TEN 20WIR-Series

20W, Ultra Wide Input, 9-36 VDC, Single & Dual DC/DC Converters

FEATURES

► RAILWAY APPLICATION

► ULTRA LOW QUIESCENT CURRENT

► SINGLE OUTPUT CURRENT UP TO 4.5A

► 4:1 ULTRA WIDE INPUT VOLTAGE RANGE

► SIX-SIDED CONTINUOUS SHIELD

► BUILT-IN EMI FILTERS

► INDUSTRY STANDARD PIN-OUT LCD20W SERIES COMPATIBLE

► HIGH EFFICIENCY UP TO 89%

► LOW PROFILE: 2.00 X 1.00 X 0.40 INCH

► FIXED SWITCHING FREQUENCY

► ROHS DIRECTIVE COMPLIANT

► NO MINIMUM LOAD REQUIRED

► INPUT TO OUTPUT ISOLATION: 1600VDC

► INPUT UNDER-VOLTAGE PROTECTION

► OUTPUT OVER-VOLTAGE PROTECTION

► OVER-CURRENT PROTECTION

► OUTPUT SHORT CIRCUIT PROTECTION

► REMOTE ON/OFF CONTROL

► ADJUSTABLE OUTPUT VOLTAGE

Applications

► Wireless Network

► Telecom/Datacom

► Industry Control System

► Measurement

► Semiconductor Equipment

► Railway System

OPTIONS

► POSITIVE LOGIC REMOTE ON/OFF

► WITHOUT ON/OFF CONTROL PIN

► WITHOUT TRIM PIN

► HEAT -SINKS AVAILABLE FOR EXTENDED OPERATION

General Description

TEN 20WIR DC/DC converters provide up to 20 watts of output power in an industry standard package and footprint. These units are specifically designed to meet the power needs of low profile. All models feature with 4:1 ultra wide input voltage of 9~36 VDC, 18~75 VDC and 43~160 VDC, ultra low quiescent current, and built-in EMI filters. Comprehensively protected against over-current, over-voltage and input under-voltage protection conditions, and trimmable output voltage.

Table of contents

Output Specification

Parameter	Model	Min	Typ	Max	Unit
Output Voltage Range (Vin = Vin(nom) , Full Load , T_A=25 °C)	TEN 20-xx10WIR TEN 20-xx11WIR TEN 20-xx12WIR TEN 20-xx13WIR TEN 20-xx22WIR TEN 20-xx23WIR	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(See Page 31)	All	-10		+10	%

Output Regulation
    Line (Vin(min) to Vin(max) at Full Load)
    Load (0% to 100% of Full Load)
    Load (10% to 90% of Full Load)
	Single / Dual
	Single / Dual
	Single / Dual
		-0.2/-0.5
		-0.2/-1.0
		-0.1/-0.8
				+0.2/+0.5
				+0.2/+1.0
				+0.1/+5.0
					%

Cross Regulation Asymetrical Load 25% / 100% of Full Load	Dual	-5.0		+5.0	%
Output Ripple & Noise(See Page 29) Peak to Peak (20MHz bandwidth) (Measured with a 1µF M/C X7R)	TEN 20-xx10WIR TEN 20-xx11WIR TEN 20-xx12WIR TEN 20-xx13WIR TEN 20-xx22WIR TEN 20-xx23WIR		75 75 100 100 100 100	100 100 125 125 125 125	$mV_{P\text{-}P}$
Temperature Coefficient	All	-0.02		+0.02	%/°C
Output Voltage Overshoot (Vin(min) to Vin(max) , Full Load , T_A=25 °C)	All			5	% Vout
Dynamic Load Response (Vin = Vin(nom) , T_A=25 °C) Load step change from 75% to 100% or 100 to 75% of Full Load Peak Deviation Setting Time (Vout < 10% peak deviation)	Single / Dual Single / Dual		350 / 200 250 / 250		mV µS
Output Current	TEN 20-xx10WIR TEN 20-xx11WIR TEN 20-xx12WIR TEN 20-xx13WIR TEN 20-xx22WIR TEN 20-xx23WIR	0 0 0 0 0 0		4500 4000 1670 1330 ±833 ±667	mA
Output Capacitor Load	TEN 20-xx10WIR TEN 20-xx11WIR TEN 20-xx12WIR TEN 20-xx13WIR TEN 20-xx22WIR TEN 20-xx23WIR			7000 5000 850 700 ±500 ±350	µF
Output Over Voltage Protection (Voltage Clamped)	TEN 20-xx10WIR TEN 20-xx11WIR TEN 20-xx12WIR TEN 20-xx13WIR TEN 20-xx22WIR TEN 20-xx23WIR	3.7 5.6 13.5 16.8 13.5 16.8		5.4 7.0 19.6 20.5 19.6 20.5	VDC
Output Over Current Protection	All		150		% FL.
Output Short Circuit Protection	All	Hiccup, automatics recovery			

Input Specification

Parameter	Model	Min	Typ	Max	Unit
Operating Input Voltage	TEN 20-241xWIR	9	24	36	
	TEN 20-481xWIR	18	48	75	
	TEN 20-721xWIR	43	110	160	VDC
	TEN 20-242xWIR	9	24	36	
	TEN 20-482xWIR	18	48	75	
	TEN 20-722xWIR	43	110	160	
Input Voltage					
Continuous	TEN 20-24xxWIR			36	
	TEN 20-48xxWIR			75	
	TEN 20-72xxWIR			160	VDC
Transient (1sec maximum)	TEN 20-24xxWIR			50	
	TEN 20-48xxWIR			100	
	TEN 20-72xxWIR			170	
Input Standby Current	TEN 20-24xxWIR		6		
(Typical value at Vin = Vin(nom), No Load)	TEN 20-48xxWIR		4		mA
	TEN 20-72xxWIR		3		
Under Voltage Lockout Turn-on Threshold	TEN 20-24xxWIR			9	
	TEN 20-48xxWIR			18	VDC
	TEN 20-72xxWIR			43	
Under Voltage Lockout Turn-off Threshold	TEN 20-24xxWIR			8	
	TEN 20-48xxWIR			16	VDC
	TEN 20-72xxWIR			40	
Input Reflected Ripple Current (See Page 29) (5 to 20MHz, 2.2µH source impedance)	All		30		mA$_{P-P}$

Start Up Time
 (Vin = Vin(nom) and constant resistive load)
    Power up
    Remote ON/OFF
	All			30
				 30
					mS

Remote ON/OFF Control (See Page 33)
 (The CTRL pin voltage is referenced to -INPUT)
 	
 Negative Logic DC-DC ON(Short)
                 DC-DC OFF(Open)
 Positive Logic   DC-DC ON(Open)
                 DC-DC OFF(Short)
	All	
		
		 0
		 3
		 3
		 0
				
				 1.2
				 15
				 15
				 1.2
					VDC

Remote Off Input Current	All		2.5		mA
Input Current of Remote Control Pin	All	-0.5		1.0	mA

Environmental Specifications

Parameter	Model	Min	Typ	Max	Unit
Operating Ambient Temperature (with derating) *	All	-40		101	°C
Operating Case Temperature	All			105	°C
Storage Temperature	All	-55		125	°C
Thermal impedance (See Page 32)	Natural convection Natural convection with Heat-sink			12°C/Watt 10°C/Watt	
Thermal shock	EN61373, MIL-STD-810F				
Vibration	EN61373, MIL-STD-810F				
Relative humidity	5% to 95% RH				

*Test condition with vertical direction by natural convection (20LFM).

General Specification

Parameter	Model	Min	Typ	Max	Unit
Efficiency(See Page 29) (Vin = Vin(nom) , Full Load , T$_A$=25°C)	TEN 20-2410WIR		85		%
	TEN 20-2411WIR		88		
	TEN 20-2412WIR		89		
	TEN 20-2413WIR		88		
	TEN 20-2422WIR		88		
	TEN 20-2423WIR		89		
	TEN 20-4810WIR		85		
	TEN 20-4811WIR		88		
	TEN 20-4812WIR		89		
	TEN 20-4813WIR		89		
	TEN 20-4822WIR		88		
	TEN 20-4823WIR		89		
	TEN 20-7210WIR		85		
	TEN 20-7211WIR		87		
	TEN 20-7212WIR		88		
	TEN 20-7213WIR		88		
	TEN 20-7222WIR		88		
	TEN 20-7223WIR		89		
Isolation Voltage (1minute) Input to Output Input (Output) to Case	All	1600 1000			VDC
Isolation Resistance	All	1			GΩ
Isolation Capacitance	All			3000	pF
Switching Frequency	All	297	330	363	KHz
Weight	All		30		g
MTBF(See Page 37) Bellcore TR-NWT-000332, T$_C$=40 °C MIL-HDBK-217F	All		$1.630×10^6$ $4.950×10^5$		hours
Case Material	Nickel-coated copper				
Base Material	FR4 PCB				
Potting Material	Silicon (UL94-V0)				
Dimensions	2.0 X 1.0 X 0.40 Inch (50.8 X 25.4 X 10.2 mm)				

*Test condition with vertical direction by natural convection (20LFM).

EMC Characteristics

EMI	EN55022, EN55011	24V, 48V 110V		Class B Class A
ESD	EN61000-4-2	Air ± 8KV Contact ± 6KV		Perf. Criteria A
Radiated immunity	EN61000-4-3	20 V/m		Perf. Criteria A
Fast transient*	EN61000-4-4	± 2KV		Perf. Criteria A
Surge*	EN61000-4-5	± 2KV		Perf. Criteria A
Conducted immunity	EN61000-4-6	10 V$_{r.m.s}$		Perf. Criteria A

*An external input filter capacitor is required if the module has to meet EN61000-4-4, EN61000-4-5.
 The filter capacitor TRACO POWER suggest: 24Vin & 48Vin: Nippon chemi-con KY series, 220µF/100V, ESR 48mΩ .
                                   110Vin:Rubycon BXF series, 100µF/250V.

Characteristic Curves

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

**Efficiency versus Output Current**
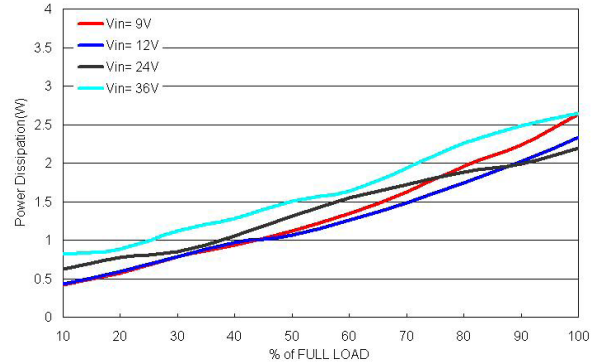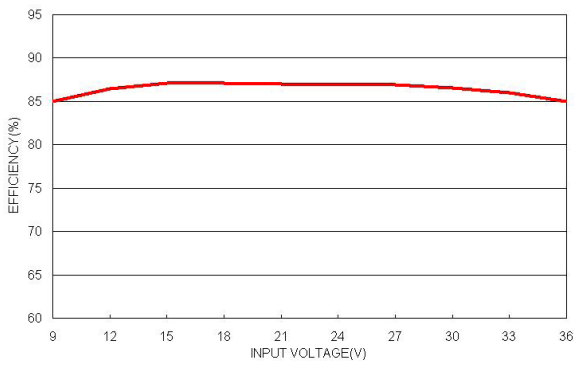
Power Dissipation versus Output Current

