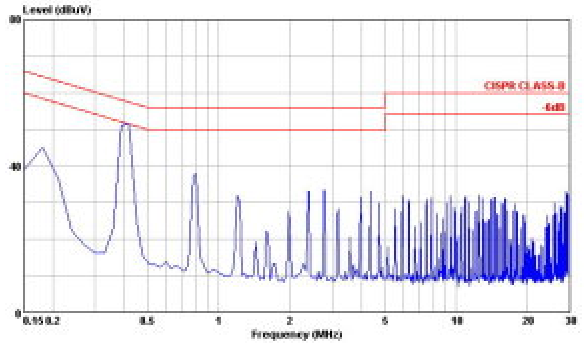
Conduction Emission of EN55022 Class A

$V_{IN\,nom}$; Full Load



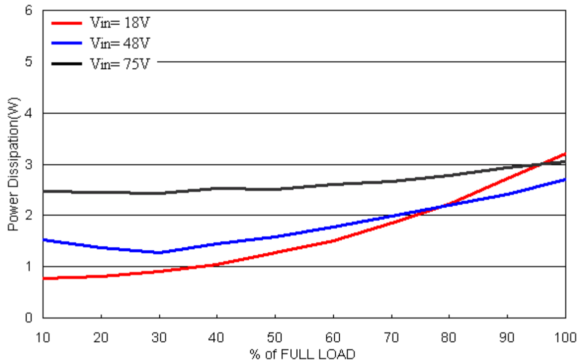
Using ON/OFF Voltage Start-Up and Vo Rise Characteristic

$V_{IN\,nom}$; Full Load



Conduction Emission of EN55022 Class B

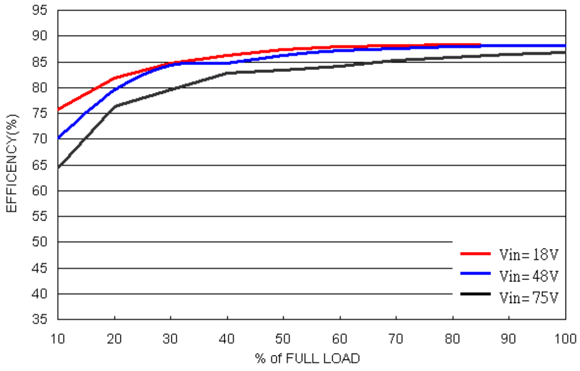
$V_{IN\,nom}$; Full Load



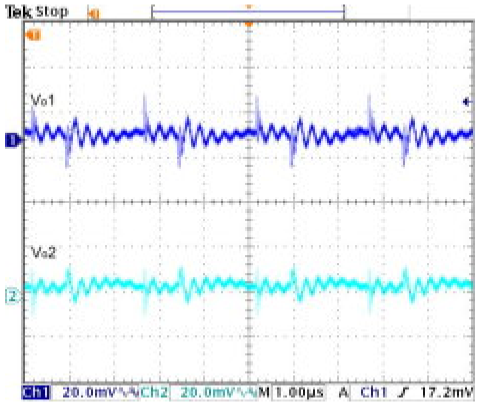
Power Dissipation versus Output Current

Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-4822 WIN

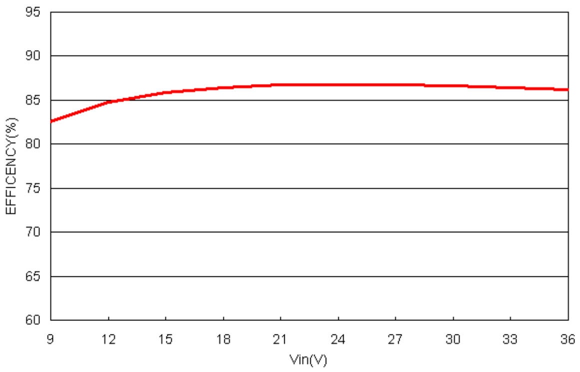


Efficiency versus Output Current

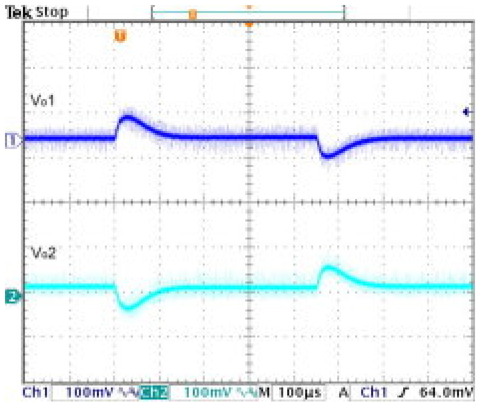


Typical Output Ripple and Noise.

