TEN 40-WI Series

Application Note

DC/DC Converter 9 to 36Vdc or 18 to 75Vdc Input

3.3 to 15Vdc Single Outputs and ±12 to ±15Vdc Dual Output, 40W

E188913

Complete TEN 40-WI datasheet can be downloaded at:
http://www.tracopower.com/products/ten40wi.pdf

Features

- Single output current up to 10A
- Dual output current up to ±1.667A
- 40 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 88%
- Low profile: 50.8×50.8×10.2 mm (2.00×2.00×0.40 inch)
- Fixed switching frequency
- RoHS directive compliant
- Input to output isolation: 1500Vdc,min
- Over-temperature protection
- Input under-voltage protection
- Output over-voltage protection
- Over-current protection, auto-recovery
- Output short circuit protection, auto-recovery
- Remote ON/OFF
- Output Voltage adjustment

Options

- Heat sinks available for extended operation

Applications

- Distributed power architectures
- Workstations
- Computer equipment
- Communications equipment

General Description

The TEN 40WI series offer 40 watts of output power from a 50.8×50.8×10.2 mm (2.00 x 2.00 x 0.4 inch) package. This product has a 4:1 ultra wide input voltage of 9 – 36Vdc and 18 – 75Vdc with an I/O isolation test voltage of 1500Vdc, indefinite short-circuit protection and over- temperature protection, as well as six sided shielding. All models are particularly suited to telecommunications, industrial, mobile telecom and test equipment applications.

Table of Contents

Absolute Maximum Rating				
Parameter	**Model**	**Min**	**Max**	**Unit**
Input Voltage Continuous	TEN 40-24xxWI TEN 40-48xxWI		36 75	Vdc
Input Voltage Transient (100ms)	TEN 40-24xxWI TEN 40-48xxWI		50 100	Vdc
Input Voltage Variation (complies with EST300 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
Input to Output Isolation (Functional Insulation)	All	1500		Vdc

Output Specification					
Parameter	**Model**	**Min**	**Typ**	**Max**	**Unit**
Output Voltage ($V_{in} = V_{in\,nom}$; Full Load; T_A = 25°C)	TEN 40-xx10WI TEN 40-xx11WI TEN 40-xx12WI TEN 40-xx13WI TEN 40-xx22WI TEN 40-xx23WI	3.267 4.95 11.88 14.85 ±11.88 ±14.85	3.3 5 12 15 ±12 ±15	3.333 5.05 12.12 15.15 ±12.12 ±15.15	Vdc
Voltage Adjustability	All	-10		+10	%
Output Regulation Line ($V_{in\,min}$ to $V_{in\,max}$ at Full Load) Load (Min. to 100% of Full Load) Load (Min. to 100% of Full Load)	 All Single Output Dual Output	 -0.2 -0.5 -1.0		 +0.2 +0.5 +1.0	%
Cross Regulation Asymmetrical Load 25% / 100% of Full Load	Dual output	-5.0		+5.0	%
Output Ripple & Noise Peak-to-Peak (20MHz bandwidth)	TEN 40-xx10WI TEN 40-xx11WI TEN 40-xx12WI TEN 40-xx13WI TEN 40-xx22WI TEN 40-xx23WI			50 50 75 75 120 150	mV pk-pk
Temperature Coefficient	All	-0.02		+0.02	%/°C
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		 250 250		 mV µS
Output Current	TEN 40-xx10WI TEN 40-xx11WI TEN 40-xx12WI TEN 40-xx13WI TEN 40-xx22WI TEN 40-xx23WI	0 0 50 50 ±65 ±50		10000 8000 3333 2666 ±1667 ±1333	mA
Output Over Voltage Protection (Single output models only) (Zener diode clamp)	TEN 40-xx10WI TEN 40-xx11WI TEN 40-xx12WI TEN 40-xx13WI		3.9 6.2 15 18		Vdc

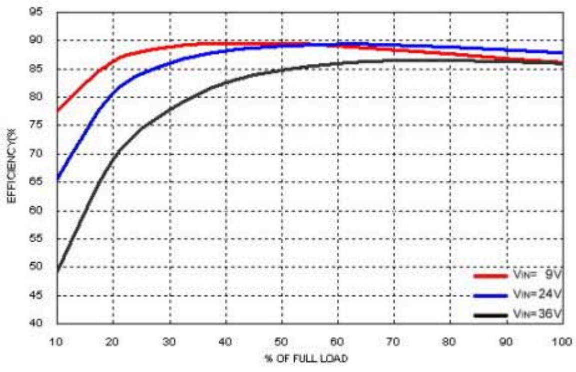
Output Specification (continue)					
Parameter	**Model**	**Min**	**Typ**	**Max**	**Unit**
Output Over Current Protection	All			150	% FL.
Output Short Circuit Protection	All	Hiccup, automatics recovery			

Input Specification					
Parameter	**Model**	**Min**	**Typ**	**Max**	**Unit**
Operating Input Voltage	TEN 40-24xxWI TEN 40-48xxWI	9 18	24 48	36 75	Vdc
Input Current (Maximum value at $V_{in} = V_{in\,nom}$; Full Load)	TEN 40-2410WI TEN 40-2411WI TEN 40-2412WI TEN 40-2413WI TEN 40-2422WI TEN 40-2423WI TEN 40-4810WI TEN 40-4811WI TEN 40-4812WI TEN 40-4813WI TEN 40-4822WI TEN 40-4823WI			1677 2008 2008 2008 2032 2032 838 992 1004 1004 1016 1016	mA
Input Standby Current (Typical value at $V_{in} = V_{in\,nom}$; No Load)	TEN 40-2410WI TEN 40-2411WI TEN 40-2412WI TEN 40-2413WI TEN 40-2422WI TEN 40-2423WI TEN 40-4810WI TEN 40-4811WI TEN 40-4812WI TEN 40-4813WI TEN 40-4822WI TEN 40-4823WI		80 100 50 50 60 60 50 60 30 30 30 30		mA
Under Voltage Lockout Turn-on Threshold	TEN 40-24xxWI TEN 40-48xxWI			9 18	Vdc
Under Voltage Lockout Turn-off Threshold	TEN 40-24xxWI TEN 40-48xxWI		8 16		Vdc
Input Reflected Ripple Current (5 to 20MHz, 12µH Source Impedance)	All		20		mA pk-pk
Start Up Time ($V_{in\,nom}$ and Constant Resistive Load) Power Up Remote ON/OFF	All			20 20	mS
Remote ON/OFF Control (The ON/OFF pin voltage is referenced to $-V_{IN}$) Positive Logic DC-DC ON (Open) DC-DC OFF (Short)	All	3 0		12 1.2	Vdc
Remote Off Input Current	TEN 40-24xxWI TEN 40-48xxWI		10 5		mA
Input Current of Remote Control Pin	All	-0.5		0.5	mA

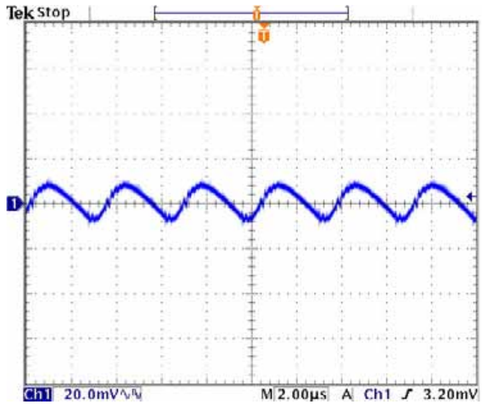
General Specification					
Parameter	**Model**	**Min**	**Typ**	**Max**	**Unit**
Efficiency ($V_{in} = V_{in\,nom}$; Full Load; T_A = 25°C)	TEN 40-2410WI TEN 40-2411WI TEN 40-2412WI TEN 40-2413WI TEN 40-2422WI TEN 40-2423WI TEN 40-4810WI TEN 40-4811WI TEN 40-4812WI TEN 40-4813WI TEN 40-4822WI TEN 40-4823WI		86 87 87 87 86 86 86 88 87 87 86 86		%
Isolation Voltage (Functional Insulation) Input to Output Input to Case, Output to Case	All	1500 1500			Vdc
Isolation Resistance	All	10			GΩ
Isolation Capacitance	All			2500	pF
Switching Frequency	All		300		KHz
Weight	All		60		g
MTBF Bellcore TR-NWT-000332, T_C = 40°C MIL-STD-217F	All		1’105’000 151’100		hours
Over Temperature Protection	All		110		°C

Characteristic Curves

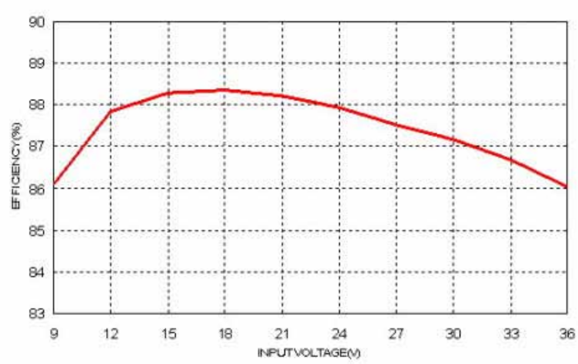
All test conditions are at 25°C. The figures are identical for TEN 40-2410WI



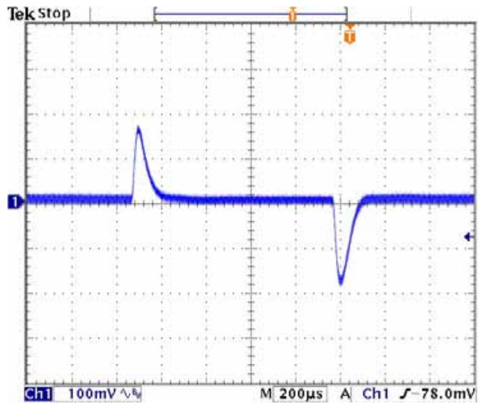
Efficiency Versus Output Current



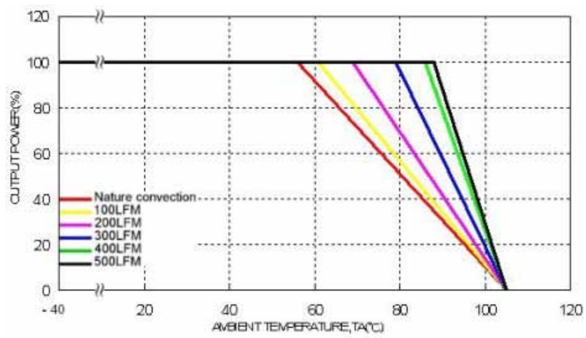
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



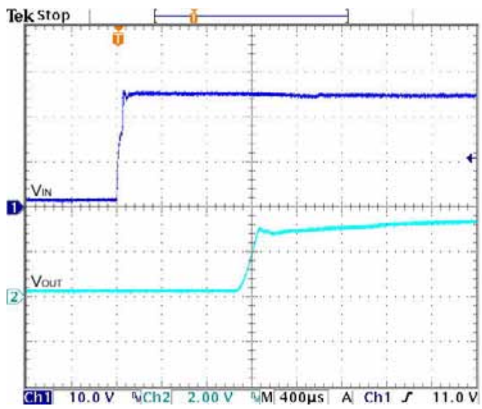
Efficiency Versus Input Voltage. Full Load



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



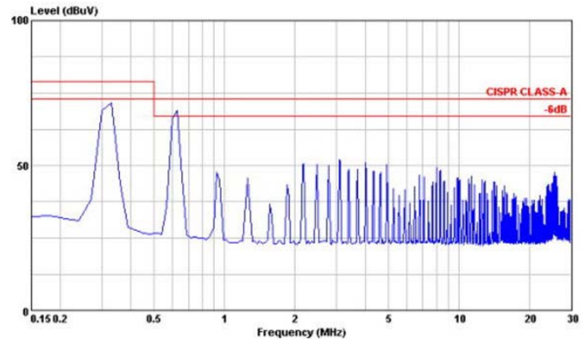
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\,nom}$



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

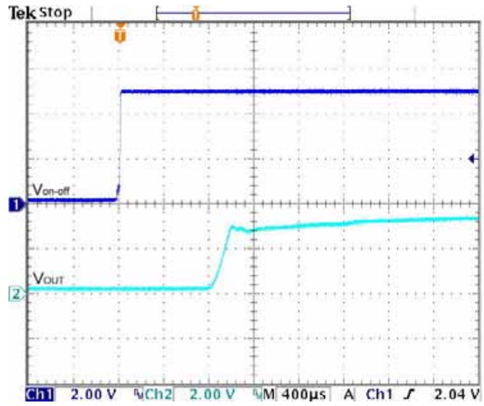
Characteristic Curves

All test conditions are at 25°C. The figures are identical for TEN 40-2410WI (Continued)



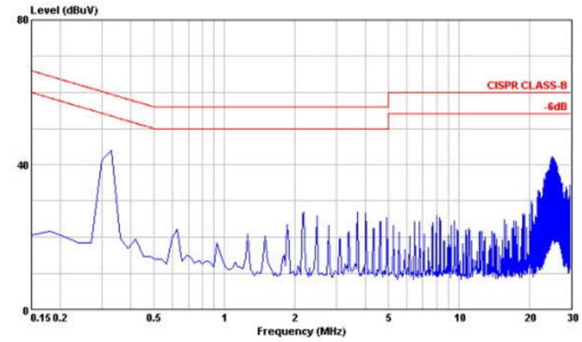
Conduction Emission of EN55022 Class A

$V_{in} = V_{in\,nom}$, Full Load



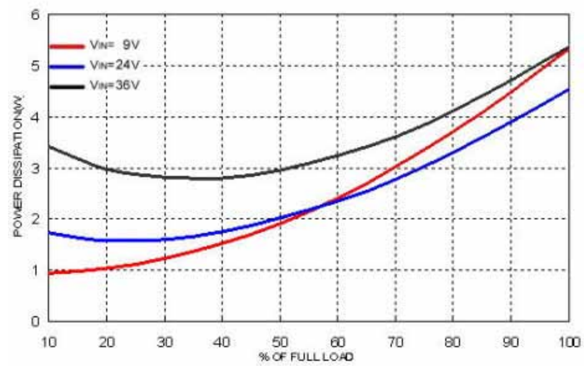
Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic

$V_{in} = V_{in\,nom}$, Full Load

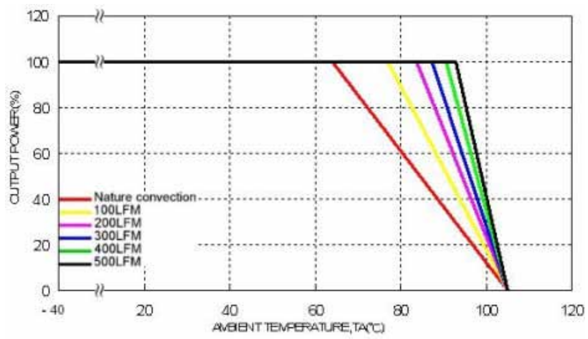


Conduction Emission of EN55022 Class B

$V_{in} = V_{in\,nom}$, Full Load



Power Dissipation Versus Output Current

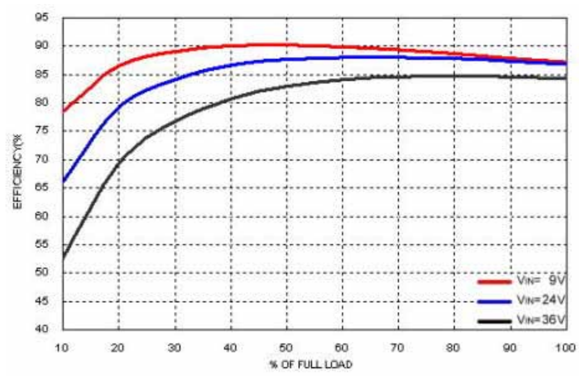


Derating Output Current Versus Ambient Temperature with

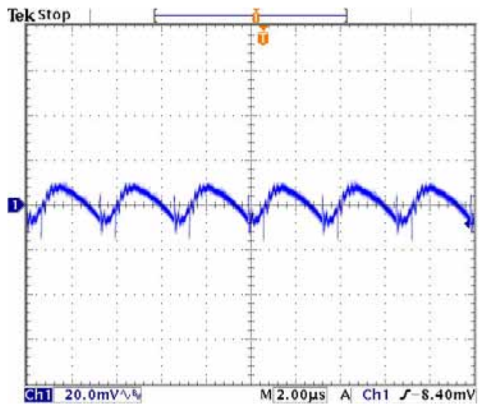
Heat-Sink and Airflow, $V_{in} = V_{in\,nom}$

Characteristic Curves

All test conditions are at 25°C. The figures are identical for TEN 40-2411WI

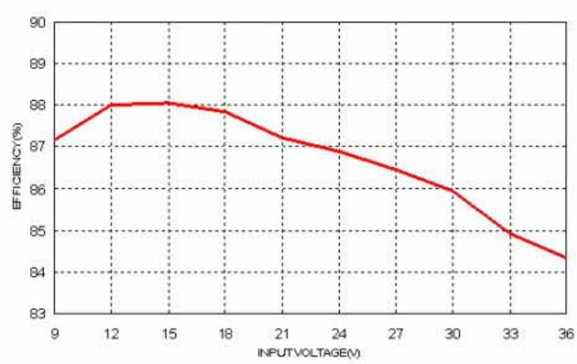


Efficiency Versus Output Current

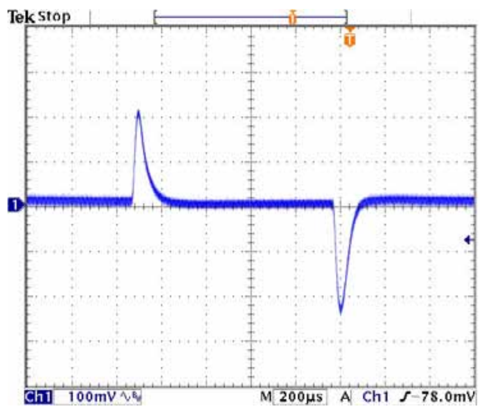


Typical Output Ripple and Noise.