**Efficiency versus Input Voltage. Full Load**
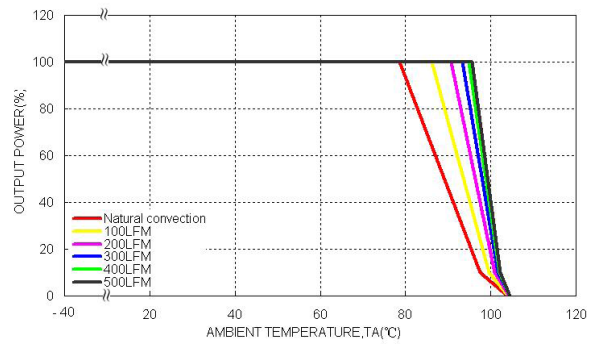
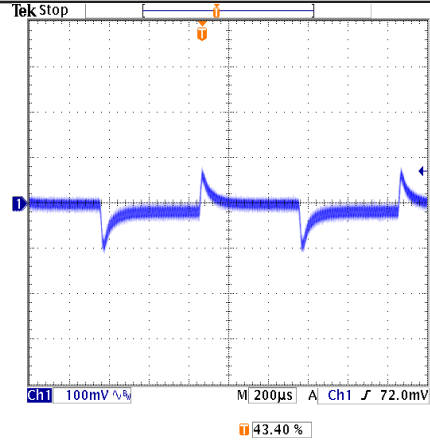**Derating Output Current versus Ambient Temperature with Airflow, Vin = Vin(nom)**
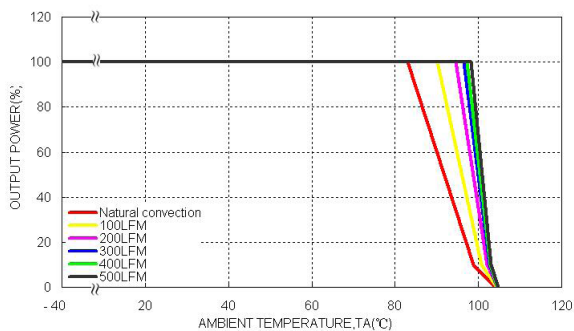
Derating Output Current Versus Ambient Temperature with Heat-sink and Airflow, Vin = Vin(nom)
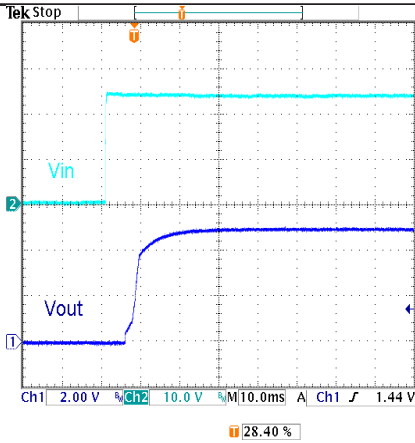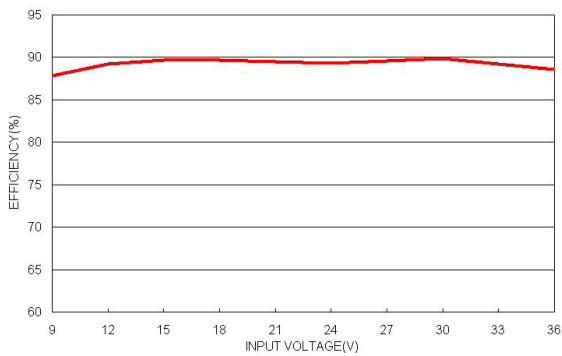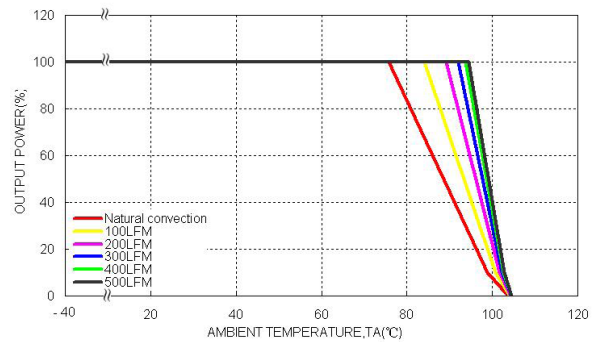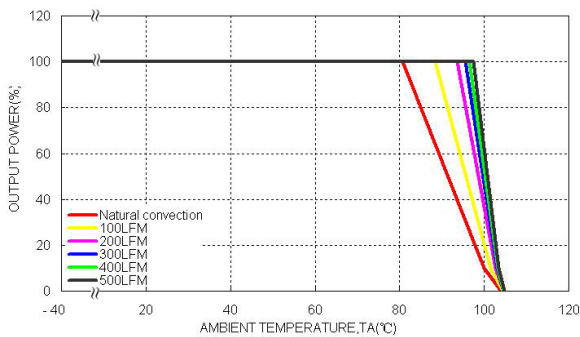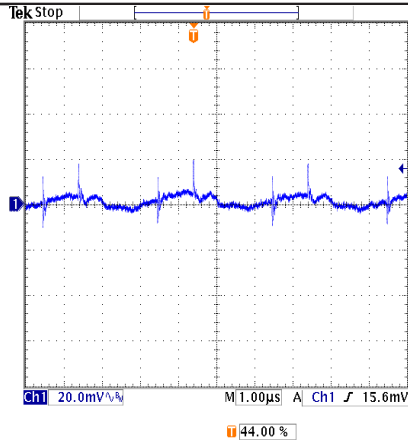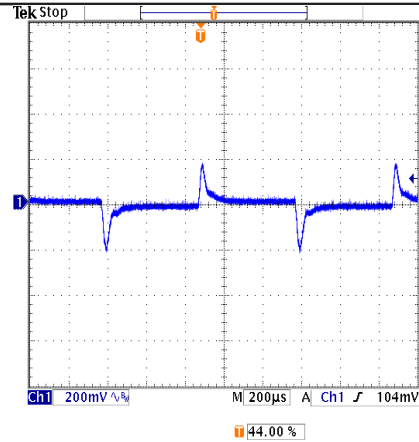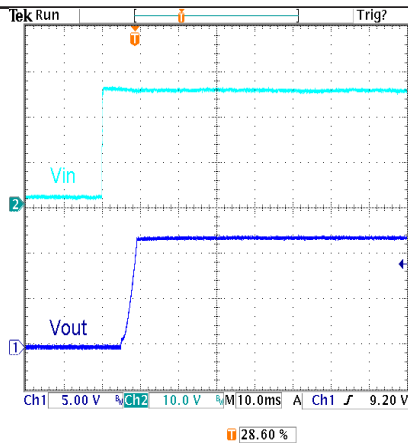
Characteristic Curves

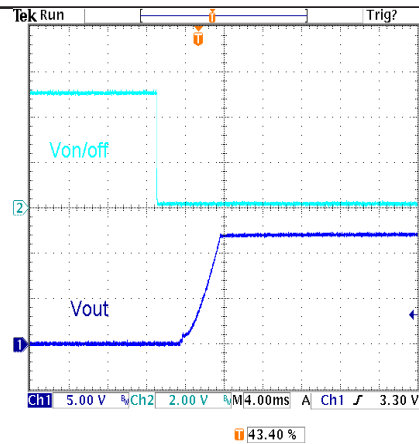All test conditions are at 25°C. The figures are identical for TEN 20-2410WIR (Continued)
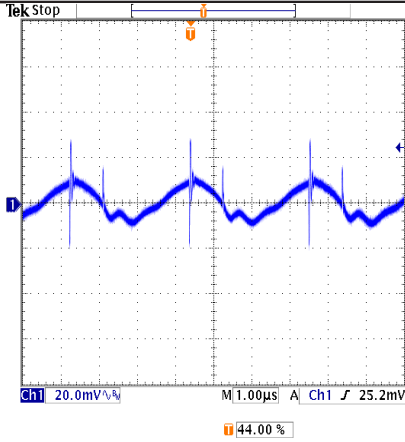
Typical Output Ripple and Noise.
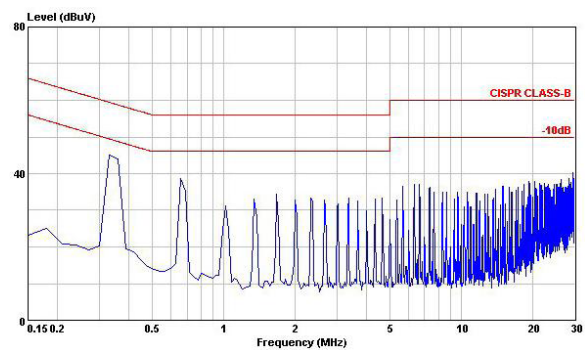**Vin = Vin(nom), Full Load**
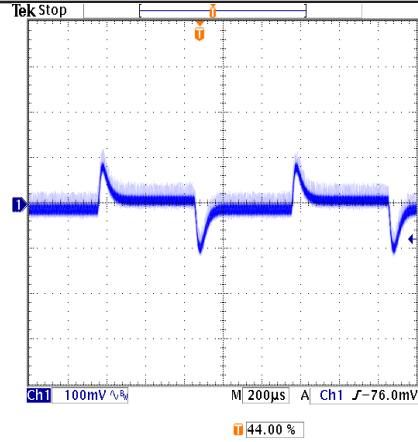
Transient Response to Dynamic Load Change from 100% to 75% to 100% of Full Load, Vin = Vin(nom)
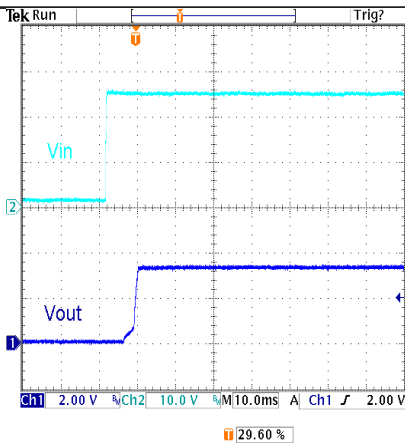
Typical Input Start-Up and Output Rise Characteristic
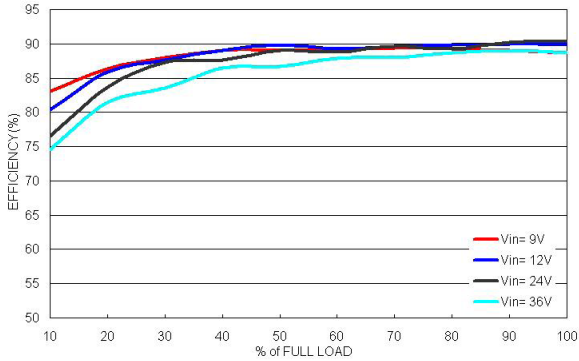**Vin = Vin(nom), Full Load**
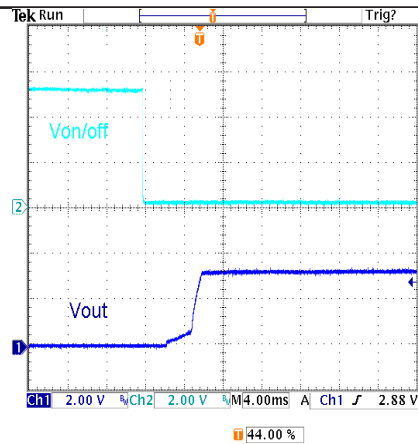
Using ON/OFF Voltage Start-Up and Vo Rise Characteristic
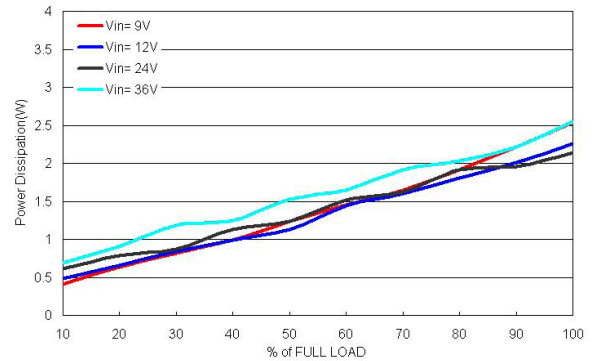**Vin = Vin(nom), Full Load**
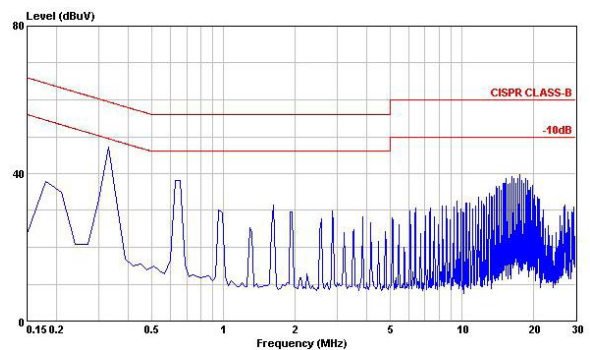
Conduction Emission of EN55022 Class B
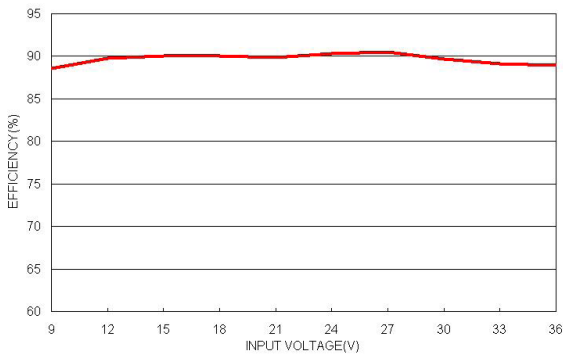**Vin = Vin(nom), Full Load**

Characteristic Curves

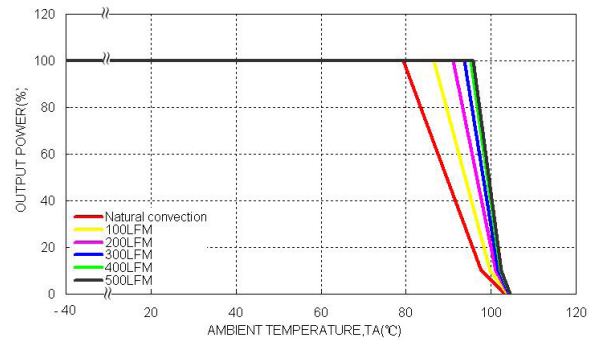All test conditions are at 25°C. The figures are identical for TEN 20-2411WIR

**Efficiency versus Output Current**
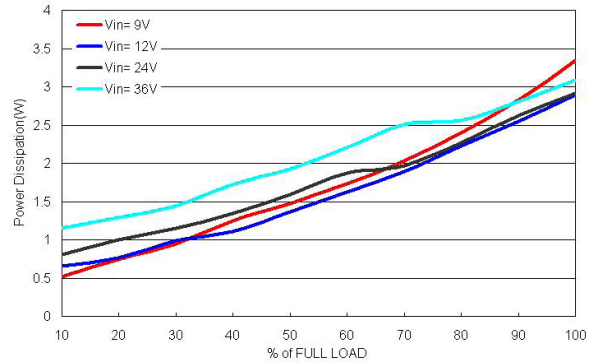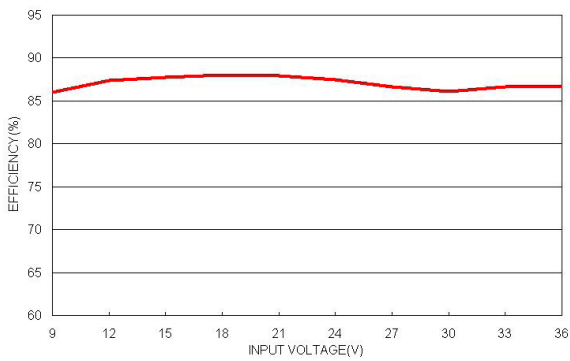
Power Dissipation versus Output Current