$V_{IN\,nom}$; Full Load

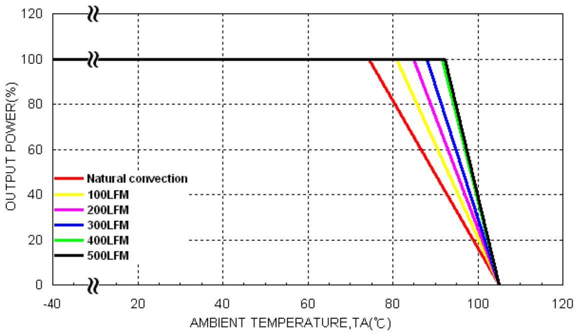


Efficiency versus Input Voltage. Full Load

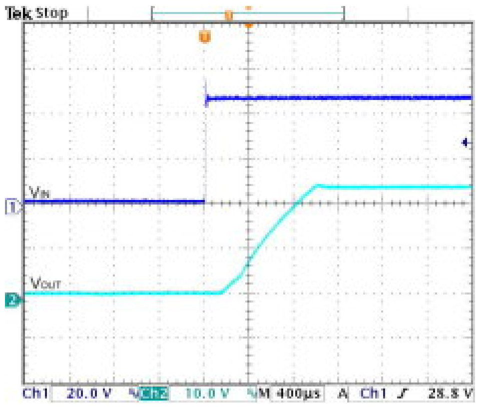


Transient Response to Dynamic Load Change from

100% to 75% to 100% of Full Load ; $V_{IN\,nom}$



Derating Output Current versus Ambient Temperature and Airflow $V_{IN\,nom}$

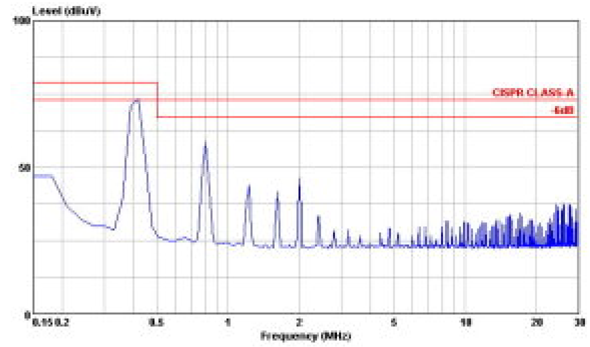


Typical Input Start-Up and Output Rise Characteristic

$V_{IN\,nom}$; Full Load

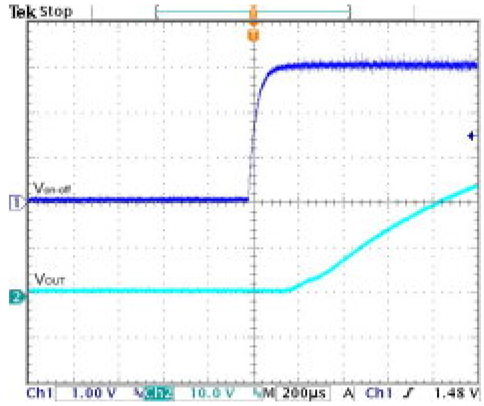
Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-4822 WIN



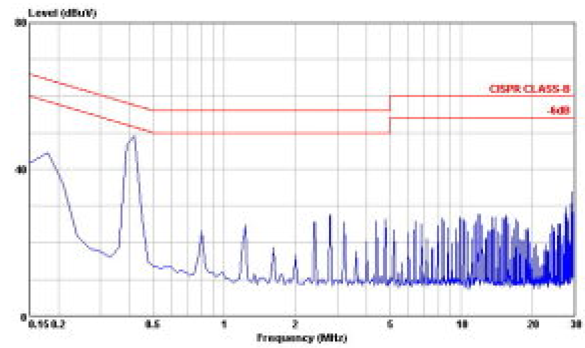
Conduction Emission of EN55022 Class A

$V_{IN\,nom}$; Full Load



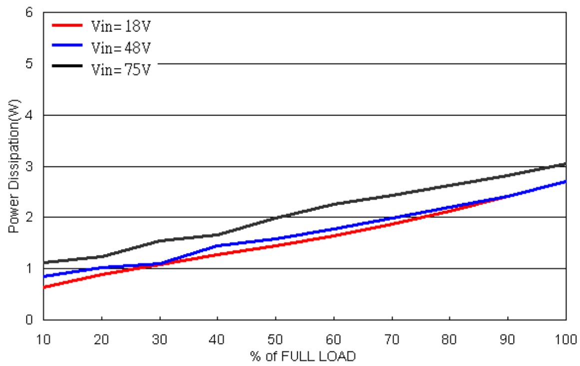
Using ON/OFF Voltage Start-Up and Vo Rise Characteristic