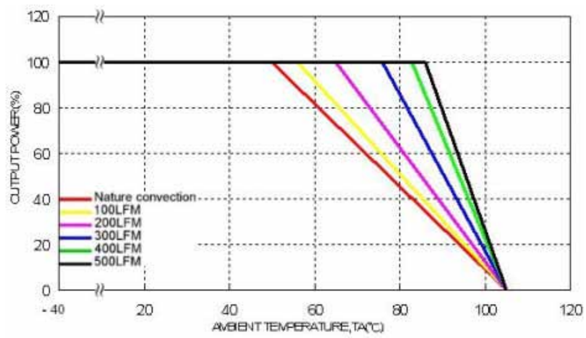
$V_{in} = V_{in\ nom}$, Full Load



Efficiency Versus Input Voltage. Full Load

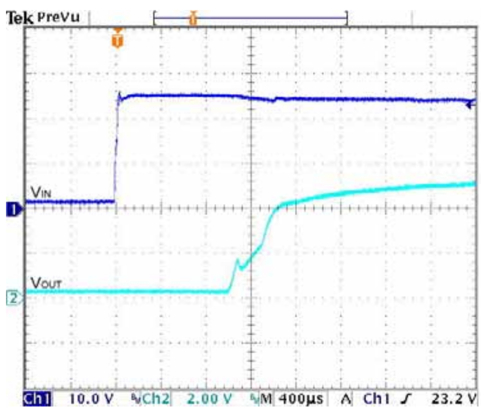


Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load ; $V_{in} = V_{in\ nom}$



Derating Output Current Versus Ambient Temperature and Airflow

$V_{in} = V_{in\ nom}$

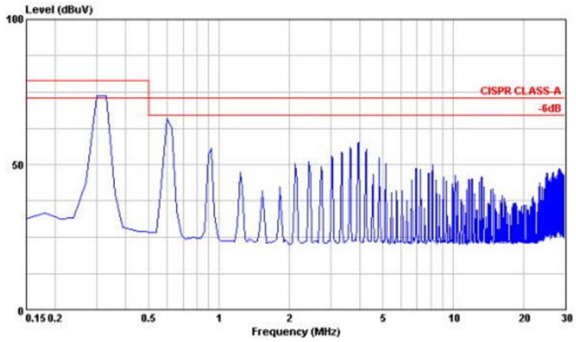


Typical Input Start-Up and Output Rise Characteristic

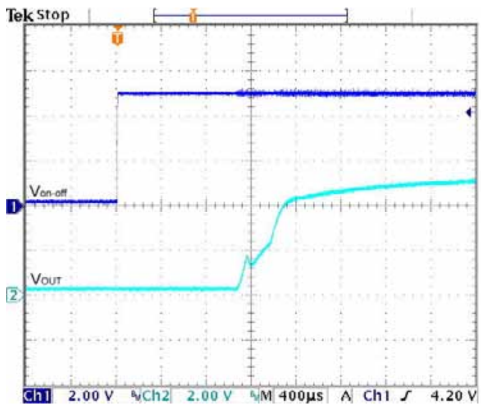
$V_{in} = V_{in\ nom}$, Full Load

Characteristic Curves

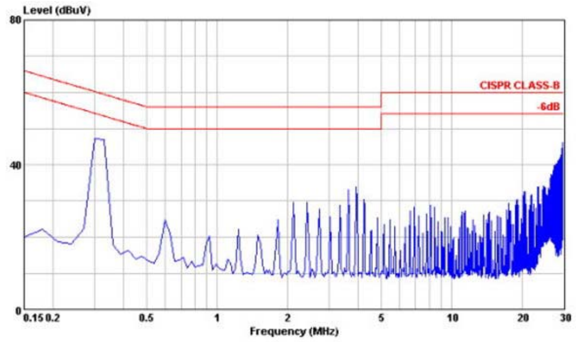
All test conditions are at 25°C. The figures are identical for TEN 40-2411WI (Continued)



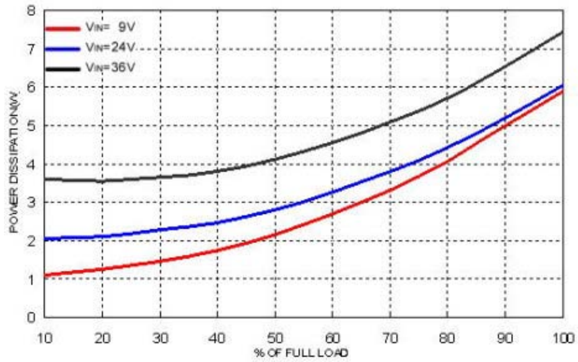
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\,nom}$, Full Load



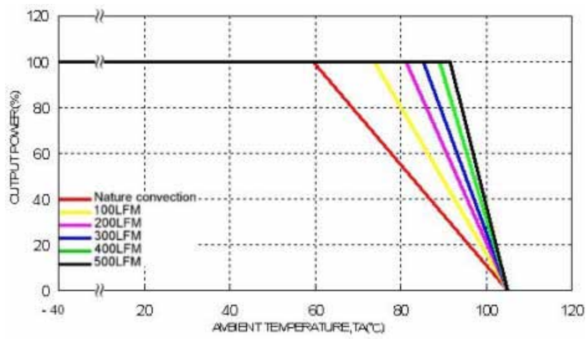
Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\,nom}$, Full Load



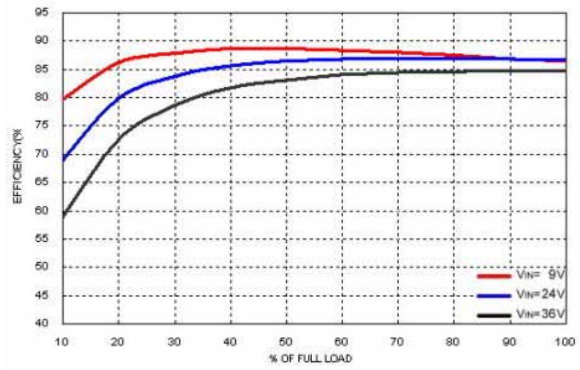
Power Dissipation Versus Output Current



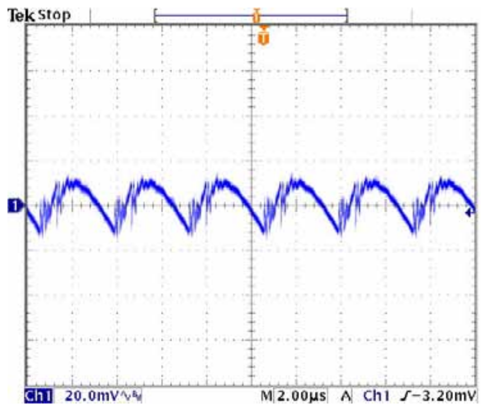
Derating Output Current Versus Ambient Temperature with Heat-Sink and Airflow, $V_{in} = V_{in\,nom}$

Characteristic Curves

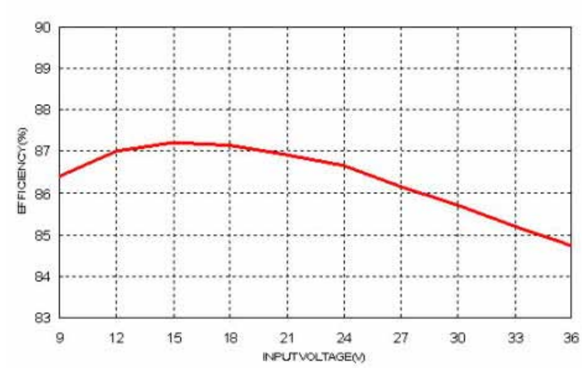
All test conditions are at 25°C. The figures are identical for TEN 40-2412WI



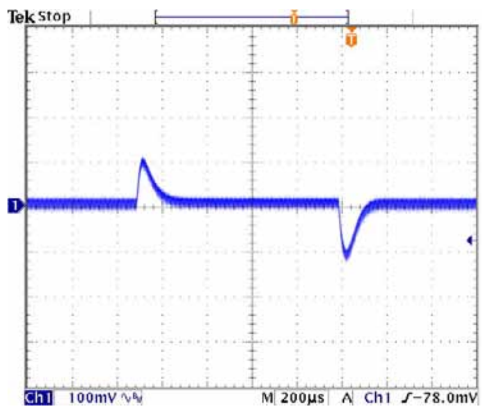
Efficiency Versus Output Current



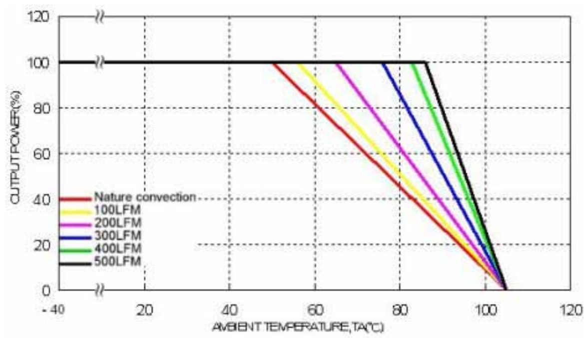
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



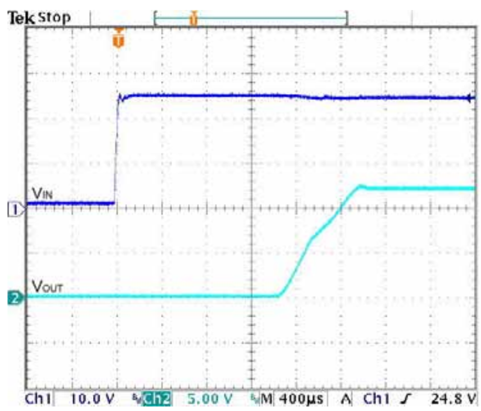
Efficiency Versus Input Voltage. Full Load



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



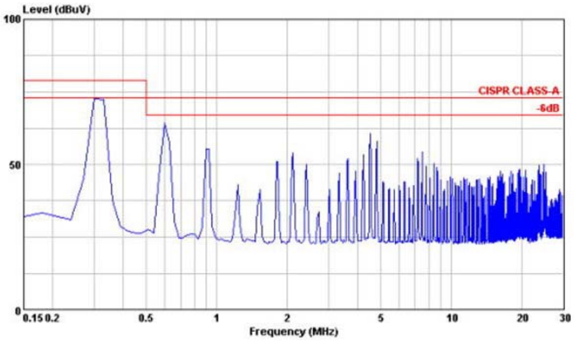
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\,nom}$



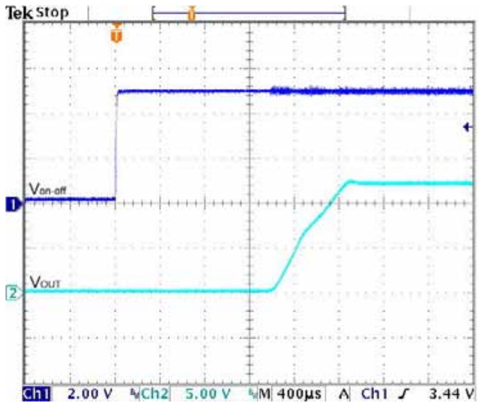
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves

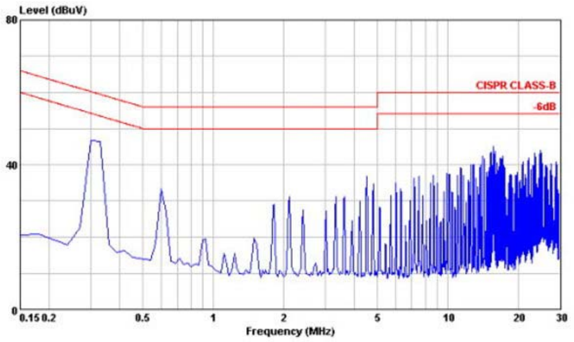
All test conditions are at 25°C. The figures are identical for TEN 40-2412WI (Continued)



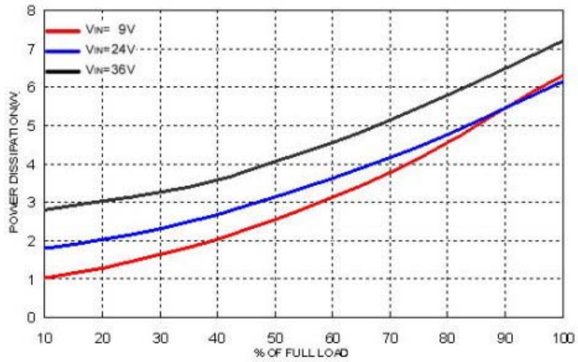
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\,nom}$, Full Load



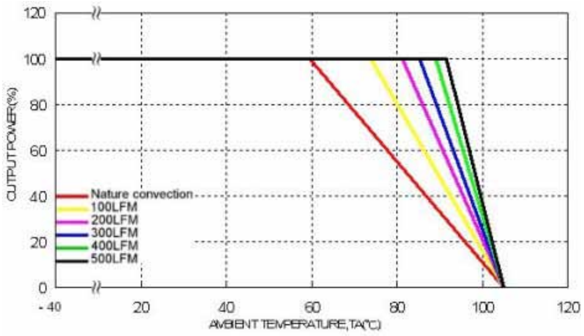
Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\,nom}$, Full Load



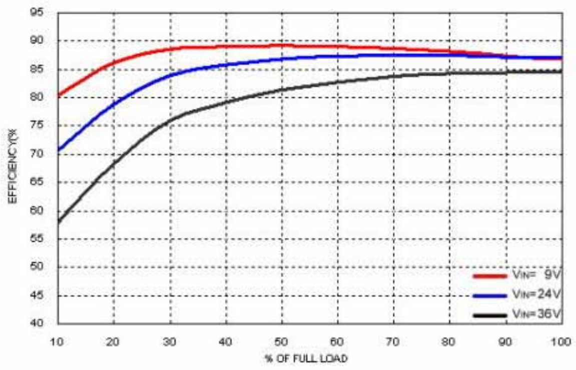
Power Dissipation Versus Output Current



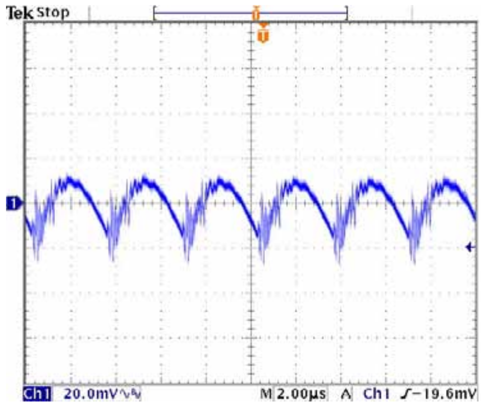
Derating Output Current Versus Ambient Temperature with Heat-Sink and Airflow, $V_{in} = V_{in\,nom}$