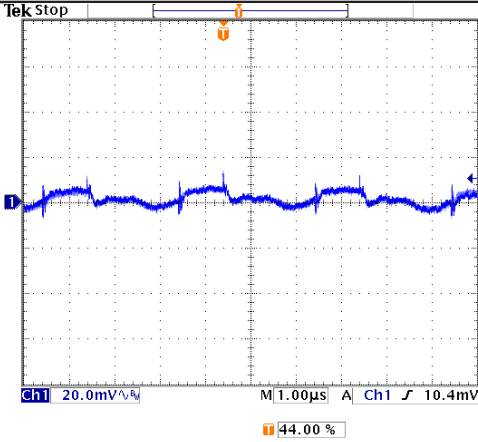**Efficiency versus Input Voltage. Full Load**
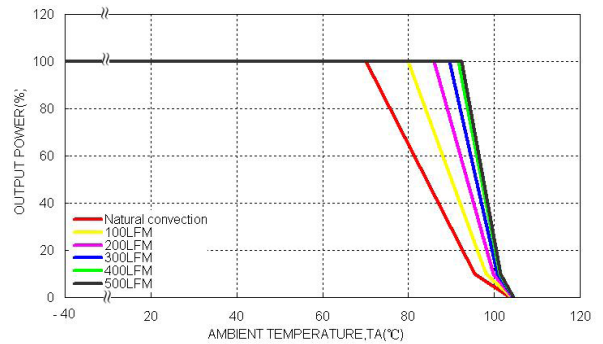
Derating Output Current versus Ambient Temperature with Airflow, Vin = Vin(nom)
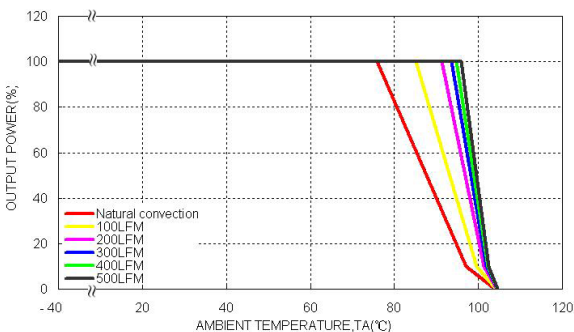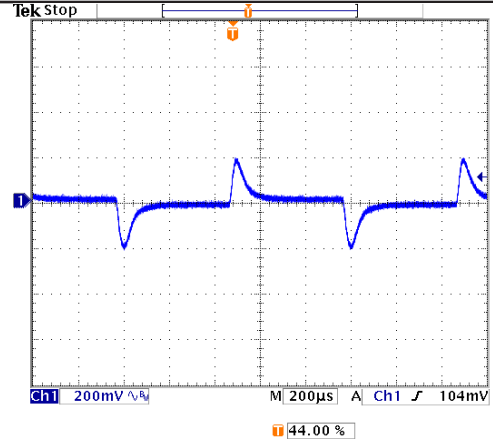
Derating Output Current Versus Ambient Temperature with Heat-sink and Airflow, Vin = Vin(nom)
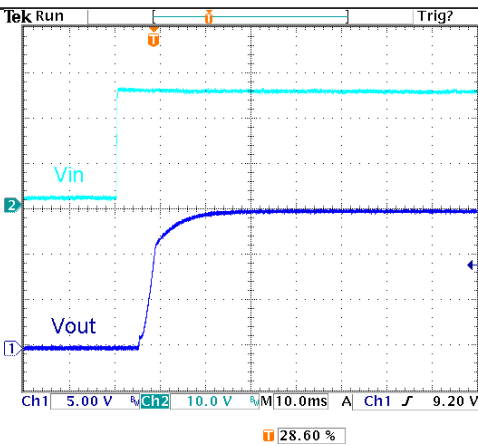
Characteristic Curves

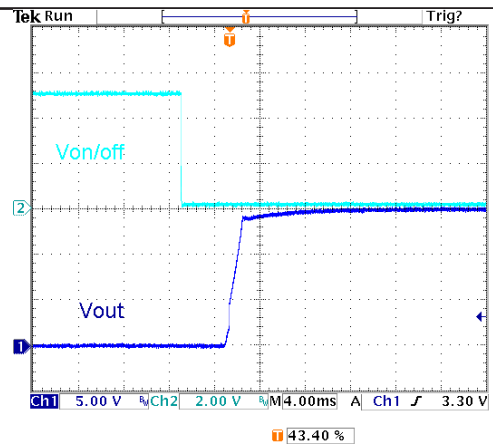All test conditions are at 25°C. The figures are identical for TEN 20-2411WIR (Continued)
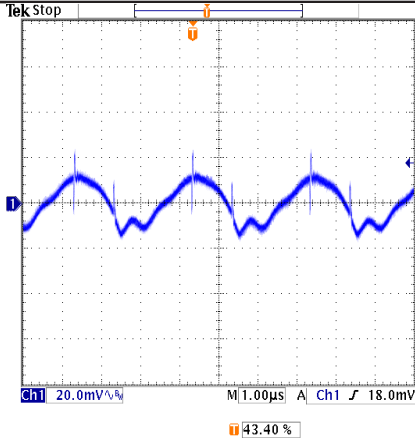
Typical Output Ripple and Noise.
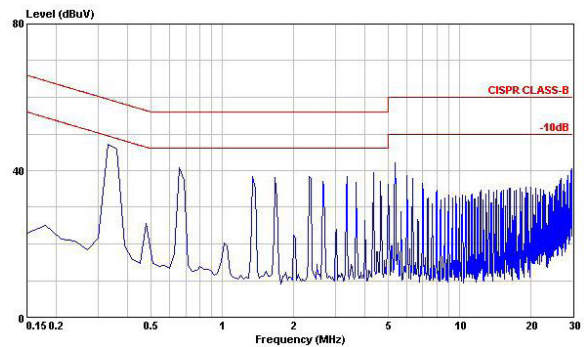**Vin = Vin(nom), Full Load**

Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load, Vin = Vin(nom)

Typical Input Start-Up and Output Rise Characteristic
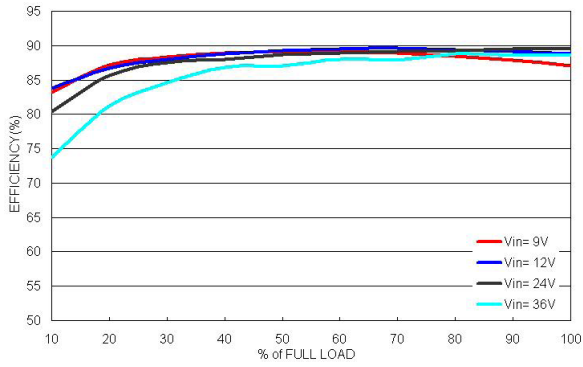**Vin = Vin(nom), Full Load**
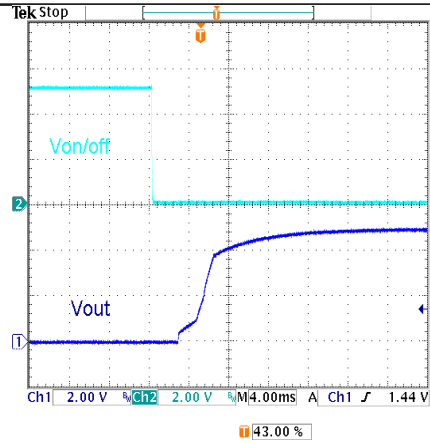
Using ON/OFF Voltage Start-Up and Vo Rise Characteristic
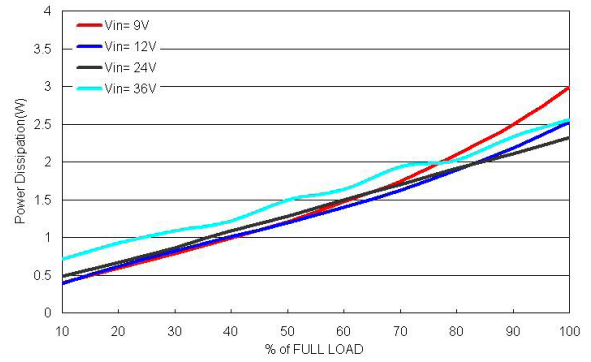**Vin = Vin(nom), Full Load**
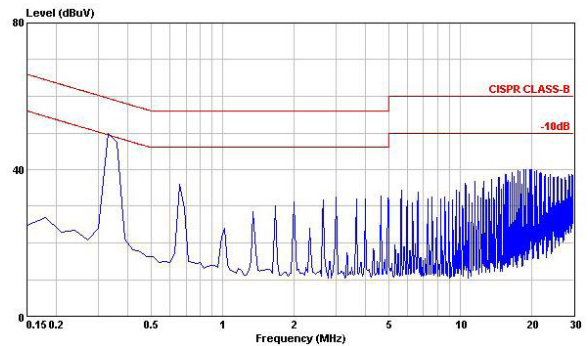
Conduction Emission of EN55022 Class B
Vin = Vin(nom), Full Load
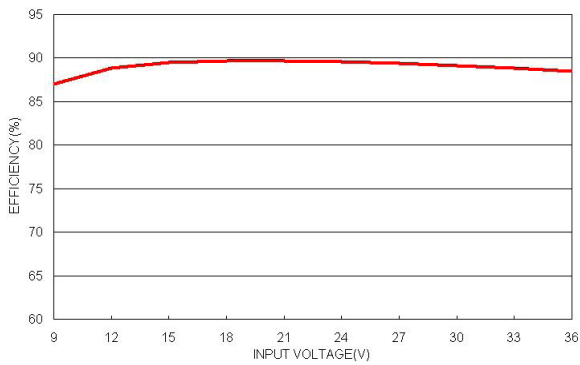
Characteristic Curves

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

Efficiency versus Output Current
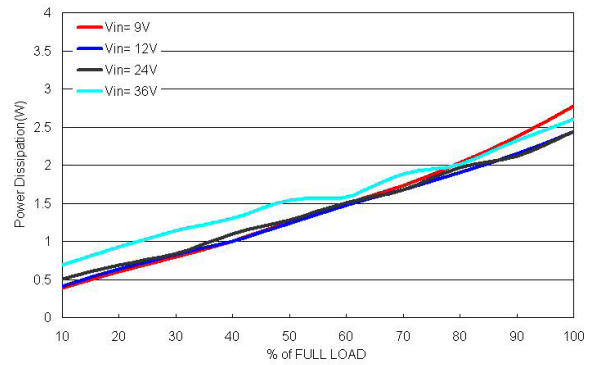
Power Dissipation versus Output Current

Efficiency versus Input Voltage. Full Load

Derating Output Current versus Ambient Temperature with Airflow, Vin = Vin(nom)

Derating Output Current Versus Ambient Temperature with Heat-sink and Airflow, Vin = Vin(nom)

Characteristic Curves

All test conditions are at 25°C. The figures are identical for TEN 20-2412WIR (Continued)

Typical Output Ripple and Noise.
Vin = Vin(nom), Full Load

Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load, Vin = Vin(nom)

Typical Input Start-Up and Output Rise Characteristic
Vin = Vin(nom), Full Load

Using ON/OFF Voltage Start-Up and Vo Rise Characteristic
Vin = Vin(nom), Full Load

Conduction Emission of EN55022 Class B
Vin = Vin(nom), Full Load

Characteristic Curves

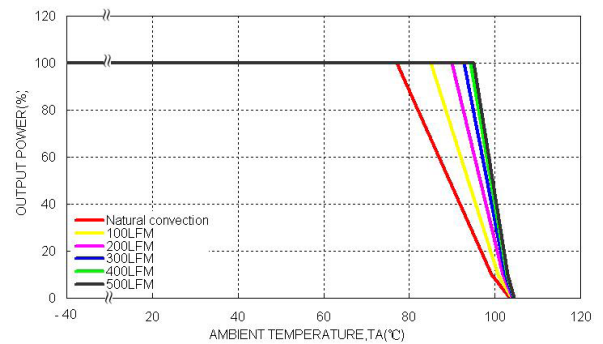All test conditions are at 25°C. The figures are identical for TEN 20-2413WIR

Efficiency versus Output Current

Power Dissipation versus Output Current
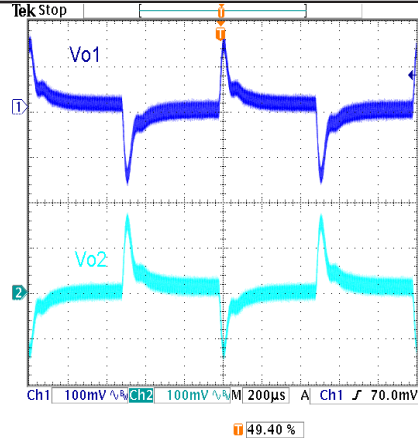
Efficiency versus Input Voltage. Full Load

Derating Output Current versus Ambient Temperature with Airflow, Vin = Vin(nom)
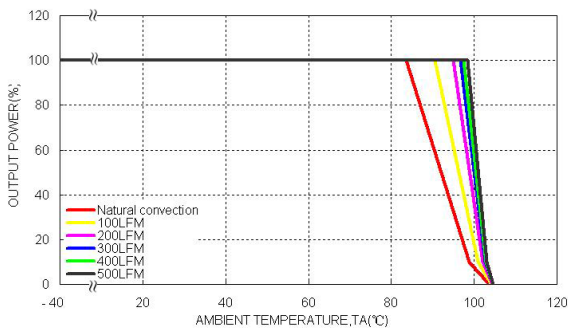
Derating Output Current Versus Ambient Temperature with Heat-sink and Airflow, Vin = Vin(nom)
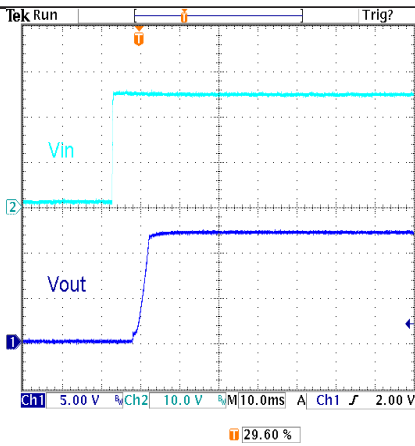
Characteristic Curves

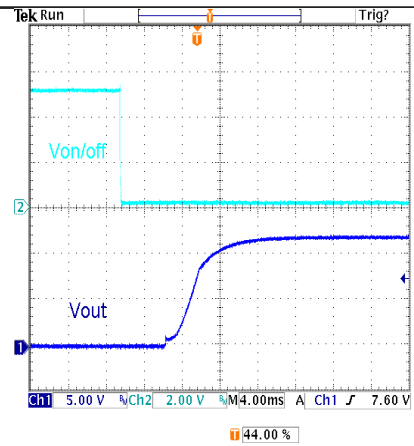All test conditions are at 25°C. The figures are identical for TEN 20-2413WIR (Continued)

Typical Output Ripple and Noise.
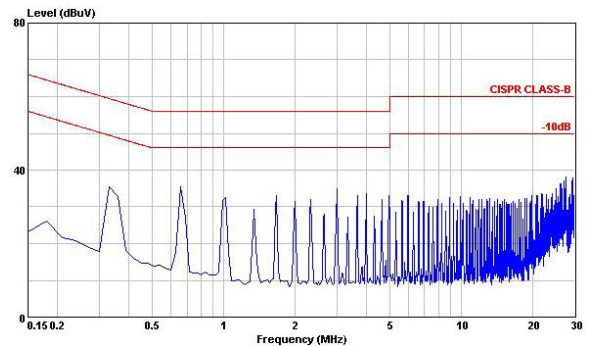**Vin = Vin(nom), Full Load**

Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load, Vin = Vin(nom)