$V_{IN\,nom}$; Full Load



Conduction Emission of EN55022 Class B

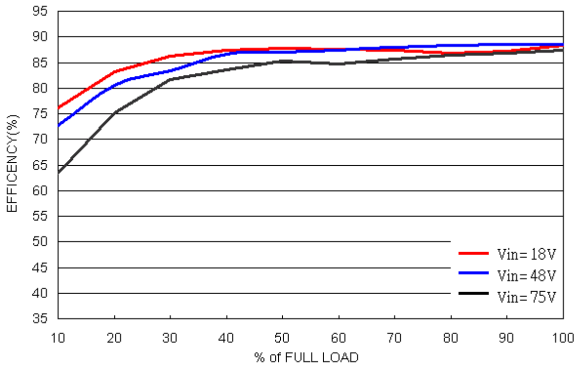
$V_{IN\,nom}$; Full Load



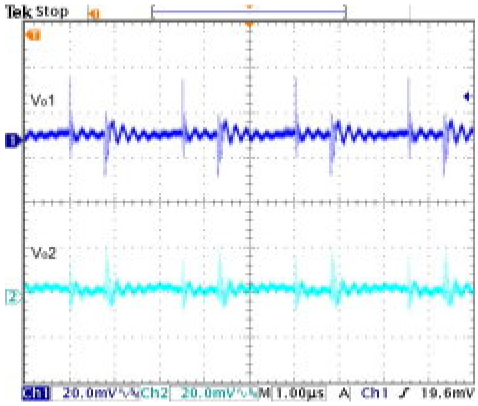
Power Dissipation versus Output Current

Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-4823 WIN

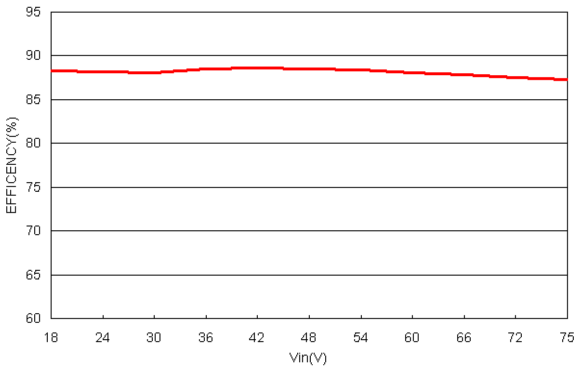


Efficiency versus Output Current

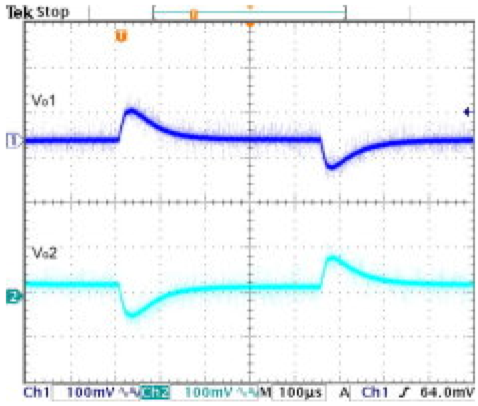


Typical Output Ripple and Noise.

$V_{IN nom}$; Full Load

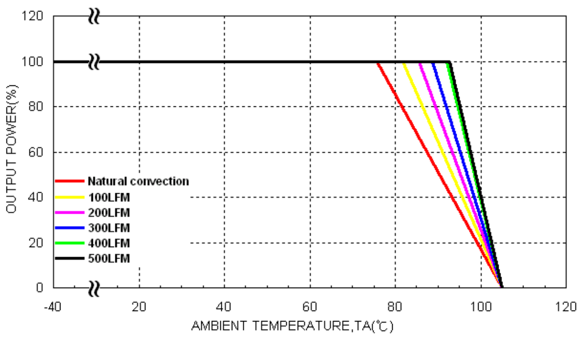


Efficiency versus Input Voltage. Full Load

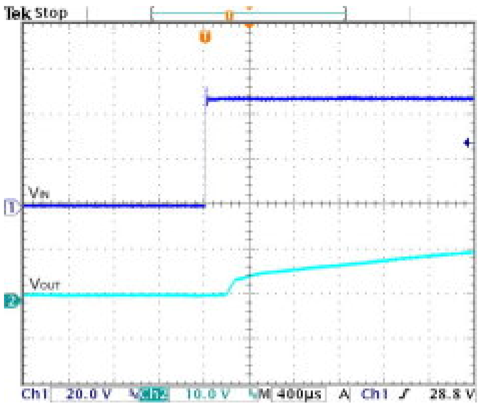


Transient Response to Dynamic Load Change from

100% to 75% to 100% of Full Load ; $V_{IN nom}$



Derating Output Current versus Ambient Temperature and Airflow $V_{IN nom}$

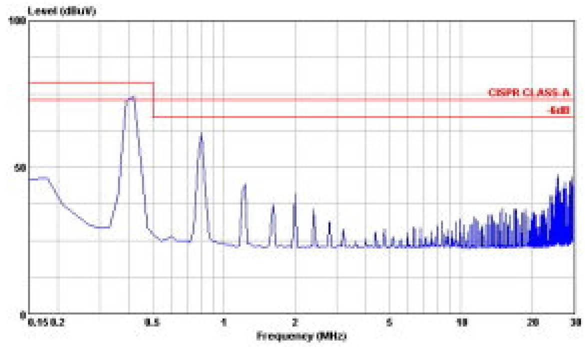


Typical Input Start-Up and Output Rise Characteristic

$V_{IN nom}$; Full Load

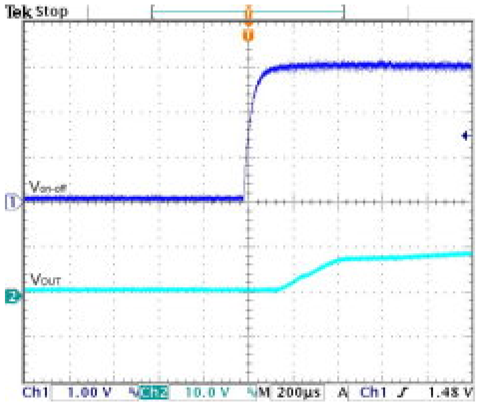
Characteristic Curves (Continued)

All test conditions are at 25°C.The figures are identical for TEN 20-4823 WIN



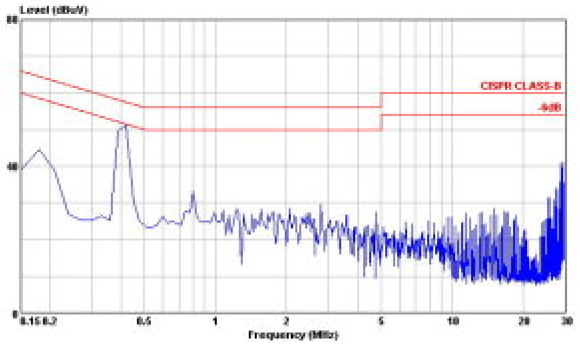
Conduction Emission of EN55022 Class A

$V_{IN\,nom}$; Full Load



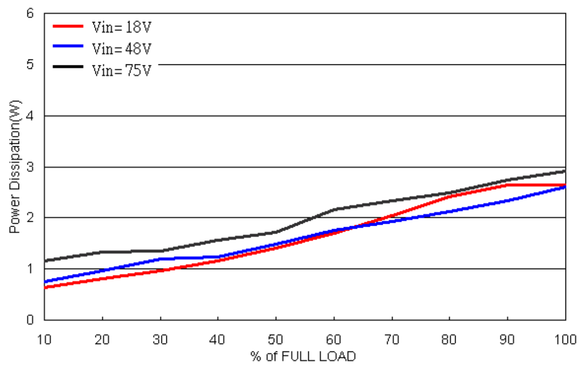
Using ON/OFF Voltage Start-Up and Vo Rise Characteristic