Characteristic Curves

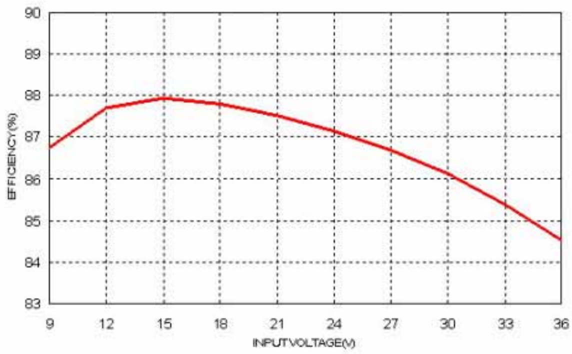
All test conditions are at 25°C. The figures are identical for TEN 40-2413WI



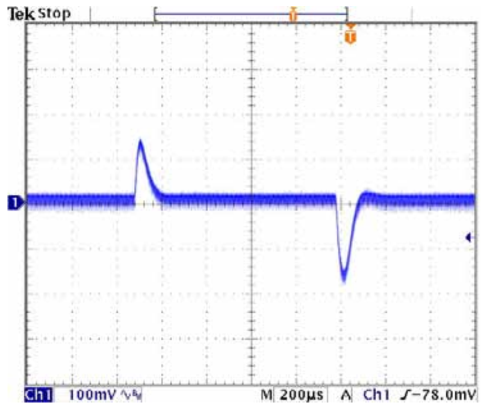
Efficiency Versus Output Current



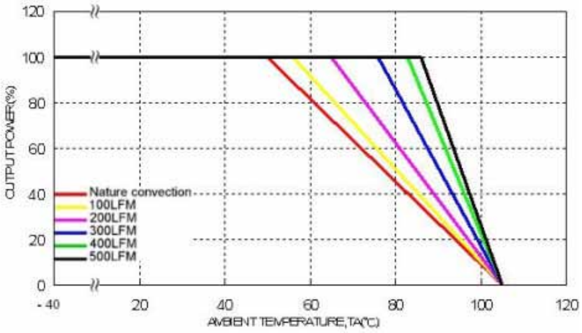
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



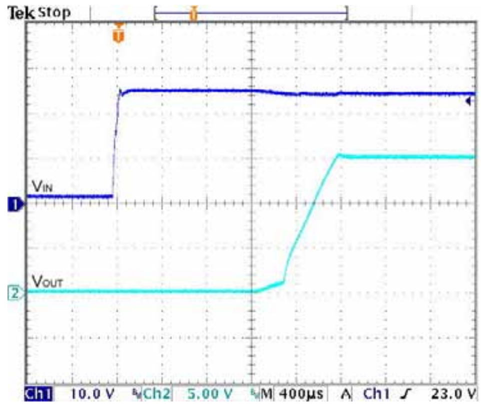
Efficiency Versus Input Voltage. Full Load



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



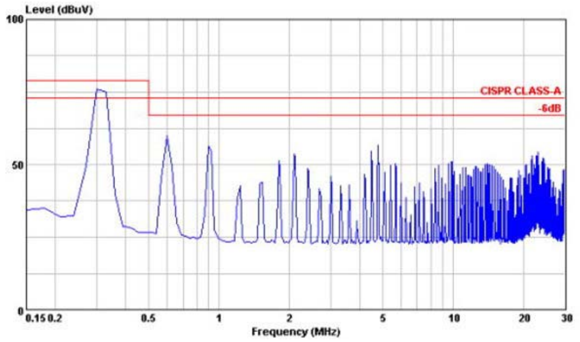
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\,nom}$



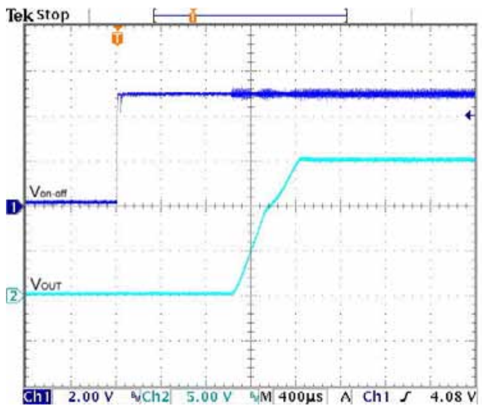
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves

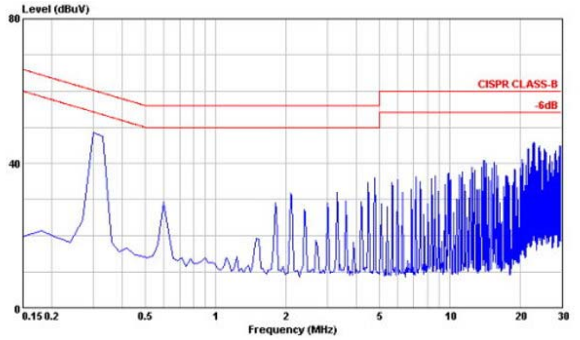
All test conditions are at 25°C. The figures are identical for TEN 40-2413WI (Continued)



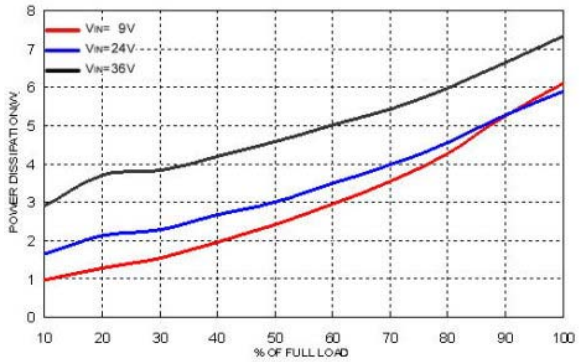
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$, Full Load



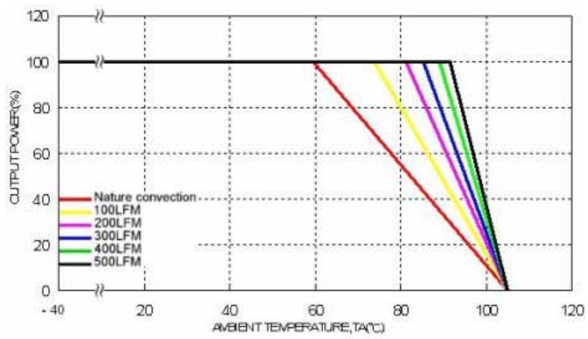
Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$, Full Load



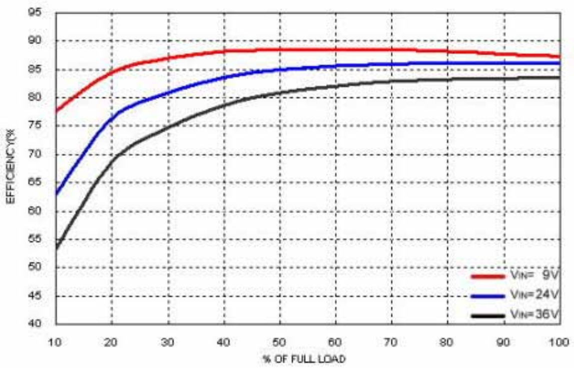
Power Dissipation Versus Output Current



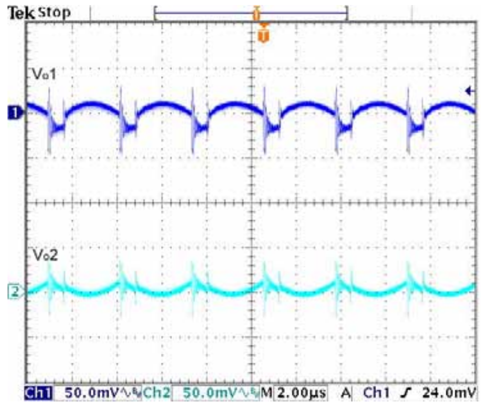
Derating Output Current Versus Ambient Temperature with
Heat-Sink and Airflow, $V_{in} = V_{in\ nom}$

Characteristic Curves

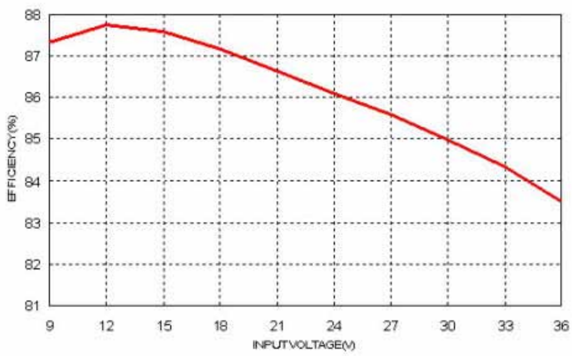
All test conditions are at 25°C. The figures are identical for TEN 40-2422WI



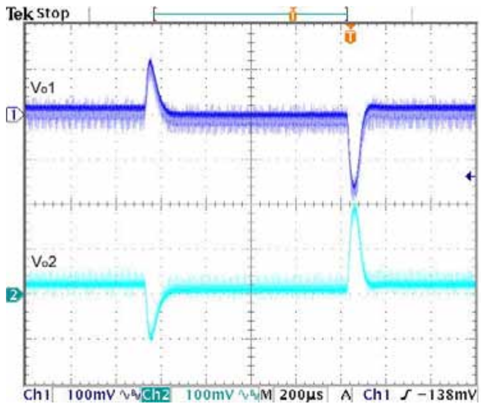
Efficiency Versus Output Current



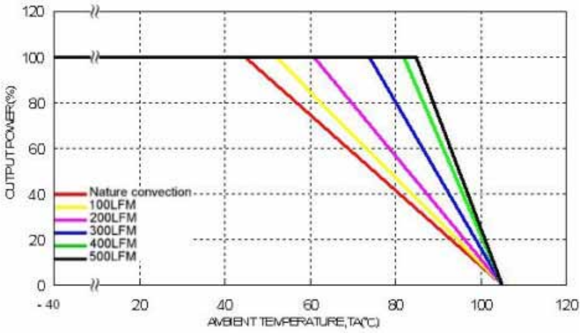
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$, Full Load



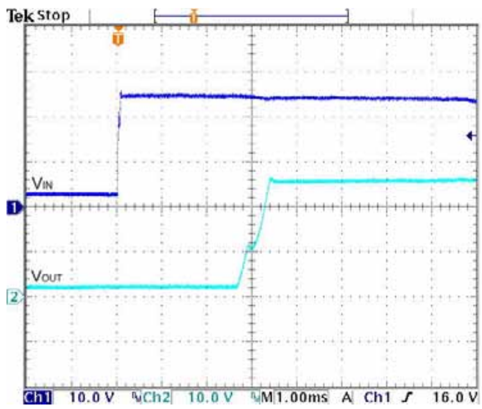
Efficiency Versus Input Voltage. Full Load



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



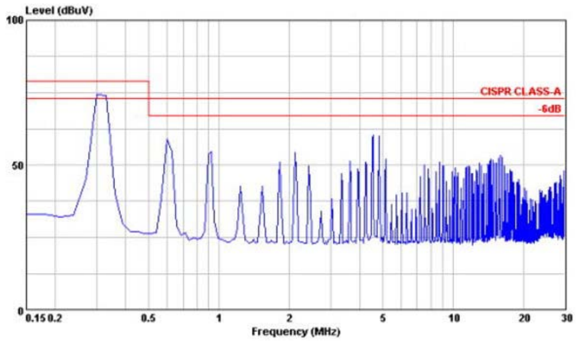
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\ nom}$



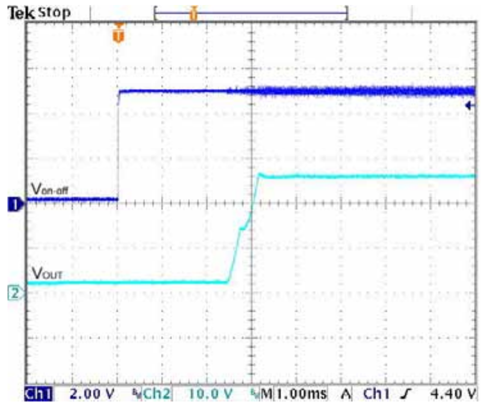
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load

Characteristic Curves

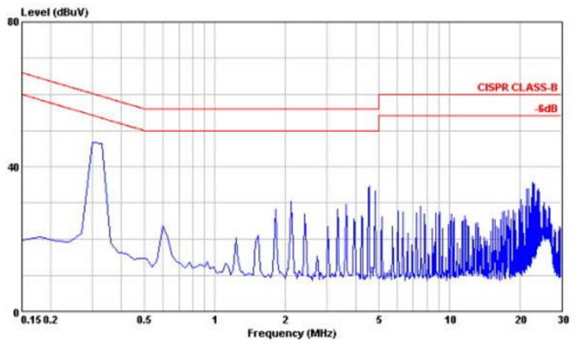
All test conditions are at 25°C. The figures are identical for TEN 40-2422WI (Continued)



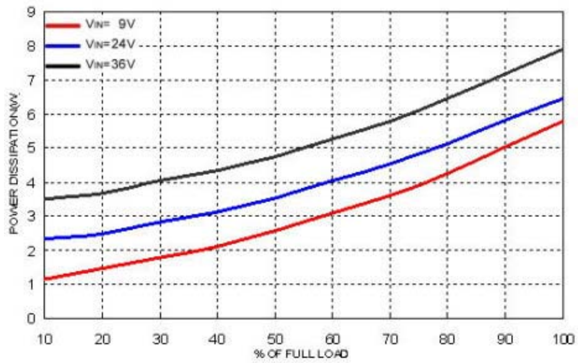
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\,nom}$, Full Load



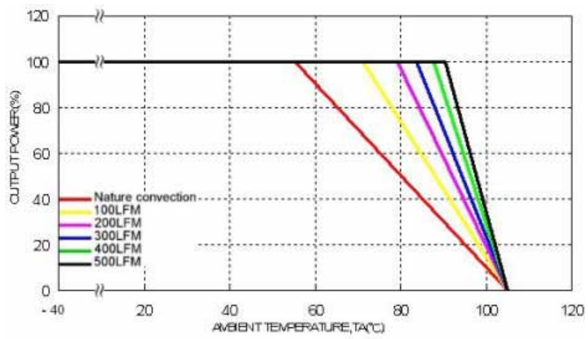
Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\,nom}$, Full Load



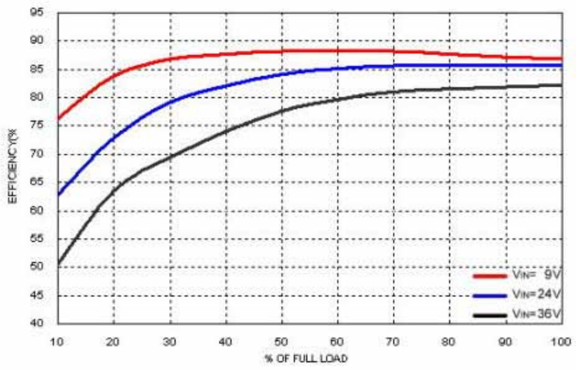
Power Dissipation Versus Output Current



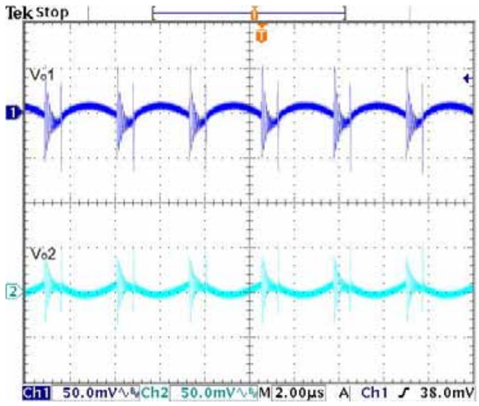
Derating Output Current Versus Ambient Temperature with Heat-Sink and Airflow , $V_{in} = V_{in\,nom}$

Characteristic Curves

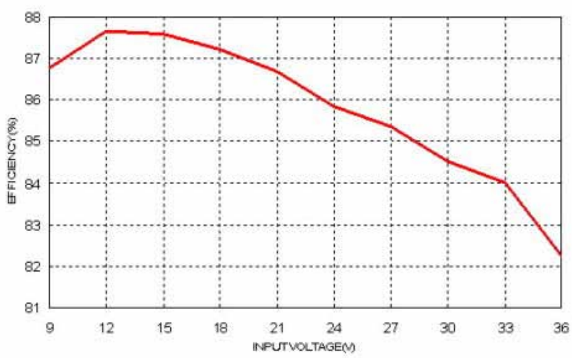
All test conditions are at 25°C. The figures are identical for TEN 40-2423WI