Typical Input Start-Up and Output Rise Characteristic
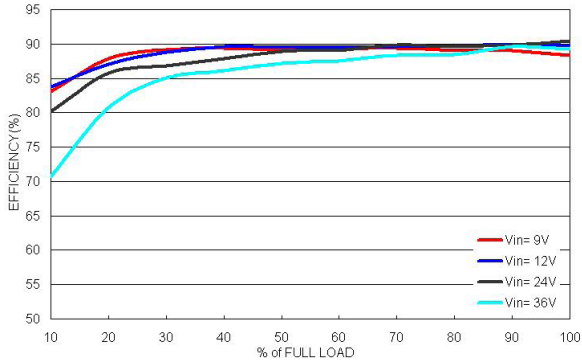**Vin = Vin(nom), Full Load**

Using ON/OFF Voltage Start-Up and Vo Rise Characteristic
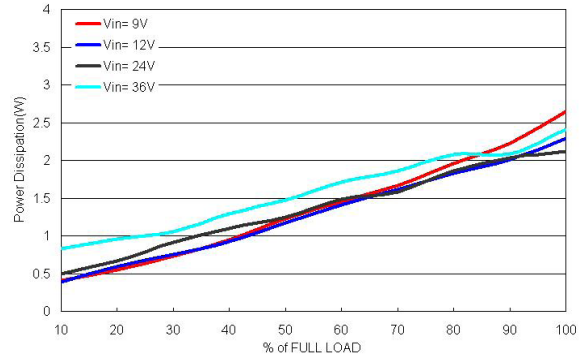**Vin = Vin(nom), Full Load**

Conduction Emission of EN55022 Class B
Vin = Vin(nom), Full Load
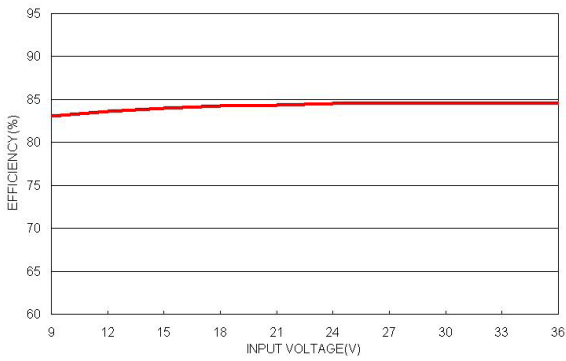
Characteristic Curves

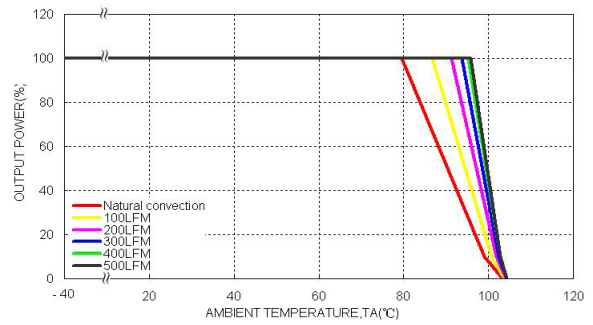All test conditions are at 25°C. The figures are identical for TEN 20-2422WIR

Efficiency versus Output Current

Power Dissipation versus Output Current

**Efficiency versus Input Voltage, Full Load**

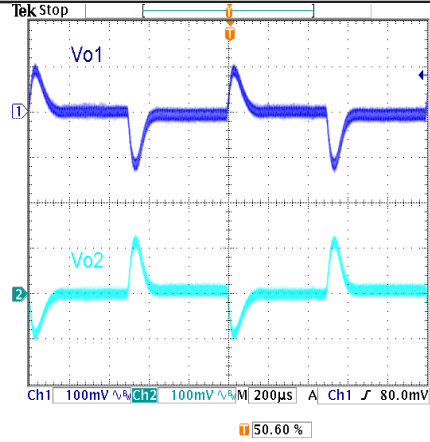**Derating Output Current versus Ambient Temperature with Airflow, Vin = Vin(nom)**
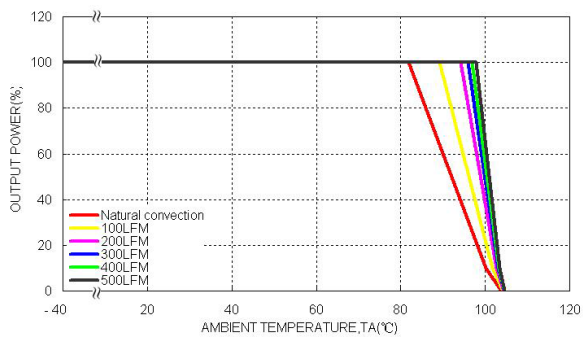
Derating Output Current Versus Ambient Temperature with Heat-sink and Airflow, Vin = Vin(nom)
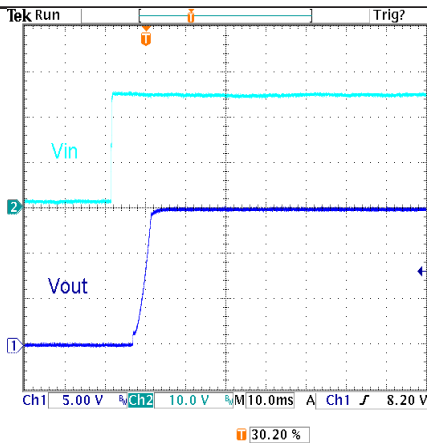
Characteristic Curves

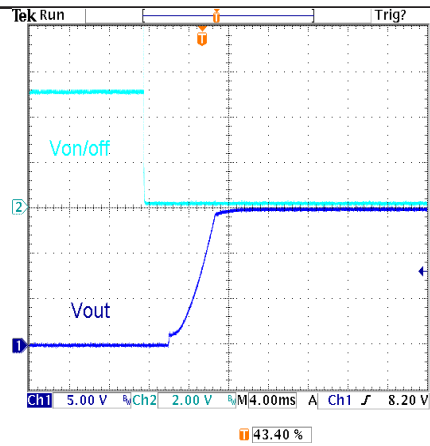All test conditions are at 25°C. The figures are identical for TEN 20-2422WIR (Continued)
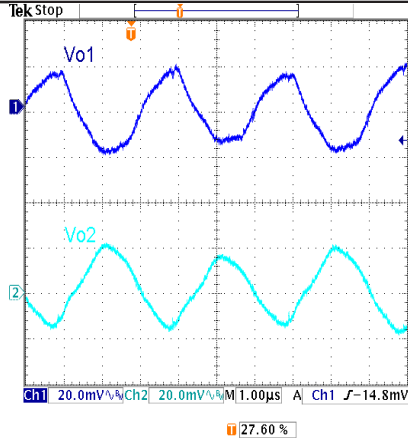
Typical Output Ripple and Noise.
Vin = Vin(nom), Full Load

Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load, Vin = Vin(nom)

Typical Input Start-Up and Output Rise Characteristic
Vin = Vin(nom), Full Load

Using ON/OFF Voltage Start-Up and Vo Rise Characteristic
Vin = Vin(nom), Full Load

Conduction Emission of EN55022 Class B
Vin = Vin(nom), Full Load

Characteristic Curves

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

Efficiency versus Output Current

Power Dissipation versus Output Current

Efficiency versus Input Voltage. Full Load

Derating Output Current versus Ambient Temperature with Airflow Vin = Vin(nom)
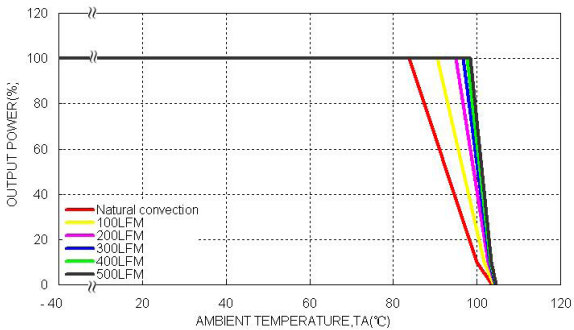
Derating Output Current Versus Ambient Temperature with Heat-sink and Airflow, Vin = Vin(nom)

Characteristic Curves (Continued)

All test conditions are at 25°C. The figures are identical for TEN 20-2423WIR (Continued)
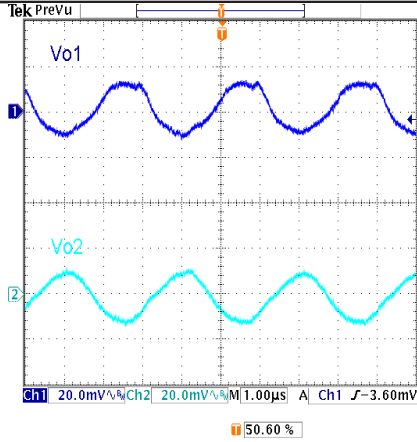
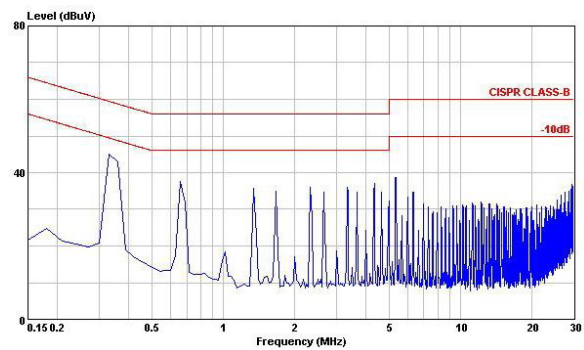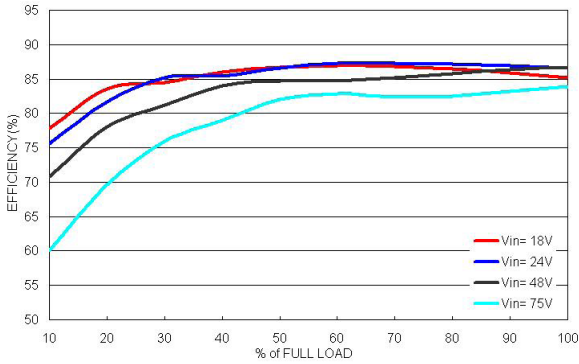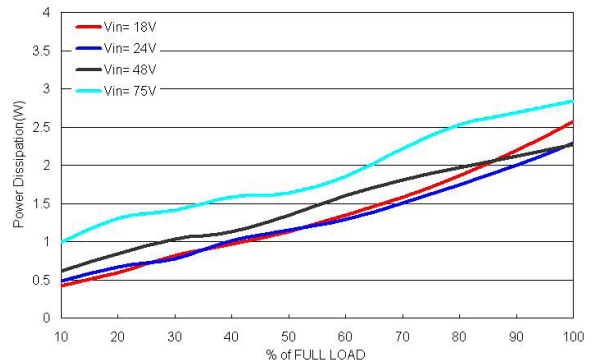**Typical Output Ripple and Noise.**
Vin = Vin(nom), Full Load

Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load , Vin = Vin(nom)

Typical Input Start-Up and Output Rise Characteristic
Vin = Vin(nom), Full Load

Using ON/OFF Voltage Start-Up and Vo Rise Characteristic
Vin = Vin(nom), Full Load

Conduction Emission of EN55022 Class B
Vin = Vin(nom), Full Load
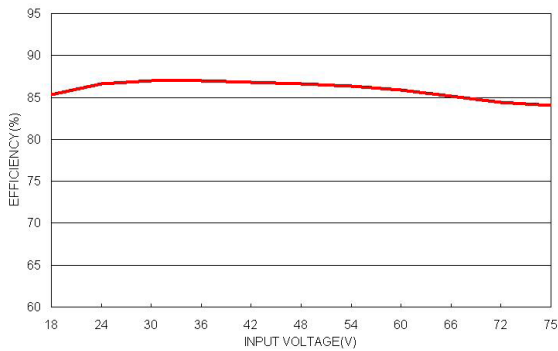
Characteristic Curves (Continued)

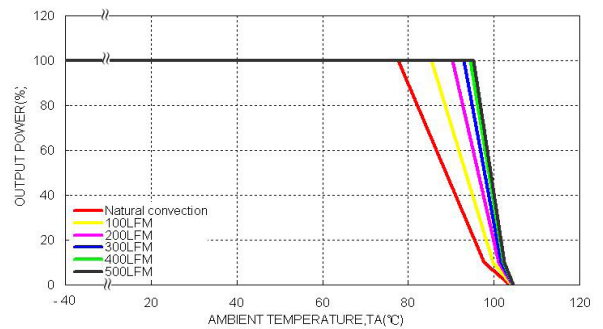All test conditions are at 25°C. The figures are identical for TEN 20-4810WIR
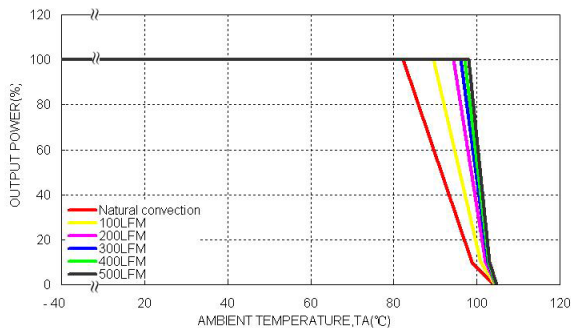
Efficiency versus Output Current

Power Dissipation versus Output Current

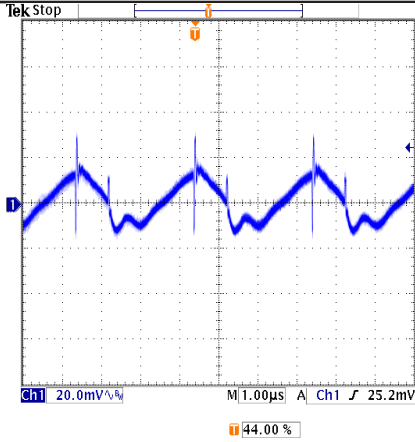**Efficiency versus Input Voltage. Full Load**

Derating Output Current versus Ambient Temperature with Airflow, Vin = Vin(nom)
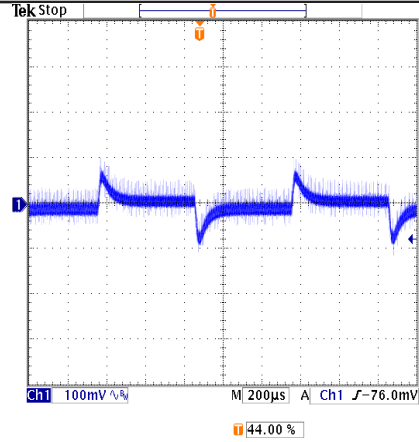
Derating Output Current Versus Ambient Temperature with Heat-sink and Airflow, Vin = Vin(nom)
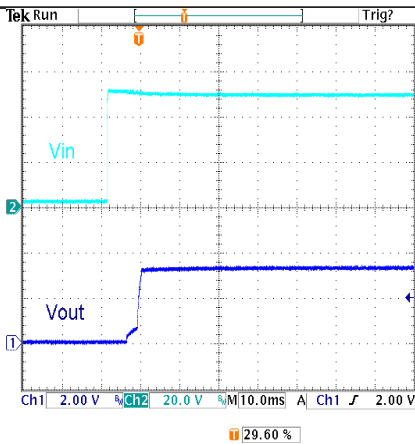
Characteristic Curves