$V_{IN\,nom}$;Full Load



Conduction Emission of EN55022 Class B

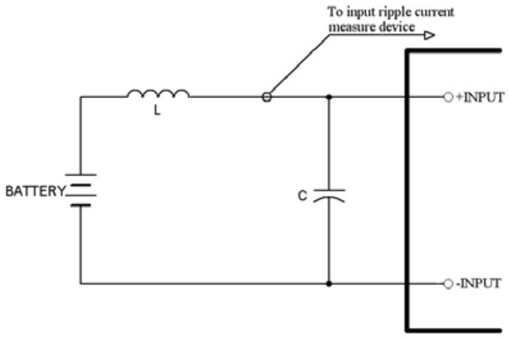
$V_{IN\,nom}$; Full Load



Power Dissipation versus Output Current

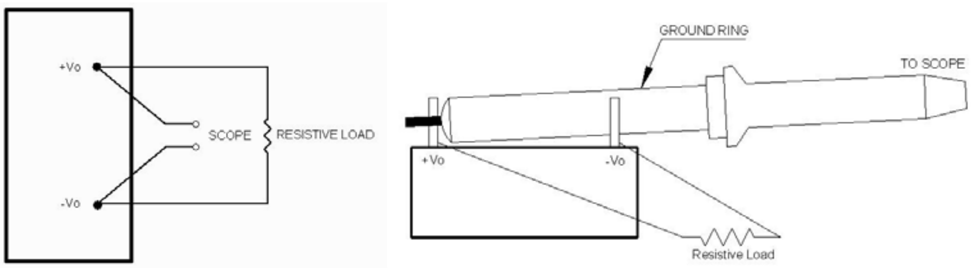
Testing Configurations

Input reflected-ripple current measurement test up

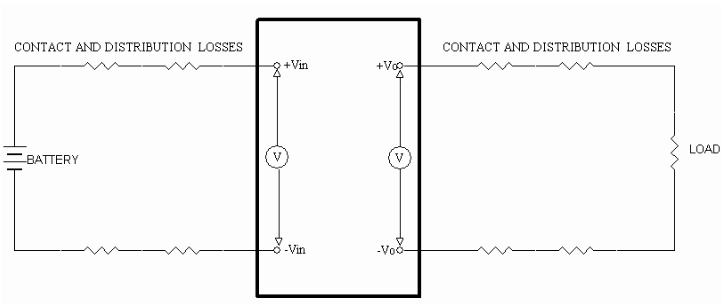


Component	Value	Voltage	Reference
L	12µH	—	—
C	100µF	100V	Aluminum Electrolytic Capacitor

Peak-to-peak output ripple & noise measurement test up



Output voltage and efficiency measurement test up



Note: All measurements are taken at the module terminals.

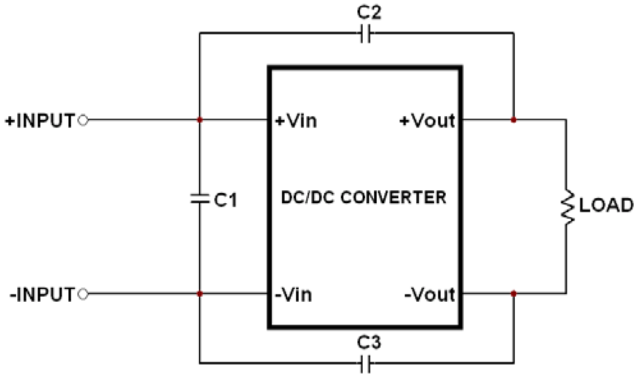
Single Output

$$Efficiency = \left(\frac{V_{out} \times I_{out}}{V_{in} \times I_{in}} \right) \times 100\%$$

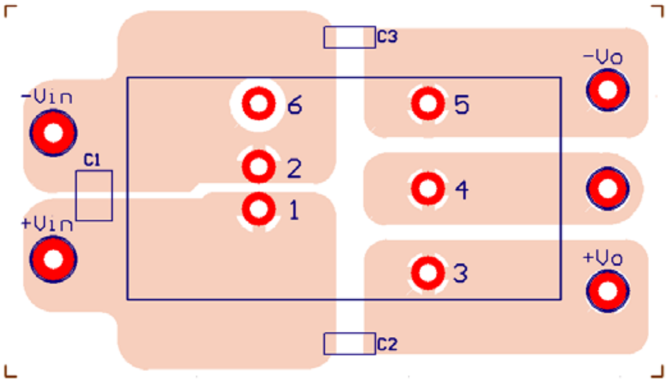
Dual Output

$$Efficiency = \left(\frac{V_{out1} \times I_{out1} + V_{out2} \times I_{out2}}{V_{in} \times I_{in}} \right) \times 100\%$$

EMC considerations Single Output



Suggested schematic for EN55022 conducted emission Class A



Recommended layout with input filter

To comply with conducted emissions noise (EN55022 CLASS A) following components are needed:

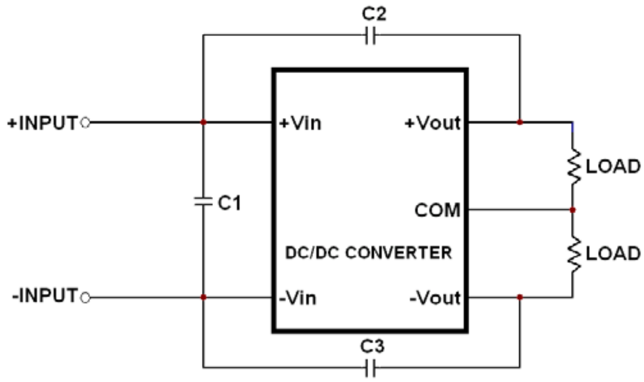
TEN 20-241x WIN

Component	Value	Voltage	Reference
C1	—	—	—
C2, C3	1000pF	2KV	1808 MLCC

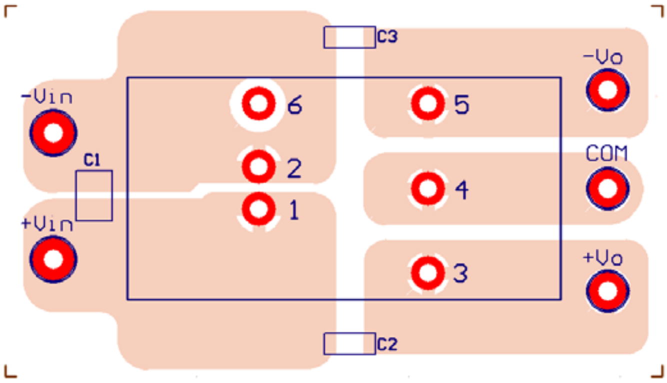
TEN 20-481x WIN

Component	Value	Voltage	Reference
C1	1µF	100V	1812 MLCC
C2, C3	1000pF	2KV	1808 MLCC

EMC considerations Dual Output



Suggested schematic for EN55022 conducted emission Class A



Recommended layout with input filter

To comply with conducted emissions noise (EN55022 CLASS A) following components are needed:

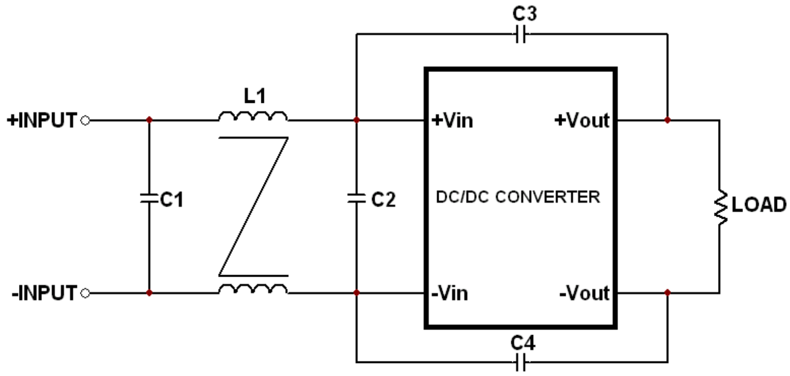
TEN 20-242x WIN

Component	Value	Voltage	Reference
C1	—	—	—
C2, C3	1000pF	2KV	1808 MLCC

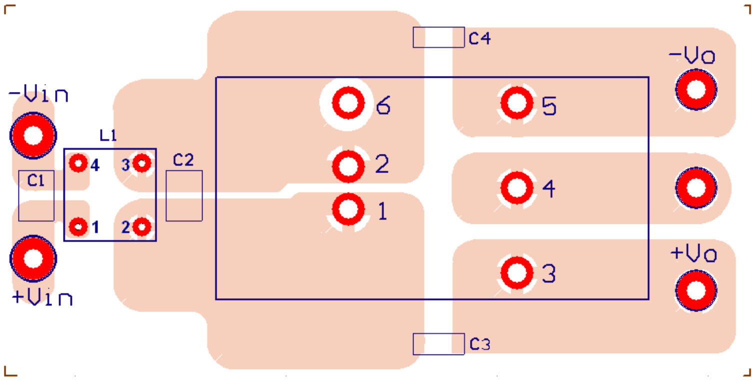
TEN 20-482x WIN

Component	Value	Voltage	Reference
C1	1µF	100V	1812 MLCC
C2, C3	1000pF	2KV	1808 MLCC

EMC considerations (Continued)



Suggested schematic for EN55022 conducted emission Class B



Recommended layout with input filter

To meet conducted emissions (EN55022 CLASS B) following components are needed:

TEN 20-241x WIN

Component	Value	Voltage	Reference
C1	4.7μF	50V	1812 MLCC
C3, C4	1000pF	2KV	1808 MLCC
L1	450μH	—	Common Choke, P/N: TCK-048

TEN 20-481x WIN

Component	Value	Voltage	Reference
C1, C2	2.2μF	100V	1812 MLCC
C3, C4	1000pF	2KV	1808 MLCC
L1	325μH	—	Common Choke, P/N: TCK-050

This Common Choke L1 has been define as follows:

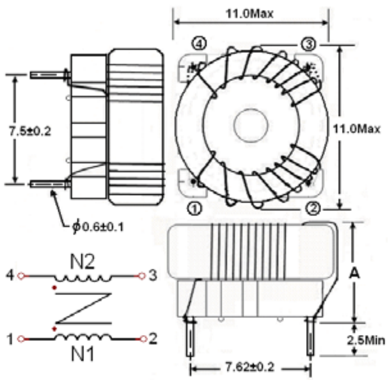
- TCK-048

  L: 450μH ±35% / DCR: 25mΩ, max

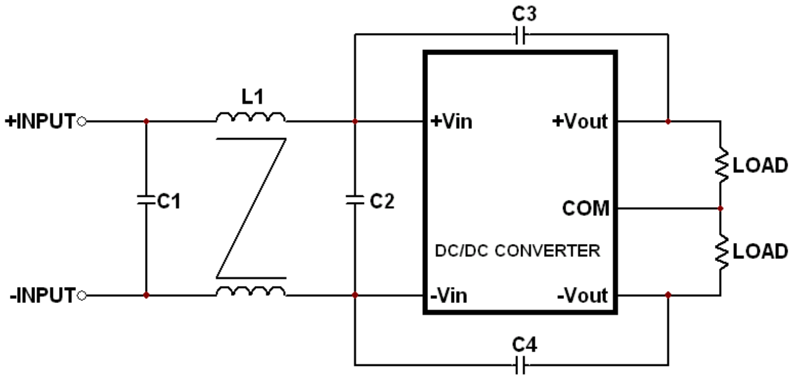
  A height: 9.8 mm, Max
- TCK-050

  L: 325μH ±35% / DCR: 35mΩ, max

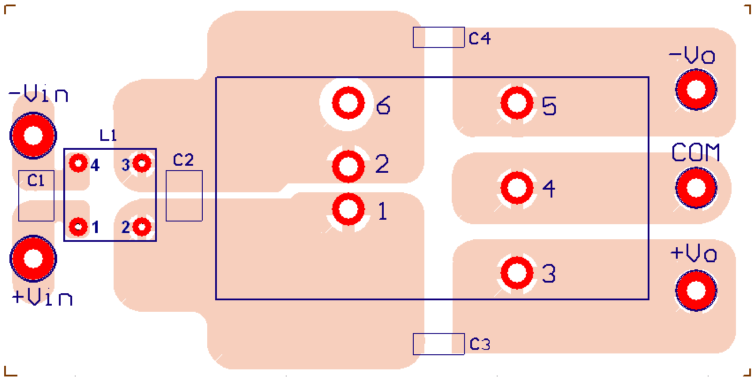
  A height: 8.8 mm, Max
- Test condition: 100KHz / 100mV
- Recommended through hole: Φ0.8mm
- All dimensions in millimeters



EMC considerations (Continued)



Suggested schematic for EN55022 conducted emission Class B limits



Recommended layout with input filter

To comply with conducted emissions noise (EN55022 CLASS B) following components are needed:

TEN 20-242x WIN

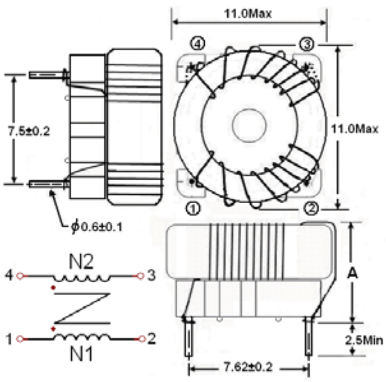
Component	Value	Voltage	Reference
C1	4.7µF	50V	1812 MLCC
C3, C4	1000pF	2KV	1808 MLCC
L1	450µH	—	Common Choke, P/N: TCK-048

TEN 20-482x WIN

Component	Value	Voltage	Reference
C1, C2	2.2µF	100V	1812 MLCC
C3, C4	1000pF	2KV	1808 MLCC
L1	325µH	—	Common Choke, P/N: TCK-050

This Common Choke L1 has been define as follows:

- TCK-048
  - L: 450µH ±35% / DCR: 25mΩ, max
  - **A** height: 9.8 mm, Max
- TCK-050
  - L: 325µH ±35% / DCR: 35mΩ, max
  - **A** height: 8.8 mm, Max
- Test condition: 100KHz / 100mV
- Recommended through hole: Φ0.8mm
- All dimensions in millimeters



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. Input external L-C filter is recommended to minimize input reflected ripple current. The inductor has a simulated source impedance of 12µH and capacitor is a 220µF/100V low ESR type. The capacitor must be equipped as close as possible to the input terminals of the power module for lower impedance.

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 140 percent of rated current for TEN 20-WIN 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.

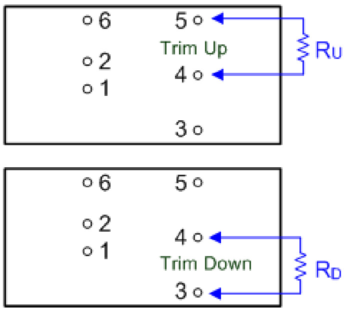
The hiccup operation can be done in various ways. For example, one can start hiccup operation any time an over-current event is detected; or prohibit hiccup during a designated start-up is usually larger than during normal operation and it is easier for an over-current event is detected; or prohibit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

Output Over Voltage Protection

The output over-voltage protection consists of output Zener diode that monitors the voltage on the output terminals. If the voltage on the output terminals exceeds the over-voltage protection threshold, then the Zener diode clamps the output voltage.

Output Voltage Adjustment

Output voltage set point adjustment allows the user to increase or decrease the output voltage set point of a module. This is accomplished by connecting an external resistor between the TRIM pin and either the $+V_{out}$ pin or $-V_{out}$ pin. With an external resistor between the TRIM and $-V_{out}$ pin, the output voltage set point increases. With an external resistor between the TRIM and $+V_{out}$ pin, the output voltage set point decreases.



TRIM TABLE

TEN 20-xx10 WIN

Trim up (%)	1	2	3	4	5	6	7	8	9	10
V_{OUT} (Volts) =	3.333	3.366	3.399	3.432	3.465	3.498	3.531	3.564	3.597	3.630
R_U (KΩ) =	57.930	26.165	15.577	10.283	7.106	4.988	3.476	2.341	1.459	0.753
Trim down (%)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
V_{OUT} (Volts) =	3.267	3.234	3.201	3.168	3.135	3.102	3.069	3.036	3.003	2.970
R_D (KΩ) =	69.470	31.235	18.490	12.117	8.294	5.745	3.924	2.559	1.497	0.647

TEN 20-xx11 WIN

Trim up (%)	1	2	3	4	5	6	7	8	9	10
V_{OUT} (Volts) =	5.050	5.100	5.150	5.200	5.250	5.300	5.350	5.400	5.450	5.500
R_U (KΩ) =	36.570	16.580	9.917	6.585	4.586	3.253	2.302	1.588	1.032	0.588
Trim down (%)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
V_{OUT} (Volts) =	4.950	4.900	4.850	4.800	4.750	4.700	4.650	4.600	4.550	4.500
R_D (KΩ) =	45.533	20.612	12.306	8.152	5.660	3.999	2.812	1.922	1.230	0.676