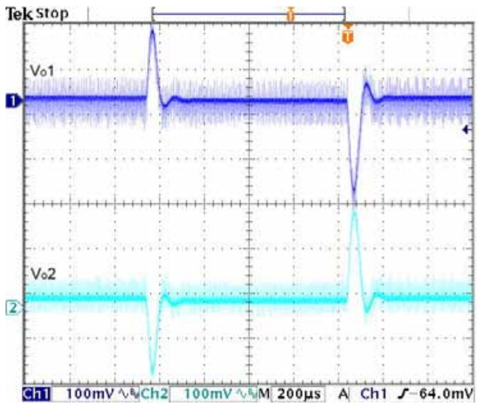
Efficiency Versus Output Current



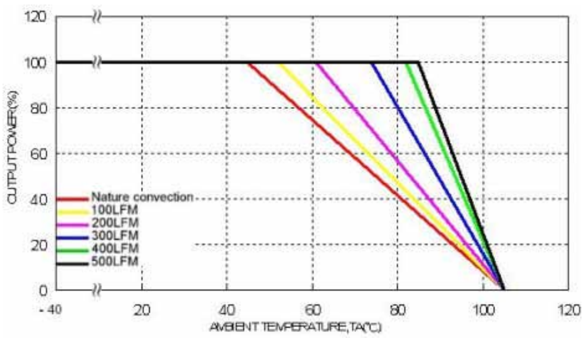
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



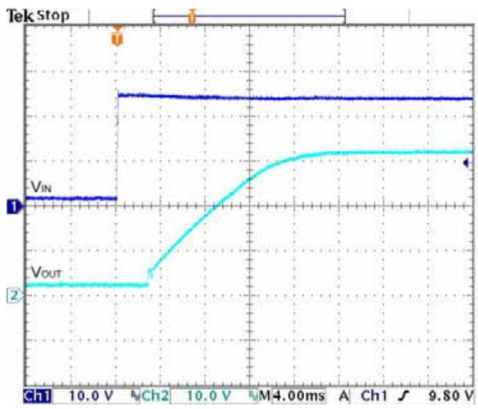
Efficiency Versus Input Voltage. Full Load



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



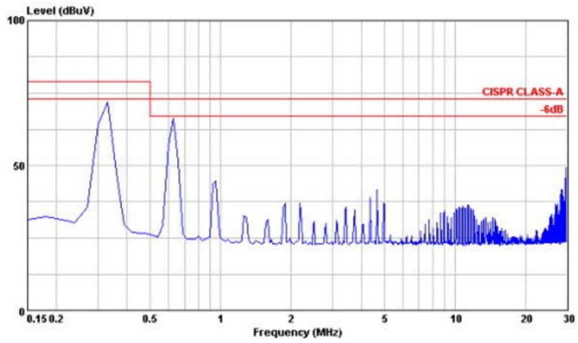
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\,nom}$



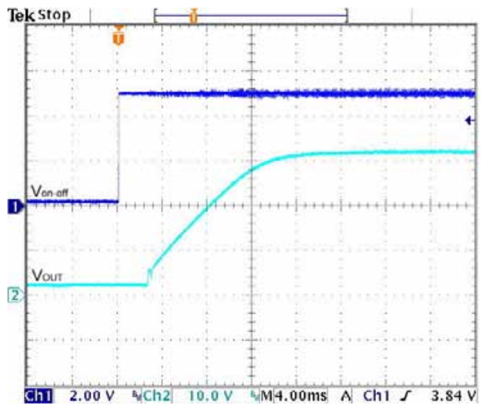
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves

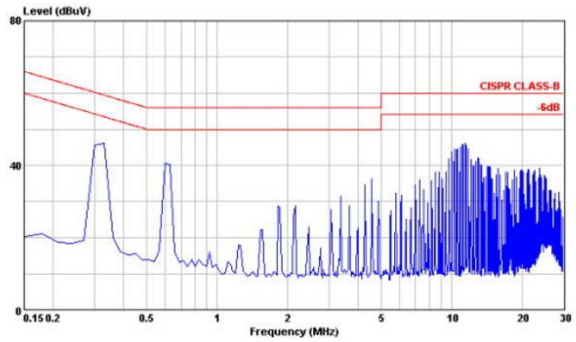
All test conditions are at 25°C. The figures are identical for TEN 40-2423WI (Continued)



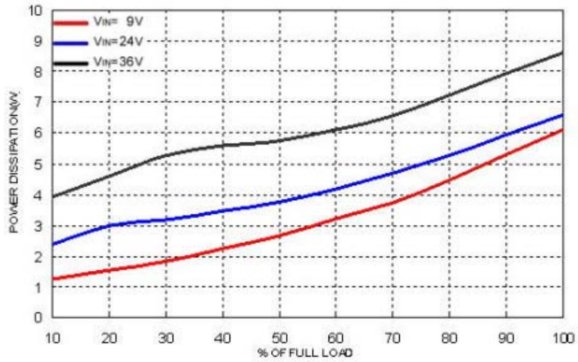
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\,nom}$, Full Load



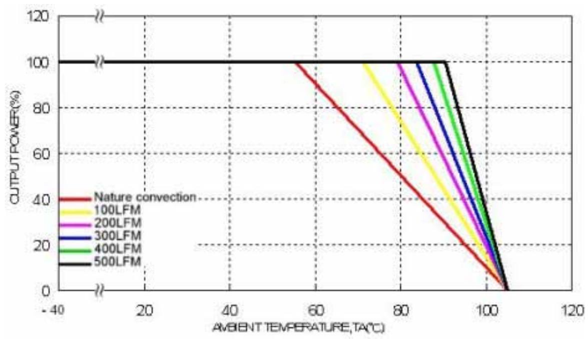
Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\,nom}$, Full Load



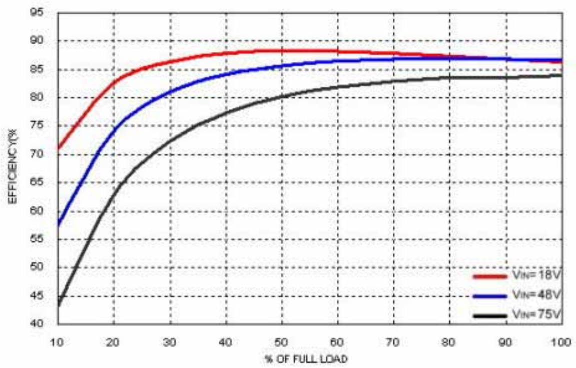
Power Dissipation Versus Output Current



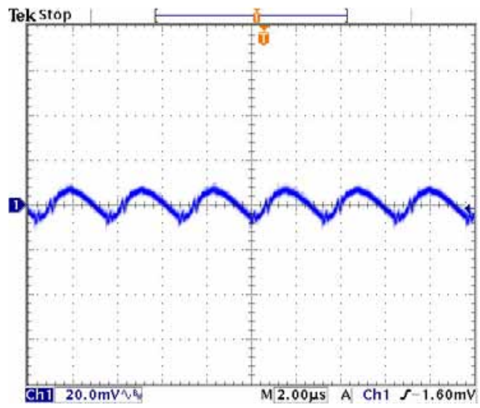
Derating Output Current Versus Ambient Temperature with Heat-Sink and Airflow , $V_{in} = V_{in\,nom}$

Characteristic Curves

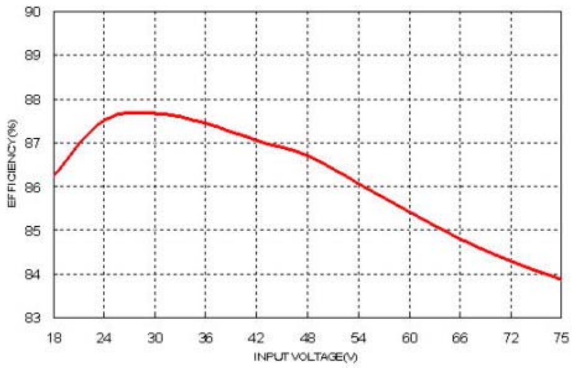
All test conditions are at 25°C. The figures are identical for TEN 40-4810WI



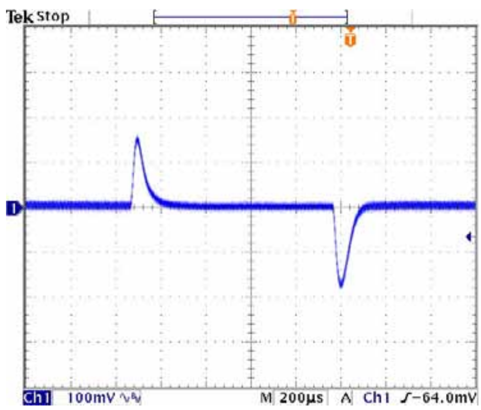
Efficiency Versus Output Current



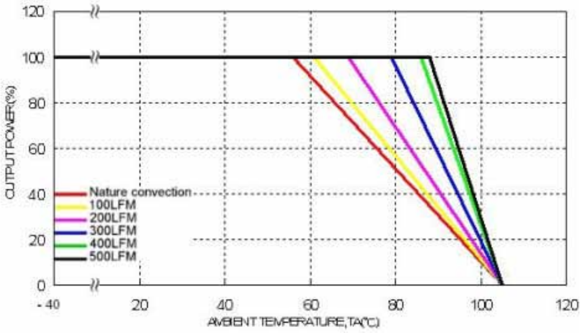
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



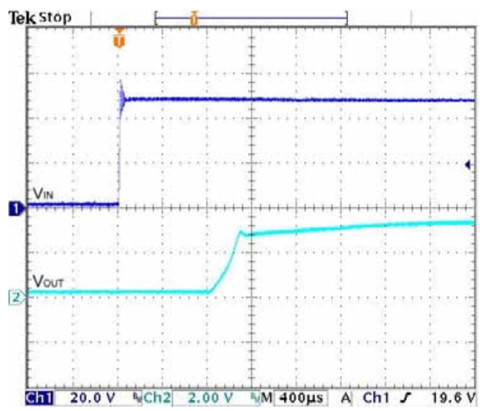
Efficiency Versus Input Voltage. Full Load



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



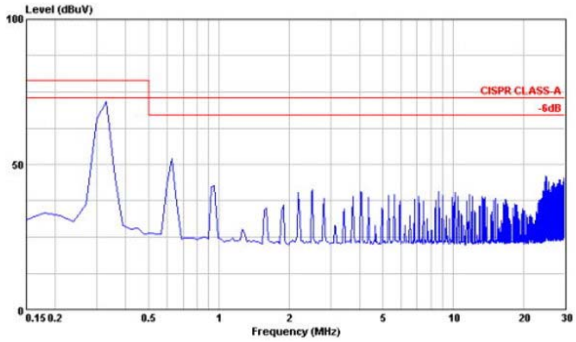
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\,nom}$



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

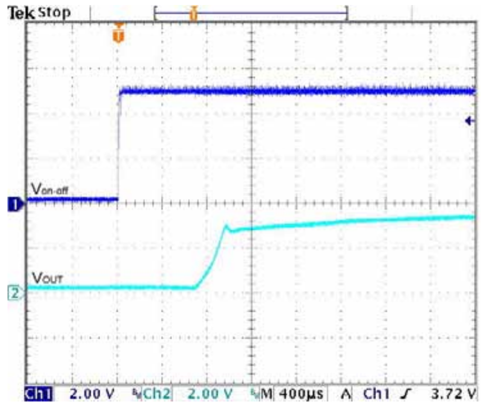
Characteristic Curves

All test conditions are at 25°C. The figures are identical for TEN 40-4810WI (Continued)



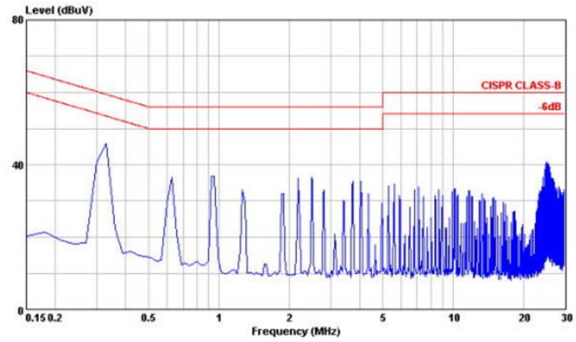
Conduction Emission of EN55022 Class A

$V_{in} = V_{in\,nom}$, Full Load



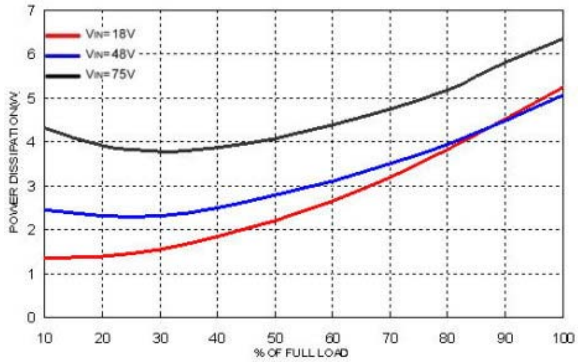
Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic

$V_{in} = V_{in\,nom}$, Full Load

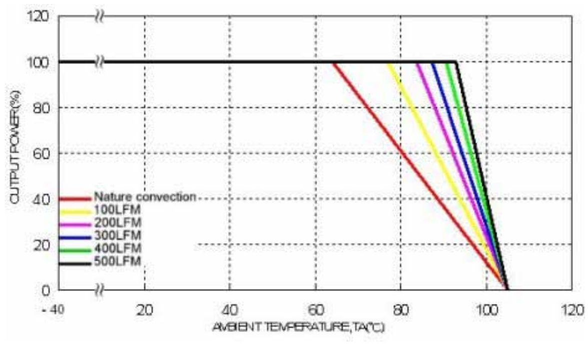


Conduction Emission of EN55022 Class B

$V_{in} = V_{in\,nom}$, Full Load



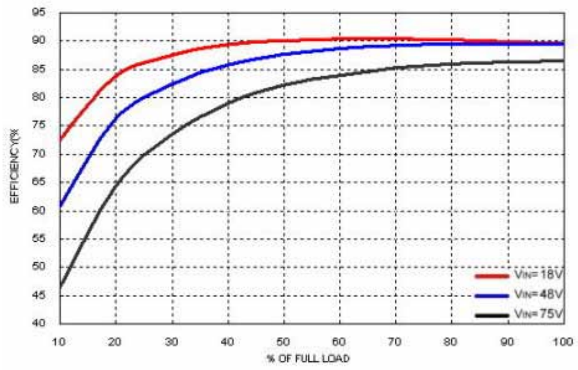
Power Dissipation Versus Output Current



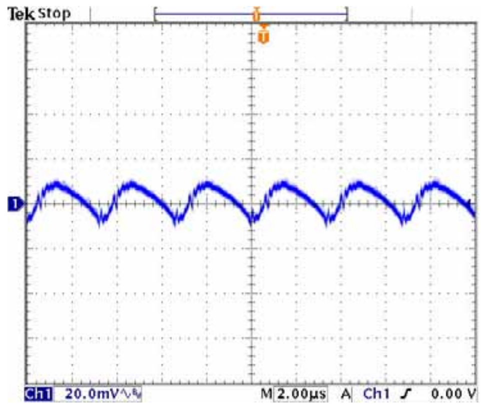
Derating Output Current Versus Ambient Temperature with Heat-Sink and Airflow, $V_{in} = V_{in\,nom}$

Characteristic Curves

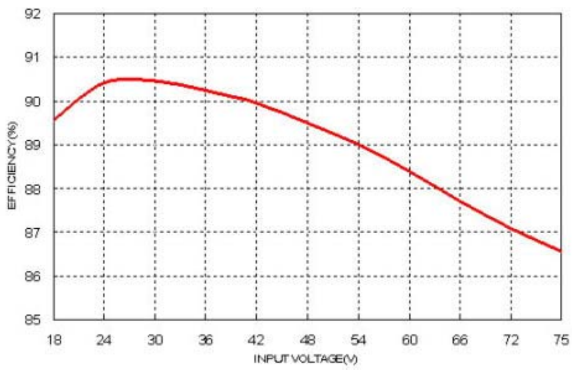
All test conditions are at 25°C. The figures are identical for TEN 40-4811WI