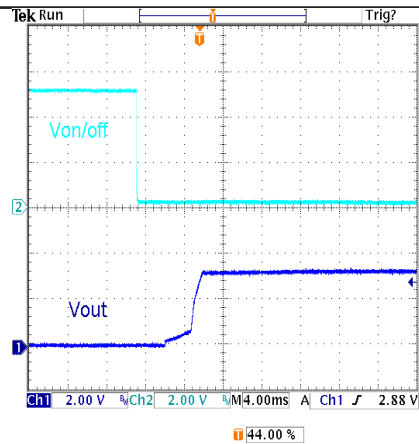All test conditions are at 25°C. The figures are identical for TEN 20-4810WIR (Continued)

Typical Output Ripple and Noise.
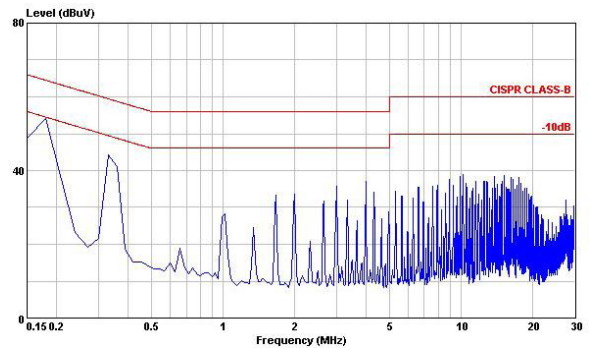**Vin = Vin(nom), Full Load**

Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load, Vin = Vin(nom)

Typical Input Start-Up and Output Rise Characteristic
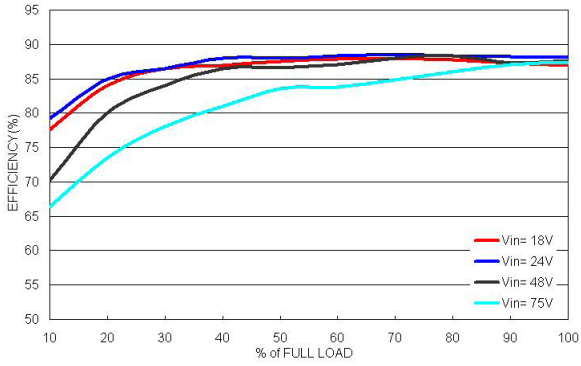**Vin = Vin(nom), Full Load**

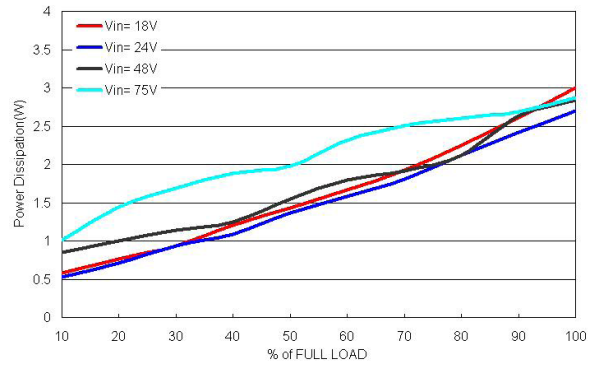**Using ON/OFF Voltage Start-Up and Vo Rise Characteristic**
Vin = Vin(nom), Full Load

Conduction Emission of EN55022 Class B
Vin = Vin(nom), Full Load
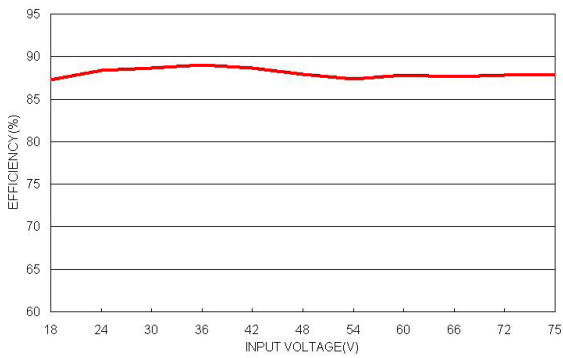
TRACO POWER

Characteristic Curves

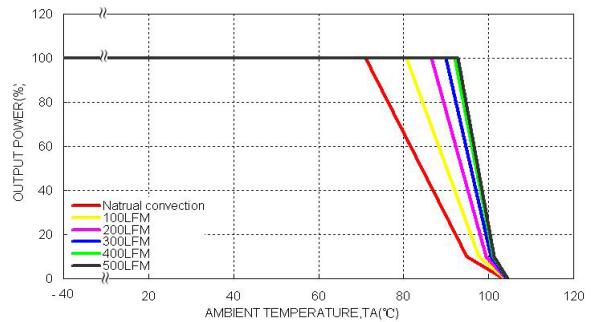All test conditions are at 25°C. The figures are identical for TEN 20-4811WIR

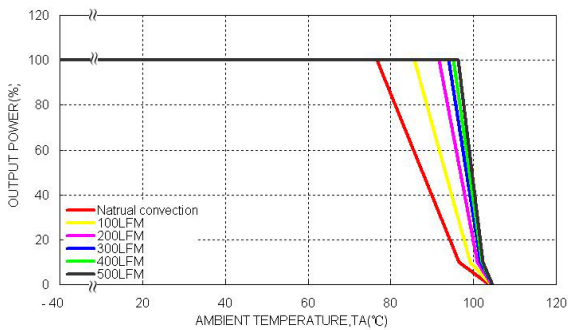**Efficiency versus Output Current**

Power Dissipation versus Output Current

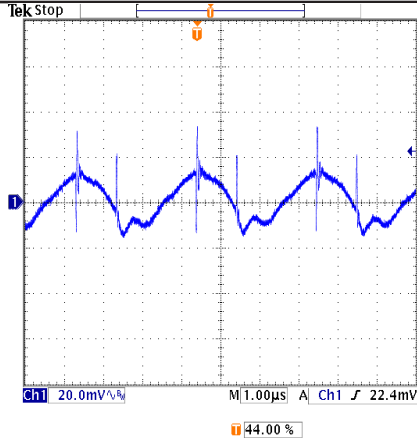**Efficiency versus Input Voltage. Full Load**

Derating Output Current versus Ambient Temperature with Airflow, Vin = Vin(nom)
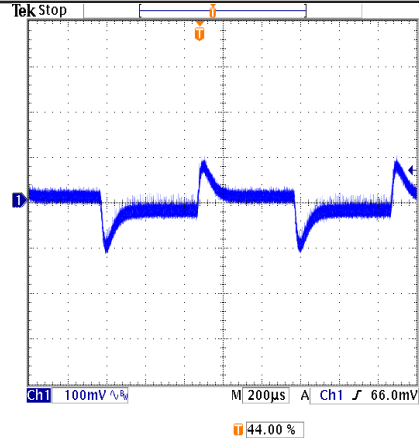

Derating Output Current Versus Ambient Temperature with Heat-sink and Airflow, Vin = Vin(nom)
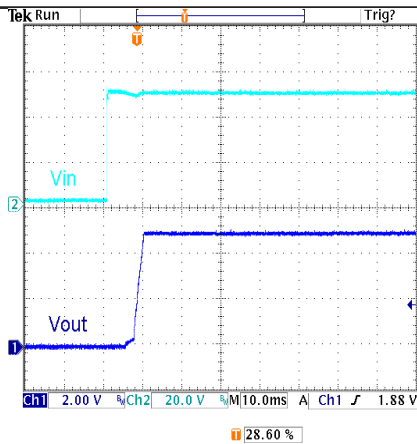
Characteristic Curves

All test conditions are at 25°C. The figures are identical for TEN 20-4811WIR (Continued)

Typical Output Ripple and Noise.
Vin = Vin(nom), Full Load

Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load, Vin = Vin(nom)

Typical Input Start-Up and Output Rise Characteristic
Vin = Vin(nom) , Full Load
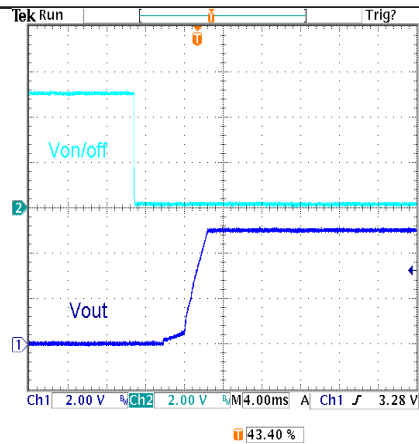
Using ON/OFF Voltage Start-Up and Vo Rise Characteristic
Vin = Vin(nom) , Full Load
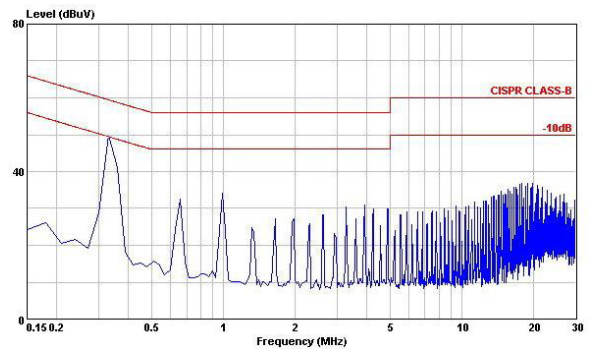
Conduction Emission of EN55022 Class B
Vin = Vin(nom), Full Load

Characteristic Curves

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

Efficiency versus Output Current

Power Dissipation versus Output Current

Efficiency versus Input Voltage. Full Load
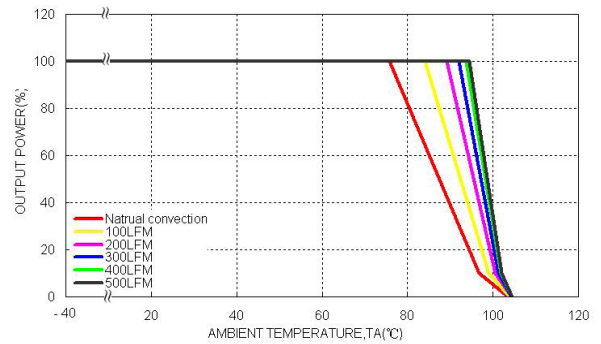
Derating Output Current versus Ambient Temperature with Airflow, Vin = Vin(nom)
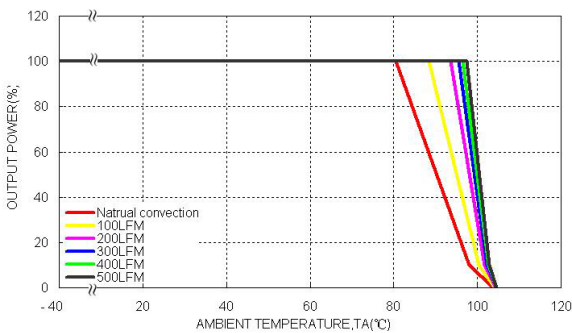
Derating Output Current Versus Ambient Temperature with Heat-sink and Airflow, Vin = Vin(nom)

Characteristic Curves

All test conditions are at 25°C. The figures are identical for TEN 20-4812WIR (Continued)
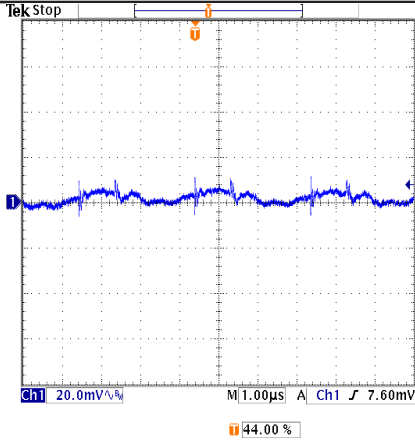

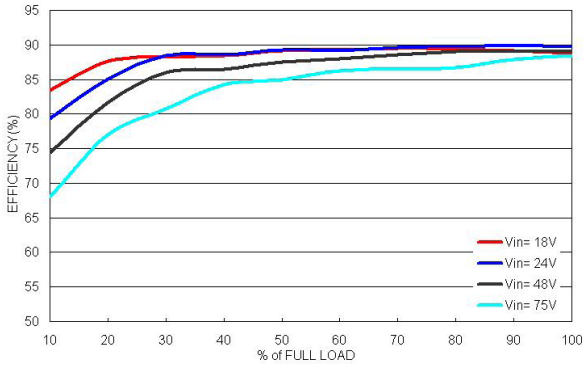**Typical Output Ripple and Noise.**
Vin = Vin(nom), Full Load

Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load, Vin = Vin(nom)

Typical Input Start-Up and Output Rise Characteristic
Vin = Vin(nom), Full Load

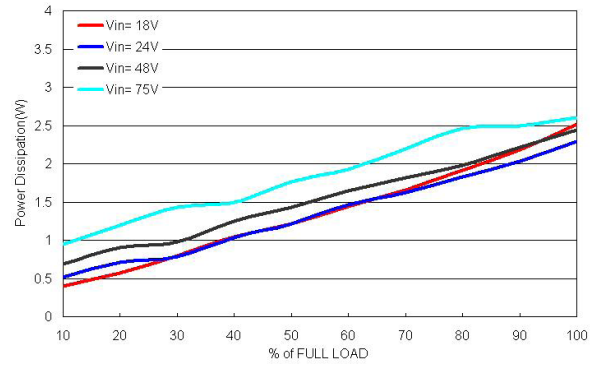**Using ON/OFF Voltage Start-Up and Vo Rise Characteristic**
Vin = Vin(nom), Full Load

