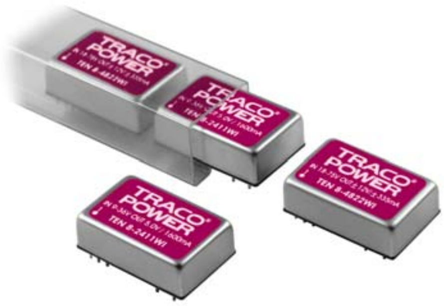
TRACO® POWER

TEN 8-WI Series

Application Note

DC/DC Converter 9 to 36Vdc or 18 to 75Vdc or 43 to 160Vdc Input Voltage Range;
3.3 to 15Vdc Single Outputs Converters and ±5 to ±15Vdc Dual Output Converters, 8W



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Complete TEN 8-WI datasheet can be downloaded at:
http://www.tracopower.com/products/ten8WI.pdf

Features

- RoHS compliant
- Single output up to 2.4A
- Dual output up to ±800mA
- Standard 24 PIN DIP Package
- Five-sided continuous shield
- No minimum load required
- High power density
- High efficiency up to 88%
- Small size
  31.8×20.3×10.4 mm (1.25×0.8×0.450 inch)
- Input to output isolation (1600Vdc for 60 seconds)
- 4:1 ultra wide input voltage range
- Fixed switching frequency
- Input under-voltage protection
- Output over-voltage protection
- Over-current protection
- Output short circuit protection
- Remote on/off

Applications

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

General Description

The TEN 8-WI series offer 8 watts of output power from a package in a 24 pin DIP configuration and have a 4:1 ultra wide input voltage range from 9 to 36Vdc respectively 18 to 75Vdc or 43 to 160Vdc. This product features 1600Vdc of isolation test voltage, short circuit protection and five side 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 Transient (100ms max.)	 24xxWI 48xxWI 72xxWI 24xxWI 48xxWI 72xxWI		 40 80 160 50 100 170	 Vdc Vdc Vdc Vdc Vdc Vdc
Input Voltage Variation (complies with EST300 132 part 4.4)	All		5	V/ms
Operating Ambient Temperature (with derating)	All	-40	85	°C
Operating Case Temperature	All		105	°C
Storage Temperature	All	-55	125	°C

Output Specification					
Parameter	**Model**	**Min**	**Typ**	**Max**	**Unit**
Output Voltage (at $V_{in\,nom}$ and Full Load; T_A = 25°C)	xx10WI xx11WI xx12WI xx13WI xx21WI xx22WI xx23WI	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	Vdc
Output Regulation Line (from $V_{in\,min}$ to $V_{in\,max}$ at Full Load) Load (from 0% up to 100% of Full Load)	Single output	 -0.2 -0.5		 +0.2 +0.5	%
Output Regulation Line ($V_{in\,min}$ to $V_{in\,max}$ at Full Load) Load (0% to 100% of Full Load)	Dual output	 -0.2 -1.0		 +0.2 +1.0	%
Output Ripple & Noise (see page 33) Peak-to-Peak (5Hz to 20MHz bandwidth)	24xxWI 48xxWI 72xxWI			50 50 75	mV pk-pk
Temperature Coefficient	All	-0.02		+0.02	%/K
Output Voltage Overshoot (over the whole Input Voltage Range and Full Load; T_A = 25°C)	All		0	3	% V_{out}
Dynamic Load Response (at $V_{in\,nom}$; 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	xx10WI xx11WI xx12WI xx13WI xx21WI xx22WI xx23WI	0 0 0 0 0 0 0		2400 1600 666 533 ±800 ±333 ±267	mA

Output Specification					
Parameter	**Model**	**Min**	**Typ**	**Max**	**Unit**
Output Over Voltage Protection (Zener diode clamp) only single output converters	xx10WI xx11WI xx12WI xx13WI		3.9 6.2 15 18		Vdc
Output Over Current Protection	All		150		% FL.
Output Short Circuit Protection	All	Continuous, automatics recovery			

Input Specification					
Parameter	**Model**	**Min**	**Typ**	**Max**	**Unit**
Operating Input Voltage	24xxWI	9	24	36	Vdc
	48xxWI	18	48	75	
	72xxWI	43	110	160	
Input Current max. (at $V_{in\ nom}$ and Full Load)	2410WI			407	mA
	2411WI			402	
	2412WI			407	
	2413WI			407	
	2421WI			417	
	2422WI			407	
	2423WI			407	
	4810WI			204	
	4811WI			201	
	4812WI			201	
	4813WI			198	
	4821WI			208	
	4822WI			203	
	4823WI			201	
	7210WI			82	
	7211WI			90	
	7212WI			88	
	7213WI			88	
	7221WI			93	
	7222WI			90	
	7223WI			90	

Input Specification					
Parameter	**Model**	**Min**	**Typ**	**Max**	**Unit**
Input Standby current typ.	2410WI		40		
(at $V_{in\ nom}$ and No Load)	2411WI		40		
	2412WI		25		
	2413WI		25		
	2421WI		20		
	2422WI		25		
	2423WI		25		
	4810WI		20		
	4811WI		20		
	4812WI		13		
	4813WI		13		mA
	4821WI		10		
	4822WI		13		
	4823WI		13		
	7210WI		8		
	7211WI		8		
	7212WI		4		
	7213WI		4		
	7221WI		5		
	7222WI		5		
	7223WI		5		
Under Voltage Lockout Turn-on Threshold	24xxWI		9		
	48xxWI		18		Vdc
	72xxWI		43		

General Specification					
Parameter	**Model**	**Min**	**Typ**	**Max**	**Unit**
Under Voltage Lockout Turn-off Threshold	24xxWI		8		
	48xxWI		16		Vdc
	72xxWI		42		
Input reflected ripple current (see page 33) (5 to 20MHz, 12µH source impedance)	All		20		mA pk-pk
Start Up Time (V_{in} = $V_{in\ nom}$ and constant resistive load)	All				ms
Power up			450		
Remote ON/OFF			5		
Remote ON/OFF Control (see page 37) (The On/Off pin voltage is referenced to negative input)					
On/Off pin High Voltage (Remote ON)	All	3.0		12	Vdc
On/Off pin Low Voltage (Remote OFF)		0		1.2	Vdc
On/Off pin Low Voltage, input current (Standby Current)				2.5	mA

General Specification

Parameter	Model	Min	Typ	Max	Unit
Efficiency (see page 21) (at $V_{in\ nom}$ and Full Load; T_A = 25°C)	2410WI		85.0		%
	2411WI		87.0		
	2412WI		86.0		
	2413WI		86.0		
	2421WI		84.0		
	2422WI		86.0		
	2423WI		86.0		
	4810WI		85.0		
	4811WI		87.0		
	4812WI		87.0		
	4813WI		88.0		
	4821WI		84.0		
	4822WI		87.0		
	4823WI		87.0		
	7210WI		84.0		
	7211WI		85.0		
	7212WI		86.0		
	7213WI		86.0		
	7221WI		82.0		
	7222WI		85.0		
	7223WI		85.0		
Isolation voltage (Basic Insulation) Input to Output (60 seconds) Input to Case, Output to Case (60 seconds)	All	1600 1600			Vdc
Isolation resistance	All	1			GΩ
Isolation capacitance	All			1500	pF
Switching Frequency (PWM)	All		300		KHz
Weight	All		18.0		g
MTBF Bellcore TR-NWT-000332, T_C = 40°C MIL-STD-217F, T_A = 25°C	All		2.35×10^6 1.08×10^6		hours

Environmental Specification

Parameter	Model	Min	Typ	Max	Unit
Relative humidity	All	5		95	% RH
Thermal shock	EN61373, MIL-STD-810F				
Vibration	EN61373, MIL-STD-810F				

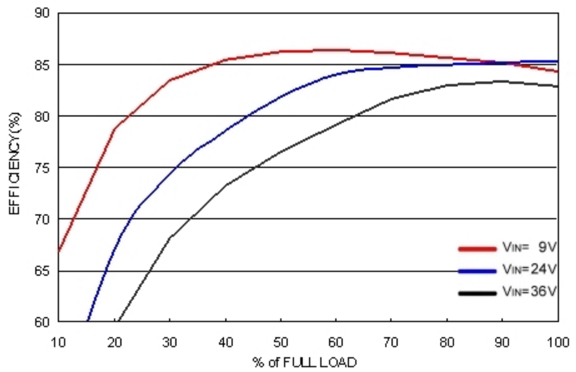
EMC characteristic

EMI	EN 55011, EN 55022		Class A
ESD	EN 61000-4-2	Air: ±8KV Contact: ±6KV	Performance Criteria A
Radiated immunity	EN 61000-4-3	10V/m	Performance Criteria A
Fast transient *	EN 61000-4-4	±2KV	Performance Criteria A
Surge *	EN 61000-4-5	±2KV	Performance Criteria A
Conducted immunity	EN 61000-4-6	10Vr.m.s	Performance Criteria A

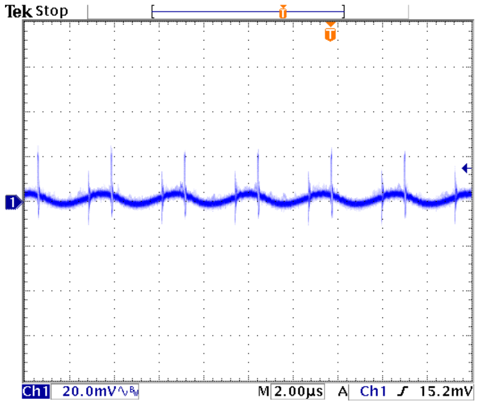
* An external input filter capacitor is required if the module has to comply with EN 61000-4-4, EN 61000-4-5.
The filter capacitor Tracopower suggest: 24Vin/48Vin: Nippon Chemi-con KY series, 220µF/100V, ESR 48mΩ.
110 Vin: Nippon Chemi-con KXJ series, 150µF/200V, ESR

Characteristic Curves

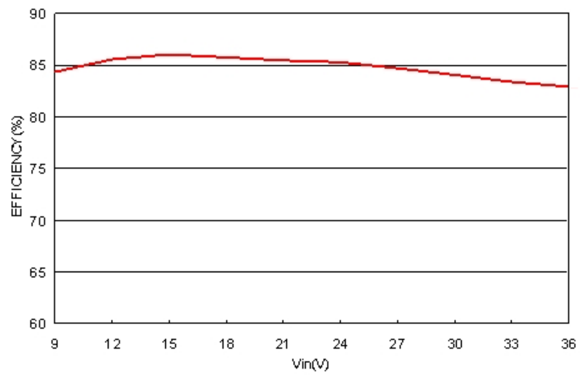
All test conditions are at 25°C. The figures are identical for TEN 8-2410WI



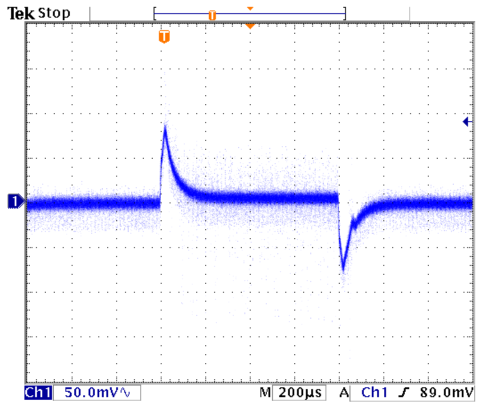
Efficiency versus Output Current



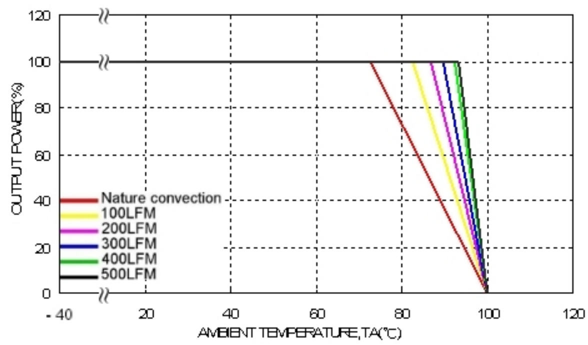
Typical Output Ripple and Noise. $V_{in} = V_{in\,nom}$, Full Load



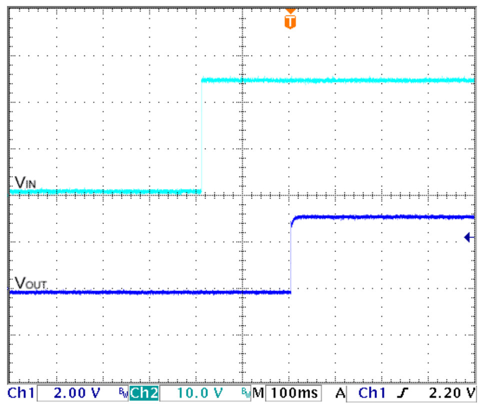
Efficiency versus Input Voltage. Full Load



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



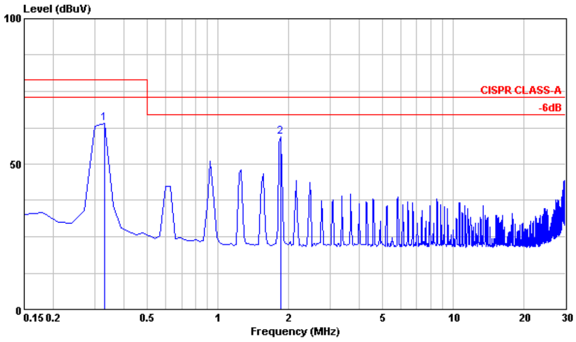
Derating Output Current versus Ambient Temperature and Airflow; $V_{in} = V_{in\,nom}$



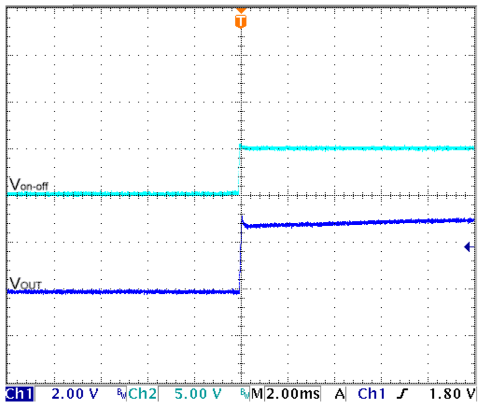
Typical Input Start-Up and Output Rise Characteristic $V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves

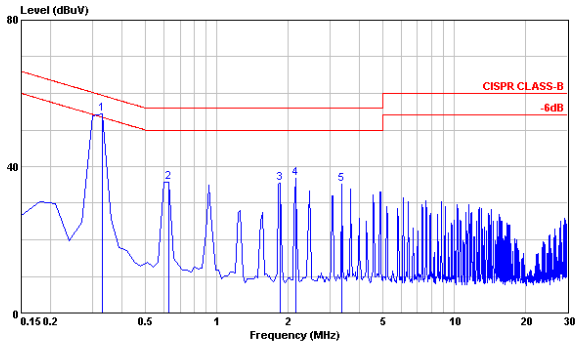
All test conditions are at 25°C. The figures are identical for TEN 8-2410WI (Continued)



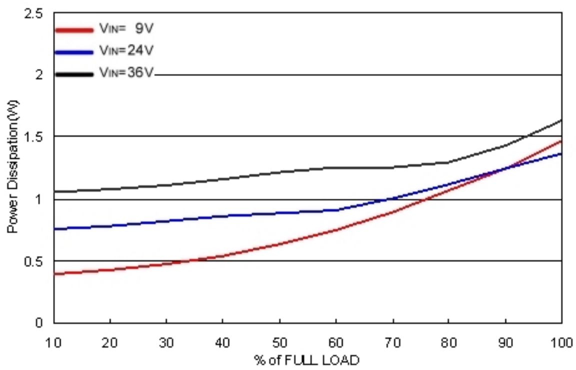
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\,nom}$, Full Load



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



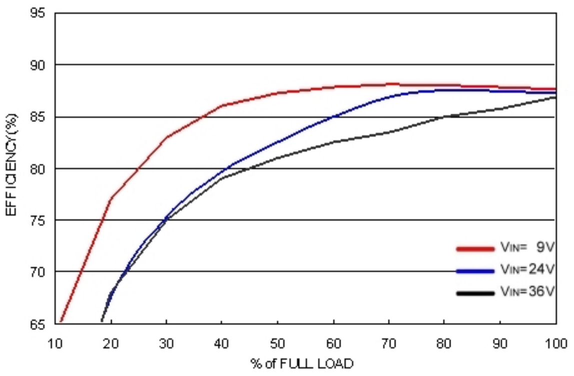
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\,nom}$; Full Load



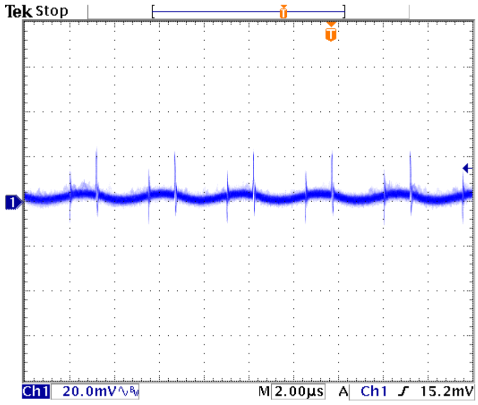
Power Dissipation versus Output Current

Characteristic Curves

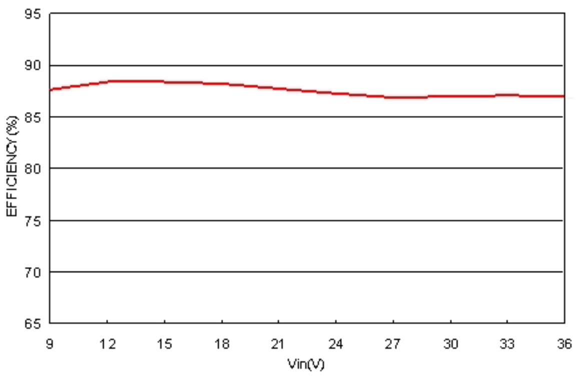
All test conditions are at 25°C. The figures are identical for TEN 8-2411WI



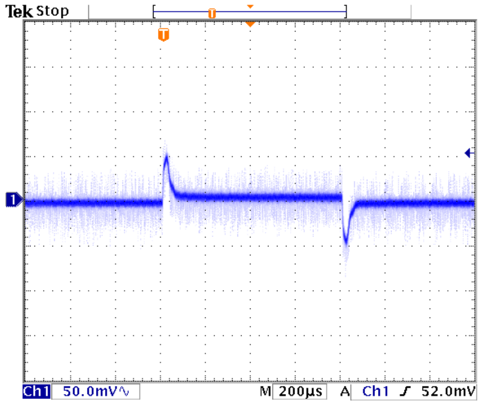
Efficiency versus Output Current



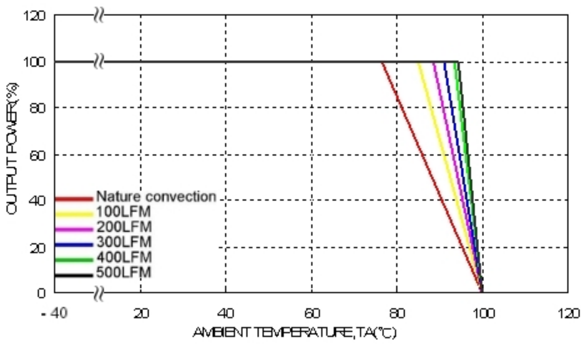
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



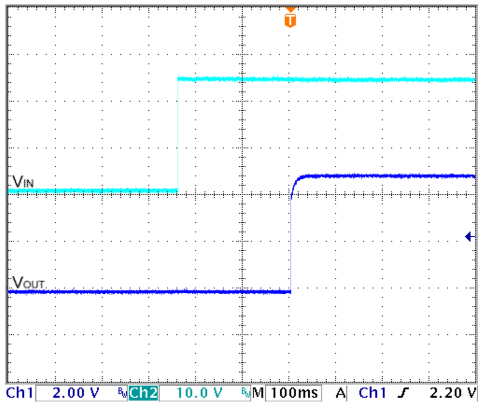
Efficiency versus Input Voltage. Full Load



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



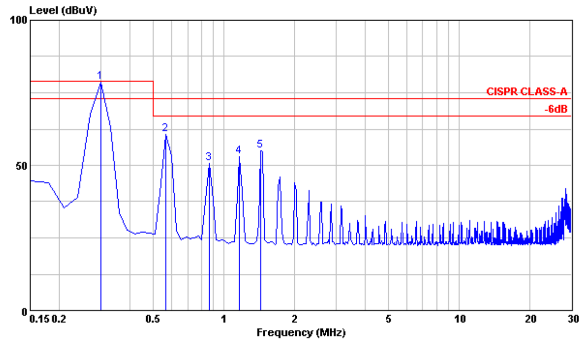
Derating Output Current versus Ambient Temperature and Airflow; $V_{in} = V_{in\,nom}$



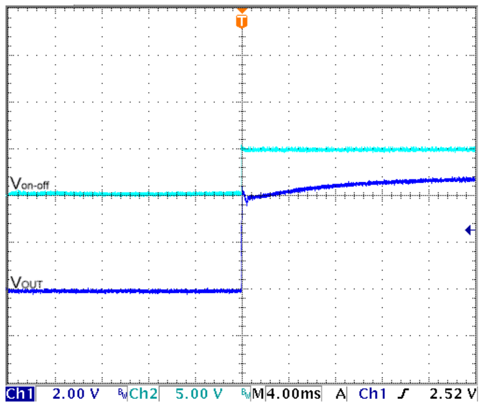
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves

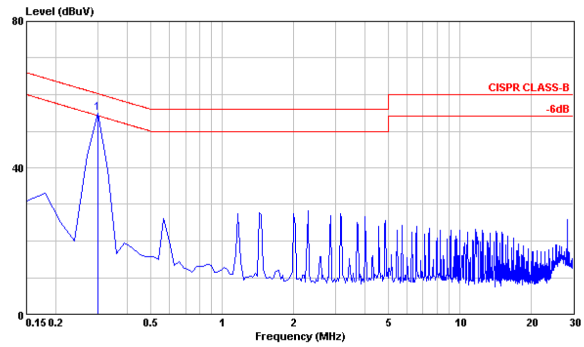
All test conditions are at 25°C. The figures are identical for TEN 8-2411WI (Continued)



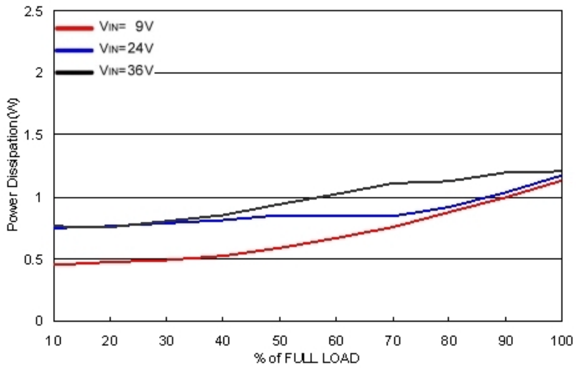
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$, Full Load