TEN 20-xx12 WIN

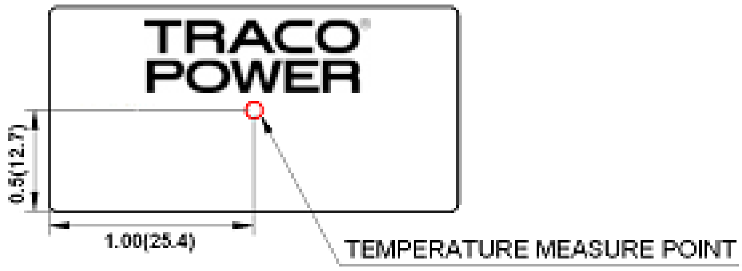
Trim up (%)	1	2	3	4	5	6	7	8	9	10
V_{OUT} (Volts) =	12.120	12.240	12.360	12.480	12.600	12.720	12.840	12.960	13.080	13.200
R_U (KΩ) =	367.908	165.954	98.636	64.977	44.782	31.318	21.701	14.488	8.879	4.391
Trim down (%)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
V_{OUT} (Volts) =	11.880	11.760	11.640	11.520	11.400	11.280	11.160	11.040	10.920	10.800
R_D (KΩ) =	460.992	207.946	123.597	81.423	56.118	39.249	27.199	18.162	11.132	5.509

TEN 20-xx13 WIN

Trim up (%)	1	2	3	4	5	6	7	8	9	10
V_{OUT} (Volts) =	15.150	15.300	15.450	15.600	15.750	15.900	16.050	16.200	16.350	16.500
R_U (KΩ) =	404.184	180.592	106.061	68.796	46.437	31.531	20.883	12.898	6.687	1.718
Trim down (%)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
V_{OUT} (Volts) =	14.850	14.700	14.550	14.400	14.250	14.100	13.950	13.800	13.650	13.500
R_D (KΩ) =	499.816	223.408	131.272	85.204	57.563	39.136	25.974	16.102	8.424	2.282

Short Circuitry 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.

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.

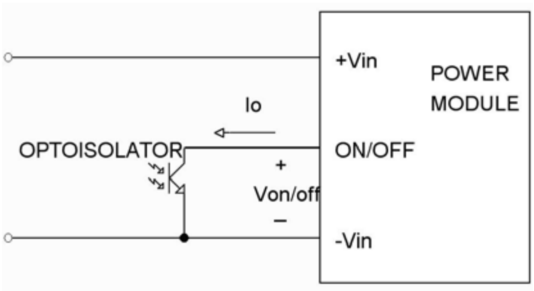


Measurement shown in inches(mm) TOP VIEW

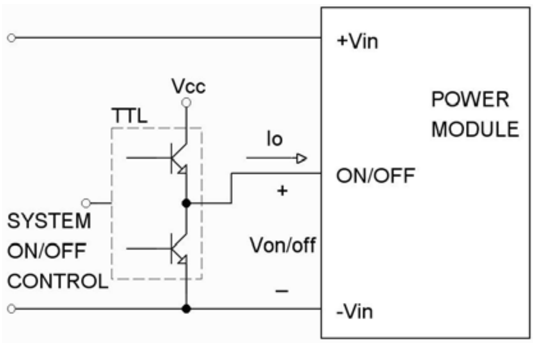
Remote ON/OFF Control

The positive logic remote On/Off control circuit is included.
Turns the module On during a logic High on the On/Off pin and turns Off during a logic Low.
The On/Off pin is an open collector/drain logic input signal (Von/off) that referenced to GND.
If not using the remote on/off feature, please open circuit between on/off pin and –input pin to turn the module on.

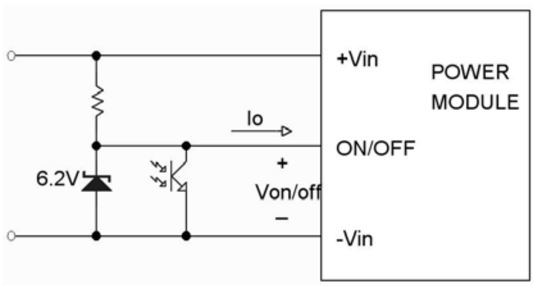
Remote On/Off Implementation



Isolated-Closure Remote On/Off



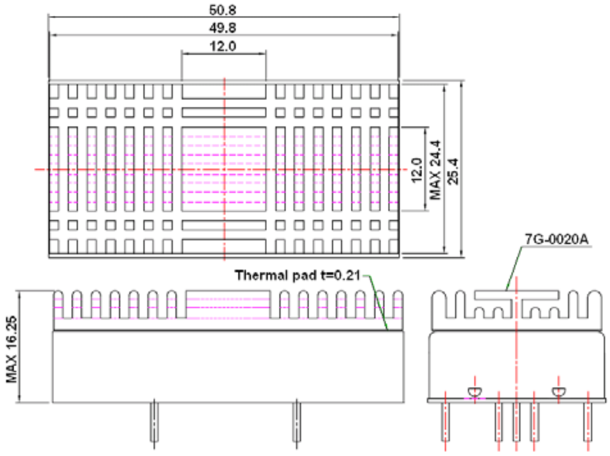
Level Control Using TTL Output



Level Control Using Line Voltage

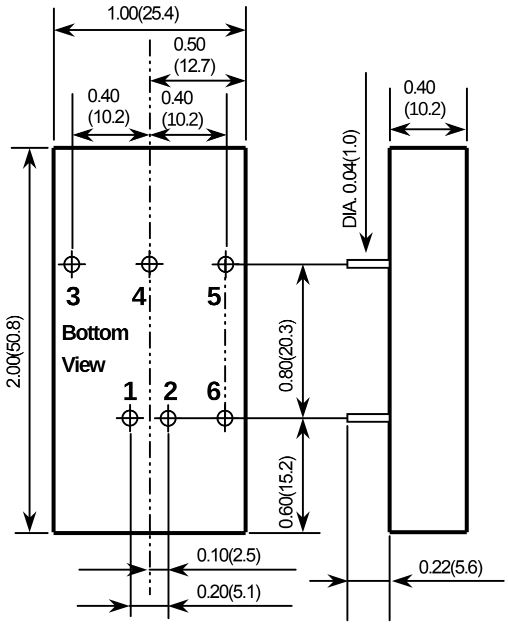
Heat Sink

Optional heat-sink to reduce the case temperature or to increase operating temperature without derating.