Conduction Emission of EN55022 Class B
Vin = Vin(nom), Full Load

TRACO®
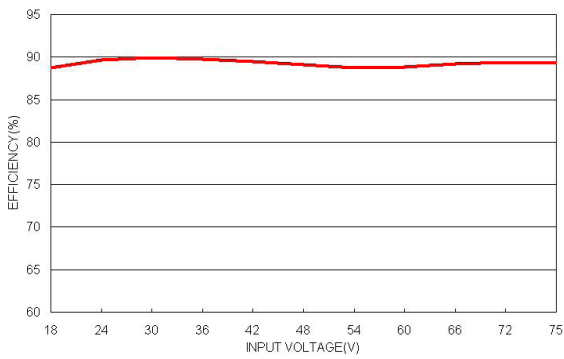POWER

Characteristic Curves

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


**Efficiency versus Output Current**

Power Dissipation versus Output Current

**Efficiency versus Input Voltage. Full Load**

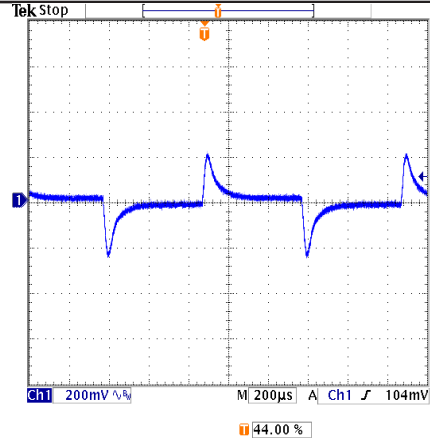**Derating Output Current versus Ambient Temperature with Airflow, Vin = Vin(nom)**
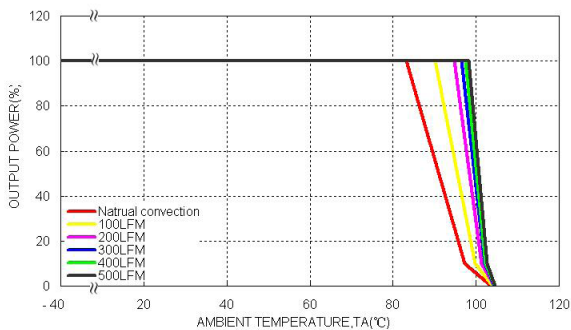
Derating Output Current Versus Ambient Temperature with Heat-sink and Airflow, Vin = Vin(nom)
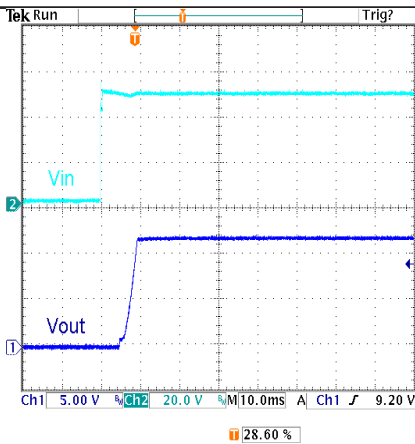
Characteristic Curves

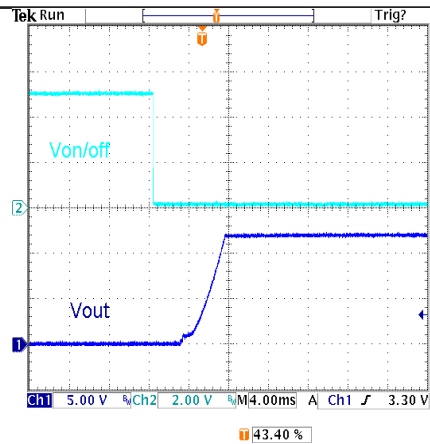All test conditions are at 25°C. The figures are identical for TEN 20-4813WIR (Continued)
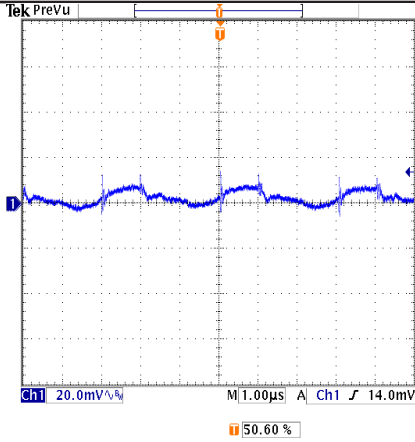
Typical Output Ripple and Noise.
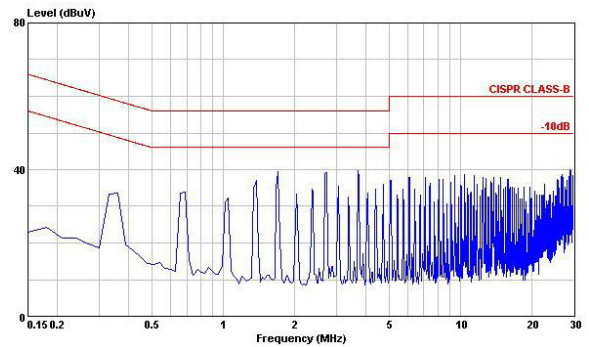**Vin = Vin(nom), Full Load**

Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load, Vin = Vin(nom)

Typical Input Start-Up and Output Rise Characteristic
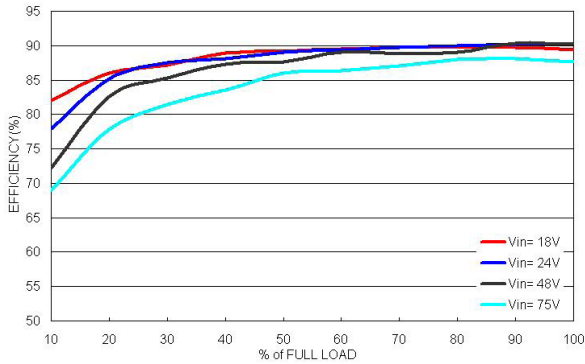**Vin = Vin(nom), Full Load**
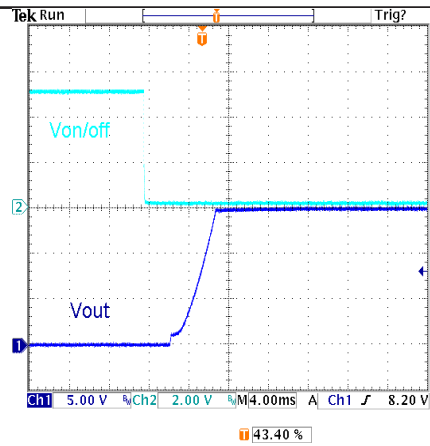
Using ON/OFF Voltage Start-Up and Vo Rise Characteristic
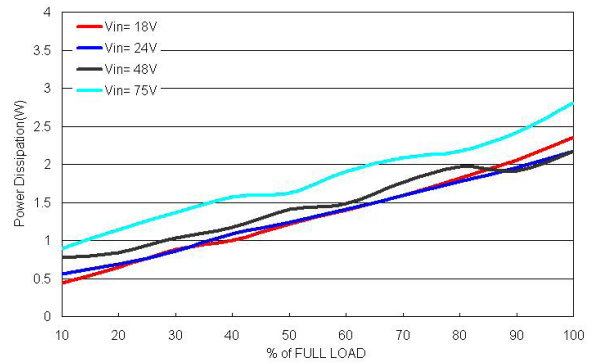**Vin = Vin(nom), Full Load**
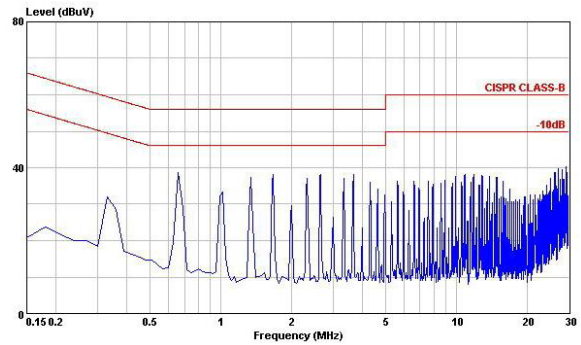
Conduction Emission of EN55022 Class B
Vin = Vin(nom), Full Load
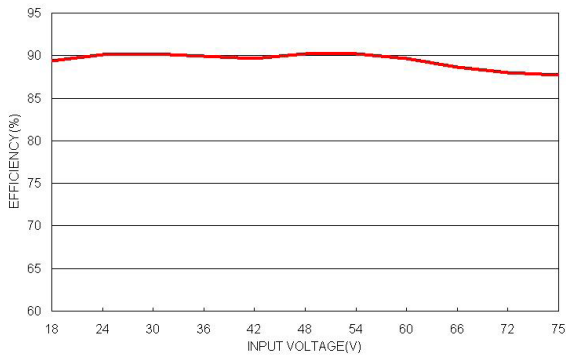
Characteristic Curves

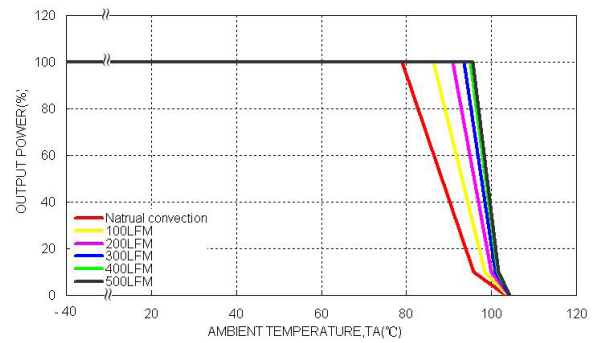All test conditions are at 25°C. The figures are identical for TEN 20-4822WIR

**Efficiency versus Output Current**

Power Dissipation versus Output Current

**Efficiency versus Input Voltage. Full Load**

Derating Output Current versus Ambient Temperature with Airflow, Vin = Vin(nom)
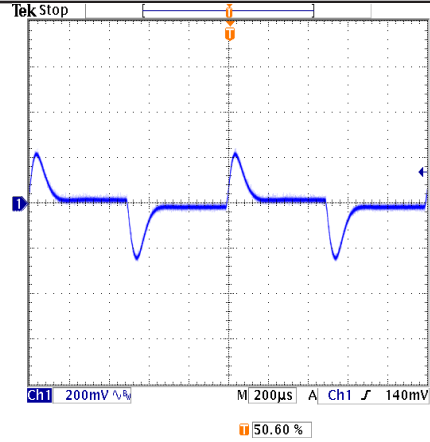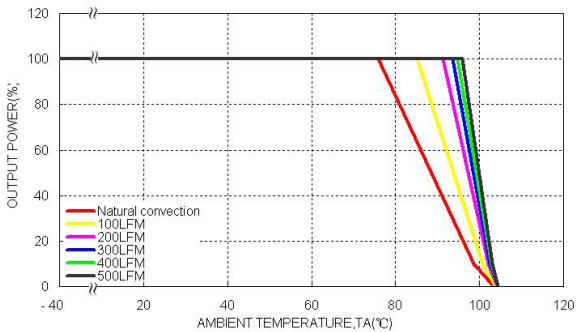
Derating Output Current Versus Ambient Temperature with Heat-sink and Airflow, Vin = Vin(nom)
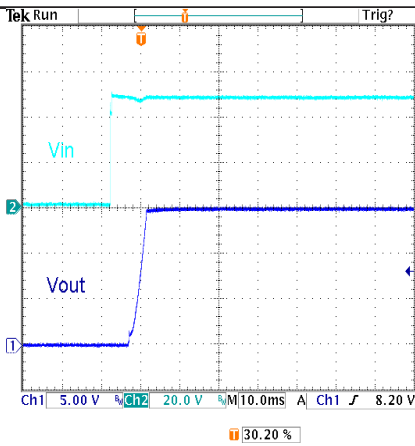
Characteristic Curves

All test conditions are at 25°C. The figures are identical for TEN 20-4822WIR (Continued)
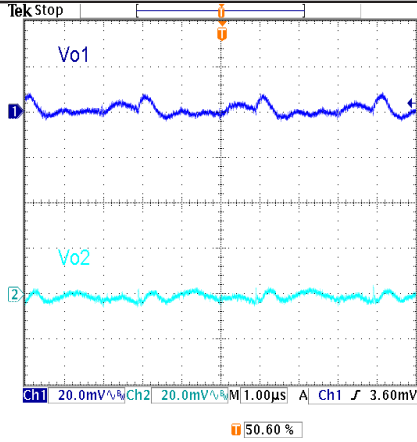
Typical Output Ripple and Noise.
Vin = Vin(nom), Full Load

Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load, Vin = Vin(nom)

Typical Input Start-Up and Output Rise Characteristic
Vin = Vin(nom), Full Load

Using ON/OFF Voltage Start-Up and Vo Rise Characteristic
Vin = Vin(nom), Full Load

Conduction Emission of EN55022 Class B
Vin = Vin(nom), Full Load

Characteristic Curves

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

Efficiency versus Output Current

Power Dissipation versus Output Current

Efficiency versus Input Voltage. Full Load

Derating Output Current versus Ambient Temperature with Airflow, Vin = Vin(nom)
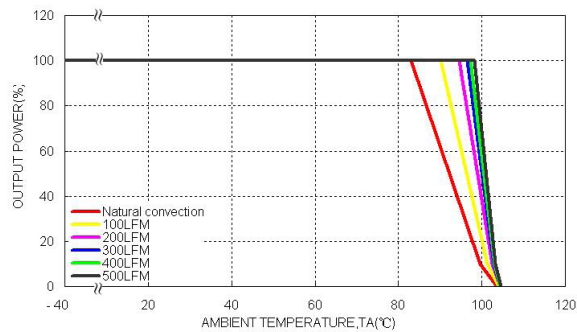
Derating Output Current Versus Ambient Temperature with Heat-sink and Airflow, Vin = Vin(nom)

Characteristic Curves

All test conditions are at 25°C. The figures are identical for TEN 4823WIR (Continued)
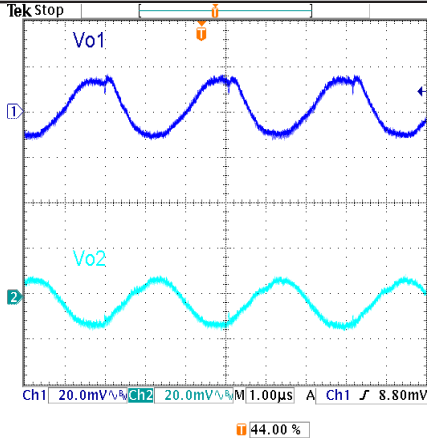
**Typical Output Ripple and Noise.**
Vin = Vin(nom), Full Load

Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load, Vin = Vin(nom)