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



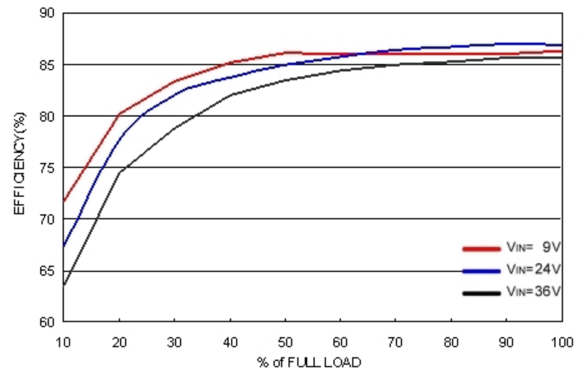
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$, Full Load



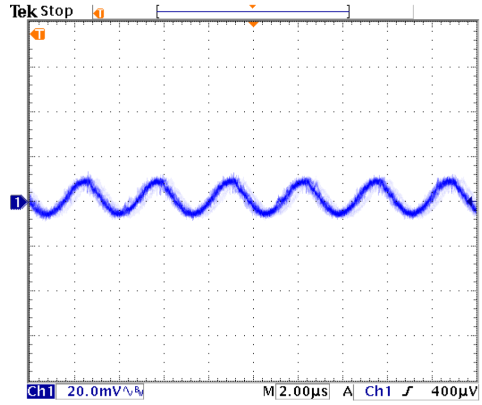
Power Dissipation versus Output Current

Characteristic Curves

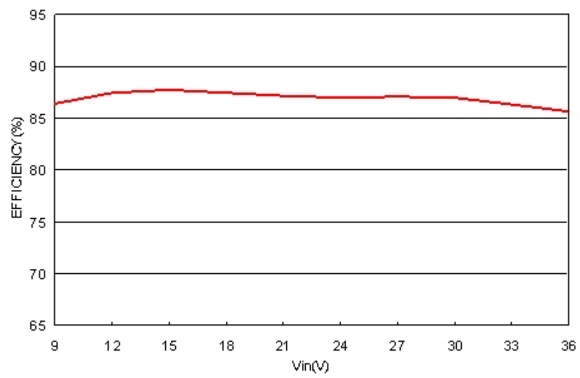
All test conditions are at 25°C. The figures are identical for TEN 8-2412WI



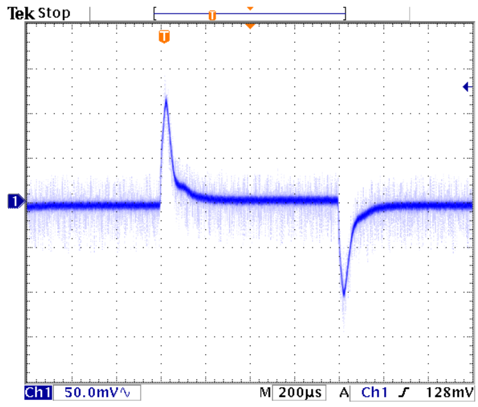
Efficiency versus Output Current



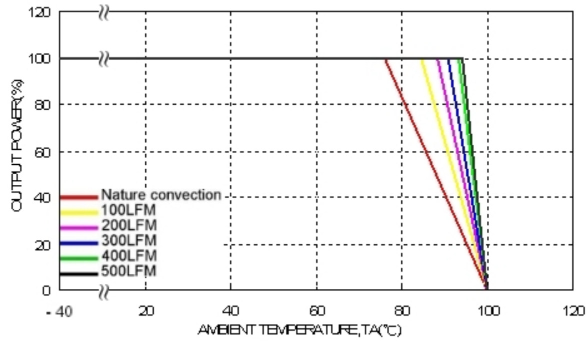
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$, Full Load



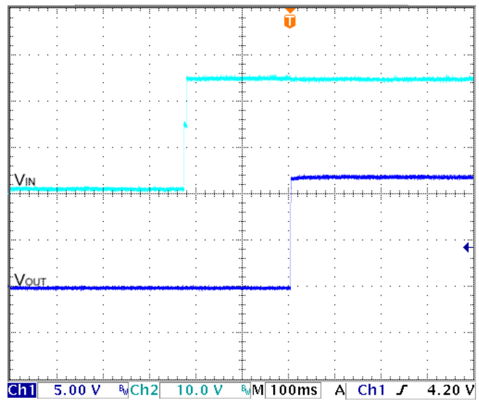
Efficiency versus Input Voltage. Full Load



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



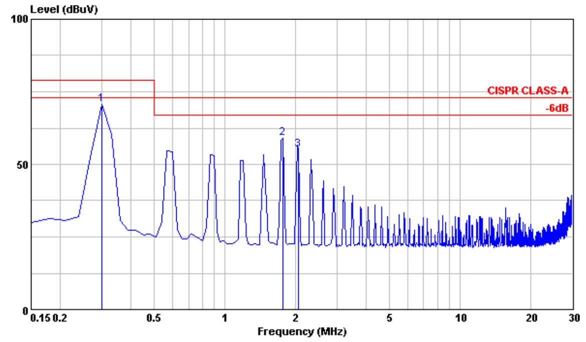
Derating Output Current versus Ambient Temperature and Airflow; $V_{in} = V_{in\ nom}$



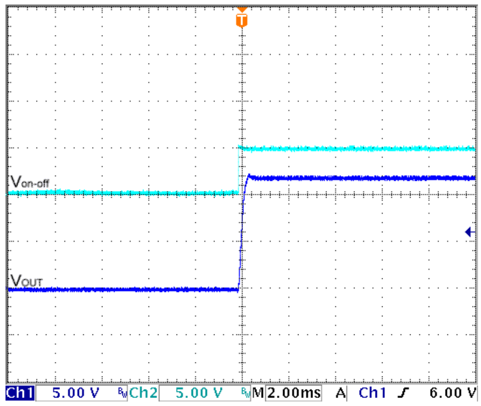
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load

Characteristic Curves

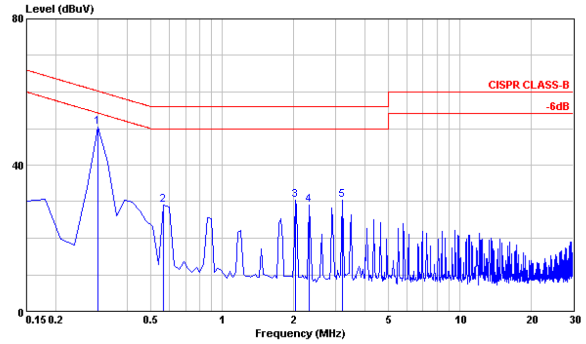
All test conditions are at 25°C. The figures are identical for TEN 8-2412WI (Continued)



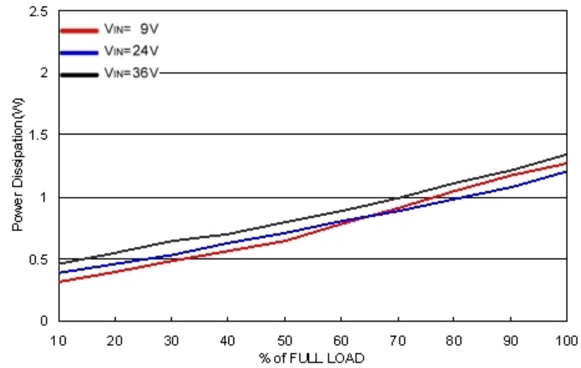
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\,nom}$, Full Load



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



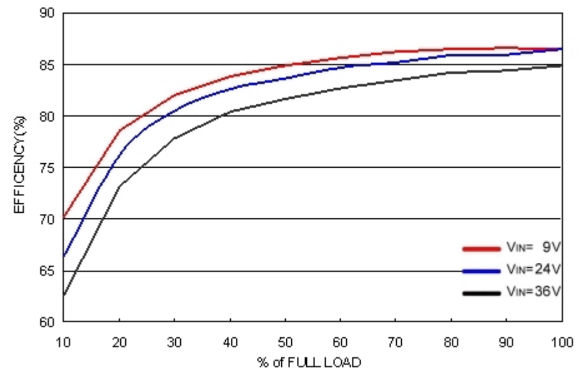
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\,nom}$, Full Load



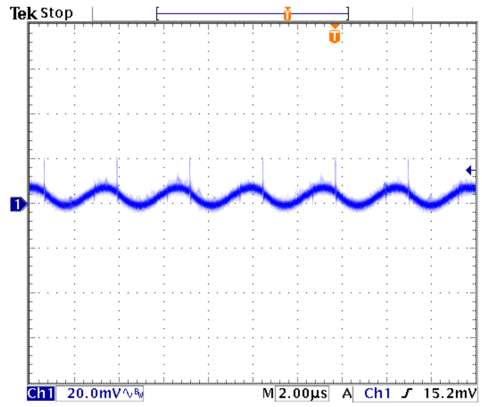
Power Dissipation versus Output Current

Characteristic Curves

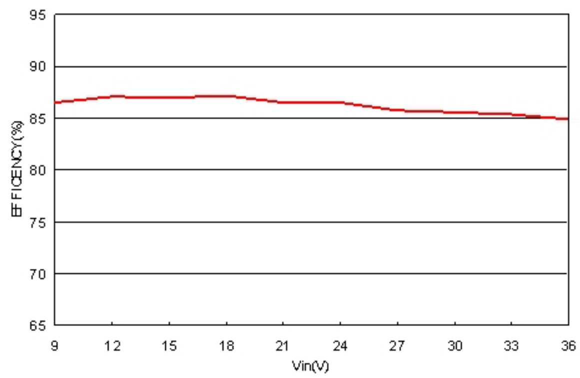
All test conditions are at 25°C. The figures are identical for TEN 8-2413WI



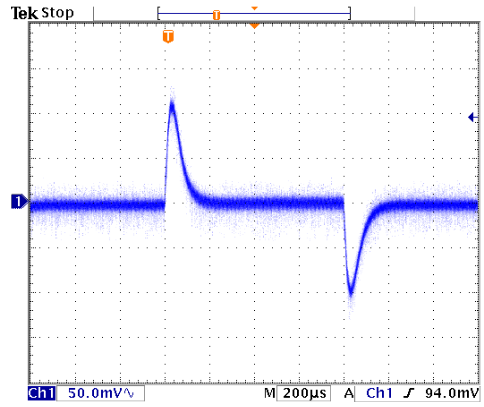
Efficiency versus Output Current



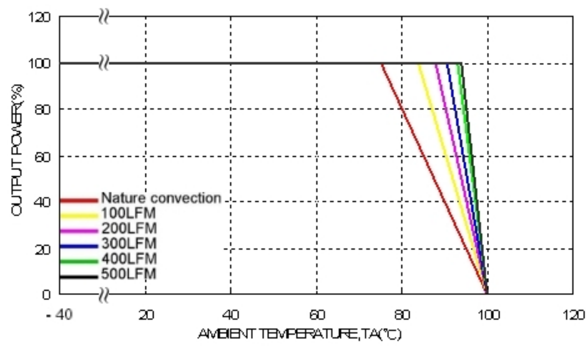
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



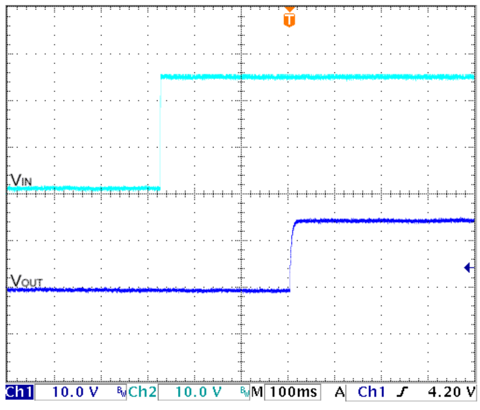
Efficiency versus Input Voltage. Full Load



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



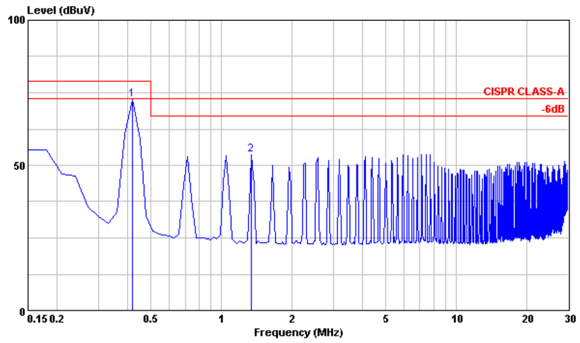
Derating Output Current versus Ambient Temperature and Airflow; $V_{in} = V_{in\,nom}$



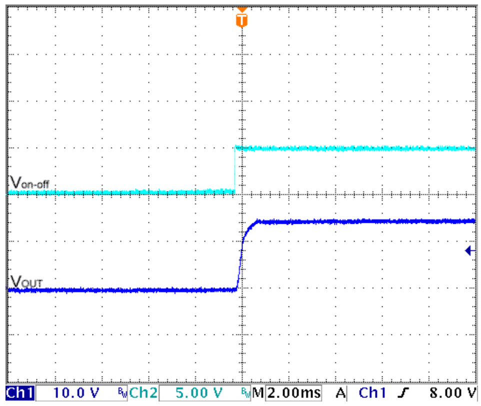
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves

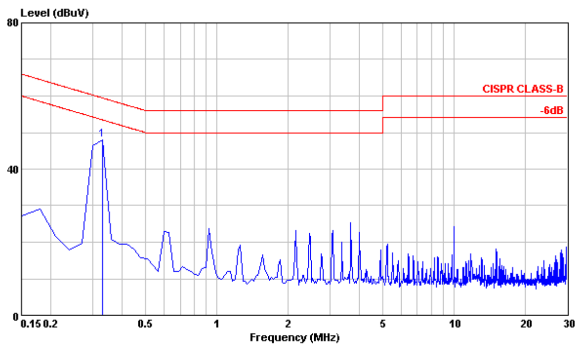
All test conditions are at 25°C. The figures are identical for TEN 8-2413WI (Continued)



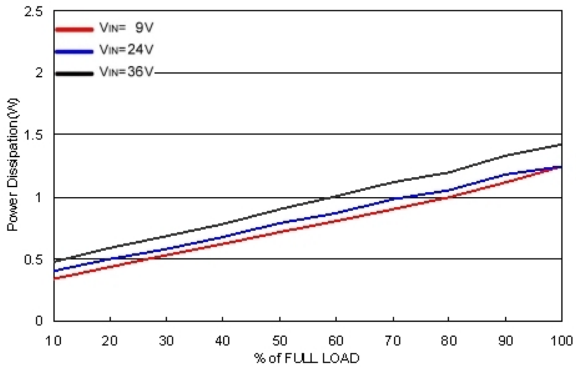
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$, Full Load



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



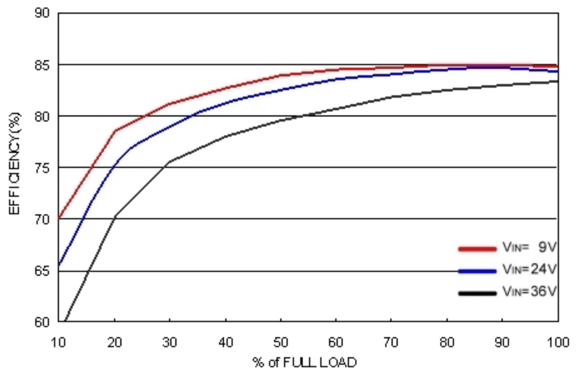
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$, Full Load



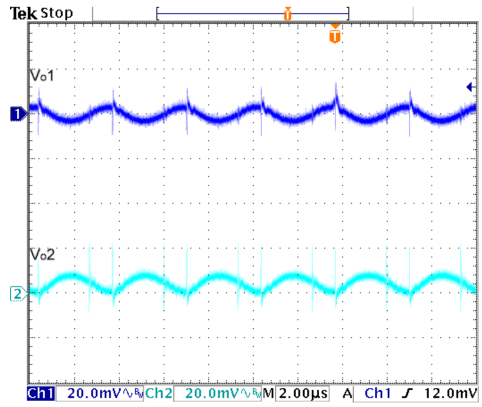
Power Dissipation versus Output Current

Characteristic Curves

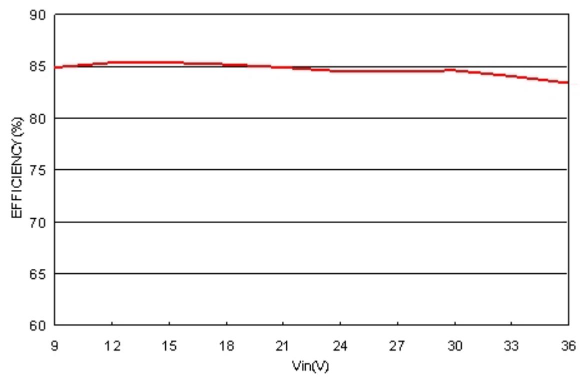
All test conditions are at 25°C. The figures are identical for TEN 8-2421WI



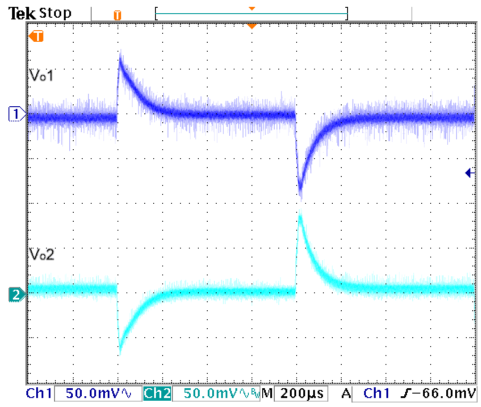
Efficiency versus Output Current



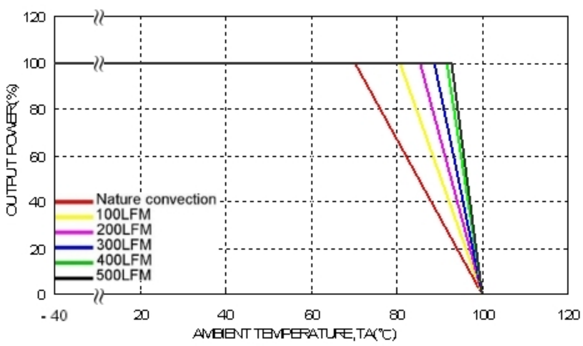
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$, Full Load



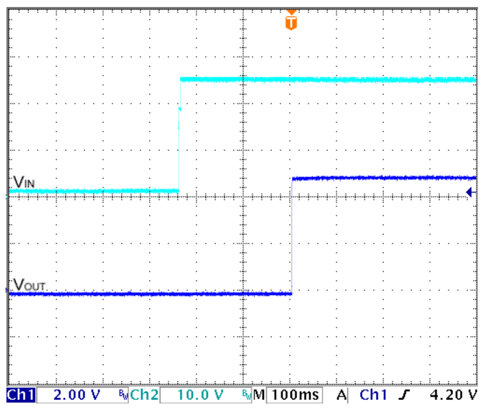
Efficiency versus Input Voltage. Full Load



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



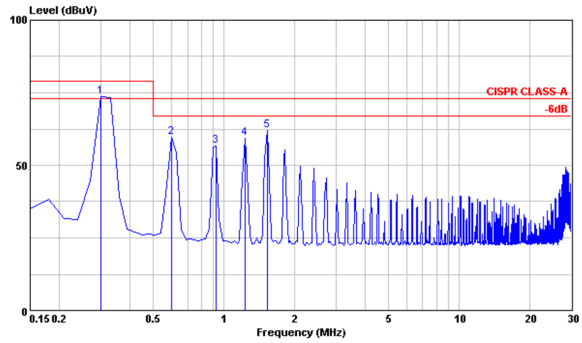
Derating Output Current versus Ambient Temperature and Airflow; $V_{in} = V_{in\ nom}$



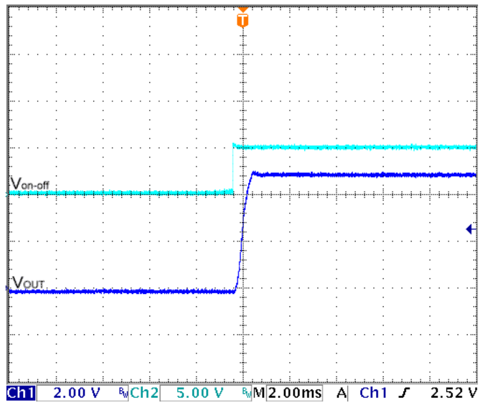
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load

Characteristic Curves

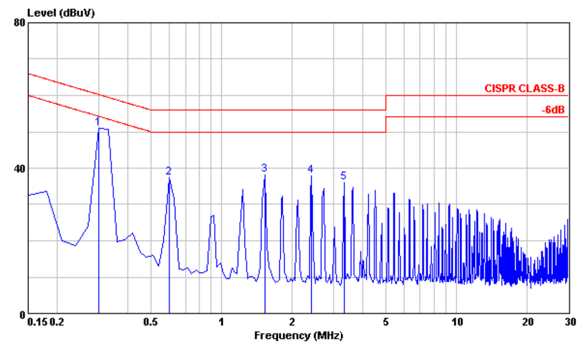
All test conditions are at 25°C. The figures are identical for TEN 8-2421WI (Continued)



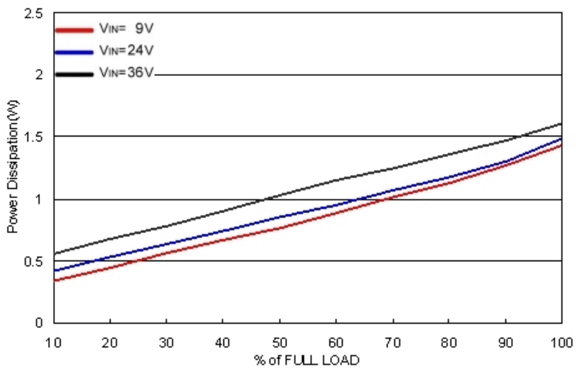
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$, Full Load



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



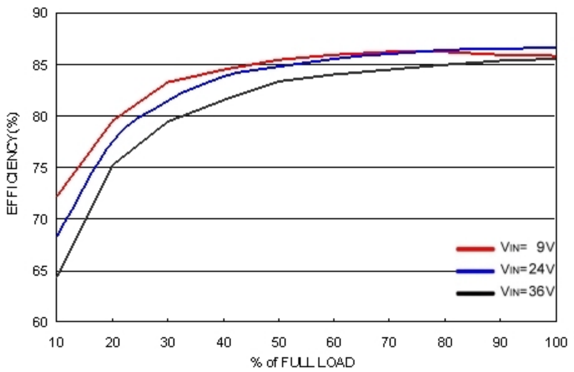
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$, Full Load