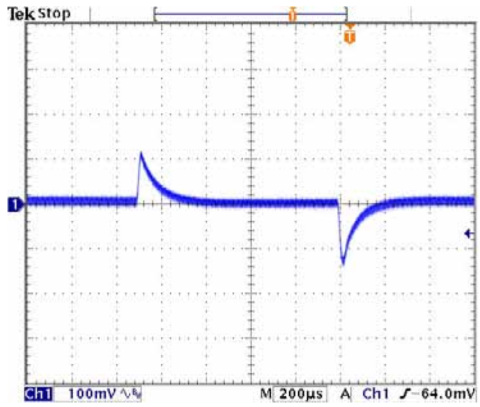
Efficiency Versus Output Current



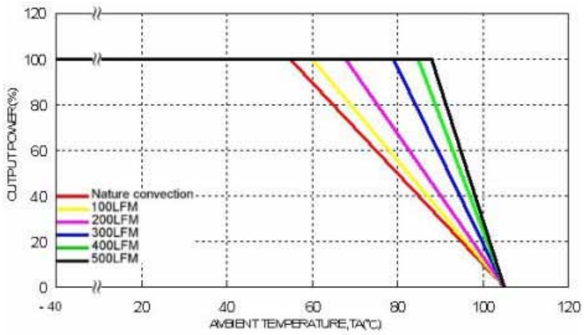
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



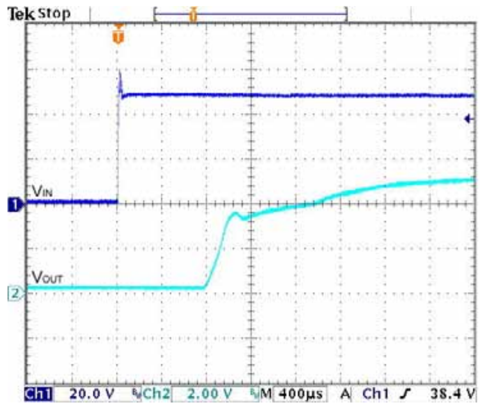
Efficiency Versus Input Voltage. Full Load



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



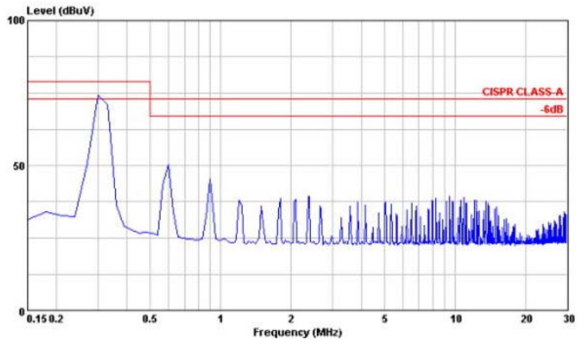
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\,nom}$



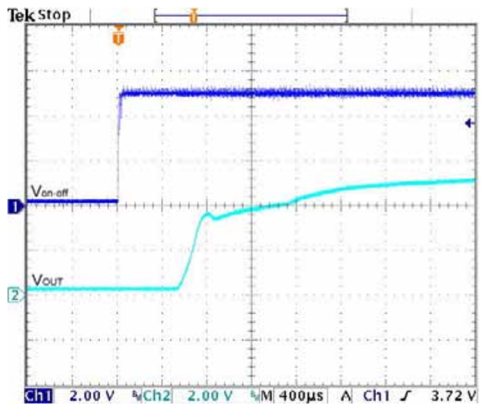
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves

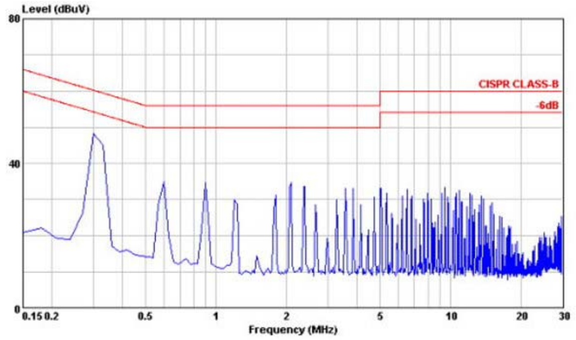
All test conditions are at 25°C. The figures are identical for TEN 40-4811WI (Continued)



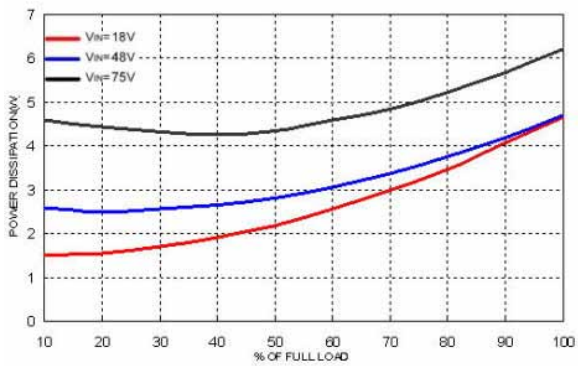
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$, Full Load



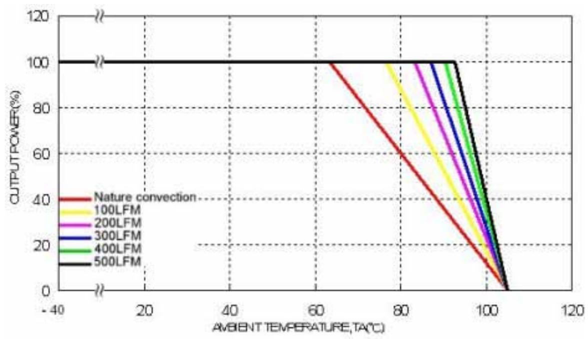
Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$, Full Load



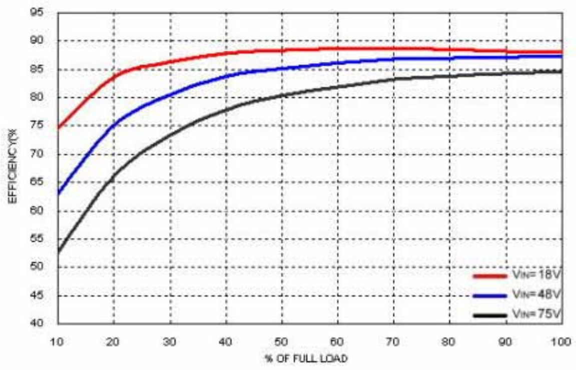
Power Dissipation Versus Output Current



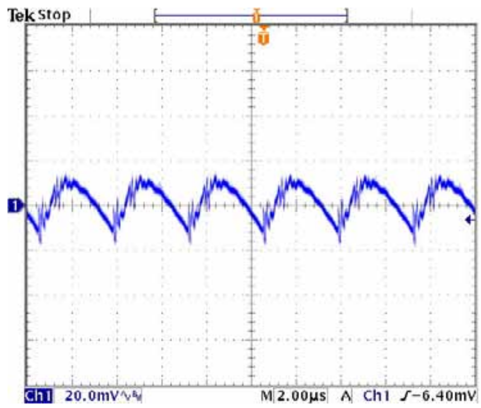
Derating Output Current Versus Ambient Temperature with
Heat-Sink and Airflow, $V_{in} = V_{in\ nom}$

Characteristic Curves

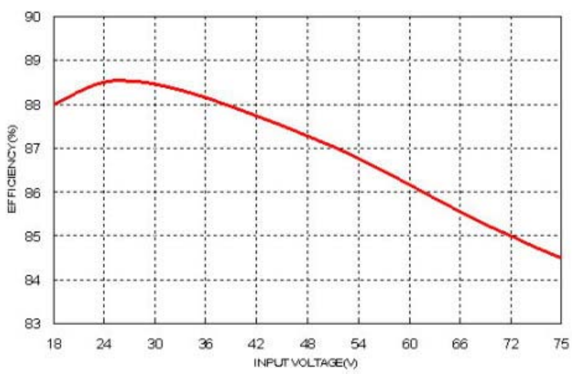
All test conditions are at 25°C. The figures are identical for TEN 40-4812WI



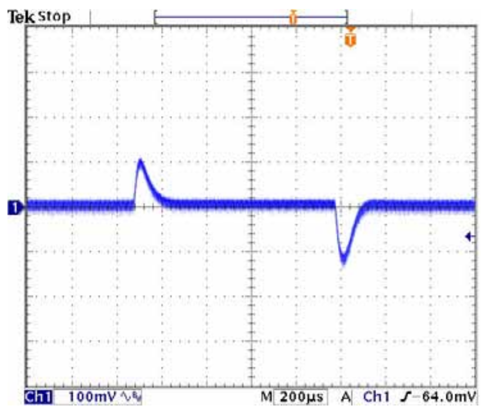
Efficiency Versus Output Current



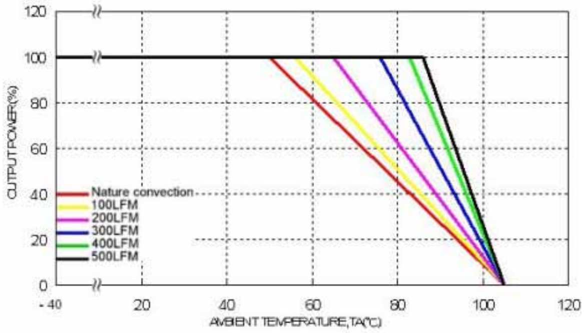
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



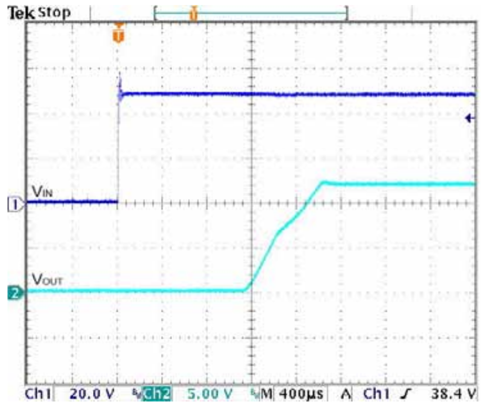
Efficiency Versus Input Voltage. Full Load



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



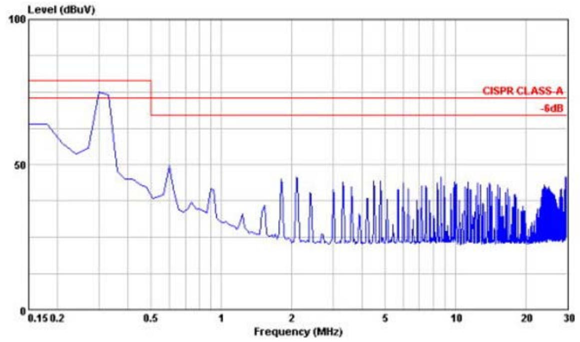
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\,nom}$



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

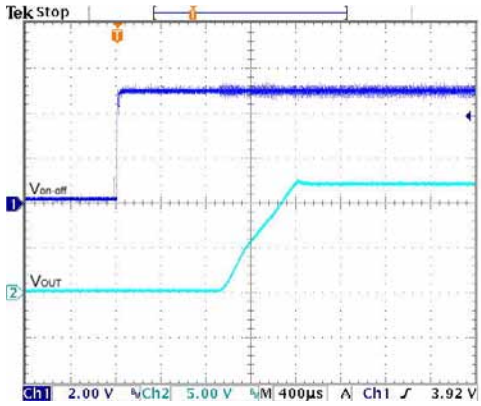
Characteristic Curves

All test conditions are at 25°C. The figures are identical for TEN 40-4812WI (Continued)



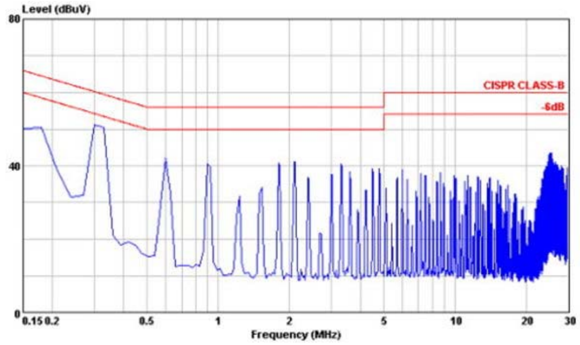
Conduction Emission of EN55022 Class A

$V_{in} = V_{in\ nom}$, Full Load



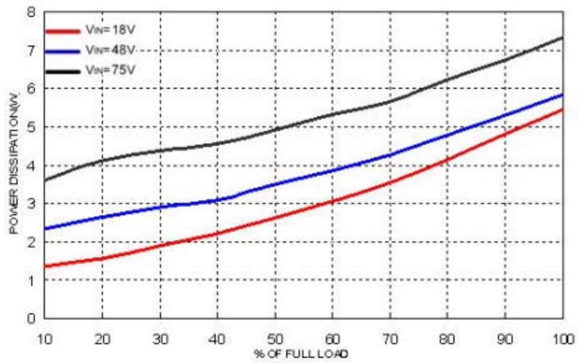
Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic

$V_{in} = V_{in\ nom}$, Full Load

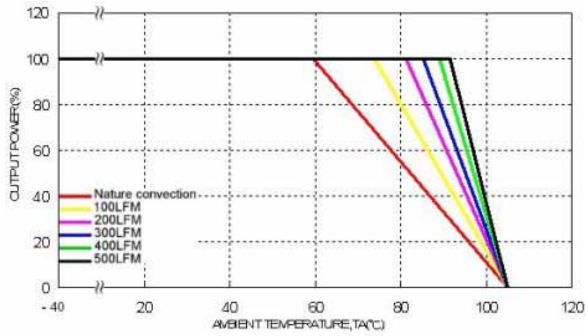


Conduction Emission of EN55022 Class B

$V_{in} = V_{in\ nom}$, Full Load



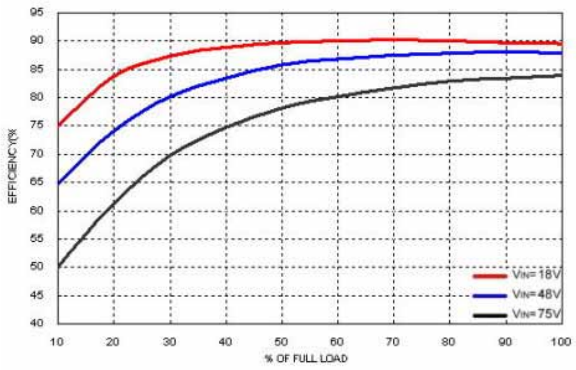
Power Dissipation Versus Output Current



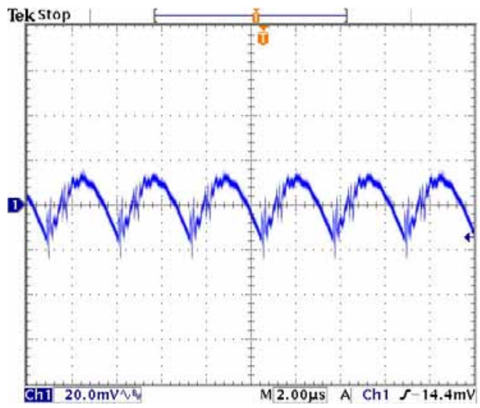
Derating Output Current Versus Ambient Temperature with Heat-Sink and Airflow, $V_{in} = V_{in\ nom}$

Characteristic Curves

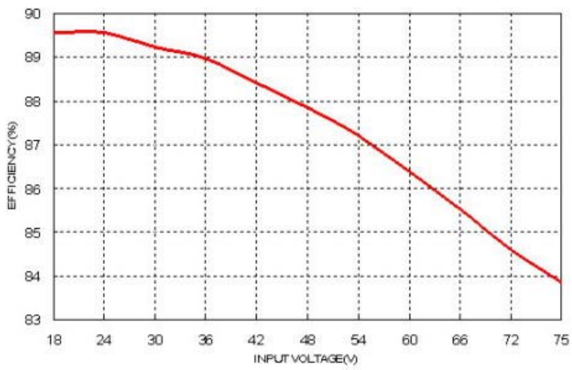
All test conditions are at 25°C. The figures are identical for TEN 40-4813WI