Typical Input Start-Up and Output Rise Characteristic
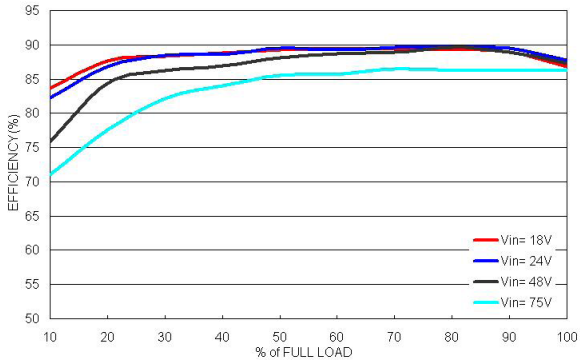**Vin = Vin(nom), Full Load**

Using ON/OFF Voltage Start-Up and Vo Rise Characteristic
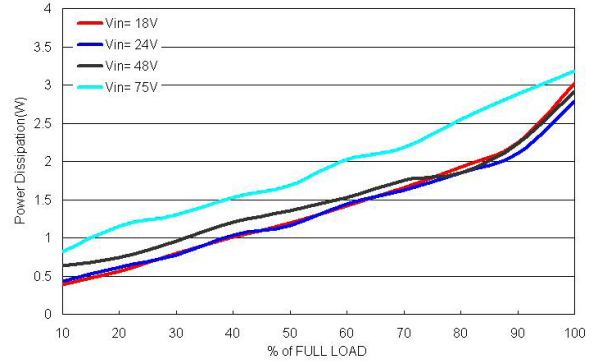**Vin = Vin(nom), Full Load**

Conduction Emission of EN55022 Class B
Vin = Vin(nom), Full Load
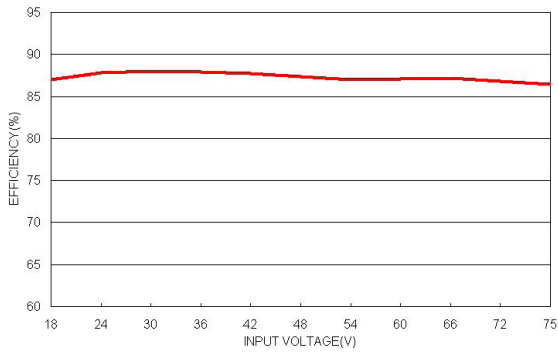
Characteristic Curves

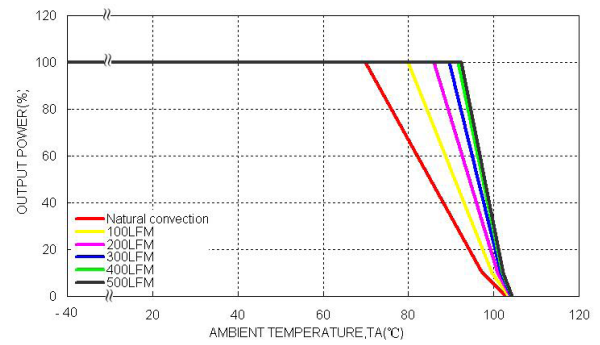All test conditions are at 25°C. The figures are identical for TEN 20-7210WIR

**Efficiency versus Output Current**

Power Dissipation versus Output Current

**Efficiency versus Input Voltage. Full Load**

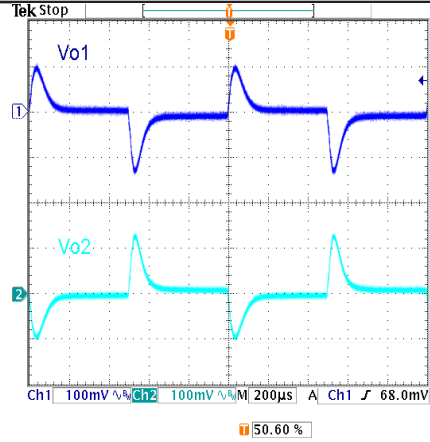**Derating Output Current versus Ambient Temperature with Airflow, Vin = Vin(nom)**

Derating Output Current Versus Ambient Temperature with Heat-sink and Airflow, Vin = Vin(nom)
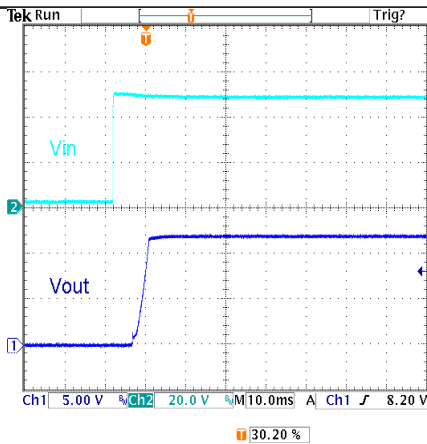
TRACO POWER
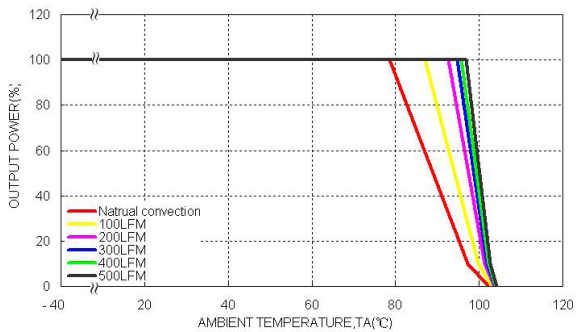
Characteristic Curves

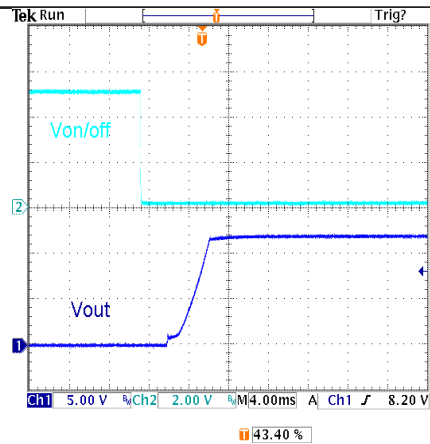All test conditions are at 25°C. The figures are identical for TEN 20-7210WIR (Continued)
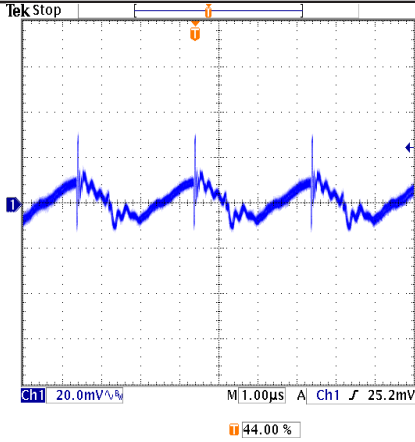
Typical Output Ripple and Noise.
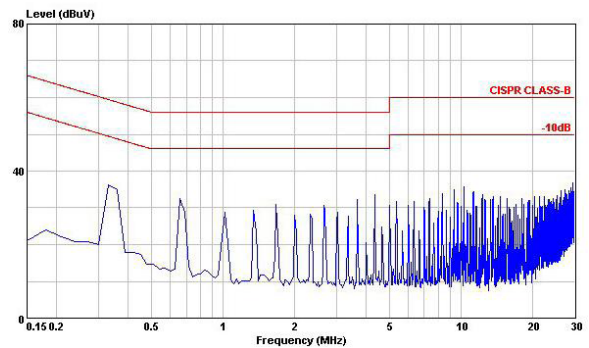**Vin = Vin(nom), Full Load**

Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load, Vin = Vin(nom)

Typical Input Start-Up and Output Rise Characteristic
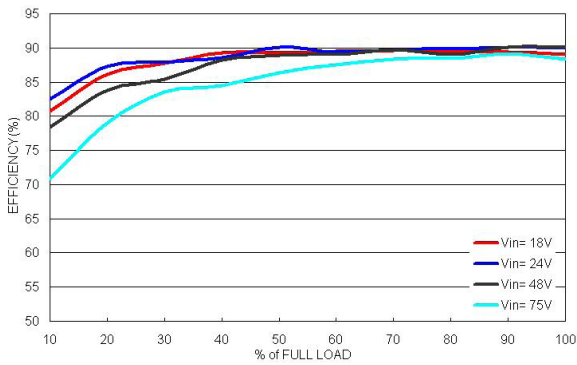**Vin = Vin(nom), Full Load**

Using ON/OFF Voltage Start-Up and Vo Rise Characteristic
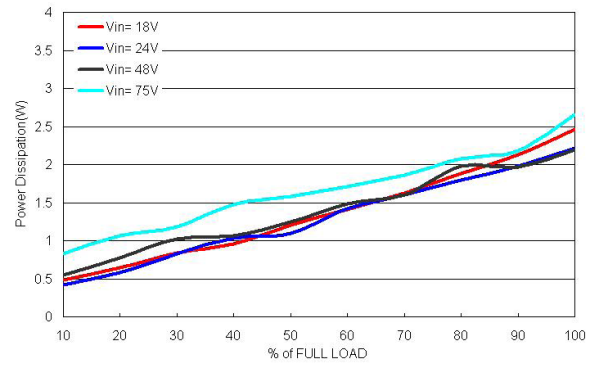**Vin = Vin(nom), Full Load**

Conduction Emission of EN55022 Class A
Vin = Vin(nom), Full Load
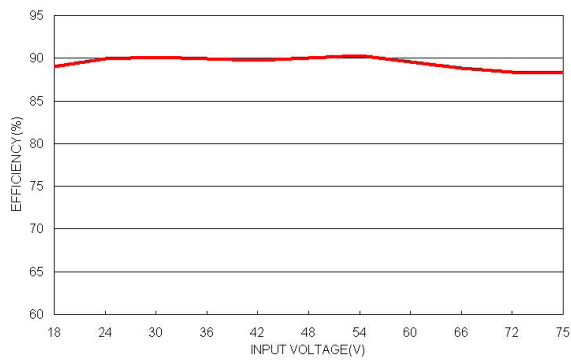
Characteristic Curves

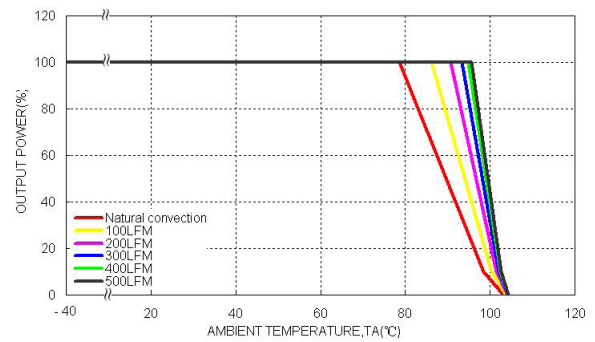All test conditions are at 25°C. The figures are identical for TEN 20-7211WIR

**Efficiency versus Output Current**

Power Dissipation versus Output Current

Efficiency versus Input Voltage. Full Load

Derating Output Current versus Ambient Temperature with Airflow, Vin = Vin(nom)

Derating Output Current Versus Ambient Temperature with Heat-sink and Airflow, Vin = Vin(nom)

TRACO POWER
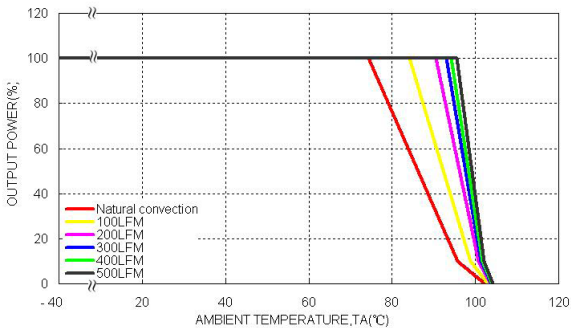
Characteristic Curves

All test conditions are at 25°C. The figures are identical for TEN 20-7211WIR (Continued)
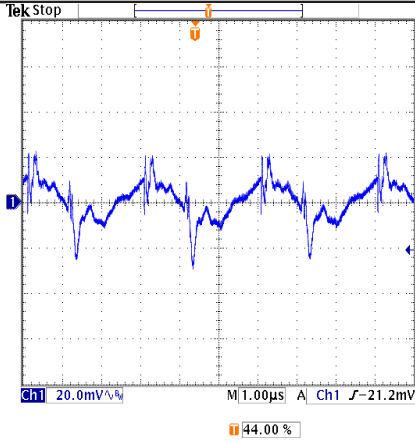
Typical Output Ripple and Noise.
Vin = Vin(nom), Full Load

Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load, Vin = Vin(nom)

Typical Input Start-Up and Output Rise Characteristic
Vin = Vin(nom), Full Load

Using ON/OFF Voltage Start-Up and Vo Rise Characteristic
Vin = Vin(nom), Full Load

Conduction Emission of EN55022 Class A
Vin = Vin(nom), Full Load

TRACO POWER

Characteristic Curves

All test conditions are at 25°C. The figures are identical for TEN 20-7212WIR

Efficiency versus Output Current
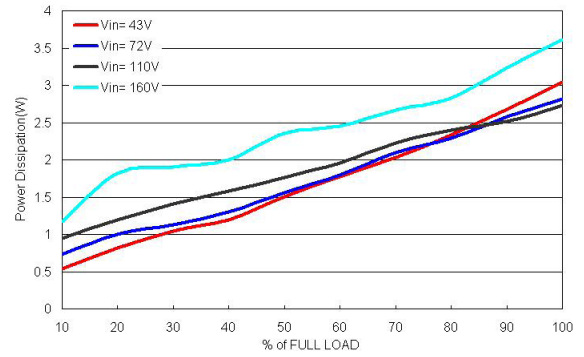
Power Dissipation versus Output Current