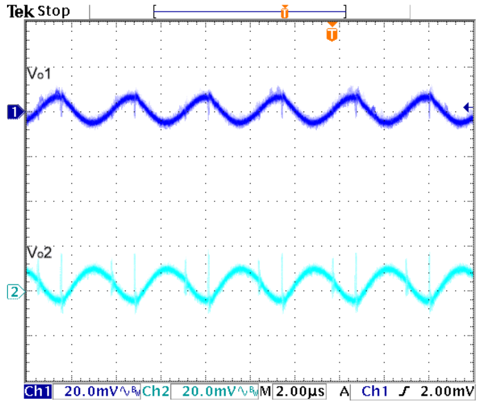
Power Dissipation versus Output Current

Characteristic Curves

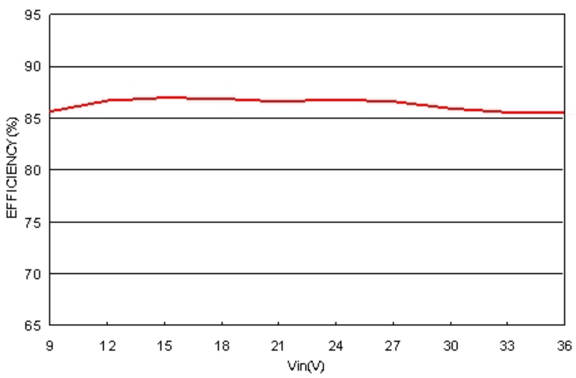
All test conditions are at 25°C. The figures are identical for TEN 8-2422WI



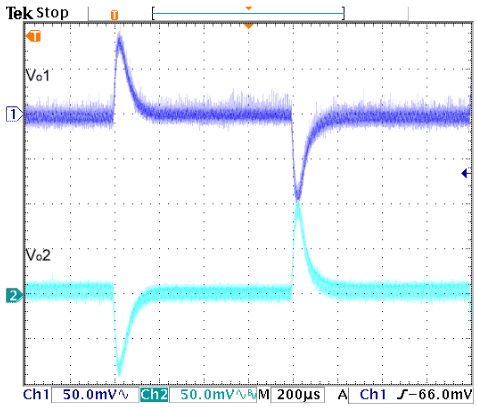
Efficiency versus Output Current



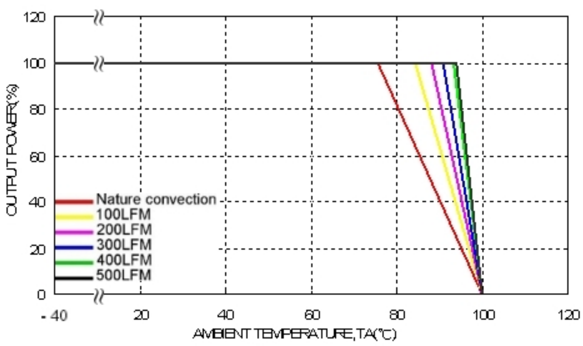
Typical Output Ripple and Noise. $V_{in} = V_{in\,nom}$ Full Load



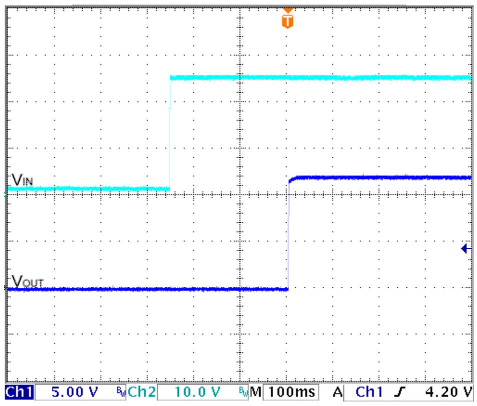
Efficiency versus Input Voltage. Full Load



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



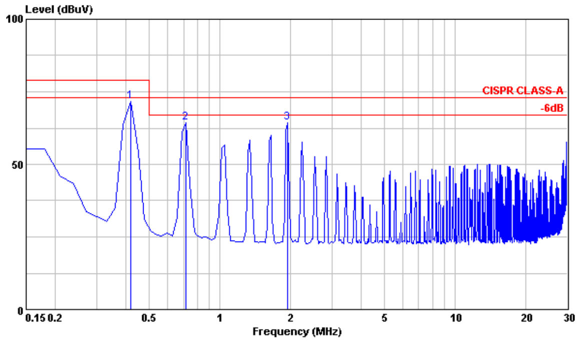
Derating Output Current versus Ambient Temperature and Airflow; $V_{in} = V_{in\,nom}$



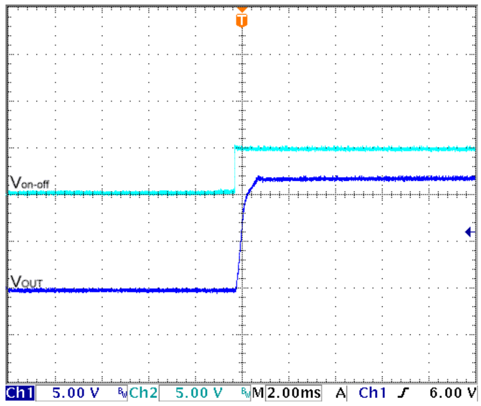
Typical Input Start-Up and Output Rise Characteristic $V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves

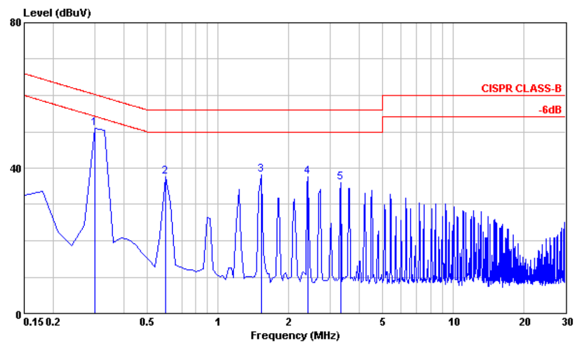
All test conditions are at 25°C. The figures are identical for TEN 8-2422WI (Continued)



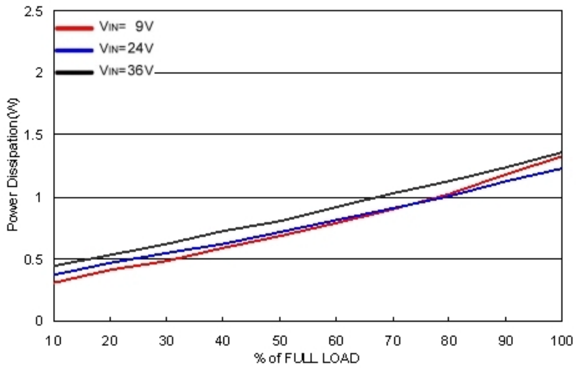
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$, Full Load



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



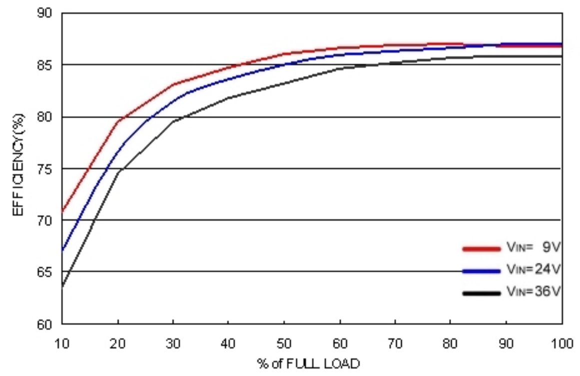
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$, Full Load



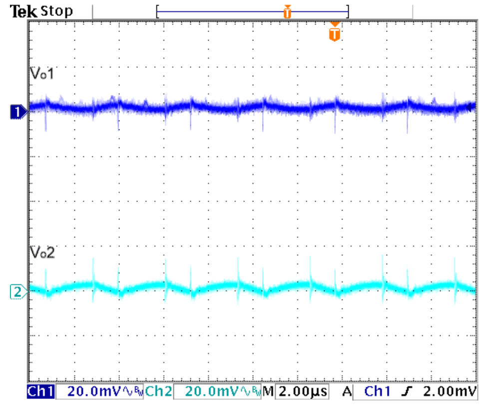
Power Dissipation versus Output Current

Characteristic Curves

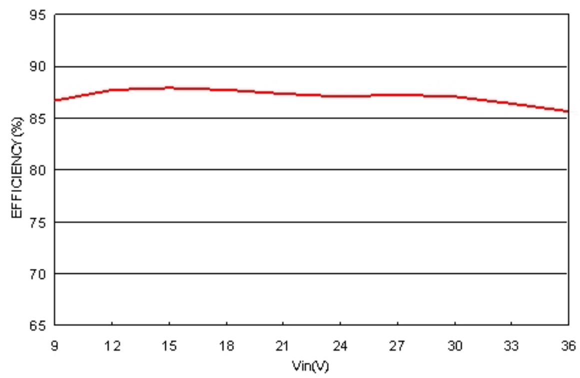
All test conditions are at 25°C. The figures are identical for TEN 8-2423WI



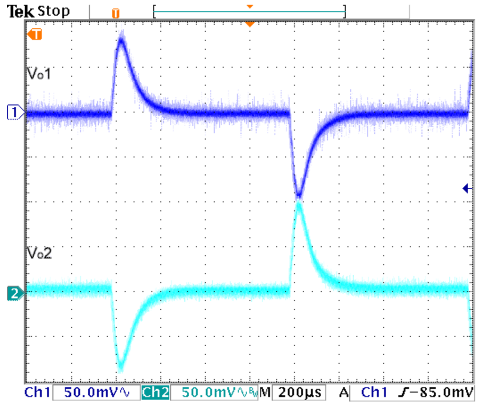
Efficiency versus Output Current



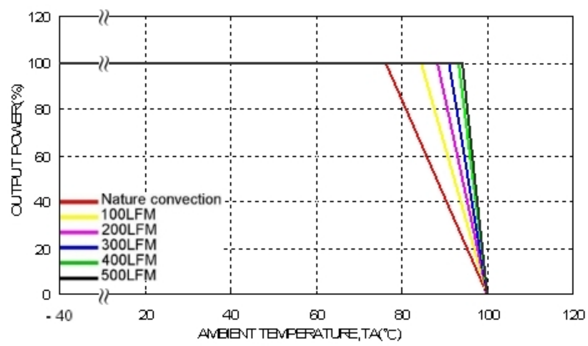
Typical Output Ripple and Noise. $V_{in} = V_{in\,nom}$, Full Load



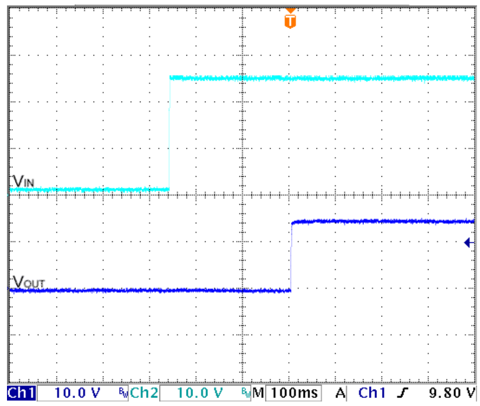
Efficiency versus Input Voltage. Full Load



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



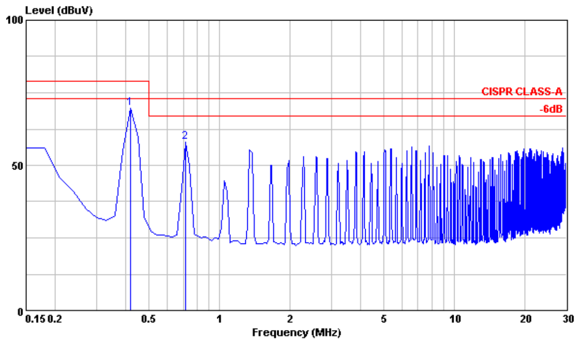
Derating Output Current versus Ambient Temperature and Airflow; $V_{in} = V_{in\,nom}$



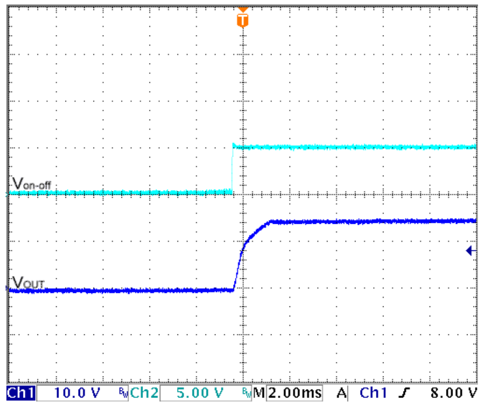
Typical Input Start-Up and Output Rise Characteristic $V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves

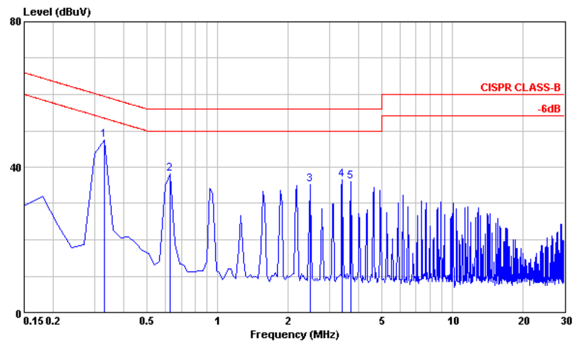
All test conditions are at 25°C. The figures are identical for TEN 8-2423WI (Continued)



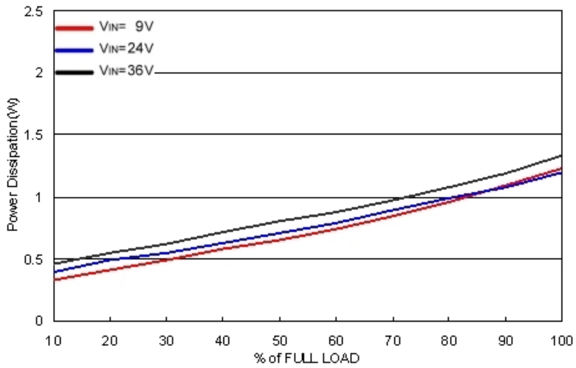
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$, Full Load



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



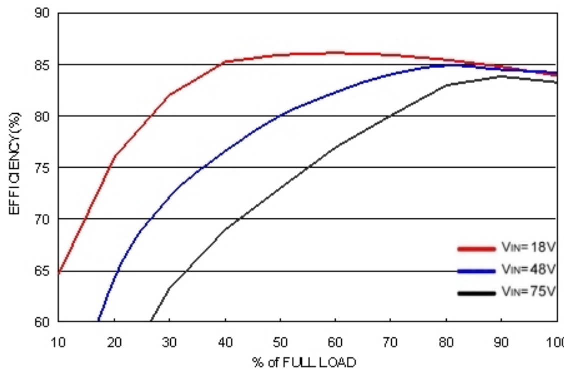
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$, Full Load



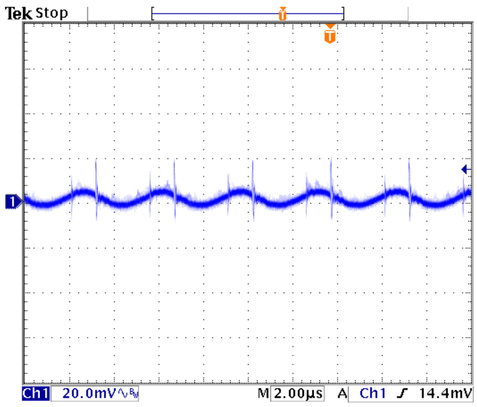
Power Dissipation versus Output Current

Characteristic Curves

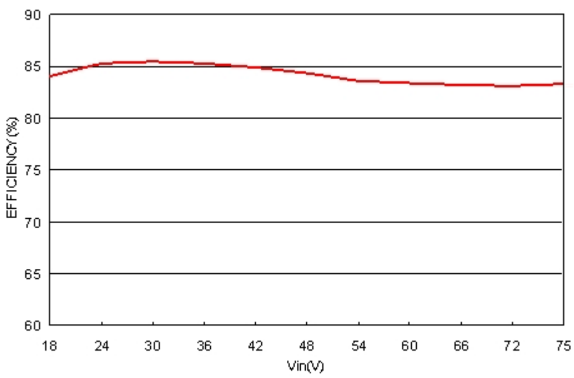
All test conditions are at 25°C. The figures are identical for TEN 8-4810WI



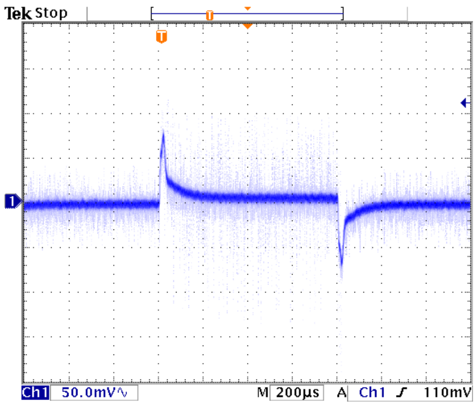
Efficiency versus Output Current



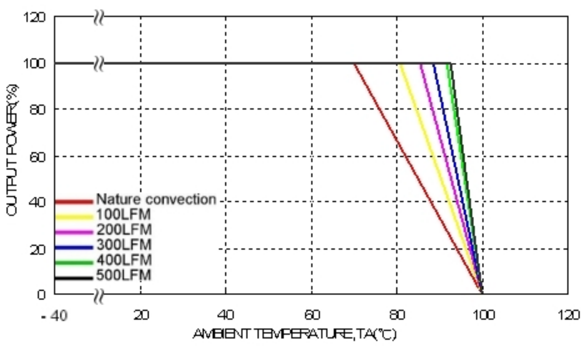
Typical Output Ripple and Noise. $V_{in} = V_{in\,nom}$, Full Load



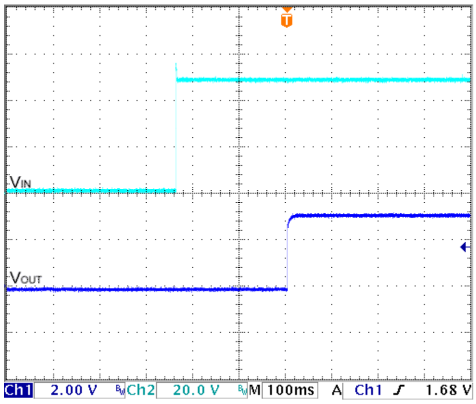
Efficiency versus Input Voltage. Full Load



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



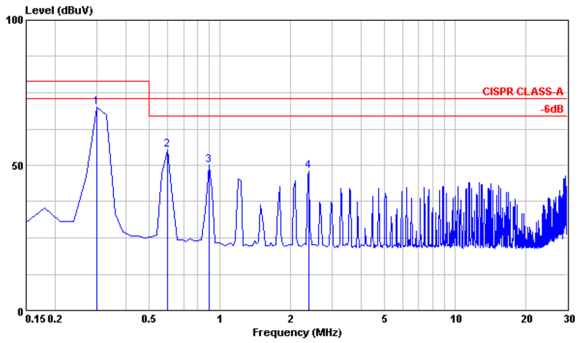
Derating Output Current versus Ambient Temperature and Airflow; $V_{in} = V_{in\,nom}$



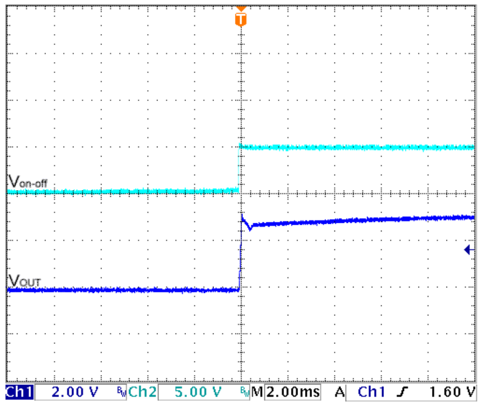
Typical Input Start-Up and Output Rise Characteristic $V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves

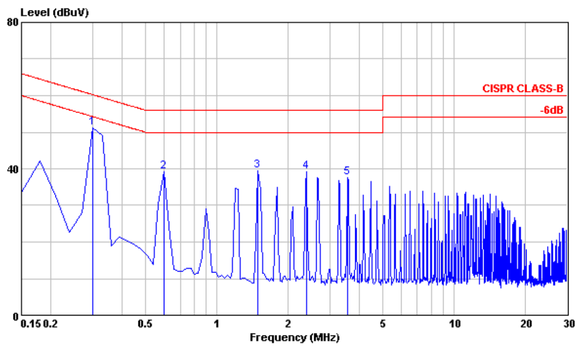
All test conditions are at 25°C. The figures are identical for TEN 8-4810WI (Continued)



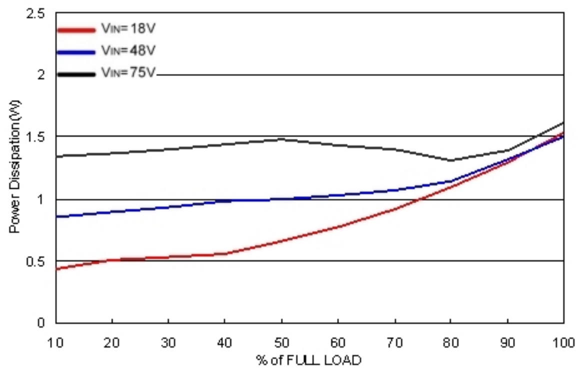
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$, Full Load



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



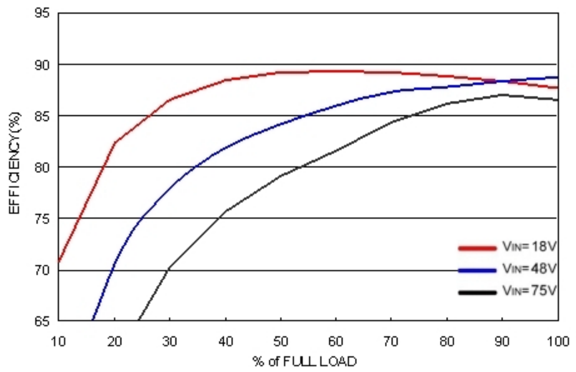
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$, Full Load