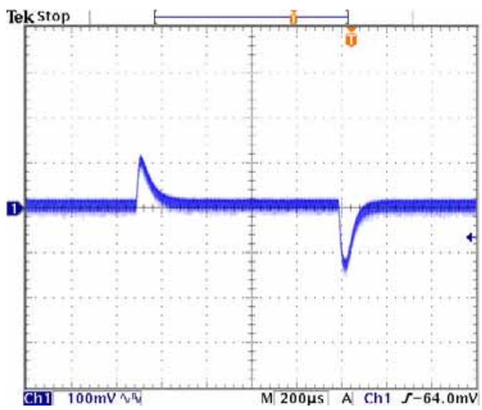
Efficiency Versus Output Current



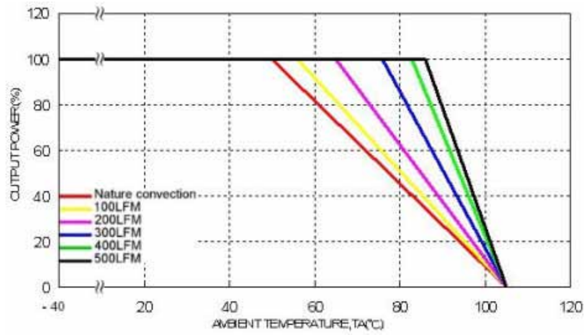
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



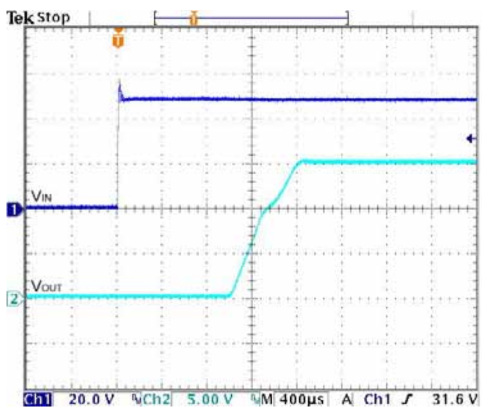
Efficiency Versus Input Voltage. Full Load



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



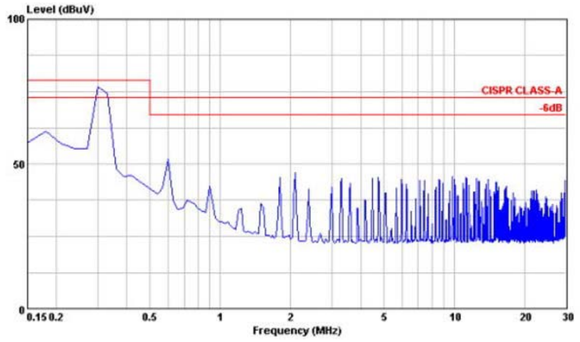
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\,nom}$



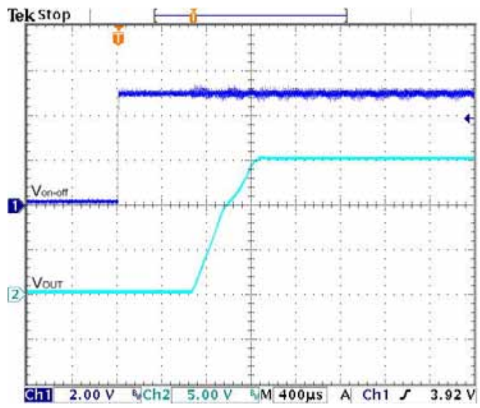
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves

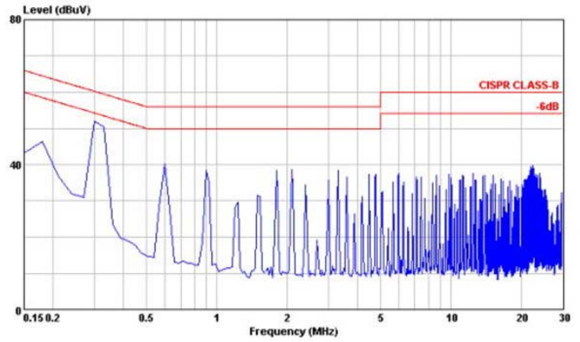
All test conditions are at 25°C. The figures are identical for TEN 40-4813WI (Continued)



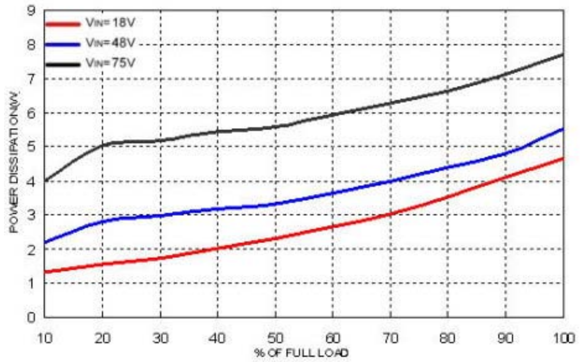
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\,nom}$, Full Load



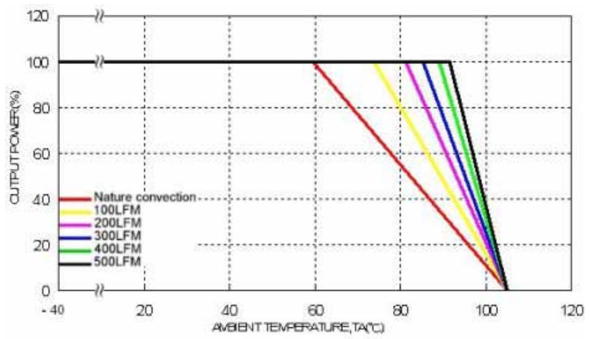
Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\,nom}$, Full Load



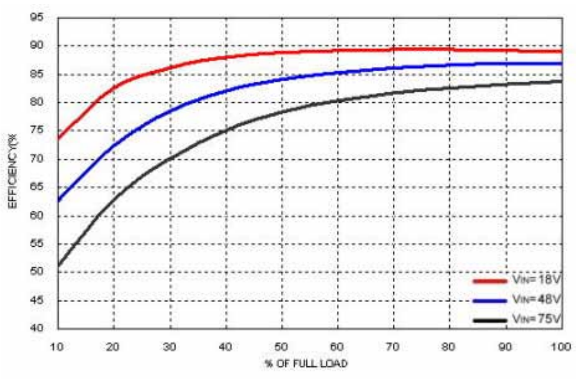
Power Dissipation Versus Output Current



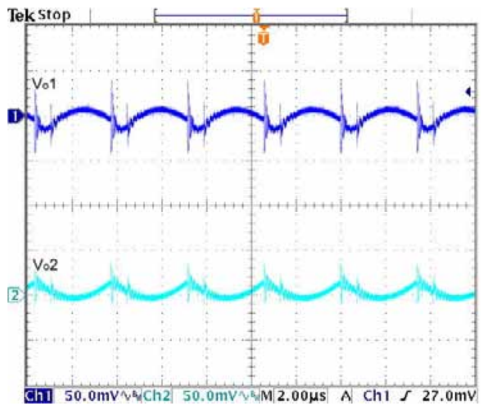
Derating Output Current Versus Ambient Temperature with Heat-Sink and Airflow, $V_{in} = V_{in\,nom}$

Characteristic Curves

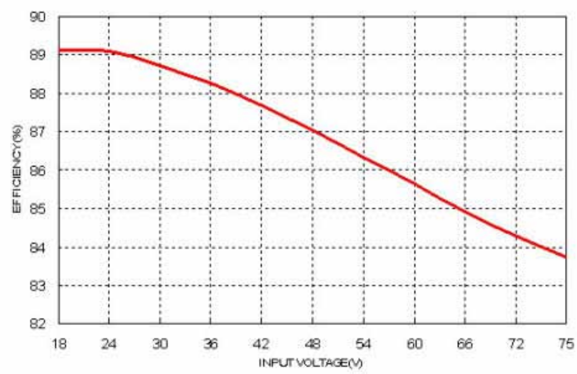
All test conditions are at 25°C. The figures are identical for TEN 40-4822WI



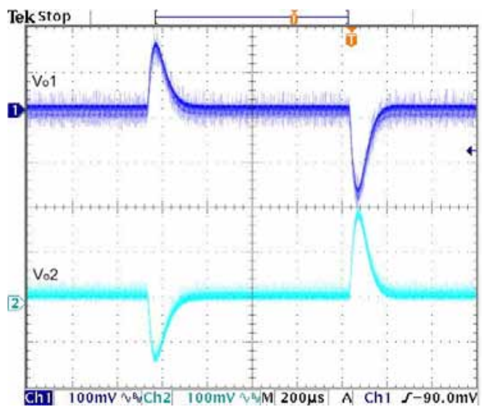
Efficiency Versus Output Current



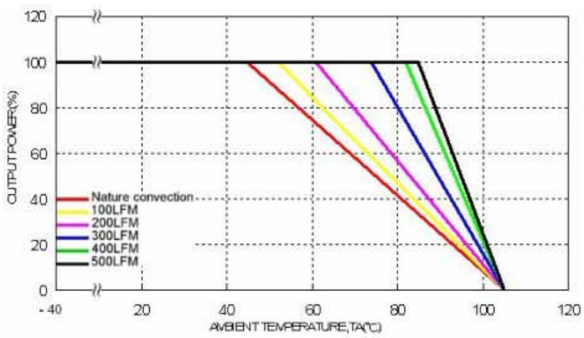
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



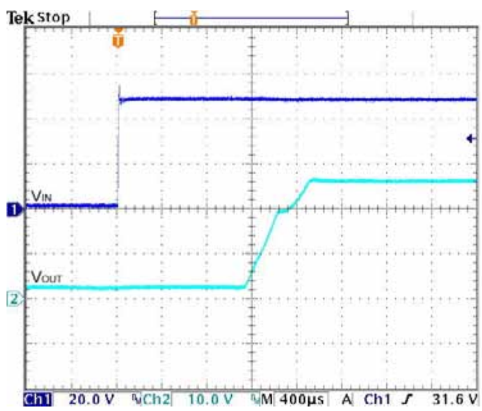
Efficiency Versus Input Voltage. Full Load



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



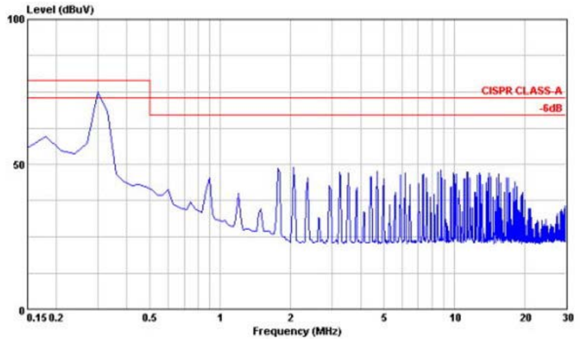
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\,nom}$



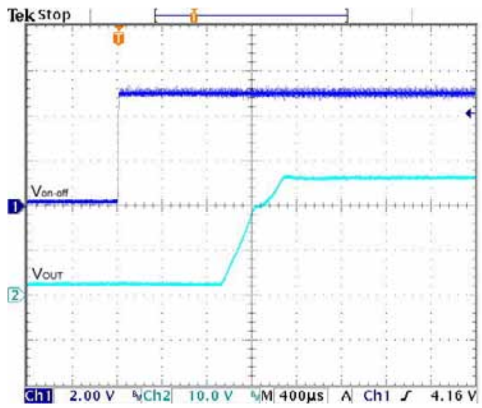
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves

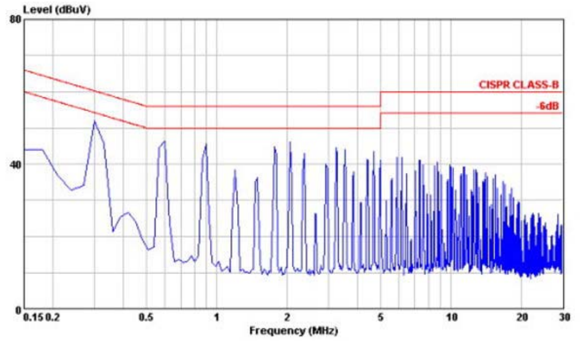
All test conditions are at 25°C. The figures are identical for TEN 40-4822WI (Continued)



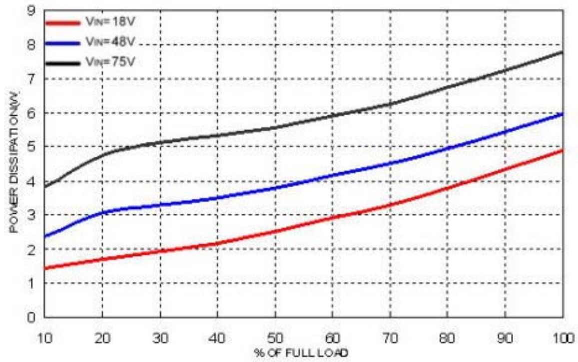
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\,nom}$, Full Load



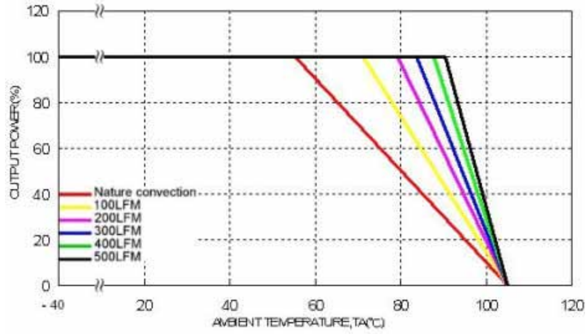
Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



Conduction Emission of EN55022 Class B
$V_{in} = V_{in\,nom}$, Full Load



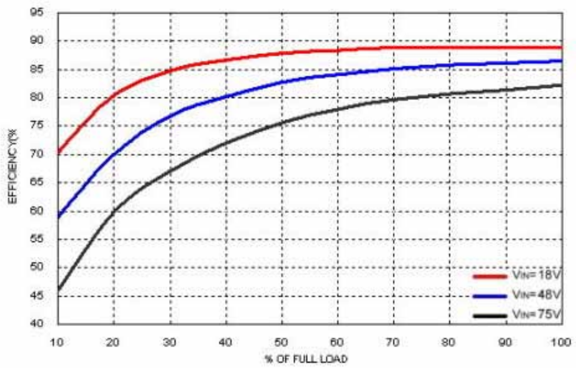
Power Dissipation Versus Output Current



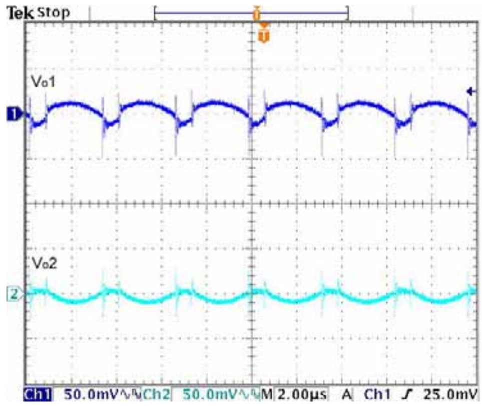
Derating Output Current Versus Ambient Temperature with Heat-Sink and Airflow , $V_{in} = V_{in\,nom}$

Characteristic Curves

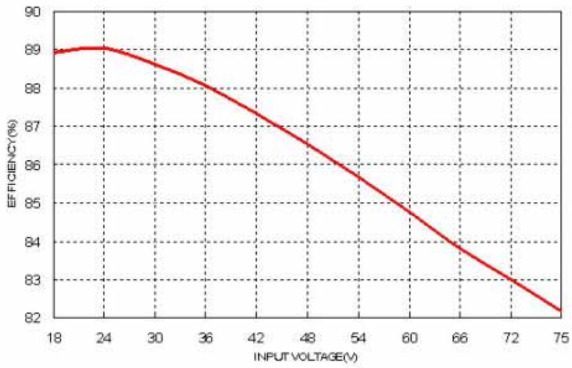
All test conditions are at 25°C. The figures are identical for TEN 40-4823WI



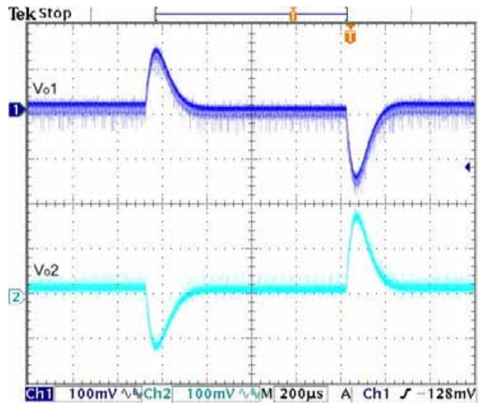
Efficiency Versus Output Current



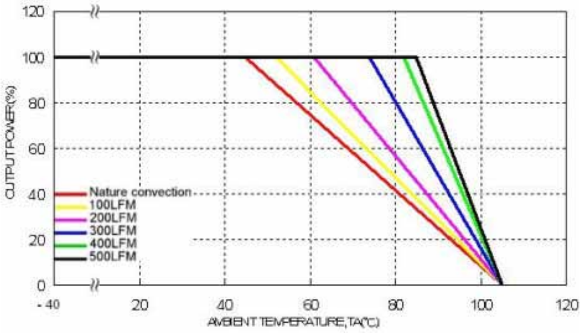
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