All dimensions in millimeters

Mechanical Data

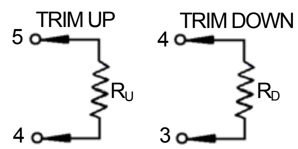


1. All dimensions in Inches (mm)
2. Pin pitch tolerance ±0.014(0.35)
3. Tolerance：x.xx±0.02 (x.x±0.5)
x.xxx±0.01 (x.xx±0.25)

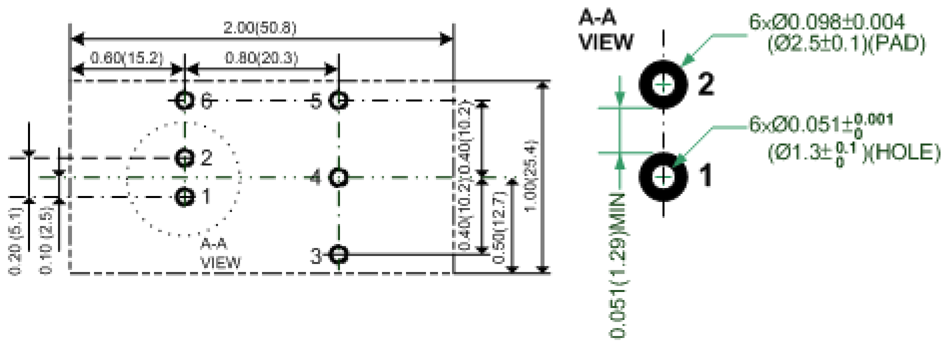
PIN CONNECTION		
PIN	Single output	Dual Output
	Define	Define
1	+ INPUT	+ INPUT
2	- INPUT	- INPUT
3	+ OUTPUT	+ OUTPUT
4	TRIM	COMMON
5	- OUTPUT	- OUTPUT
6	CTRL	CTRL

EXTERNAL OUTPUT TRIMMING

Output can be externally trimmed by using the method shown below.



Recommended Pad Layout

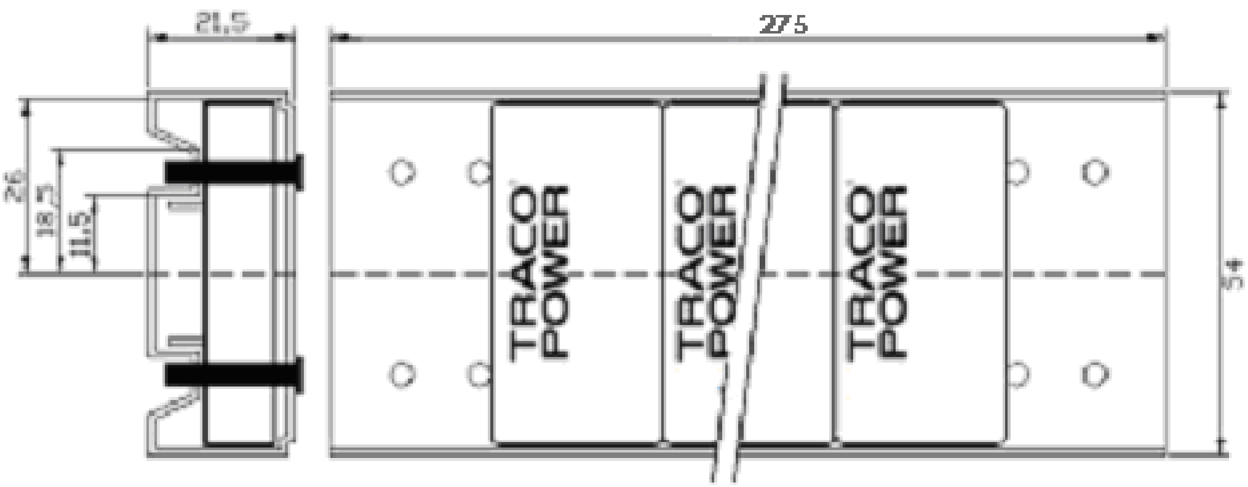


1. All dimensions in Inches (mm)
2. Pin pitch tolerance ±0.014 (±0.35)
3. Tolerance：x.xx±0.02 (x.x±0.5)
   x.xxx±0.01 (x.xx±0.25)

Soldering and Reflow Considerations

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

Packaging Information



All dimensions in millimeters

10 PCS per TUBE

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 safety agencies require a normal-blow fuse with maximum rating of 6A. 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.

MTBF and Reliability

The MTBF of TEN 20-WIN SERIES of DC/DC converters has been calculated using

Bellcore TR-NWT-000332 Case I: 50% stress, Operating Temperature at 40℃ (Ground fixed and controlled environment). The resulting figure for MTBF is 1.691×10^6 hours.

MIL-HDBK 217F NOTICE2 FULL LOAD, Operating Temperature at 25℃. The resulting figure for MTBF is $.629\times10^5$ hours.