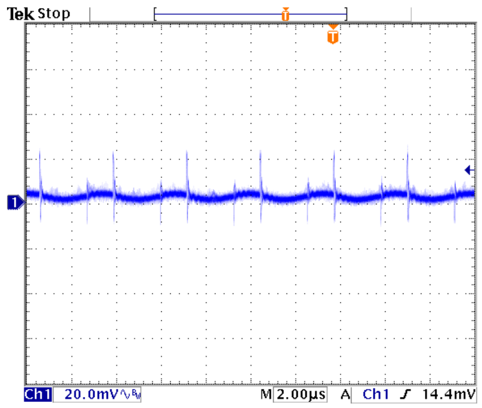
Power Dissipation versus Output Current

Characteristic Curves

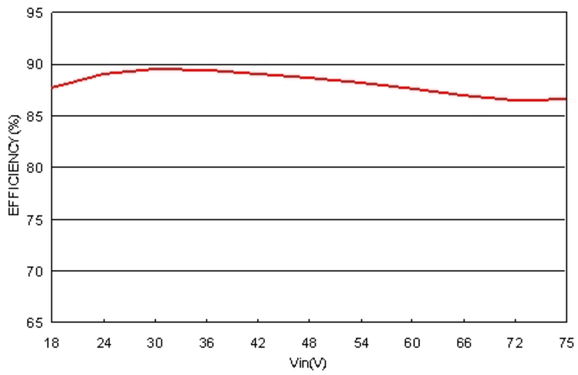
All test conditions are at 25°C. The figures are identical for TEN 8-4811WI



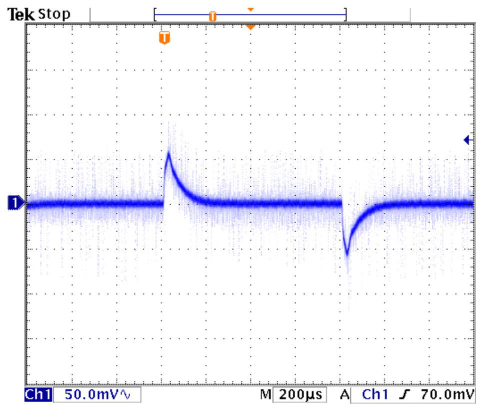
Efficiency versus Output Current



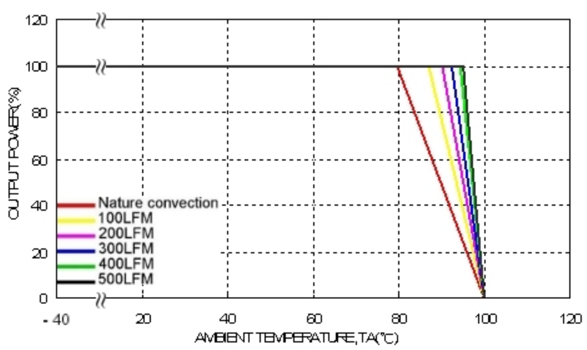
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



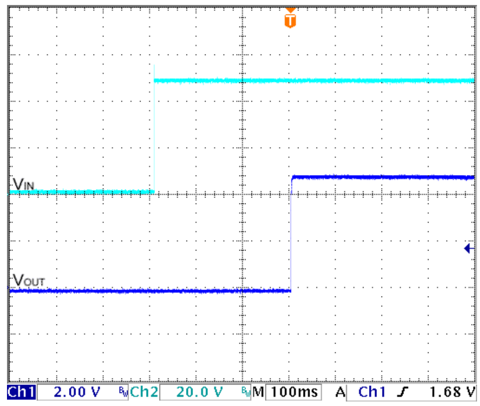
Efficiency versus Input Voltage. Full Load



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



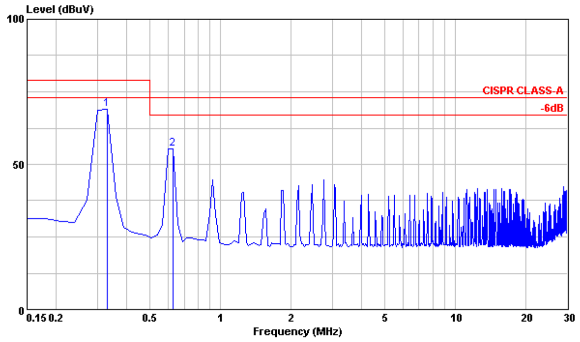
Derating Output Current versus Ambient Temperature and Airflow; $V_{in} = V_{in\,nom}$



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

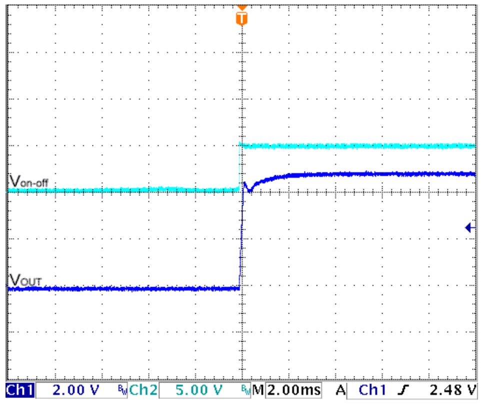
Characteristic Curves

All test conditions are at 25°C. The figures are identical for TEN 8-4811WI (Continued)



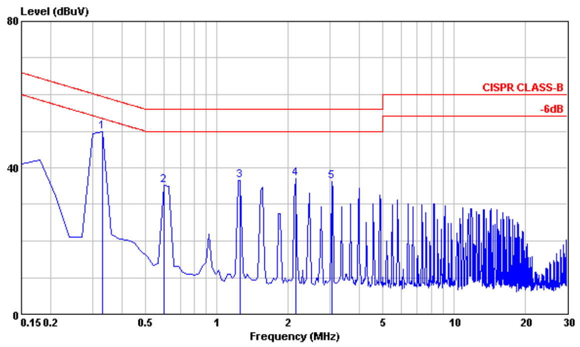
Conduction Emission of EN55022 Class A

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



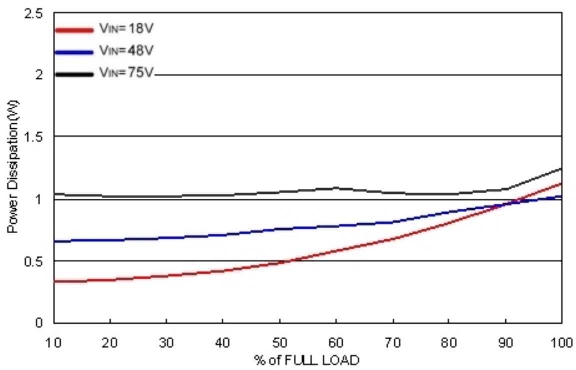
Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic

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



Conduction Emission of EN55022 Class B

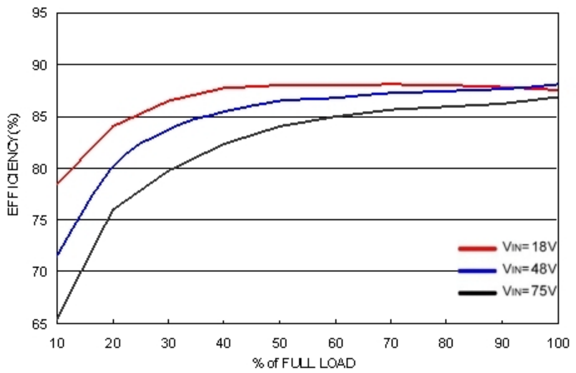
$V_{in} = V_{in\,nom}$, Full Load



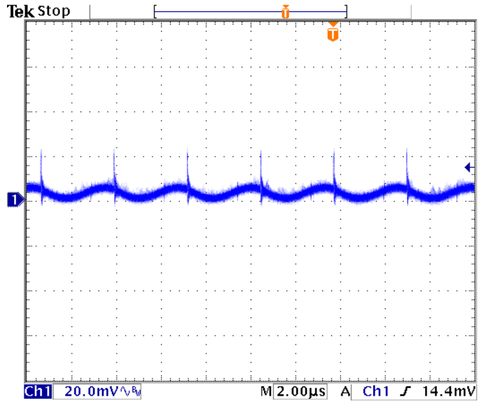
Power Dissipation versus Output Current

Characteristic Curves

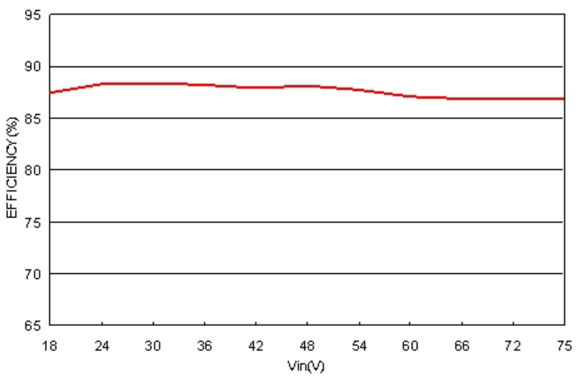
All test conditions are at 25°C. The figures are identical for TEN 8-4812WI



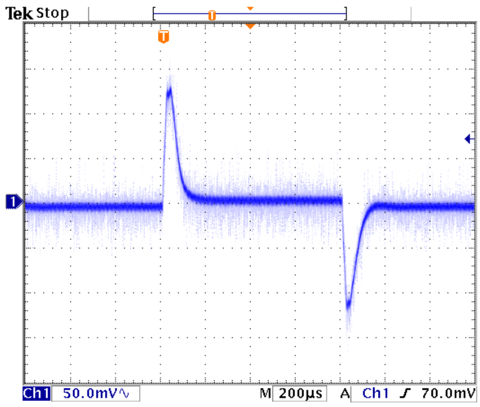
Efficiency versus Output Current



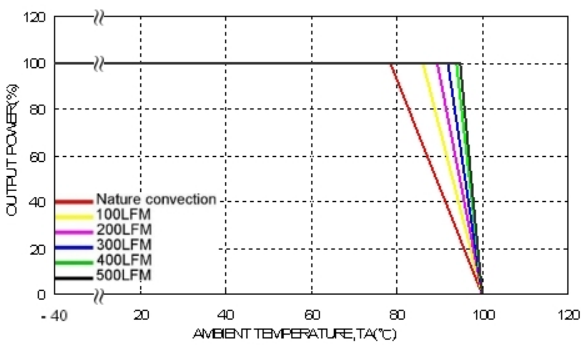
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$, Full Load



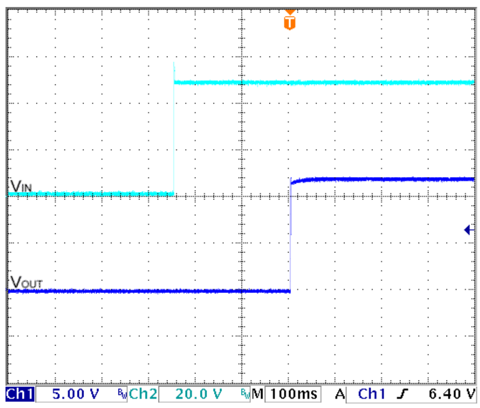
Efficiency versus Input Voltage. Full Load



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



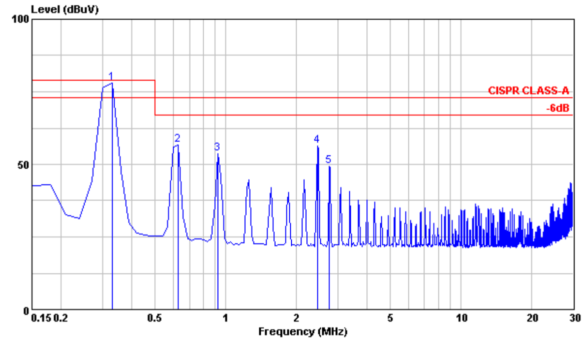
Derating Output Current versus Ambient Temperature and Airflow; $V_{in} = V_{in\ nom}$



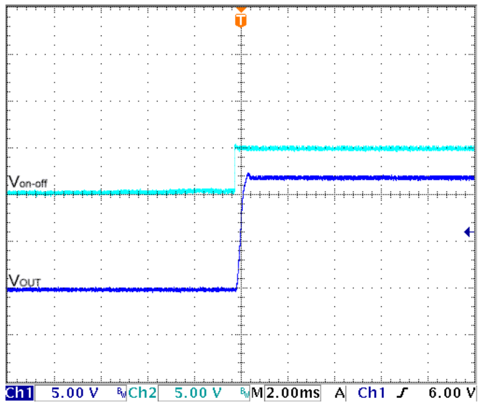
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load

Characteristic Curves

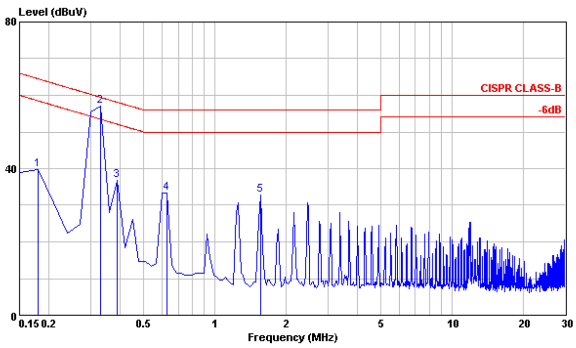
All test conditions are at 25°C. The figures are identical for TEN 8-4812WI (Continued)



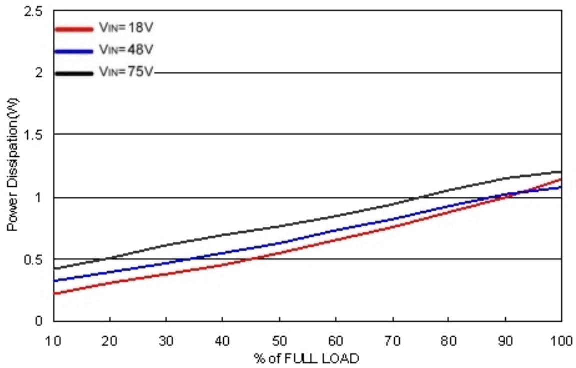
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$, Full Load



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



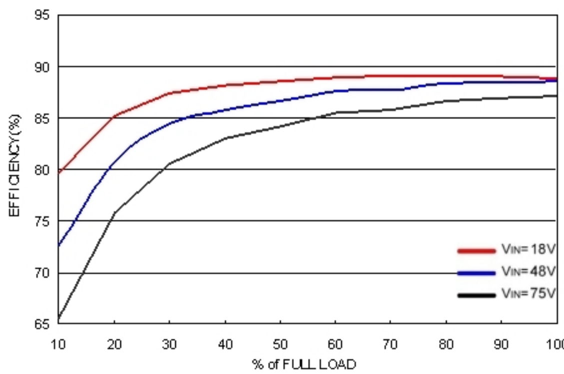
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$, Full Load



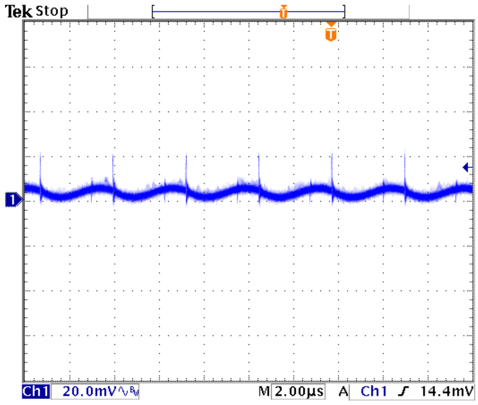
Power Dissipation versus Output Current

Characteristic Curves

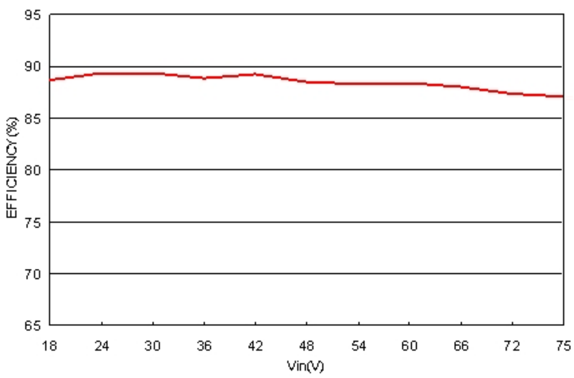
All test conditions are at 25°C. The figures are identical for TEN 8-4813WI



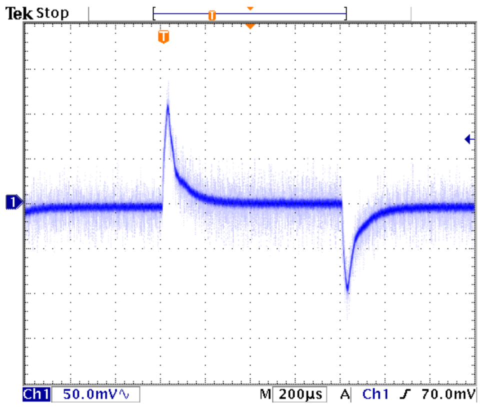
Efficiency versus Output Current



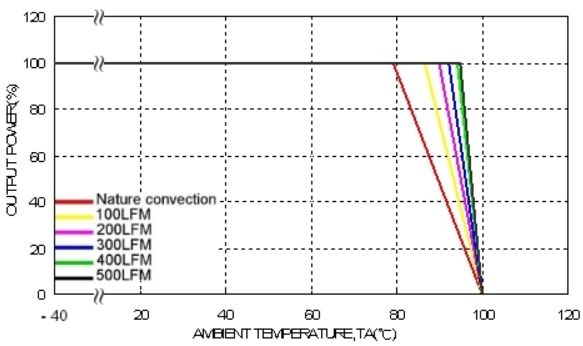
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



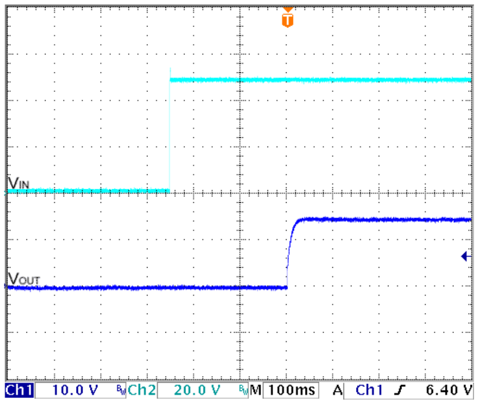
Efficiency versus Input Voltage. Full Load



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

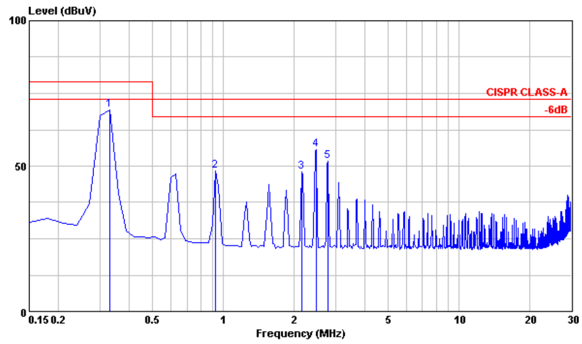


Derating Output Current versus Ambient Temperature and Airflow; $V_{in} = V_{in\,nom}$

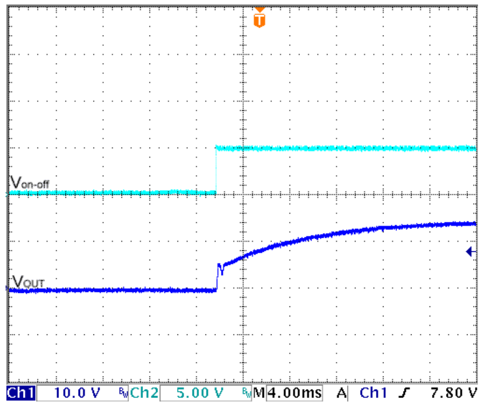


Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load

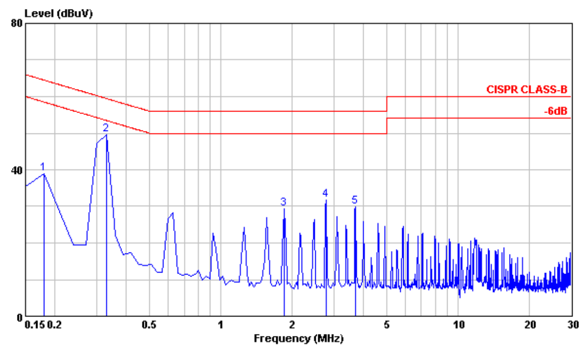
Characteristic Curves	
All test conditions are at 25°C. The figures are identical for TEN 8-4813WI (Continued)	



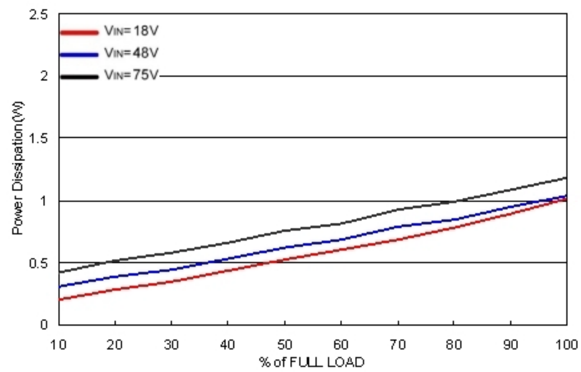
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\,nom}$, Full Load



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



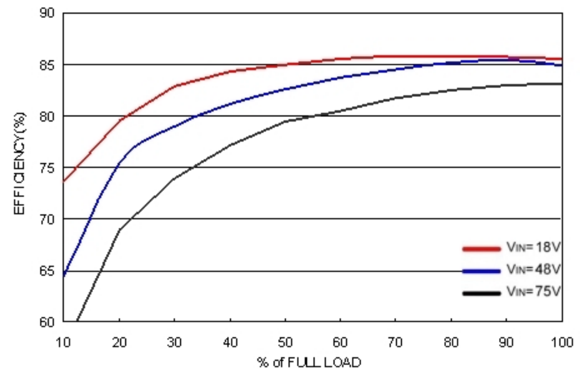
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\,nom}$, Full Load



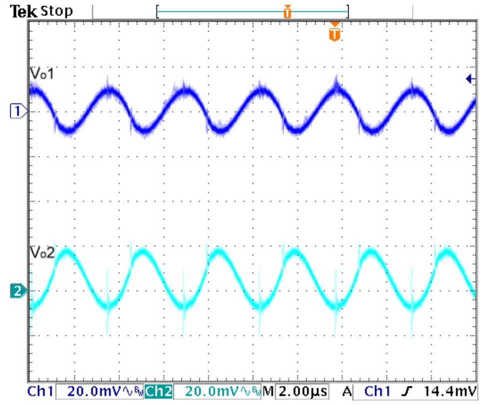
Power Dissipation versus Output Current

Characteristic Curves

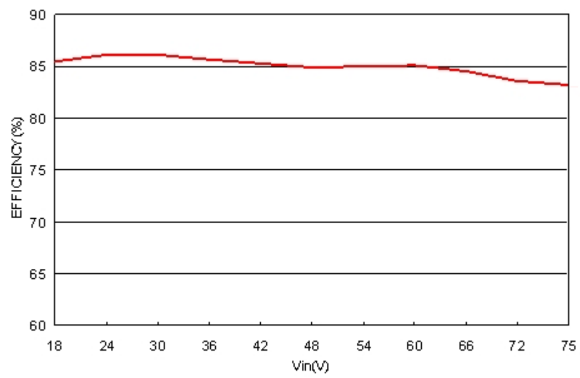
All test conditions are at 25°C. The figures are identical for TEN 8-4821WI