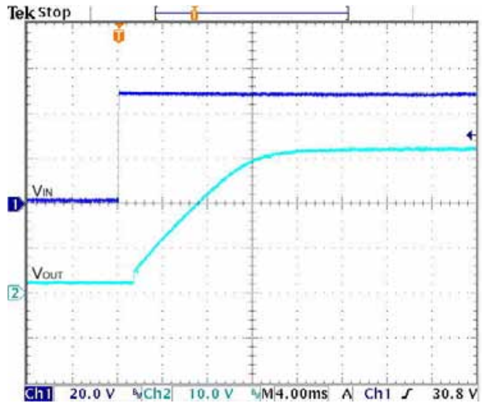
Efficiency Versus Input Voltage. Full Load



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



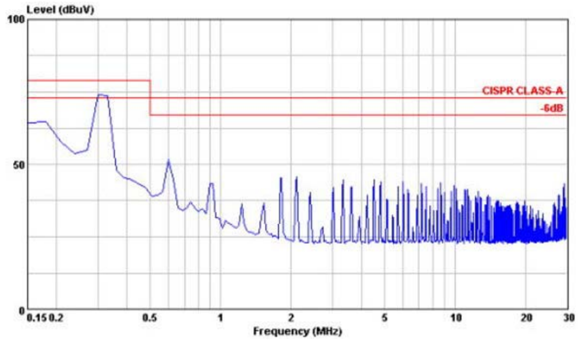
Derating Output Current Versus Ambient Temperature and Airflow
$V_{in} = V_{in\,nom}$



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

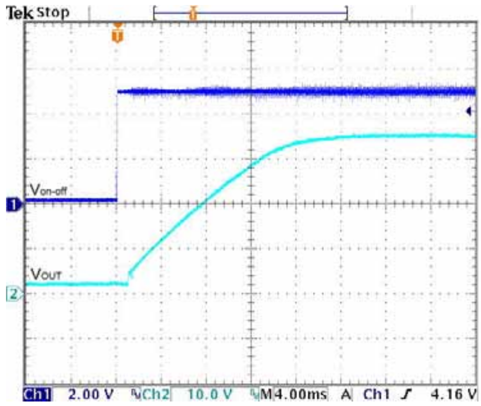
Characteristic Curves

All test conditions are at 25°C. The figures are identical for TEN 40-4823WI (Continued)



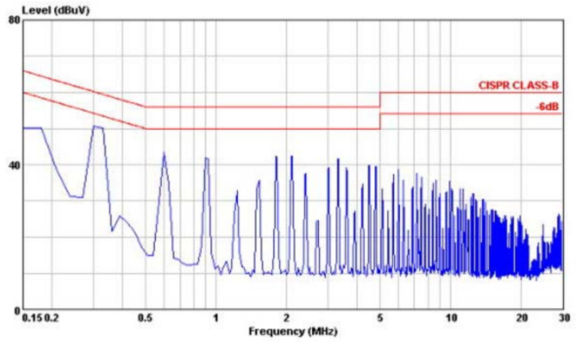
Conduction Emission of EN55022 Class A

$V_{in} = V_{in\,nom}$, Full Load



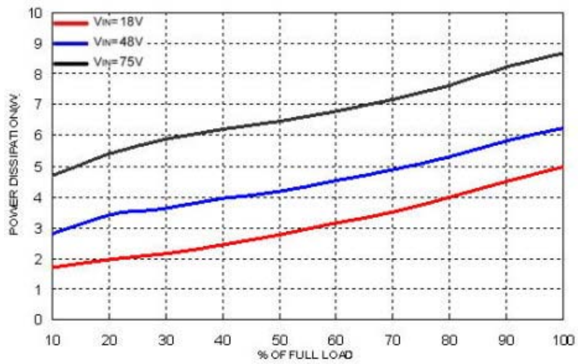
Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic

$V_{in} = V_{in\,nom}$, Full Load

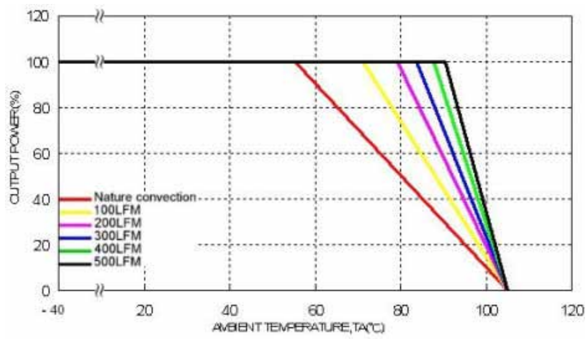


Conduction Emission of EN55022 Class B

$V_{in} = V_{in\,nom}$, Full Load



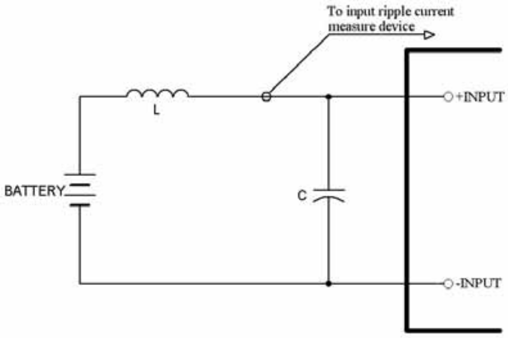
Power Dissipation Versus Output Current



Derating Output Current Versus Ambient Temperature with Heat-Sink and Airflow, $V_{in} = V_{in\,nom}$

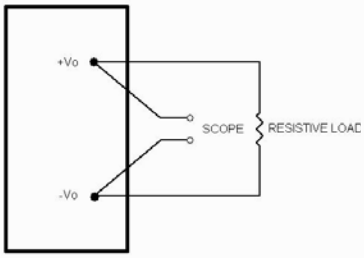
Test Configurations

Input reflected-ripple current measurement test up

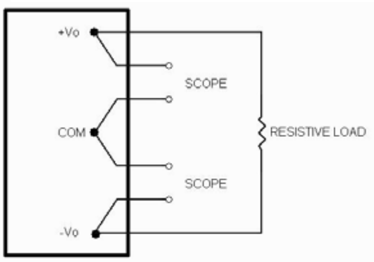


Component	Value	Voltage	Reference
L	12µH	----	----
C	47µF	100V	Aluminum Electrolytic Capacitor

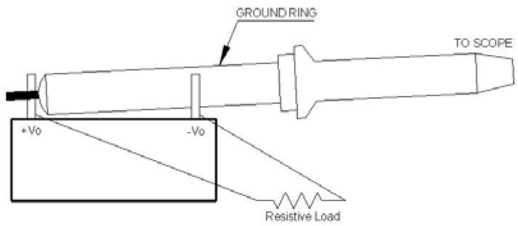
Peak-to-peak output ripple & noise measurement test up



Single output

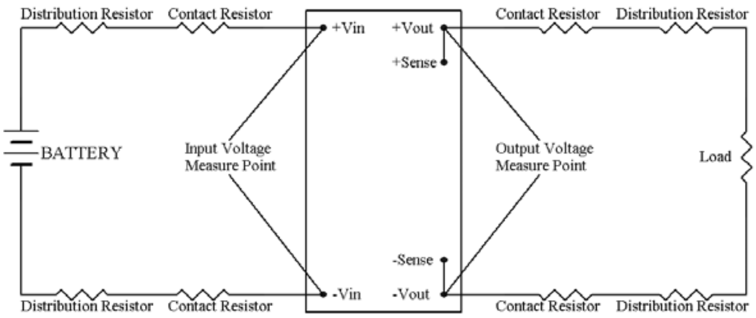


Dual Output

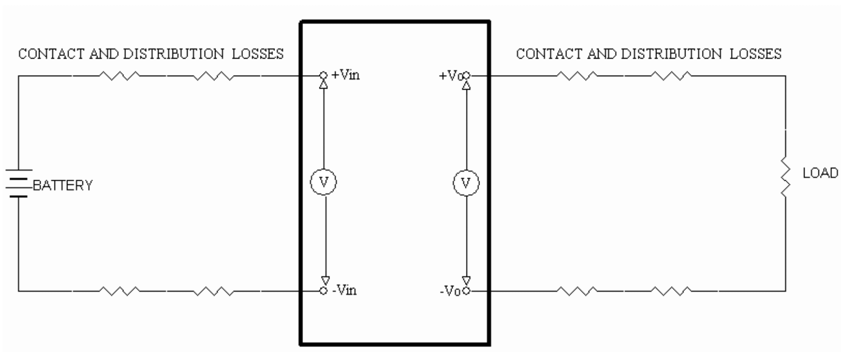


Output voltage and efficiency measurement test up

Single Output



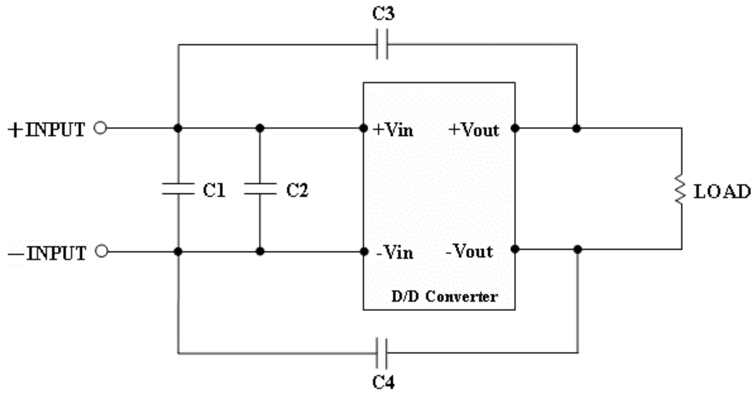
Dual Output



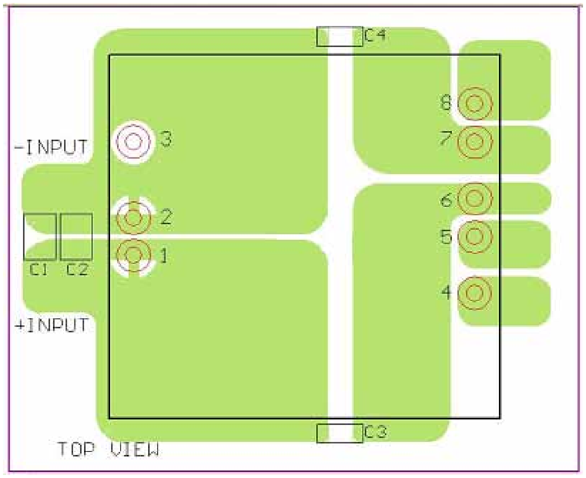
$$Efficiency = \left(\frac{V_o \times I_o}{V_{in} \times I_{in}}\right) \times 100\%$$

Note: All measurements are taken at the module terminals.

EMC Considerations



Suggested Schematic to comply with Conducted Noise according to EN55022 Class A



Recommended Layout with Input Filter

Following components are needed to comply with EN55022 Class A conducted noise:

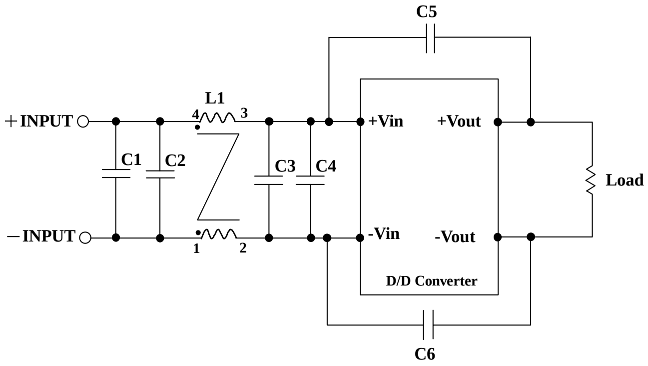
TEN 40-24xxWI

Component	Value	Voltage	Reference
C1, C2	----	----	----
C3, C4	1000pF	2KV	1206 MLCC

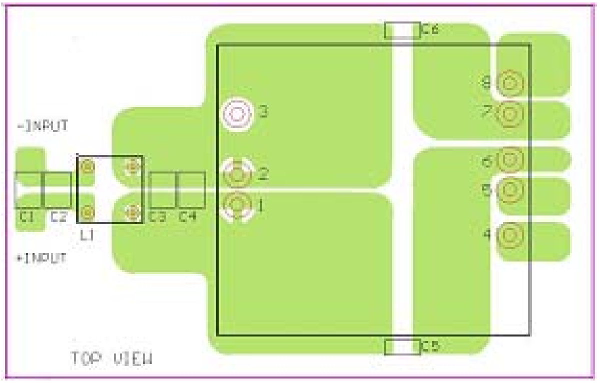
TEN 40-48xxWI

Component	Value	Voltage	Reference
C1, C2	2.2uF	100V	1812 MLCC
C3, C4	1000pF	2KV	1206 MLCC

EMC Considerations (Continued)



Suggested Schematic to comply with Conducted Noise according to EN55022 Class B



Recommended Layout with Input Filter

T Following components are needed to comply with EN55022 Class B conducted noise:

TEN 40-24xxWI

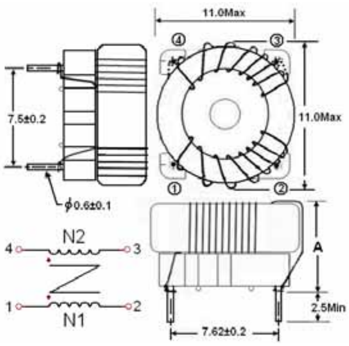
Component	Value	Voltage	Reference
C1, C3	4.7uF	50V	1812 MLCC
C5, C6	1000pF	2KV	1206 MLCC
L1	450uH	----	Common Choke, P/N: TCK-048

TEN 40-48xxWI

Component	Value	Voltage	Reference
C1, C2	2.2uF	100V	1812 MLCC
C3, C4	2.2uF	100V	1812 MLCC
C5, C6	1000pF	2KV	1206 MLCC
L1	830uH	----	Common Choke, P/N: TCK-053

This Common Choke L1 has been define as follows:

- TCK-048:
  L: 450µH ±35% / DCR: 25mΩ, max
  A height: 9.8 mm, max
- TCK-053:
  L: 830µH ±35% / DCR: 31mΩ, max
  A height: 8.8 mm, Max
- Test condition: 100KHz / 100mV
- Recommended through hole: Φ0.8mm
- All dimensions in millimetres



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 is simulated source impedance of 12µH and capacitor is Nippon chemi-con KZE series 47µF/100V. The capacitor must 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 converters. Normally, overload current is maintained at approximately 150 percent of rated output current .

Hiccup-mode is a method of operation in a converter whose purpose is to protect the converter from being damaged during an over-current fault condition. It also enables the converter to restart after the fault is removed.

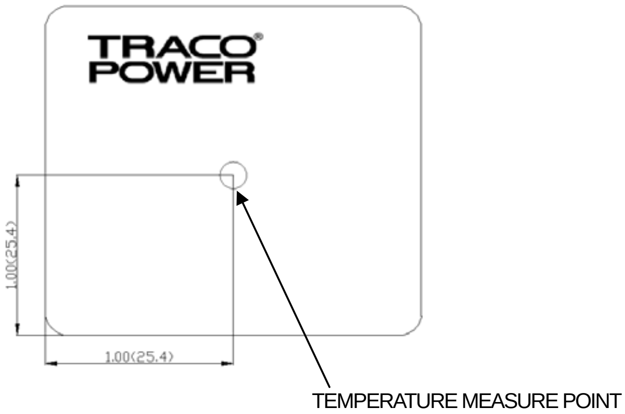
One of the problems resulting from over current is that excessive heat may be generated in the converter; especially MOSFET and Schottky diodes and the temperature of those devices may exceed their specified limits. A protection mechanism has to be used to prevent those power devices from being damaged due to over heating.

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. This protection is only available on the TEN 40-WI single output.

Thermal Consideration

The TEN 40-WI operates in a variety of thermal environments. However, sufficient cooling should be provided to 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 shown in the figure below. The temperature at this point 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 higher reliability.