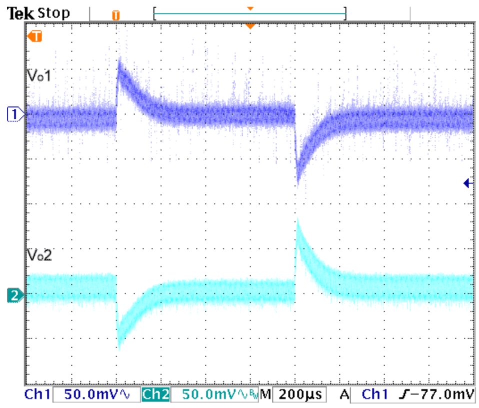
Efficiency versus Output Current



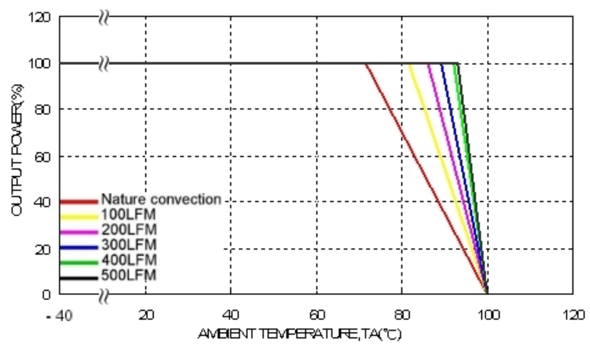
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$, Full Load



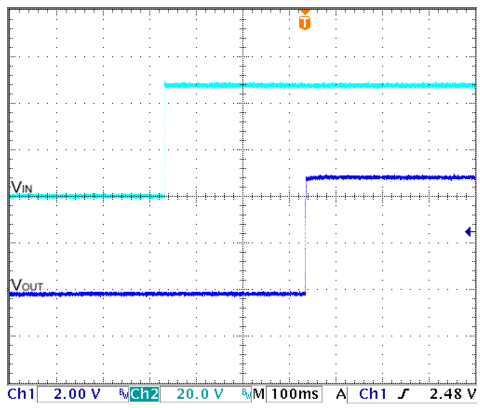
Efficiency versus Input Voltage. Full Load



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



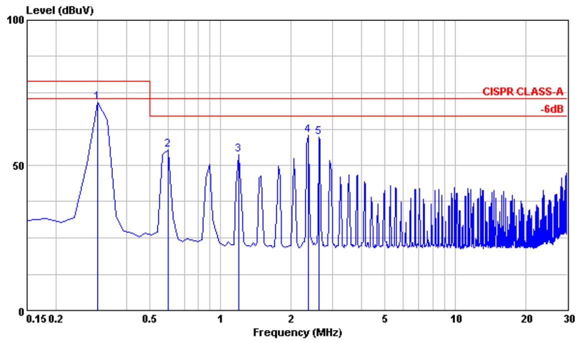
Derating Output Current versus Ambient Temperature and Airflow; $V_{in} = V_{in\ nom}$



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

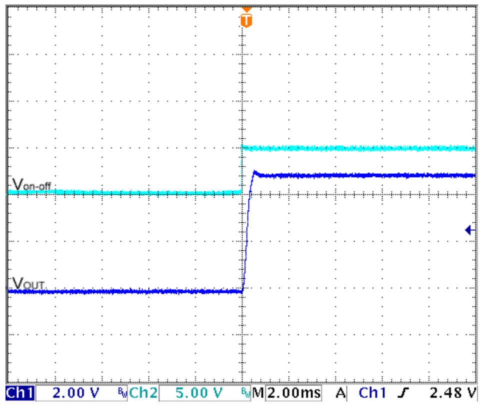
Characteristic Curves

All test conditions are at 25°C. The figures are identical for TEN 8-4821WI (Continued)



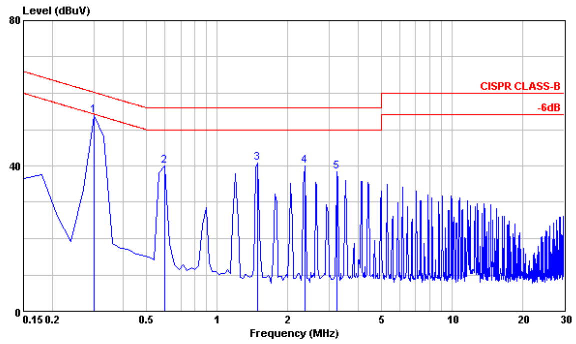
Conduction Emission of EN55022 Class A

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



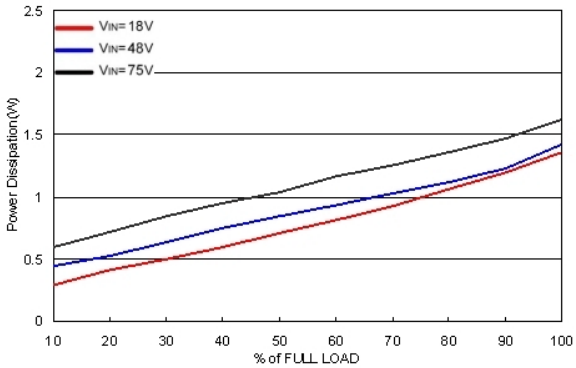
Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic

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



Conduction Emission of EN55022 Class B

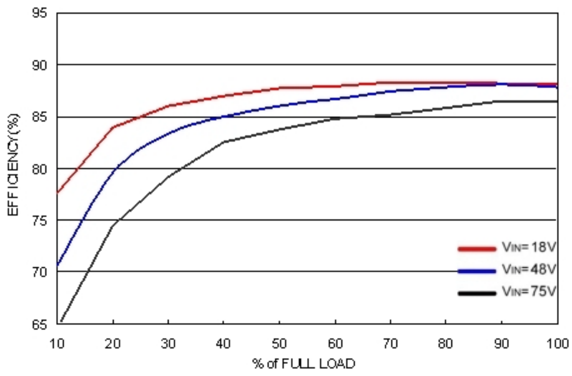
$V_{in} = V_{in\,nom}$, Full Load



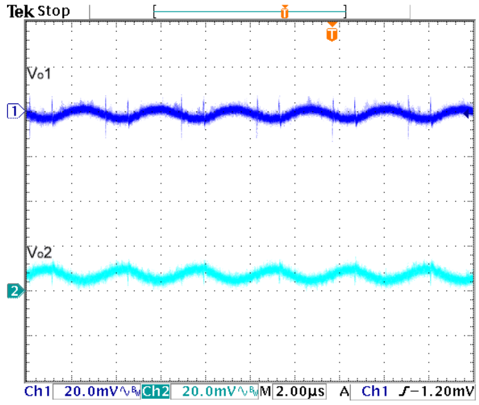
Power Dissipation versus Output Current

Characteristic Curves

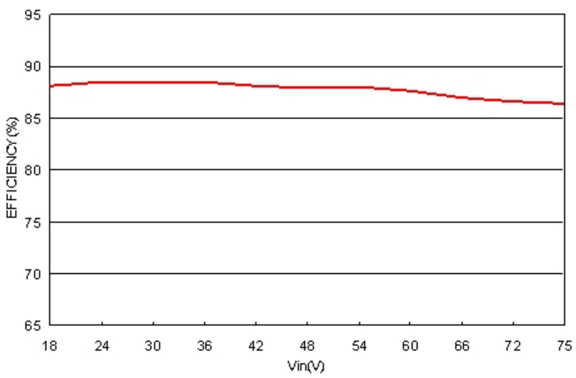
All test conditions are at 25°C. The figures are identical for TEN 8-4822WI



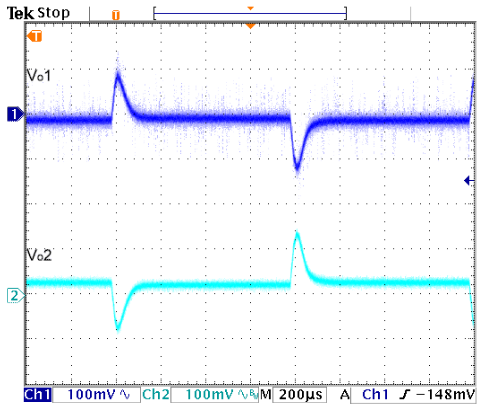
Efficiency versus Output Current



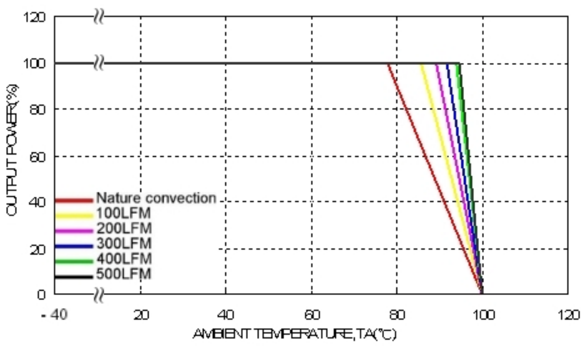
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



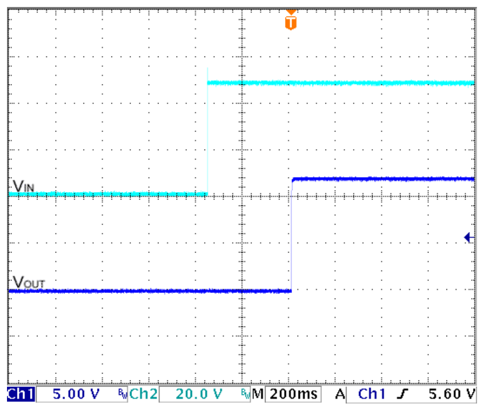
Efficiency versus Input Voltage. Full Load



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



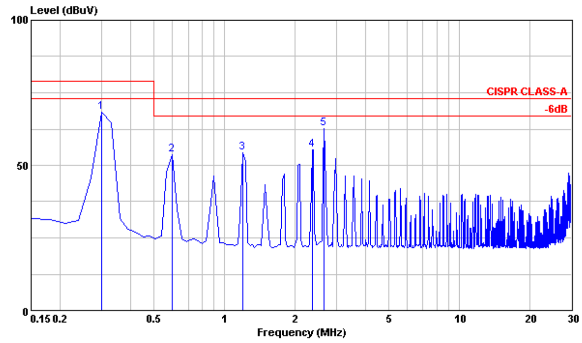
Derating Output Current versus Ambient Temperature and Airflow; $V_{in} = V_{in\,nom}$



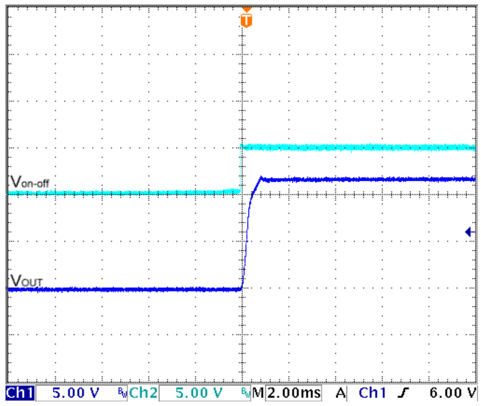
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves

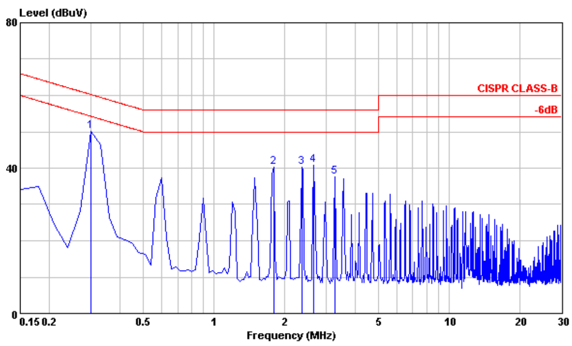
All test conditions are at 25°C. The figures are identical for TEN 8-4822WI (Continued)



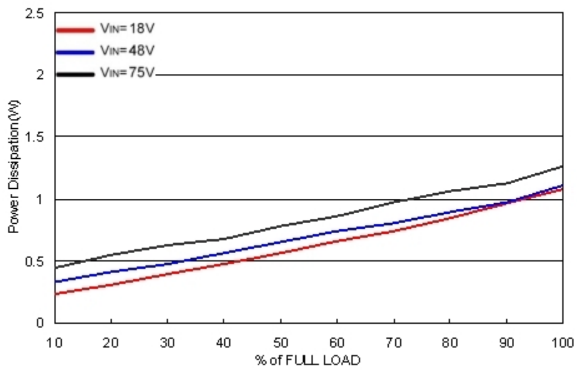
Conduction Emission of EN55022 Class A
$V_{in} = V_{in\ nom}$, Full Load



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



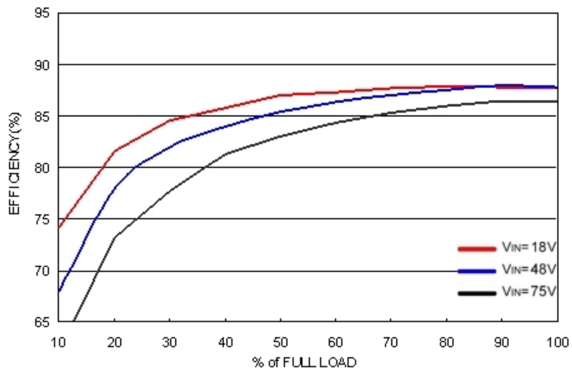
Conduction Emission of EN55022 Class B
$V_{in} = V_{in\ nom}$, Full Load



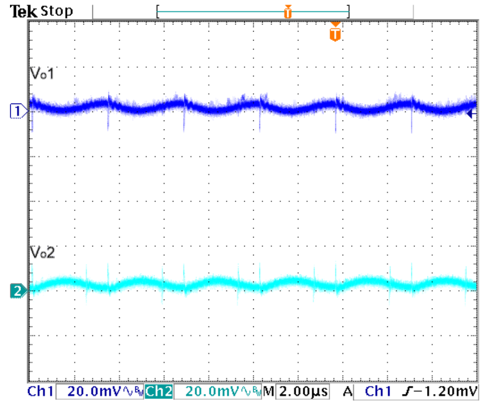
Power Dissipation versus Output Current

Characteristic Curves

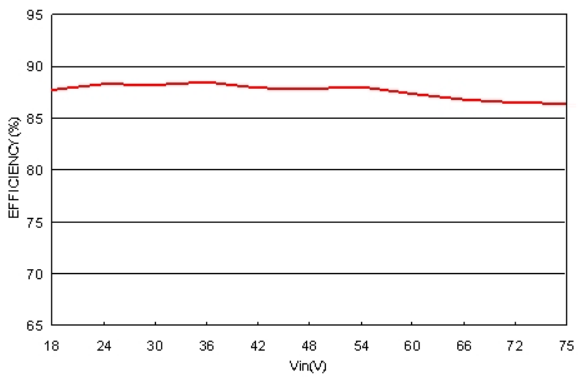
All test conditions are at 25°C. The figures are identical for TEN 8-4823WI



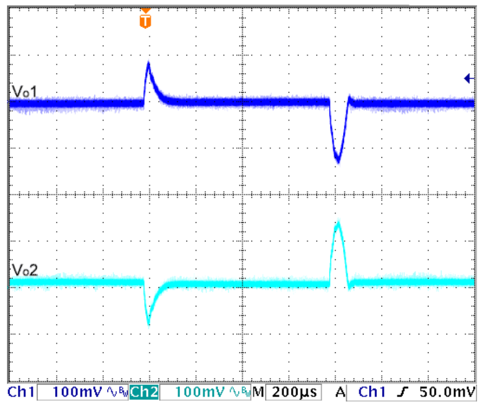
Efficiency versus Output Current



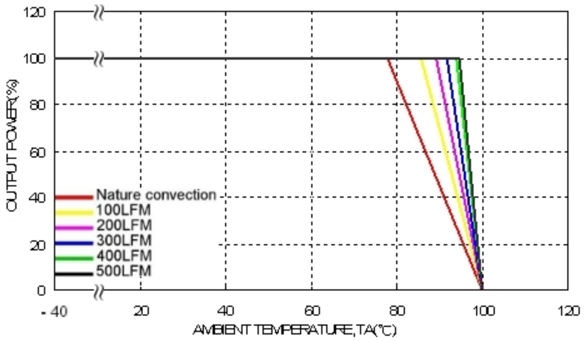
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



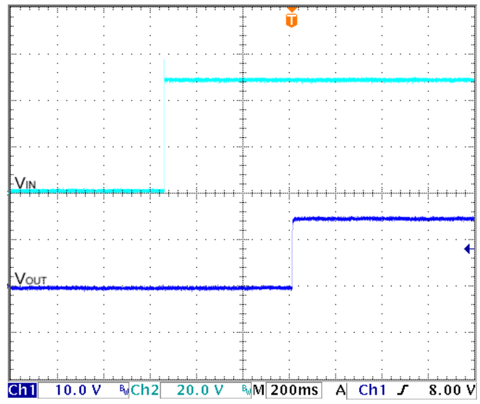
Efficiency versus Input Voltage. Full Load



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



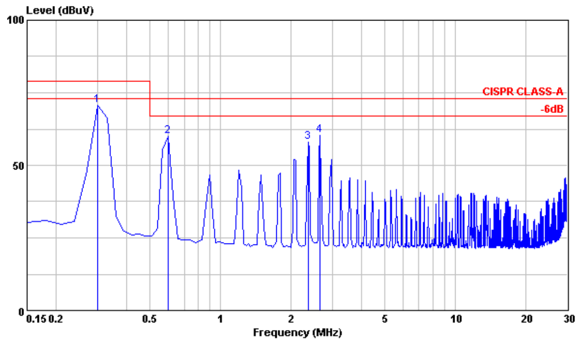
Derating Output Current versus Ambient Temperature and Airflow; $V_{in} = V_{in\,nom}$



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

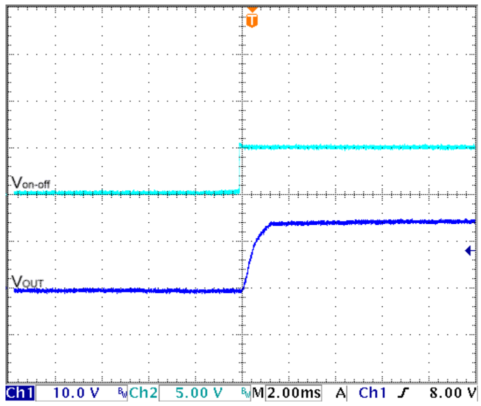
Characteristic Curves

All test conditions are at 25°C. The figures are identical for TEN 8-4823WI (Continued)



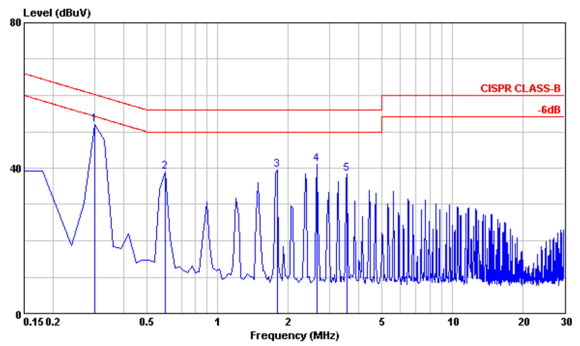
Conduction Emission of EN55022 Class A

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



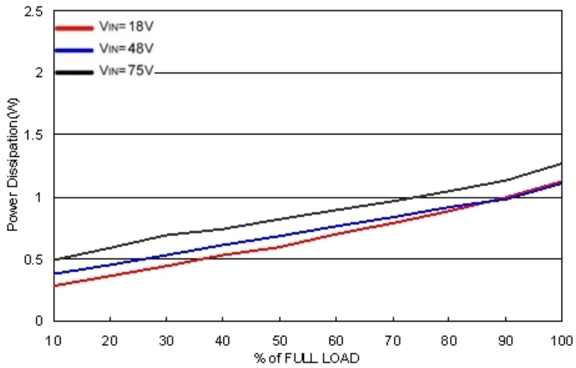
Using ON/OFF Voltage Start-Up and V_{out} Rise Characteristic

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



Conduction Emission of EN55022 Class B

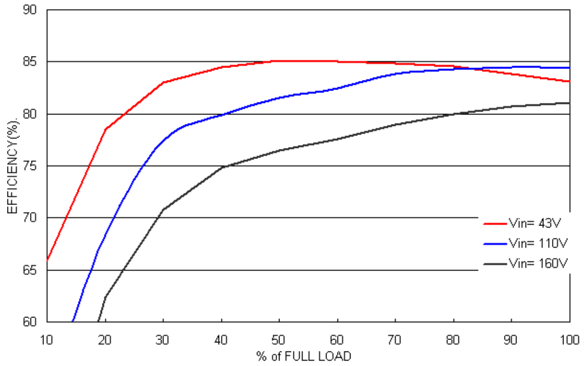
$V_{in} = V_{in\ nom}$, Full Load



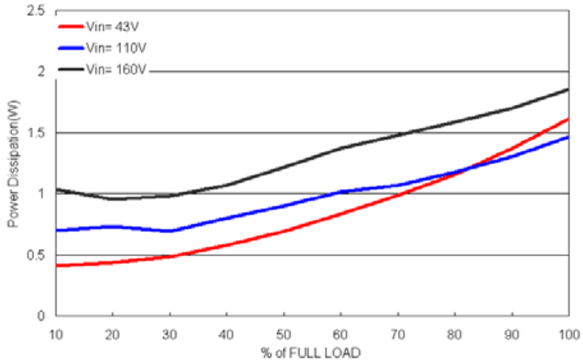
Power Dissipation versus Output Current

Characteristic Curves (Continued)

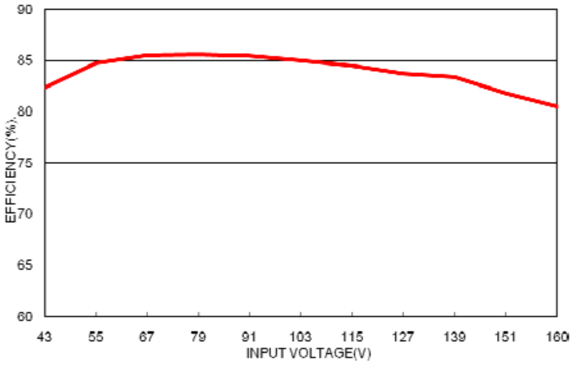
All test conditions are at 25°C. The figures are identical for TEN 8-7210WI



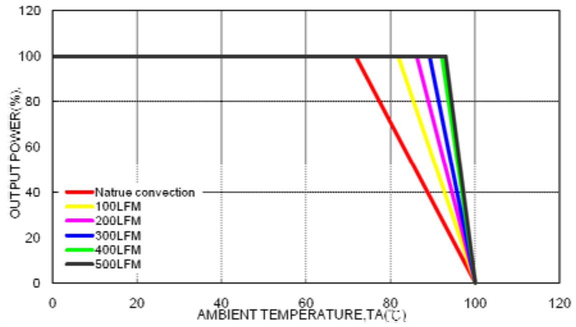
Efficiency versus Output Current



Power Dissipation versus Output Current



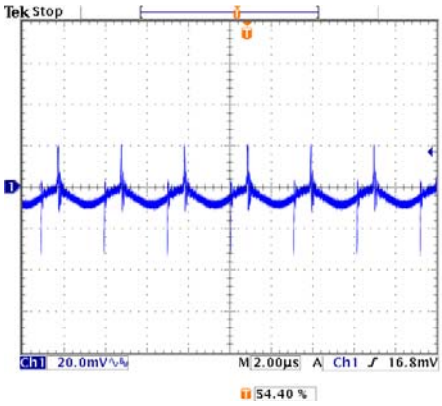
Efficiency versus Input Voltage. Full Load



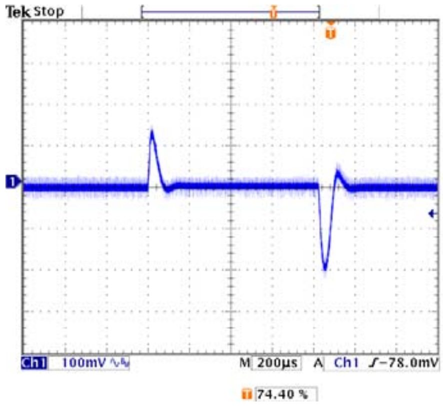
Derating Output Current versus Ambient Temperature and Airflow
$V_{in} = V_{in\,nom}$

Characteristic Curves (Continued)

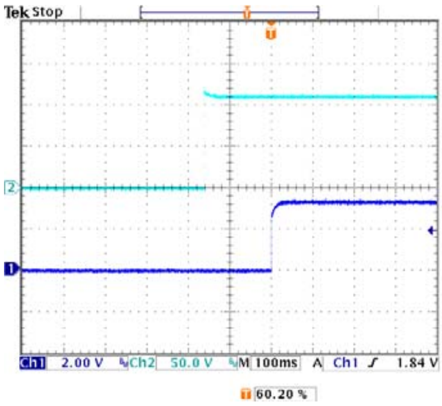
All test conditions are at 25°C. The figures are identical for TEN 8-7210WI



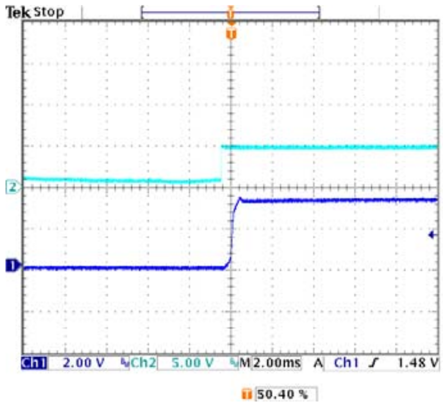
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$, Full Load



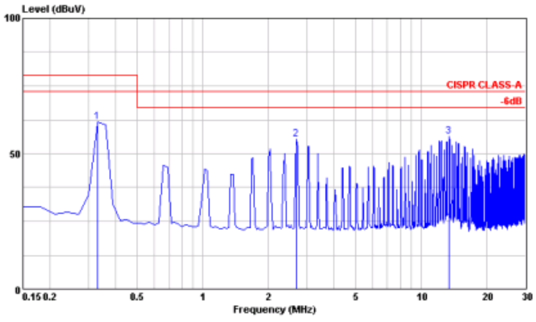
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load ; $V_{in} = V_{in\ nom}$



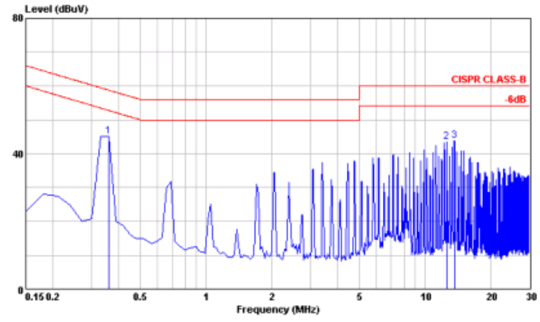
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load



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



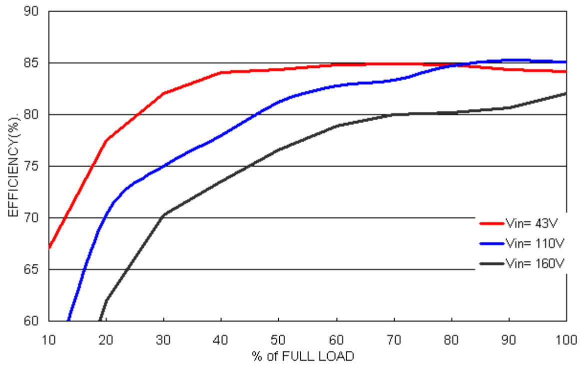
Conduction Emission of EN55011, EN55022 Class A
$V_{in} = V_{in\ nom}$, Full Load



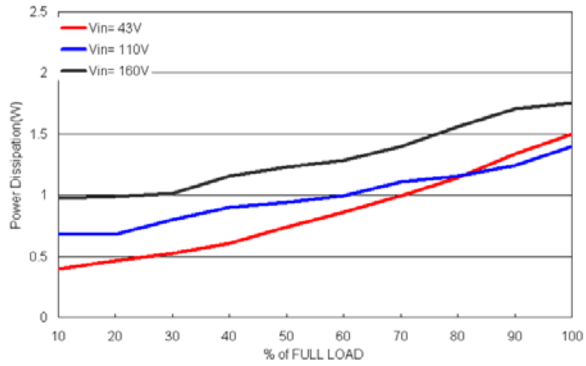
Conduction Emission of EN55011, EN55022 Class B
$V_{in} = V_{in\ nom}$, Full Load

Characteristic Curves (Continued)

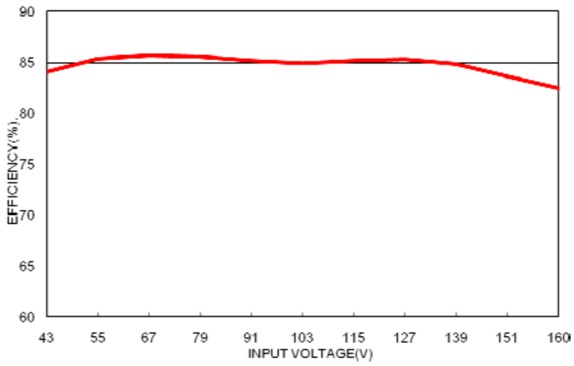
All test conditions are at 25°C. The figures are identical for TEN 8-7211WI



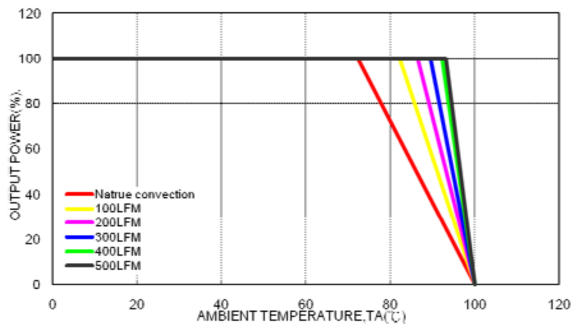
Efficiency versus Output Current



Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load

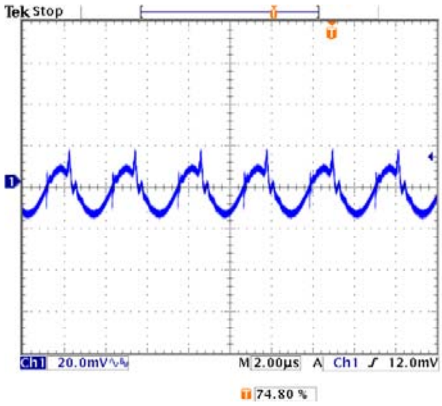


Derating Output Current versus Ambient Temperature and Airflow

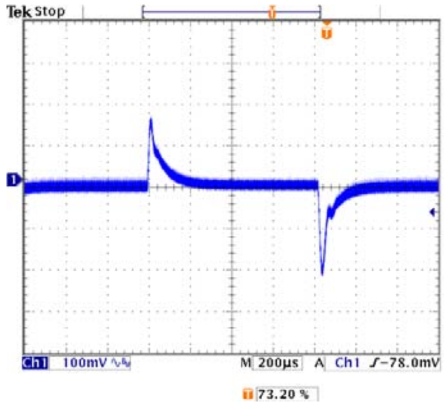
$V_{in} = V_{in\ nom}$

Characteristic Curves (Continued)

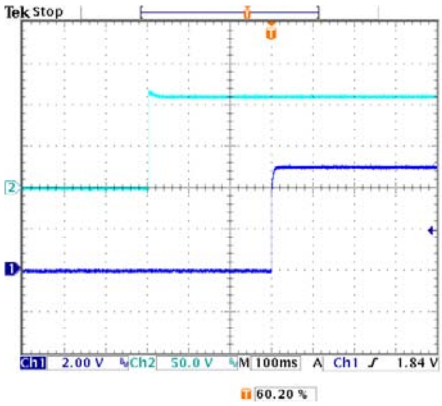
All test conditions are at 25°C. The figures are identical for TEN 8-7211WI



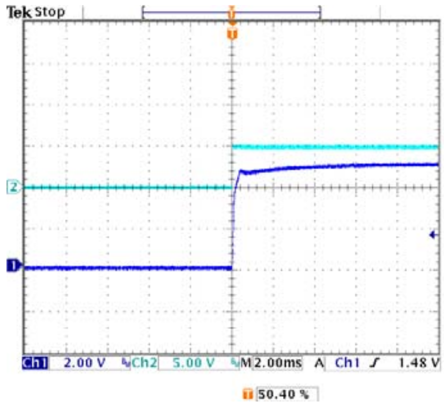
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$, Full Load



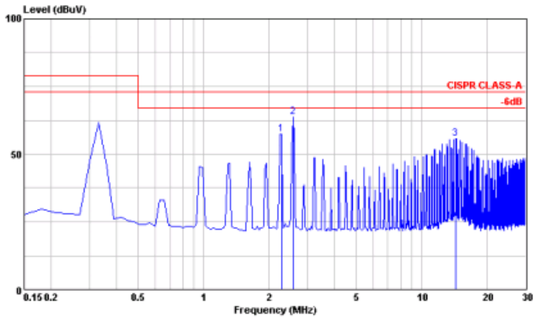
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load; $V_{in} = V_{in\ nom}$



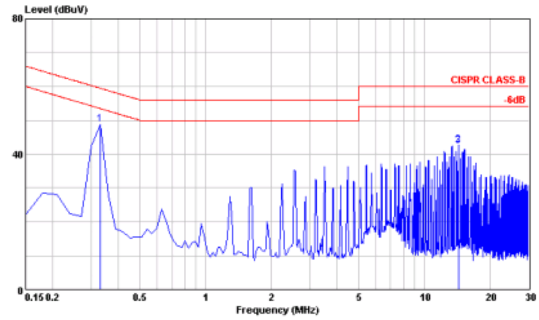
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load



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



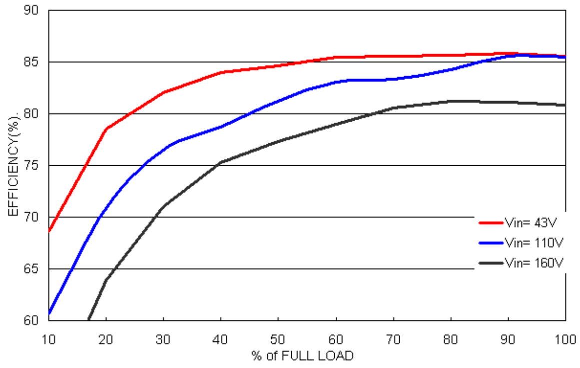
Conduction Emission of EN55011, EN55022 Class A
$V_{in} = V_{in\ nom}$, Full Load



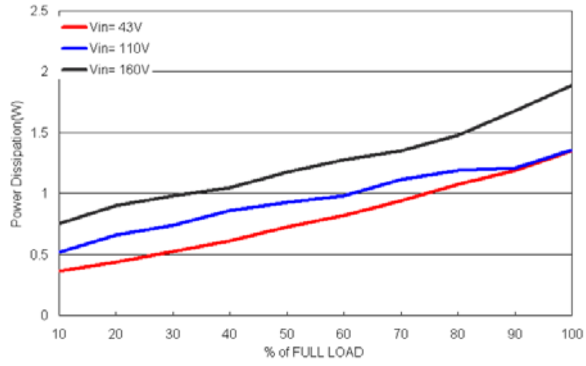
Conduction Emission of EN55011, EN55022 Class B
$V_{in} = V_{in\ nom}$, Full Load

Characteristic Curves (Continued)

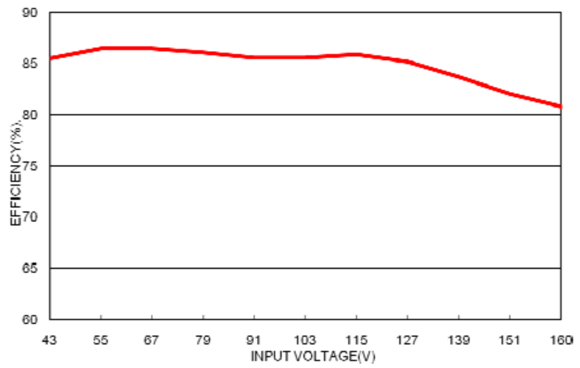
All test conditions are at 25°C. The figures are identical for TEN 8-7212WI



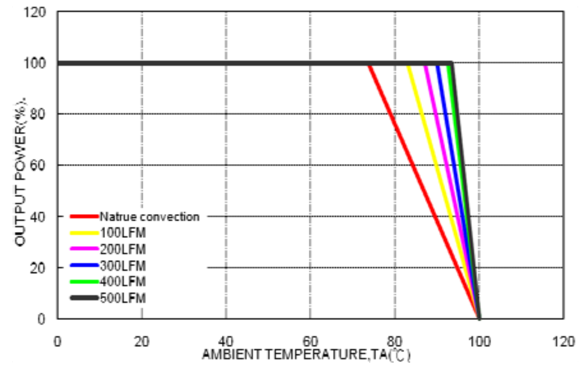
Efficiency versus Output Current



Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load

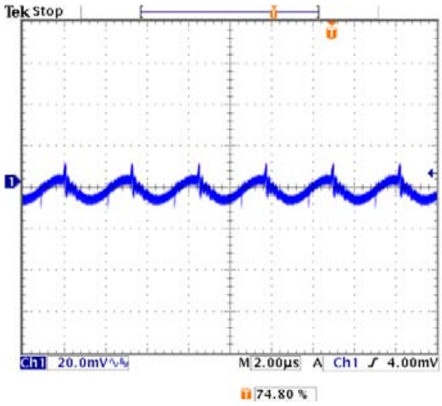


Derating Output Current versus Ambient Temperature and Airflow

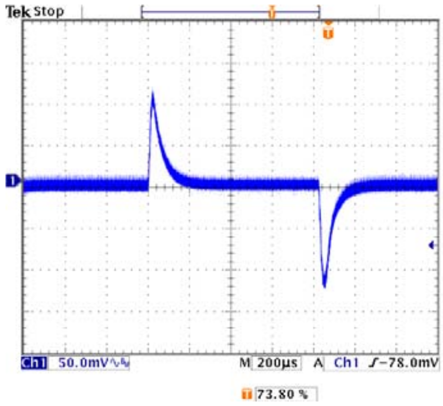
$V_{in} = V_{in\,nom}$

Characteristic Curves (Continued)

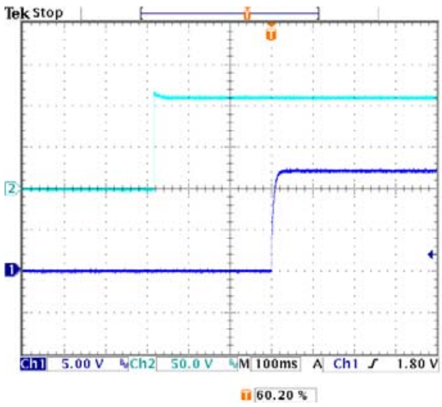
All test conditions are at 25°C. The figures are identical for TEN 8-7212WI



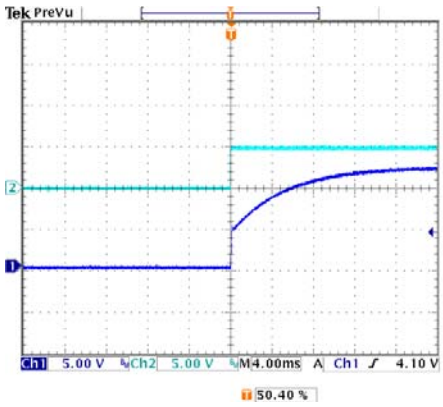
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



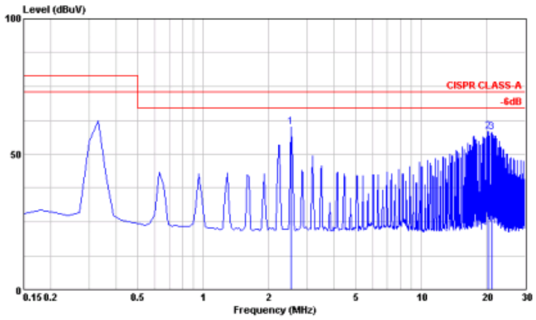
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load; $V_{in} = V_{in\,nom}$



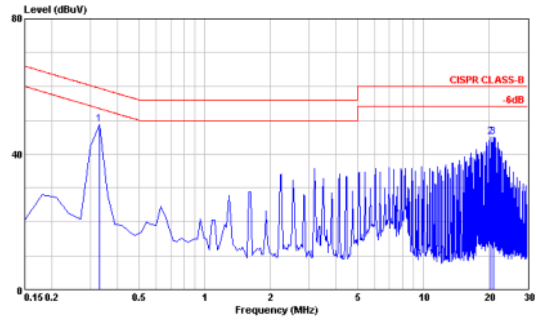
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



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



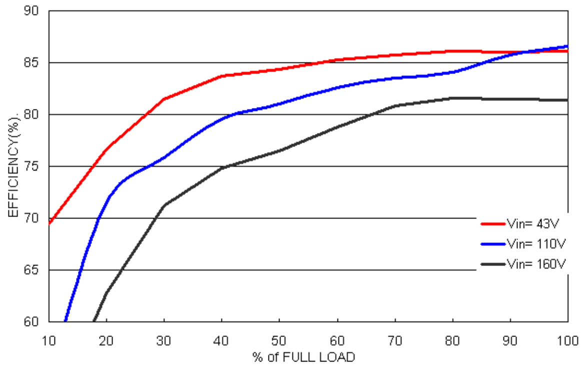
Conduction Emission of EN55011, EN55022 Class A
$V_{in} = V_{in\,nom}$, Full Load



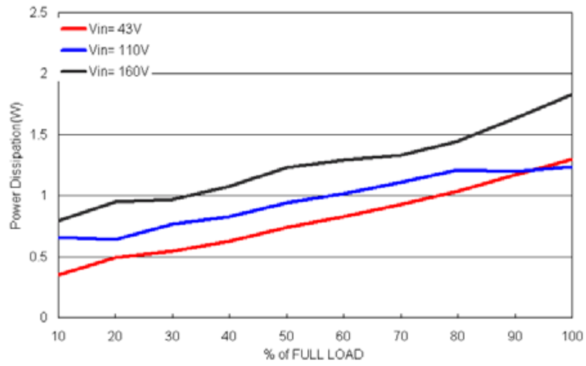
Conduction Emission of EN55011, EN55022 Class B
$V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves (Continued)

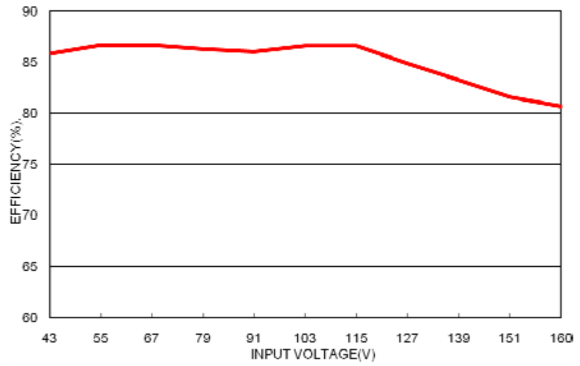
All test conditions are at 25°C. The figures are identical for TEN 8-7213WI



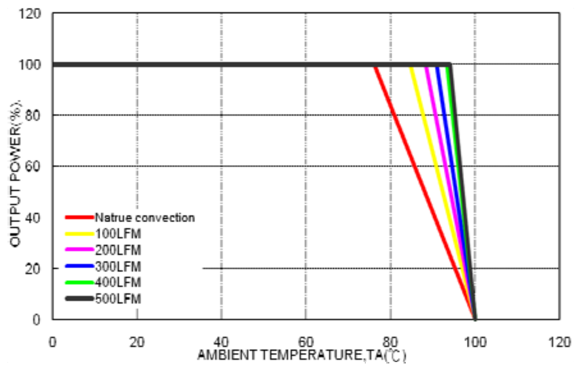
Efficiency versus Output Current



Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load

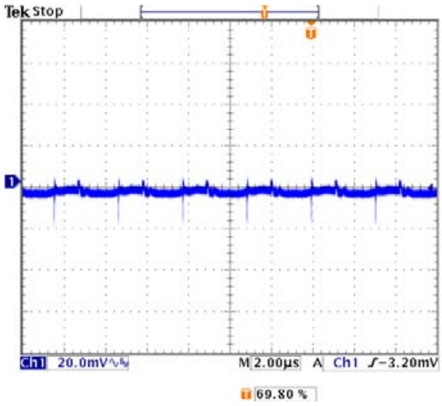


Derating Output Current versus Ambient Temperature and Airflow

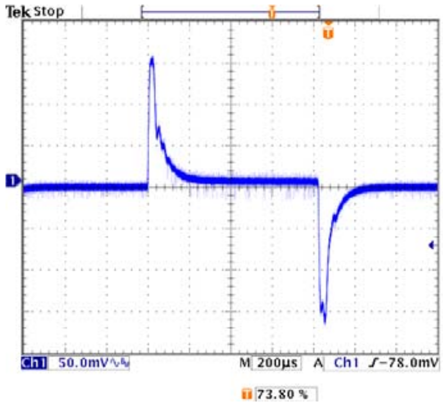
$V_{in} = V_{in\ nom}$

Characteristic Curves (Continued)