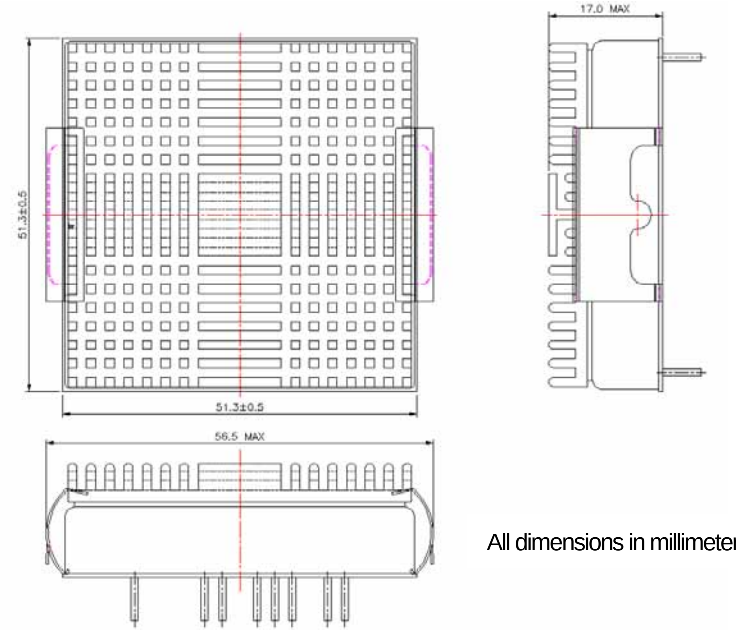


Measurement shown in inches and (millimeters)

TOP VIEW

Heat Sink Consideration

Equip heat-sink for lower temperature and higher reliability of the module. Considering space and air-flow is the way to choose which heat-sink is needed. Order Code: TEN-HS3

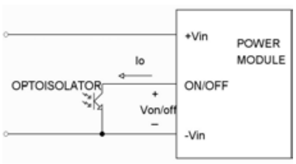


All dimensions in millimeters

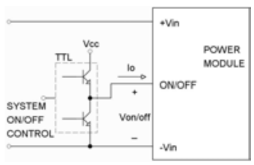
Remote ON/OFF Control

The Remote ON/OFF Pin is controlled DC/DC power module to turn on and off; the user must use a switch to control the logic voltage high or low level of the pin referenced to $-V_{in}$. The switch can be open collector transistor, FET and Photo-Couple. The switch must be capable of sinking up to 1 mA at low-level logic Voltage. High-level logic of the ON/OFF signal maximum voltage is allowable leakage current of the switch at 15V is 50µA.

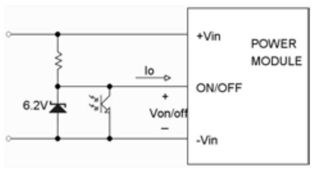
Remote ON/OFF recommended Circuits



Isolated-Closure Remote ON/OFF

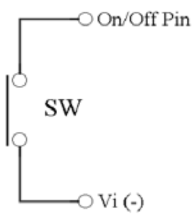


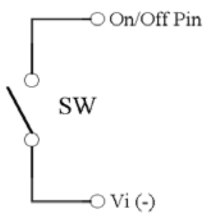
Level Control Using TTL Output



Level Control Using Line Voltage

The Positive logic structure turned on of the DC/DC module when the ON/OFF pin is at high-level logic and low-level logic is turned off it.

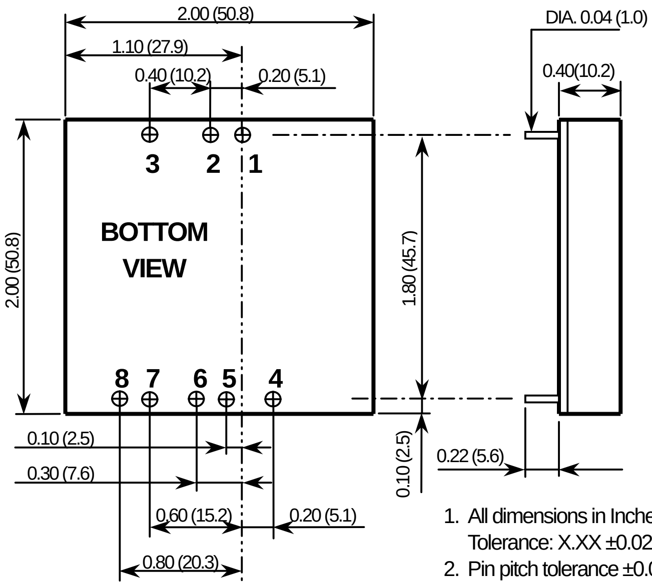




TEN 40-WI module is turned off at Low-level logic

TEN 40-WI module is turned on at High-level logic

Mechanical Data

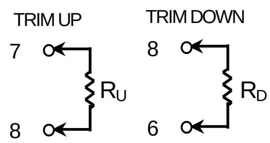


1. All dimensions in Inches (mm)
   Tolerance: X.XX ±0.02 (X.X ±0.5)
2. Pin pitch tolerance ±0.014(0.35)

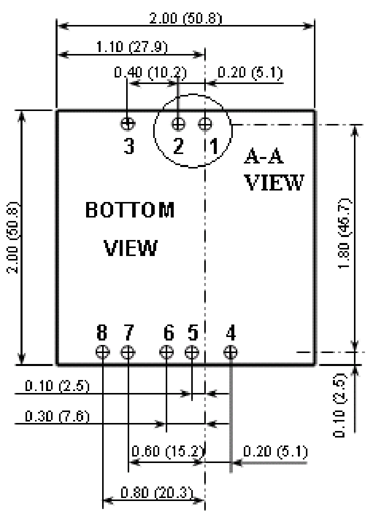
PIN CONNECTION		
PIN	Single Output	Dual Output
1	+Vin (Vcc)	+Vin (Vcc)
2	-Vin (GND)	-Vin (GND)
3	CTRL	CTRL
4	-Sense	+Vout
5	+Sense	Com
6	+Vout	Com
7	-Vout	-Vout
8	TRIM	TRIM

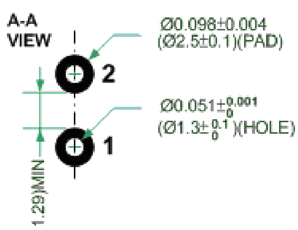
EXTERNAL OUTPUT

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



Recommended Pad Layout



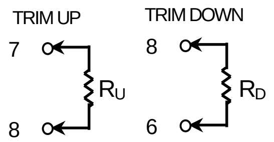


TOP VIEW

1. All dimensions in Inches (mm)
   Tolerance: X.XX ±0.02 (X.X ±0.5)
2. Pin pitch tolerance ±0.014(0.35)

Output Voltage Adjustment

Output voltage set point adjustment allows the user to adjust the output voltage of a module. This is accomplished by connecting an external resistor between the TRIM pin and either the +SENSE or -SENSE pins. With an external resistor between the TRIM and -SENSE pin, the output voltage value will increases. With an external resistor between the TRIM and +SENSE pin, the output voltage value will decreases.



TRIM TABLE

TEN 40-xx10WI

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 40-xx11WI

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 (K Ohms) =	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 40-xx12WI

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) =	367.910	165.950	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) =	460.990	207.950	123.600	81.423	56.118	39.249	27.199	18.162	11.132	5.509

TEN 40-xx13WI

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) =	404.180	180.590	106.060	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) =	499.820	223.410	131.270	85.204	57.563	39.136	25.974	16.102	8.424	2.282

TEN 40-xx22WI

Trim up (%)	1	2	3	4	5	6	7	8	9	10
V_{OUT} (Volts)=	±12.12	±12.24	±12.36	±12.48	±12.6	±12.72	±12.84	±12.96	±13.08	±13.2
R_U (kΩ) =	218.21	98.105	58.07	38.052	26.042	18.035	12.316	8.026	4.69	2.021
Trim down (%)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
V_{OUT} (Volts)=	±11.88	±11.76	±11.64	±11.52	±11.4	±11.28	±11.16	±11.04	±10.92	±10.8
R_D (kΩ) =	273.44	123.02	72.874	47.803	32.76	22.732	15.568	10.196	6.017	2.675

TEN 40-xx23WI

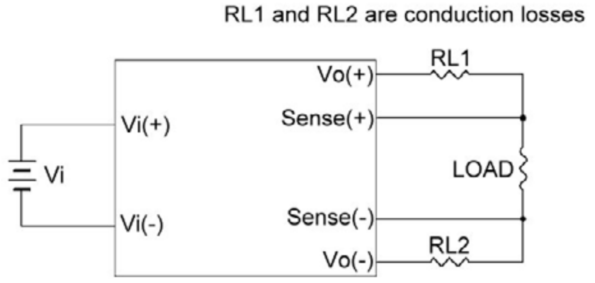
Trim up (%)	1	2	3	4	5	6	7	8	9	10
V_{OUT} (Volts)=	±15.15	±15.3	±15.45	±15.6	±15.75	±15.9	±16.05	±16.2	±16.35	±16.5
R_U (kΩ) =	268.29	120.64	71.429	46.822	32.058	22.215	15.184	9.911	5.81	2.529
Trim down (%)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
V_{OUT} (Volts)=	±14.85	±14.7	±14.55	±14.4	±14.25	±14.1	±13.95	±13.8	±13.65	±13.5
R_D (kΩ) =	337.71	152.02	90.126	59.178	40.609	28.23	19.387	12.756	7.598	3.471

Remote Sense Application Circuit (only single output converters)

The Remote Sense function can be regulate terminals the voltage of load when output current through the line resistor to bring about drop voltage. The Remote Sense voltage range can't be over 10% V_{out}, i.e.:

$$[+V_{out} \text{ to } -V_{out}] - [+\text{Sense to } -\text{Sense}] \leqq 10\% V_{out}$$

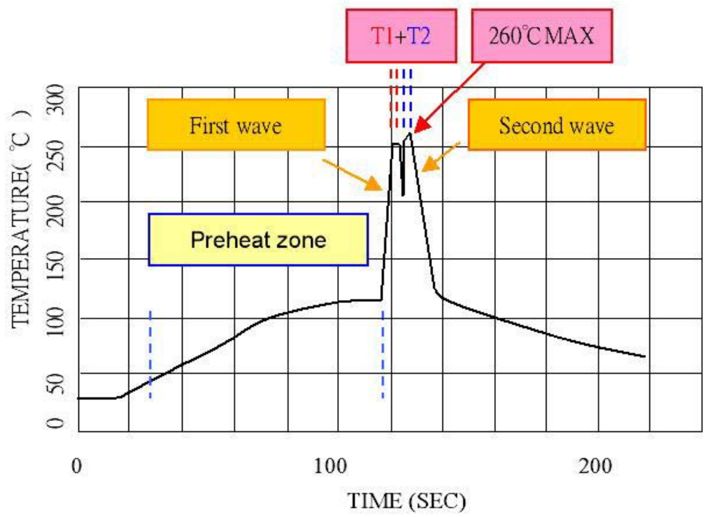
If the Remote Sense function is not used, then the +Sense has to be connected with $+V_{out}$ and the -SENSE has to be connected with $-V_{out}$ direct on the terminals of the TEN 40-WI modules.



Operation with Output Voltage and Sense Function used

Soldering and Reflow Consideration

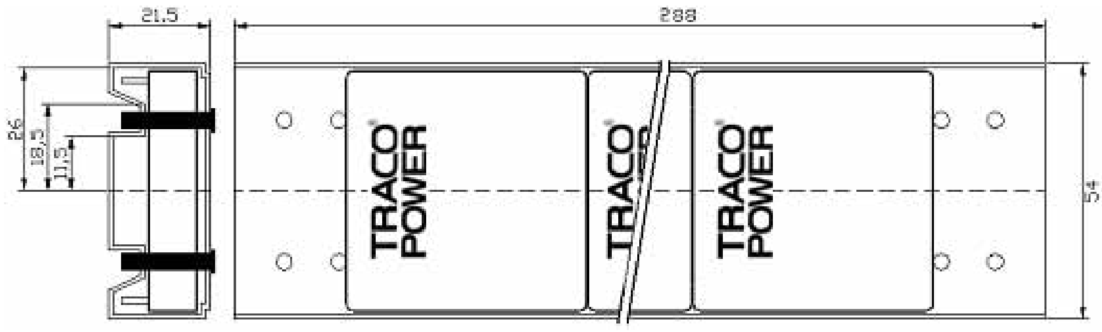
Lead free wave solder profile for TEN 40-WI converters



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

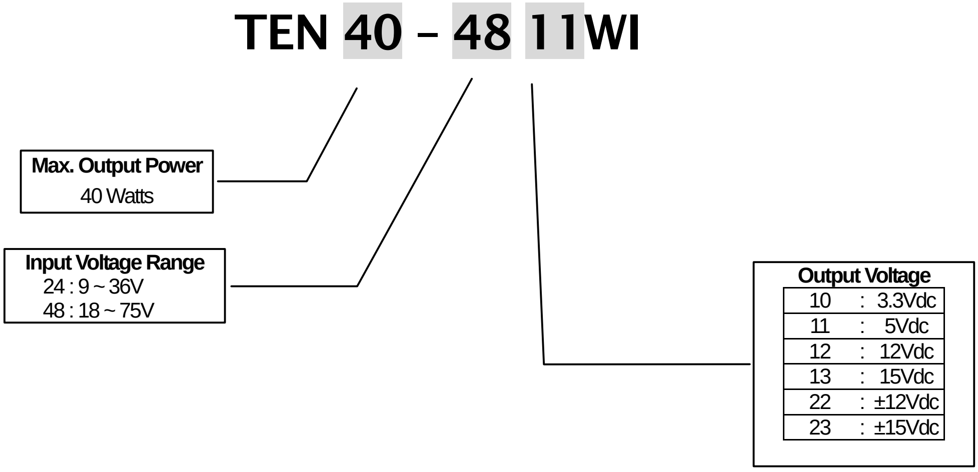
Reference Solder: Sn-Ag-Cu: Sn-Cu
Hand Soldering: Soldering iron: Power 90W
Welding Time: 2～4 sec
Temperature: 380～400℃

Packaging Information



5 PCS per TUBE

Part Number Structure



Model Number	Input Voltage Range	Output Voltage	Output Current Full Load	Input Current Full Load (1)	Efficiency (2) (%)
TEN 40-2410WI	9 – 36 Vdc	3.3 Vdc	10000mA	1677mA	86
TEN 40-2411WI	9 – 36 Vdc	5 Vdc	8000mA	2008mA	87
TEN 40-2412WI	9 – 36 Vdc	12 Vdc	3333mA	2008mA	87
TEN 40-2413WI	9 – 36 Vdc	15 Vdc	2666mA	2008mA	87
TEN 40-2422WI	9 – 36 Vdc	±12 Vdc	± 1667mA	2032mA	86
TEN 40-2423WI	9 – 36 Vdc	±15 Vdc	± 1333mA	2032mA	86
TEN 40-4810WI	18 – 75 Vdc	3.3 Vdc	10000mA	838mA	86
TEN 40-4811WI	18 – 75 Vdc	5 Vdc	8000mA	992mA	88
TEN 40-4812WI	18 – 75 Vdc	12 Vdc	3333mA	1004mA	87
TEN 40-4813WI	18 – 75 Vdc	15 Vdc	2666mA	1004mA	87
TEN 40-4822WI	18 – 75 Vdc	±12 Vdc	± 1667mA	1016mA	86
TEN 40-4823WI	18 – 75 Vdc	±15 Vdc	± 1333mA	1016mA	86

Note 1. Maximum value at nominal input voltage and full load.
Note 2. Typical value at nominal input voltage and full load.

Safety and Installation Instruction

Fusing Consideration

Caution: The TEN 40-WI is not internally fused. An input line fuse must always be used.

This encapsulated converter can be used in a wide variety of applications, ranging from simple stand-alone operation to an integrated part of sophisticated power architecture. To keep 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 8A for TEN 40-24xxWI modules and 5A for TEN 40-48xxWI modules. 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 40-WI DC/DC converters has been calculated according to:

- Bellcore TR-NWT-000332 Case I: 50% stress, Operating Temperature at 40°C (Ground fixed and controlled environment). The resulting figure for MTBF is: 1'105'000 hours.
- MIL-HDBK 217F NOTICE2 FULL LOAD, Operating Temperature at 25°C. The resulting figure for MTBF is: 151'100 hours.