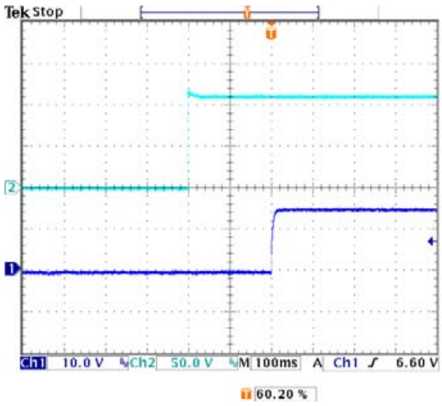
All test conditions are at 25°C. The figures are identical for TEN 8-7213WI



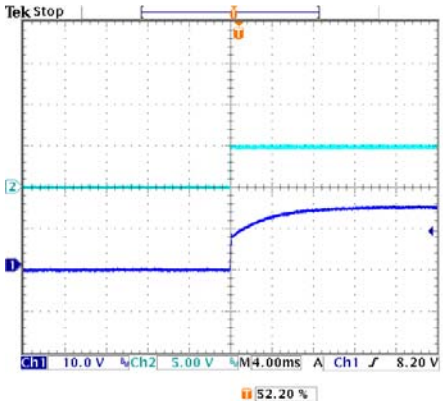
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$, Full Load



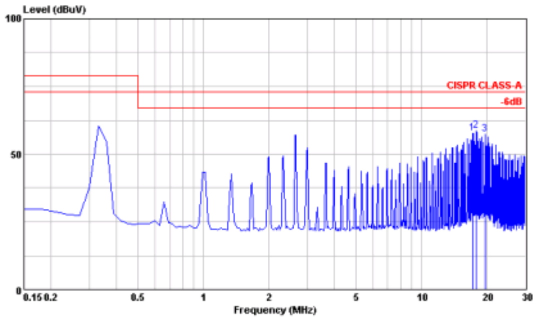
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load; $V_{in} = V_{in\ nom}$



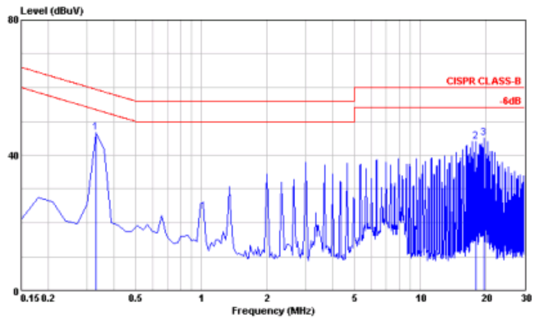
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load



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



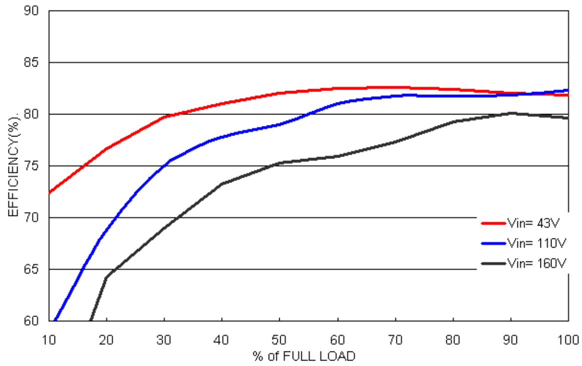
Conduction Emission of EN55011, EN55022 Class A
$V_{in} = V_{in\ nom}$, Full Load



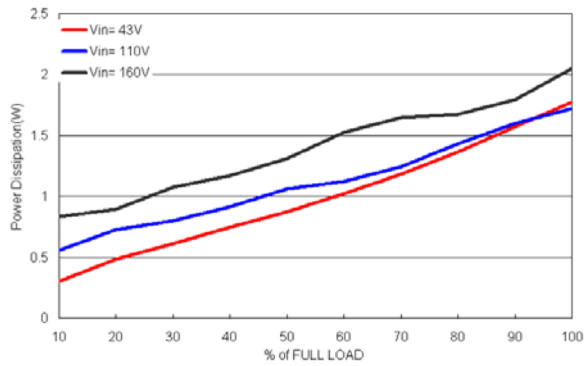
Conduction Emission of EN55011, EN55022 Class B
$V_{in} = V_{in\ nom}$, Full Load

Characteristic Curves (Continued)

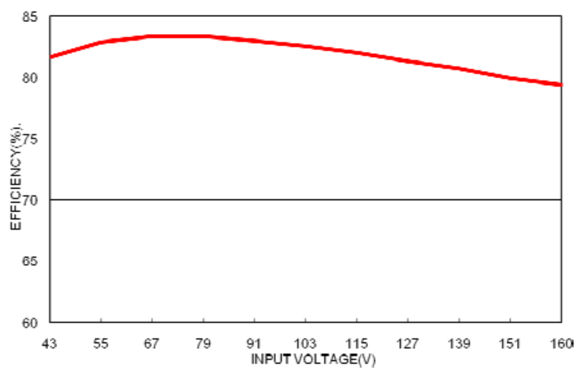
All test conditions are at 25°C. The figures are identical for TEN 8-7221WI



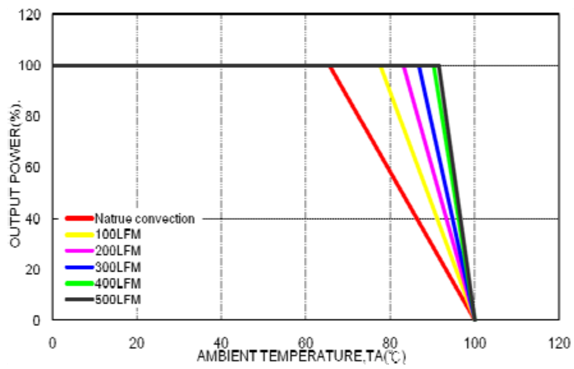
Efficiency versus Output Current



Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load

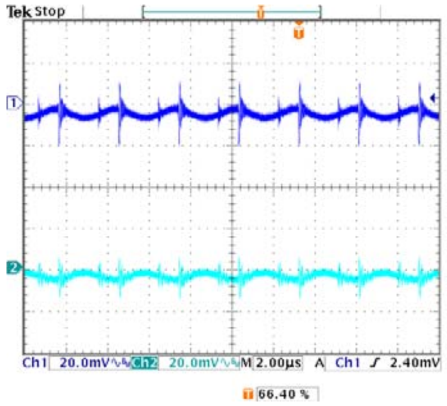


Derating Output Current versus Ambient Temperature and Airflow

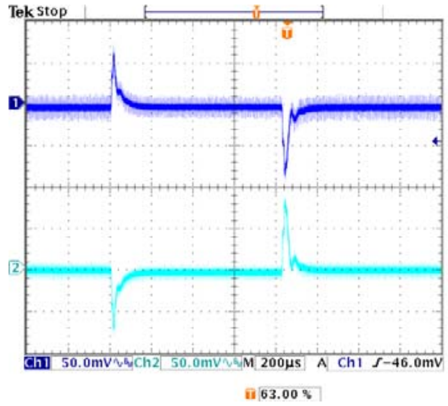
$V_{in} = V_{in\ nom}$

Characteristic Curves (Continued)

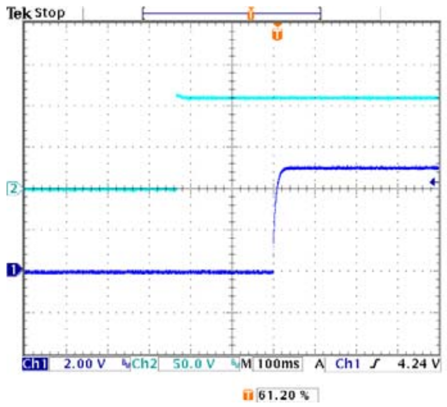
All test conditions are at 25°C. The figures are identical for TEN 8-7221WI



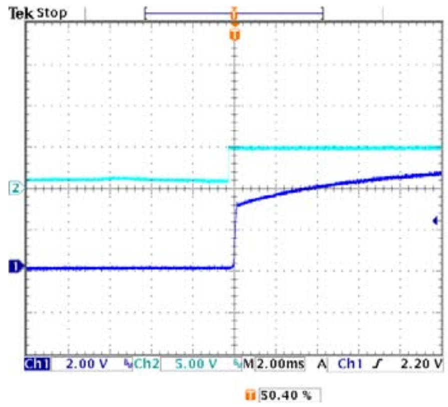
Typical Output Ripple and Noise.
$V_{in} = V_{in\,nom}$, Full Load



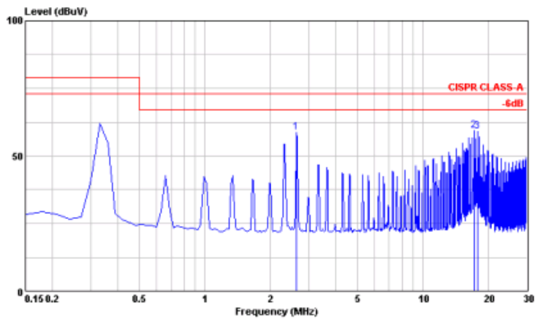
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load; $V_{in} = V_{in\,nom}$



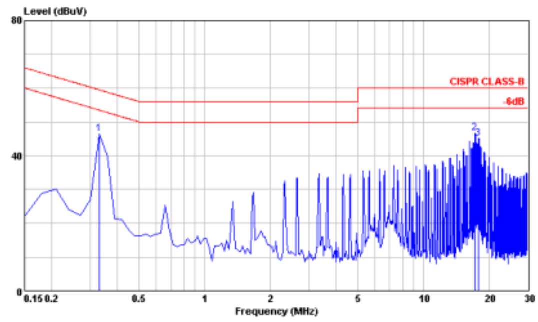
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\,nom}$, Full Load



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



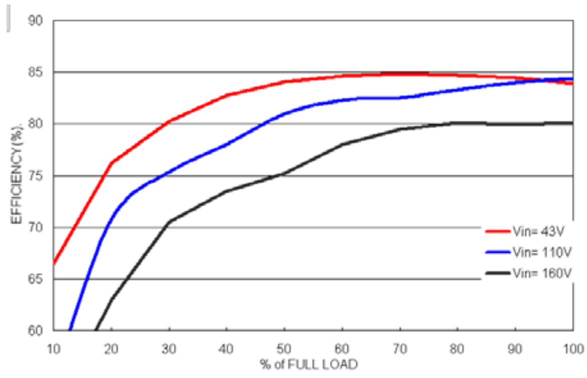
Conduction Emission of EN55011, EN55022 Class A
$V_{in} = V_{in\,nom}$, Full Load



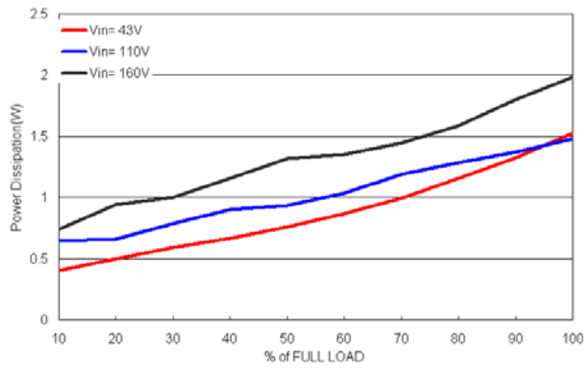
Conduction Emission of EN55011, EN55022 Class B
$V_{in} = V_{in\,nom}$, Full Load

Characteristic Curves (Continued)

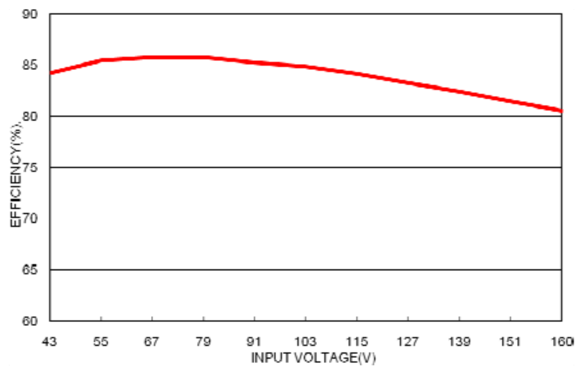
All test conditions are at 25°C. The figures are identical for TEN 8-7222WI



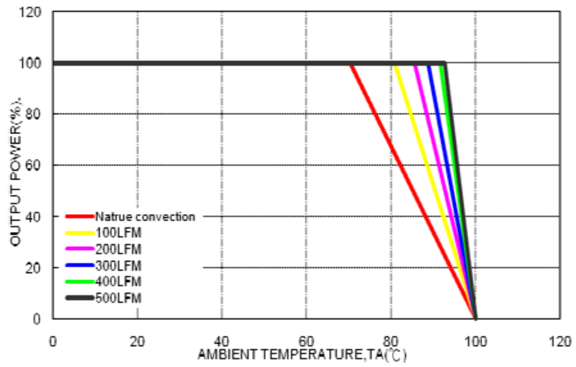
Efficiency versus Output Current



Power Dissipation versus Output Current



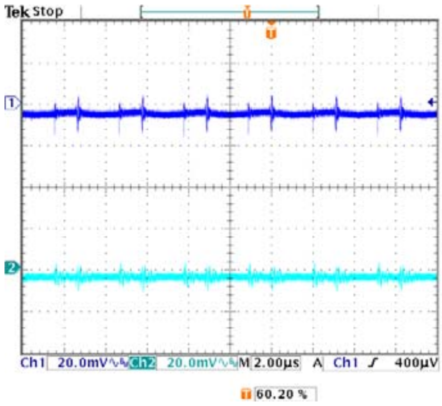
Efficiency versus Input Voltage. Full Load



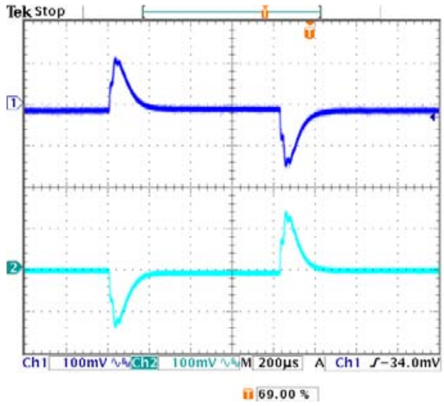
Derating Output Current versus Ambient Temperature and Airflow
$V_{in} = V_{in\,nom}$

Characteristic Curves (Continued)

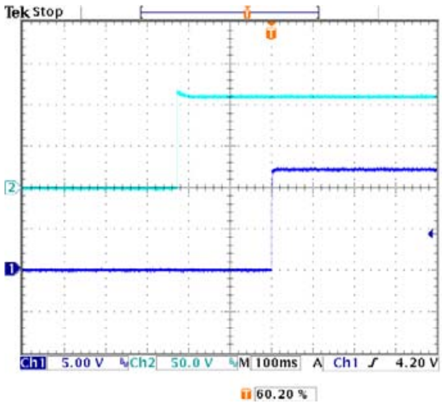
All test conditions are at 25°C. The figures are identical for TEN 8-7222WI



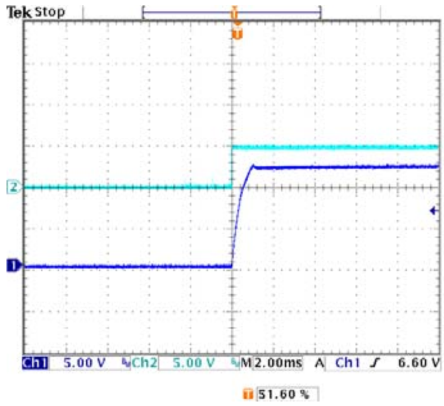
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$, Full Load



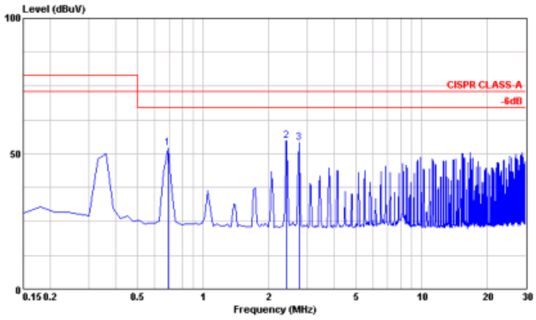
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load; $V_{in} = V_{in\ nom}$



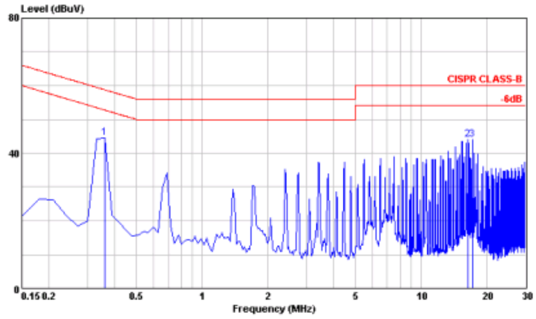
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load



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



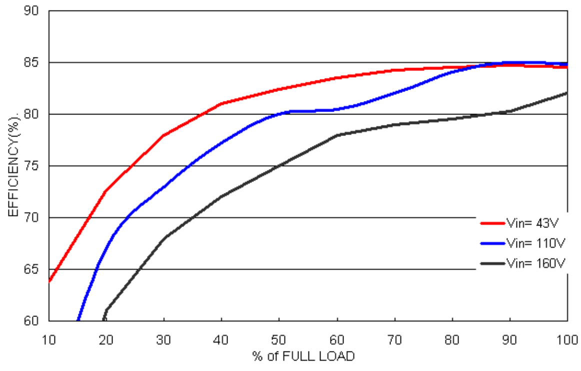
Conduction Emission of EN55011, EN55022 Class A
$V_{in} = V_{in\ nom}$, Full Load



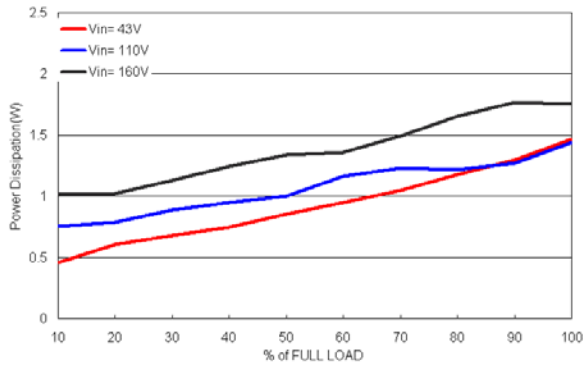
Conduction Emission of EN55011, EN55022 Class B
$V_{in} = V_{in\ nom}$, Full Load

Characteristic Curves (Continued)

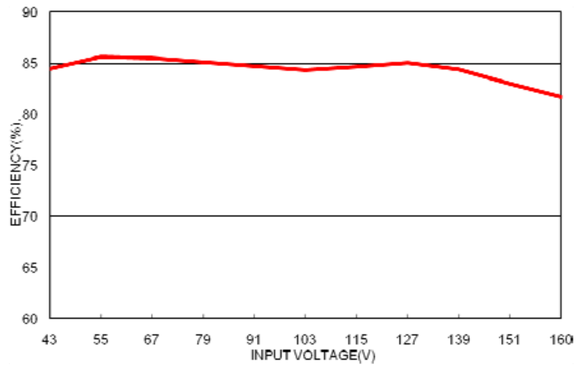
All test conditions are at 25°C. The figures are identical for TEN 8-7223WI



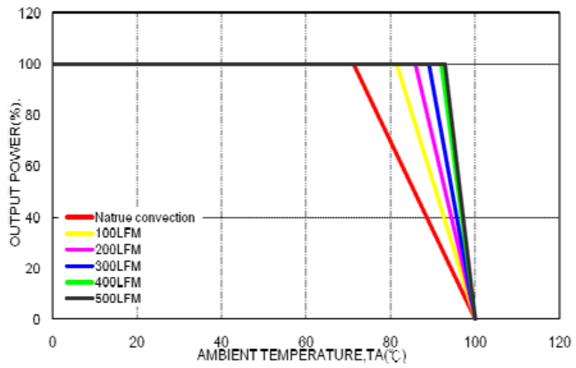
Efficiency versus Output Current



Power Dissipation versus Output Current



Efficiency versus Input Voltage. Full Load

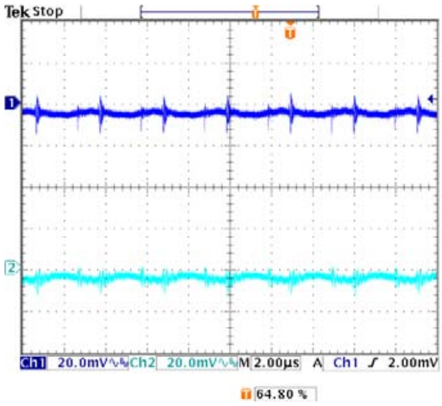


Derating Output Current versus Ambient Temperature and Airflow

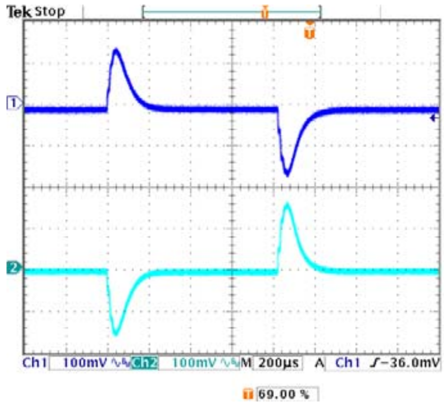
$V_{in} = V_{in\ nom}$

Characteristic Curves (Continued)

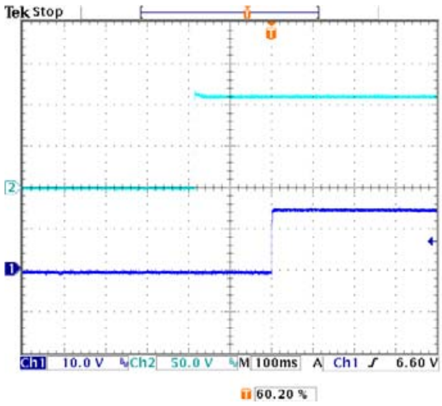
All test conditions are at 25°C. The figures are identical for TEN 8-7223WI



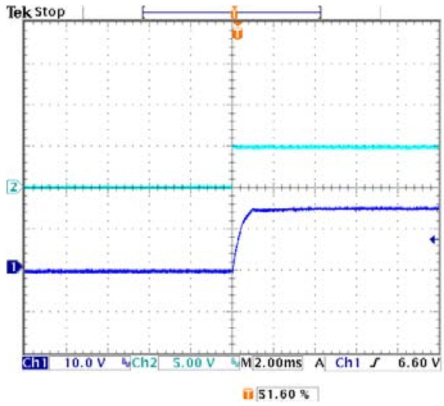
Typical Output Ripple and Noise.
$V_{in} = V_{in\ nom}$, Full Load



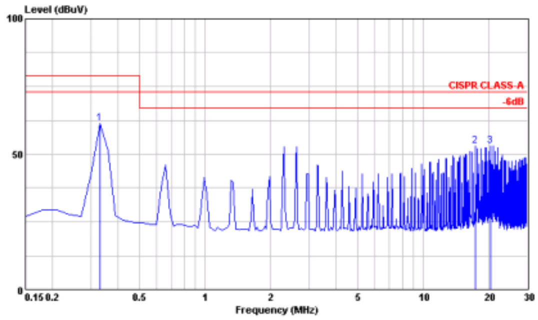
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load; $V_{in} = V_{in\ nom}$



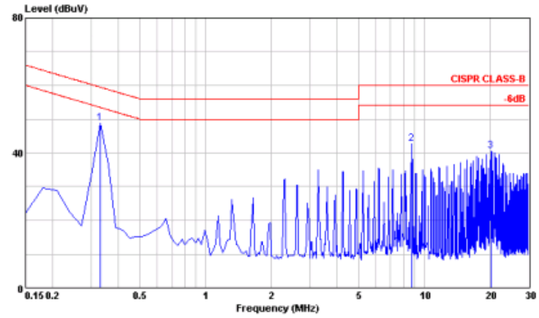
Typical Input Start-Up and Output Rise Characteristic
$V_{in} = V_{in\ nom}$, Full Load



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



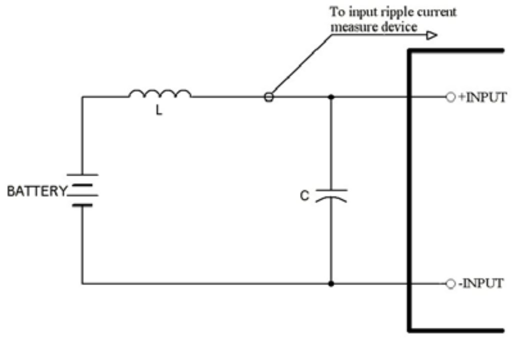
Conduction Emission of EN55011, EN55022 Class A
$V_{in} = V_{in\ nom}$, Full Load



Conduction Emission of EN55011, EN55022 Class B
$V_{in} = V_{in\ nom}$, Full Load

Testing Configurations

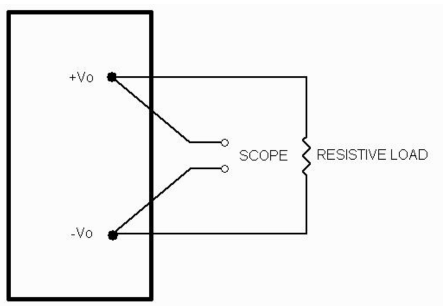
Input reflected-ripple current measurement test up



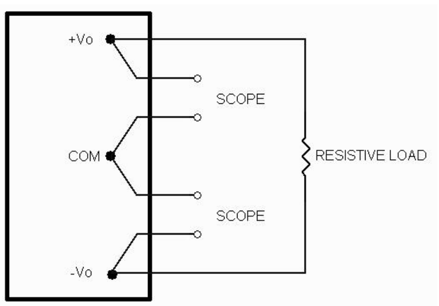
Component	Value	Voltage	Reference
L	12µH	—	—
C	47µF	100V	Aluminum Electrolytic Capacitor

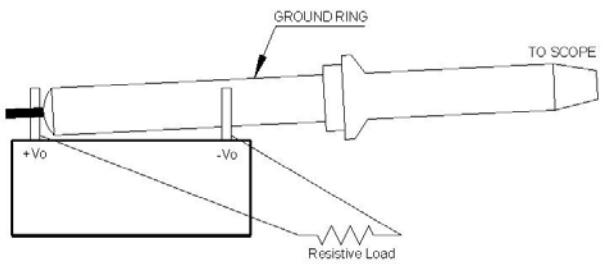
Peak-to-peak output ripple & noise measurement test up

Single output

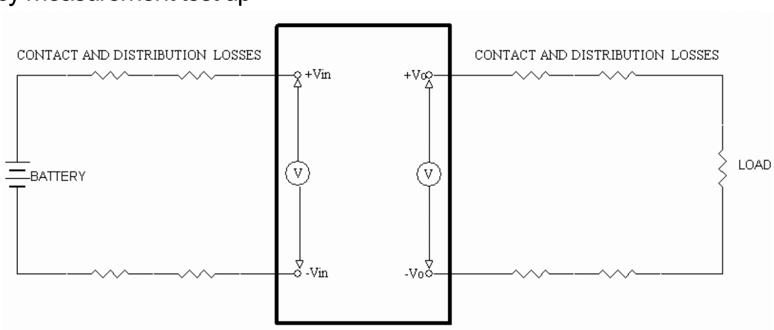


Dual output





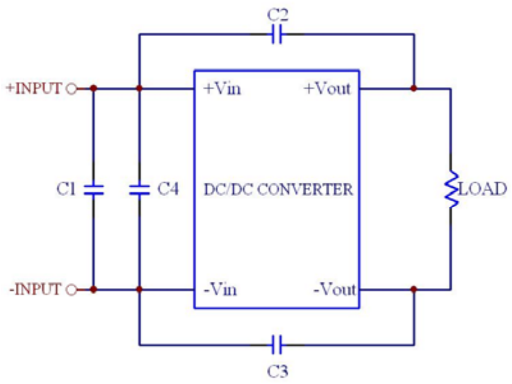
Output voltage and efficiency measurement test up

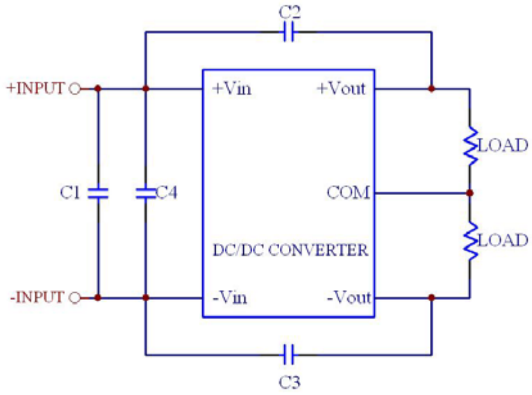


Note: All measurements are taken at the module terminals.

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

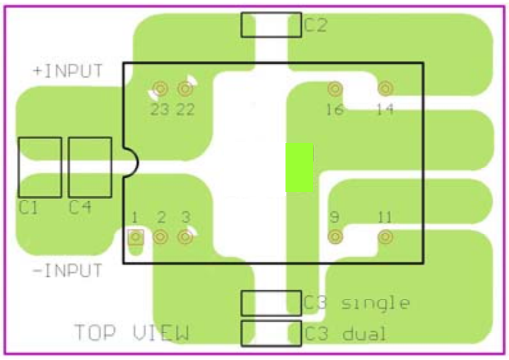
EMC considerations Single and Dual Output Converter / Emission (Conducted Noise)





recommended circuit to comply with EN55022 Class A Limits

Single Output



recommended Layout with Input Filter

To comply with EN55022 Class A following components are needed:

for TEN 8-24xxWI

Component	Value	Voltage	Reference
C1	1µF	50V	1210 MLCC
C2, C3	1000pF	2KV	1206 MLCC

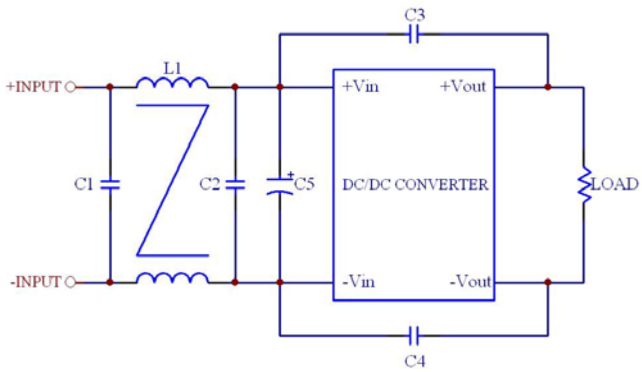
for TEN 8-48xxWI

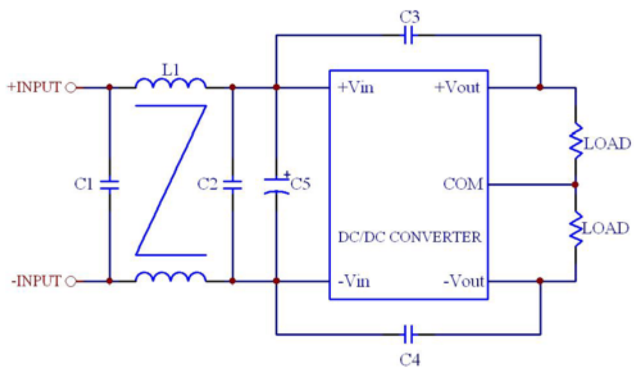
Component	Value	Voltage	Reference
C1	0.47µF	100V	1812 MLCC
C2, C3	1000pF	2KV	1206 MLCC

for TEN 8-72xxWI

Component	Value	Voltage	Reference
C1, C4	1µF	250V	1812 MLCC
C2, C3	1000pF	2KV	1206 MLCC

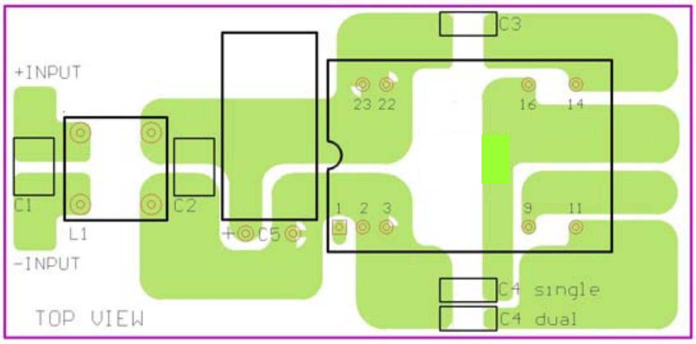
EMC considerations Single and Dual Output Converter (Continued)





recommended circuit to comply with EN55022 Class B Limits

Single Output & Dual Output



recommended Layout with Input Filter

To comply with EN55022 Class B following components are needed:

for TEN 8-24xxWI

Component	Value	Voltage	Reference
C1	4.7µF	50V	1812 MLCC
C3, C4	1000pF	2KV	1206 MLCC
L1	325µH	----	Common Choke, P/N: TCK-050

for TEN 8-48xxWI

Component	Value	Voltage	Reference
C1, C2	1.5µF	100V	1812 MLCC
C3, C4	1000pF	2KV	1206 MLCC
L1	325µH	----	Common Choke, P/N: TCK-050

for TEN 8-72xxWI

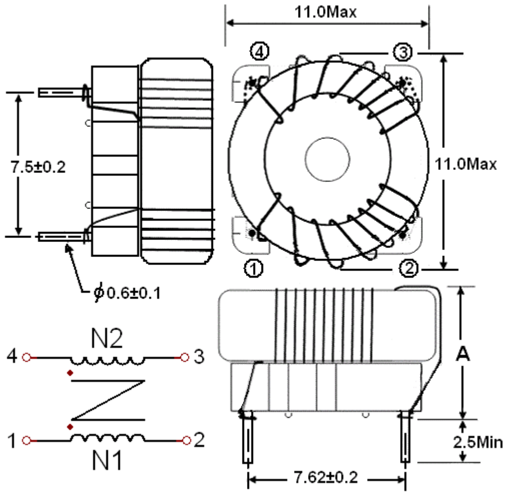
Component	Value	Voltage	Reference
C1	1µF	250V	1812 MLCC
C5	22µF	200V	UNITED CHEMI-CON: KMF series KMF200VB22RM10X20LL (To lie down)
C3, C4	1000pF	2KV	1206 MLCC
L1	497µH	----	Common Choke, P/N：TCK-017

EMC considerations Single and Dual Output Converter (Continued)

This Common Choke L1 has been define as following：

- 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

- TCK-017
  L: 497µH ±25%
  DCR: 80mΩ, max
  A height: 8.8 mm, Max
  - Test condition: 100KHz / 20mV
  - 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 47µF/100V low ESR type. The capacitor must be equipped as close as possible to the input terminals of the power module for lower impedance.

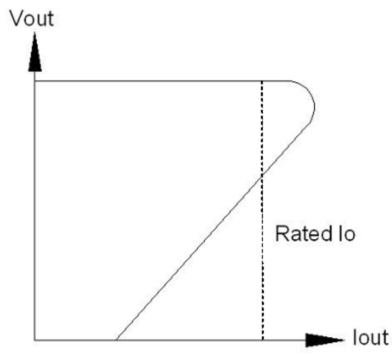
Output Over Current Protection

When excessive output currents occur in the system, circuit protection is required on all power supplies. Normally, overload current is maintained at approximately about 150 percent of rated current for TEN 8-WI series.

Fold back-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 operate normally when the fault is removed.

One of the problems resulting from over current is that excessive heat may be generated in power devices; especially MOSFET and Shottky 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 fold back is as follows. When the current sense circuit sees an over-current event, the output voltage of the module will be decreased for low power dissipation and decrease the heat of the module.

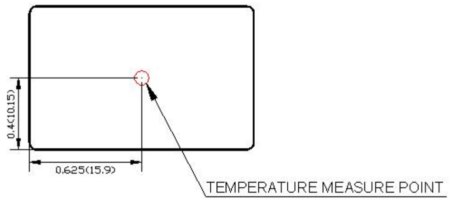


Output Over Voltage Protection (only single output converters)

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.

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.



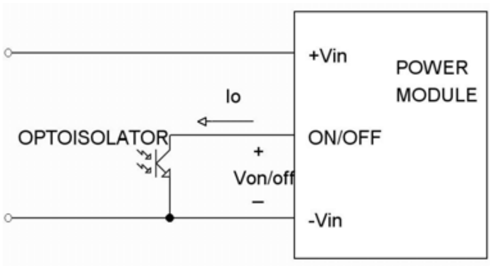
Measurement shown in inches and (millimeters)

TOP VIEW

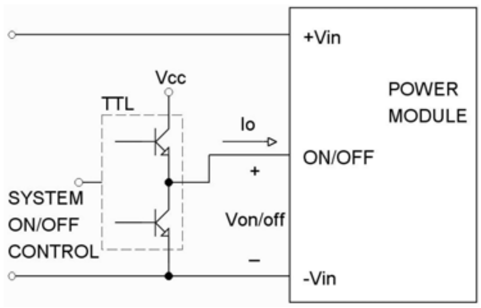
Remote ON/OFF Control

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.

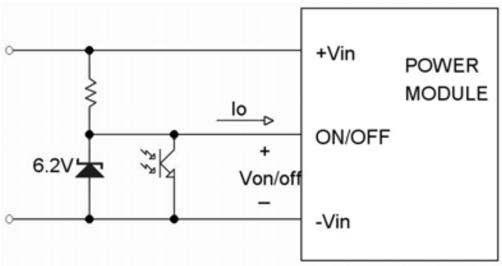
Proposals of Remote ON/OFF circuits



Isolated-Closure Remote ON/OFF



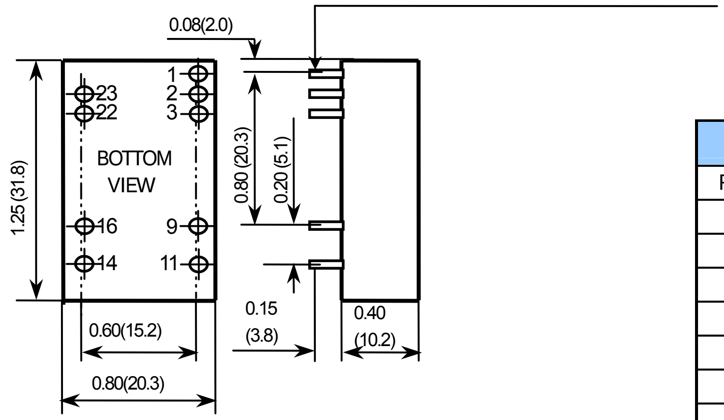
Level Control Using TTL Output



Level Control Using Line Voltage

Mechanical Data

DIP Package

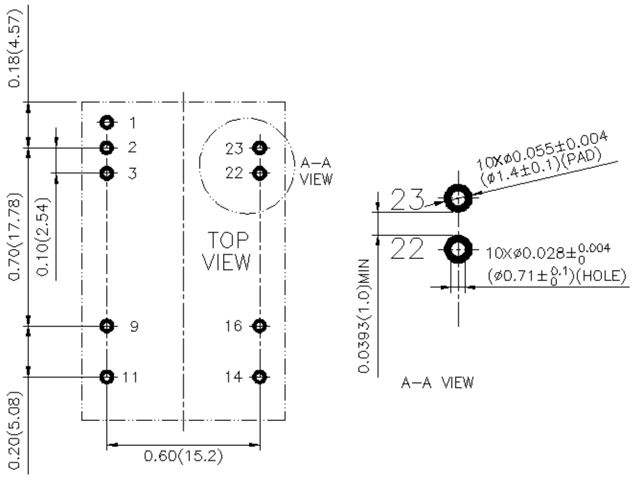


1. All dimensions in Inches (mm)
   Tolerance: x.xx ±0.02 (x.x ±0.5mm)
2. Pin pitch tolerance ±0.014 (±0.35mm)

PIN-OUT		
PIN	Single	Dual
1	Remote ON/OFF	Remote ON/OFF
2	-Vin (GND)	-Vin (GND)
3	-Vin (GND)	-Vin (GND)
9	No connection	Common
11	No connection	-Vout
14	+Vout	+Vout
16	-Vout	Common
22	+Vin (Vcc)	+Vin (Vcc)
23	+Vin (Vcc)	+Vin (Vcc)

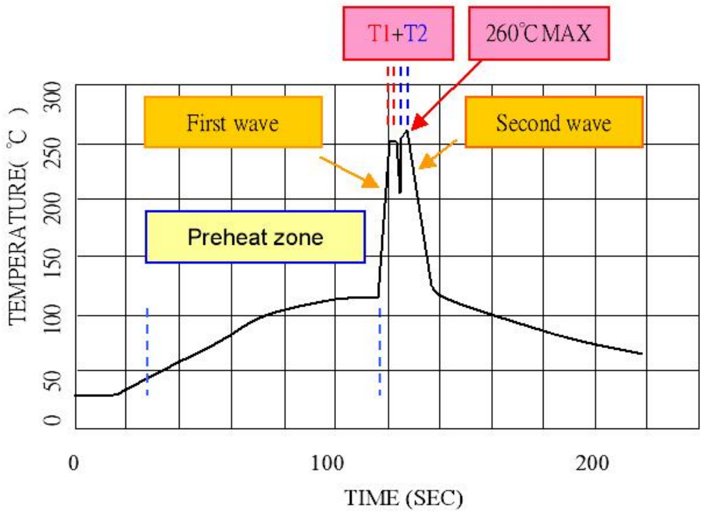
Recommended Pad Layout

DIP Package



Soldering and Reflow Considerations

Lead free wave solder profile for TEN 8-WI Converters



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

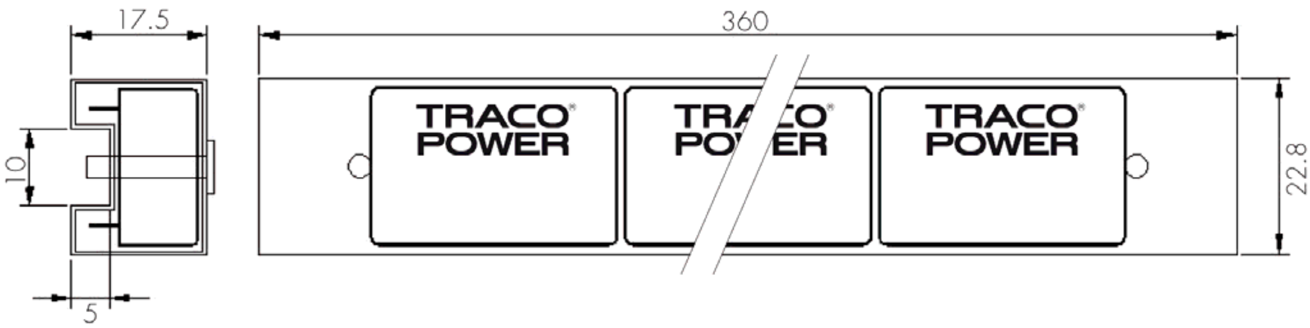
Reference Solder: Sn-Ag-Cu; Sn-Cu

Hand Welding :

Soldering iron: Power 90 Watt
Soldering Time: 2 ~ 4 sec
Temp.: 380°C ~ 400°C

Packaging Information

10 Pcs TEN 8-xxxxWI Converters per Tube



Part Number Structure

Model Number	Input Range	Output Voltage	Output Current Max. Load	Input Current Full Load (1)	Efficiency (2) (%)
TEN 8-2410WI	9 – 36 VDC	3.3 VDC	2400mA	407mA	85
TEN 8-2411WI	9 – 36 VDC	5 VDC	1600mA	402mA	87
TEN 8-2412WI	9 – 36 VDC	12 VDC	666mA	407mA	86
TEN 8-2413WI	9 – 36 VDC	15 VDC	533mA	407mA	86
TEN 8-2421WI	9 – 36 VDC	±5 VDC	±800mA	417mA	84
TEN 8-2422WI	9 – 36 VDC	±12 VDC	±333mA	407mA	86
TEN 8-2423WI	9 – 36 VDC	±15 VDC	±267mA	407mA	87
TEN 8-4810WI	18 – 75 VDC	3.3 VDC	2400mA	204mA	85
TEN 8-4811WI	18 – 75 VDC	5 VDC	1600mA	201mA	87
TEN 8-4812WI	18 – 75 VDC	12 VDC	666mA	201mA	87
TEN 8-4813WI	18 – 75 VDC	15 VDC	533mA	198mA	88
TEN 8-4821WI	18 – 75 VDC	±5 VDC	±800mA	208mA	84
TEN 8-4822WI	18 – 75 VDC	±12 VDC	±333mA	203mA	87
TEN 8-4823WI	18 – 75 VDC	±15 VDC	±267mA	201mA	87
TEN 8-7210WI	43 – 160 VDC	3.3 VDC	2400mA	407mA	84
TEN 8-7211WI	43 – 160 VDC	5 VDC	1600mA	402mA	85
TEN 8-7212WI	43 – 160 VDC	12 VDC	666mA	407mA	86
TEN 8-7213WI	43 – 160 VDC	15 VDC	533mA	407mA	86
TEN 8-7221WI	43 – 160 VDC	±5 VDC	±800mA	417mA	82
TEN 8-7222WI	43 – 160 VDC	±12 VDC	±333mA	407mA	85
TEN 8-7223WI	43 – 160 VDC	±15 VDC	±267mA	407mA	85

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: 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 slow-blow fuse with maximum rating of 3A. 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 8-WI DUAL-SERIES of DC/DC converters has been calculated using
Bellcore TR-NWT-000332 Case I: 50% stress, Operating Temperature at 40°C (Ground fixed and controlled environment). The resulting figure for MTBF is 2'350'000 hours.

MIL-HDBK 217F NOTICE2 FULL LOAD, Operating Temperature at 25°C. The resulting figure for MTBF is 1'078'000 hours.