**Efficiency versus Input Voltage. Full Load**
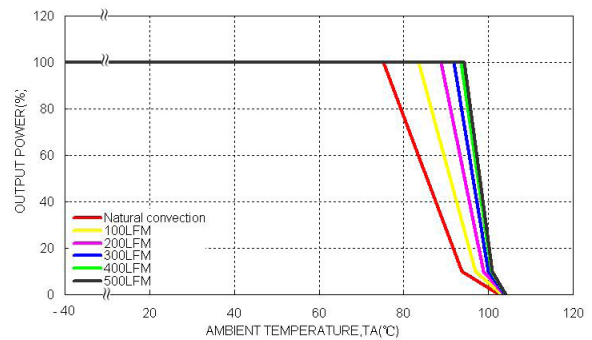
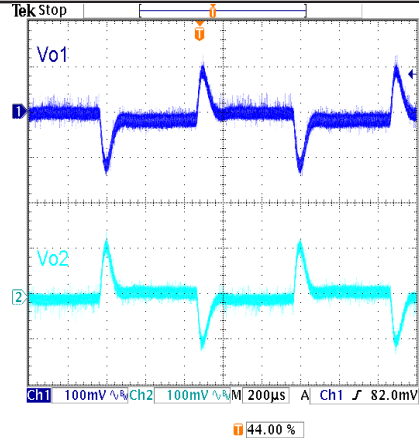**Derating Output Current versus Ambient Temperature with Airflow, Vin = Vin(nom)**
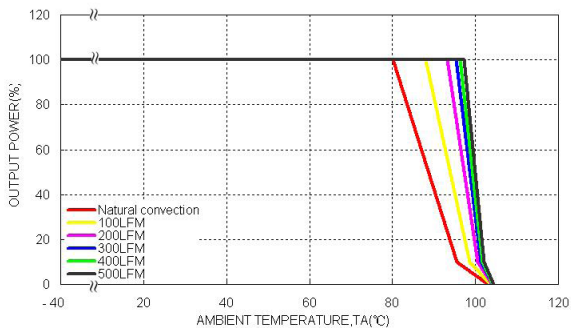
Derating Output Current Versus Ambient Temperature with Heat-sink and Airflow, Vin = Vin(nom)
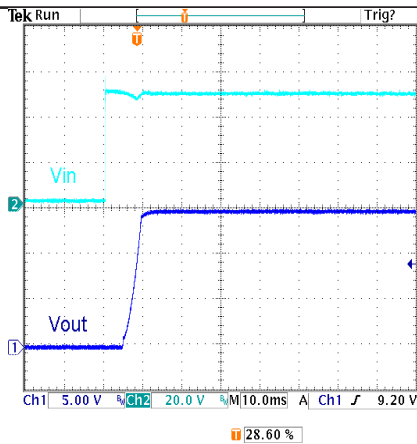
Characteristic Curves

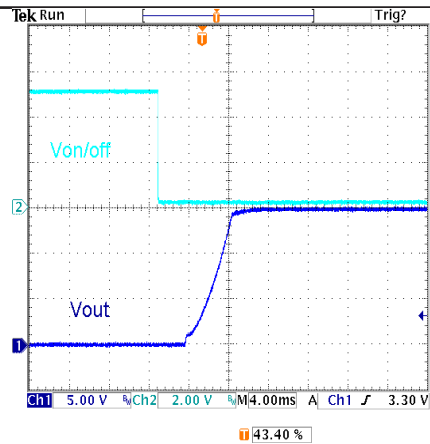All test conditions are at 25°C. The figures are identical for TEN 20-7212WIR (Continued)
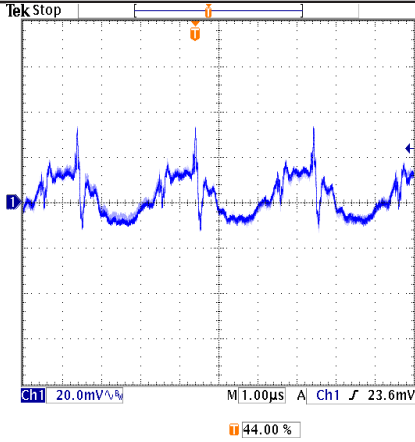
Typical Output Ripple and Noise.
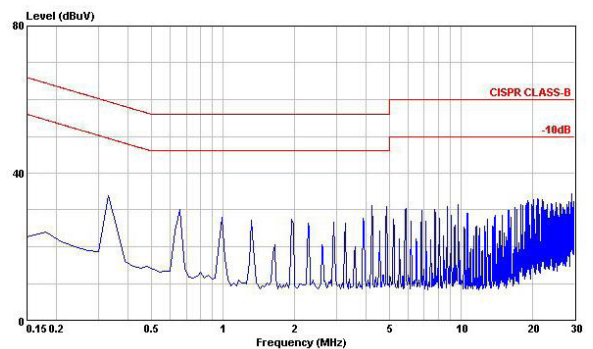**Vin = Vin(nom), Full Load**
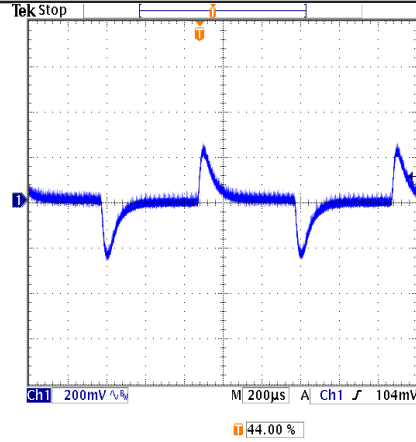
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load, Vin = Vin(nom)
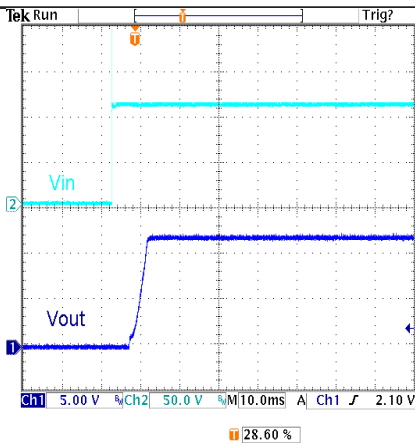
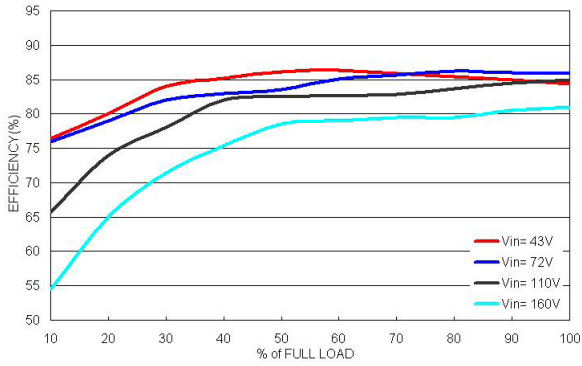**Typical Input Start-Up and Output Rise Characteristic**
Vin = Vin(nom), Full Load
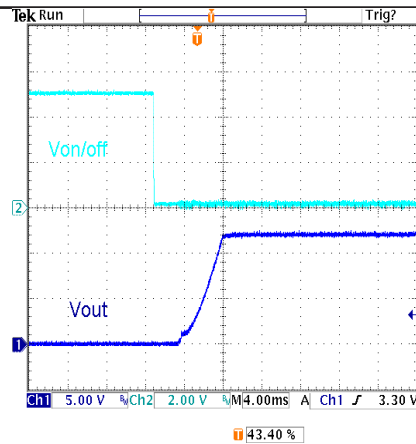
Using ON/OFF Voltage Start-Up and Vo Rise Characteristic
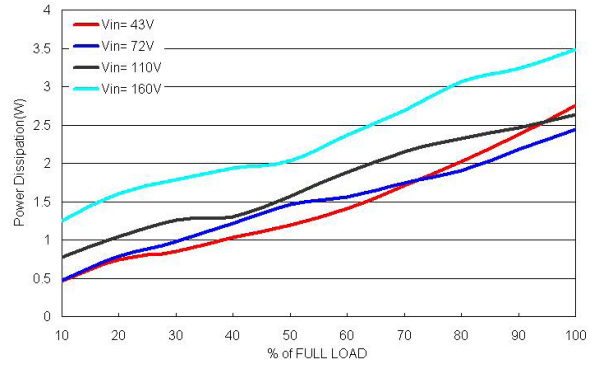**Vin = Vin(nom), Full Load**
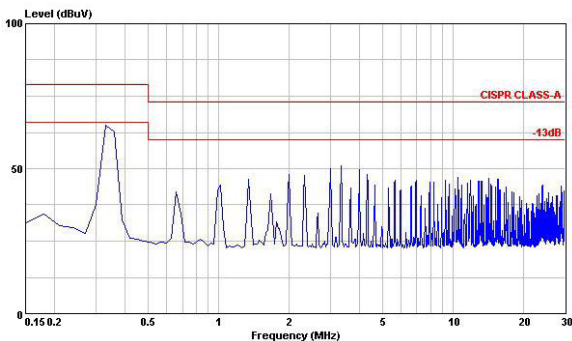
Conduction Emission of EN55022 Class A
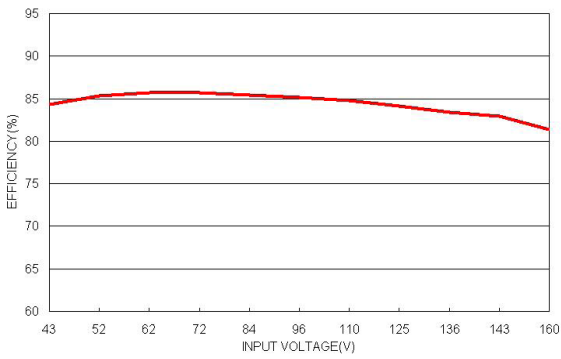**Vin = Vin(nom), Full Load**

Characteristic Curves

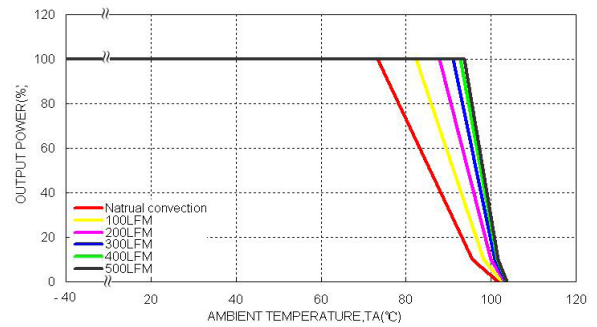All test conditions are at 25°C. The figures are identical for TEN 20-7213WIR

**Efficiency versus Output Current**
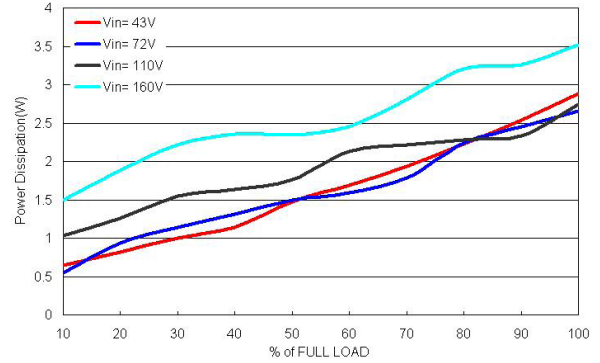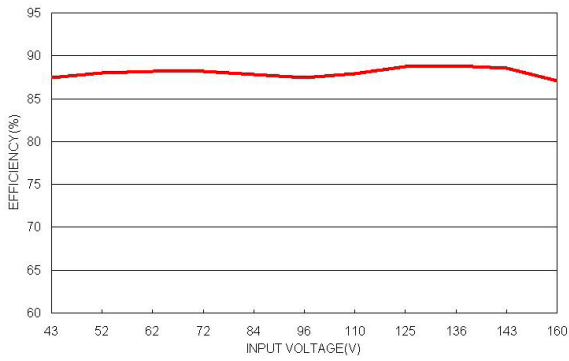
Power Dissipation versus Output Current

**Efficiency versus Input Voltage. Full Load**
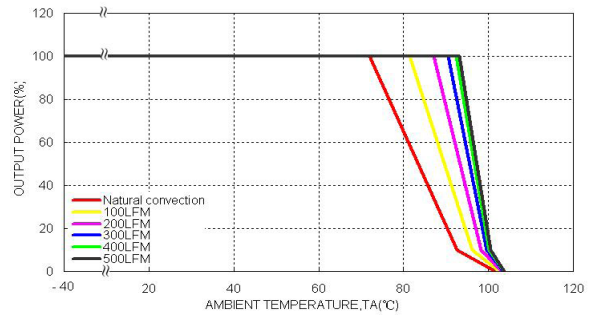
Derating Output Current versus Ambient Temperature with Airflow, Vin = Vin(nom)
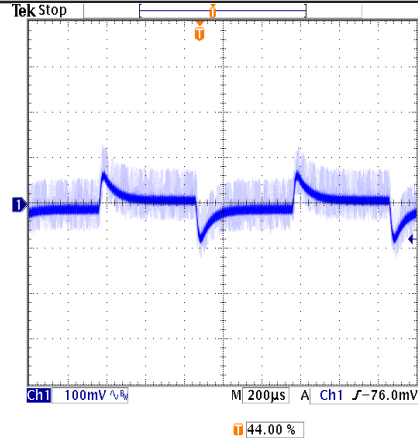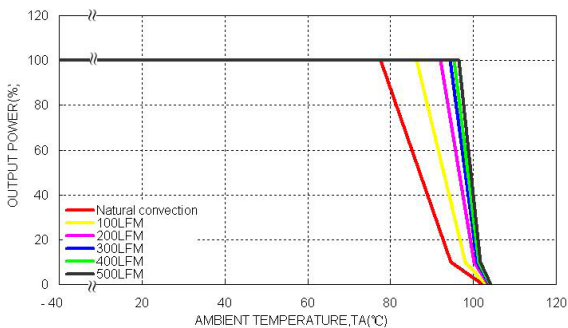
Derating Output Current Versus Ambient Temperature with Heat-sink and Airflow, Vin = Vin(nom)
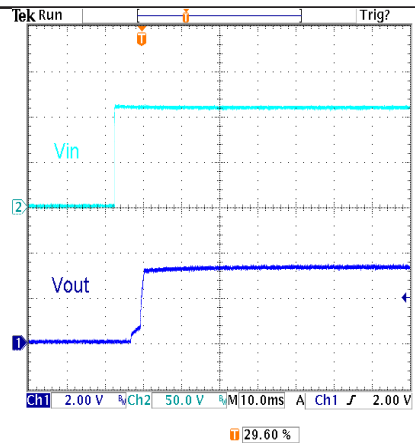
Characteristic Curves

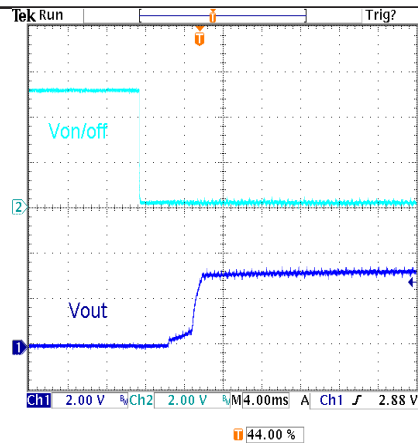All test conditions are at 25°C. The figures are identical for TEN 20-7213WIR (Continued)
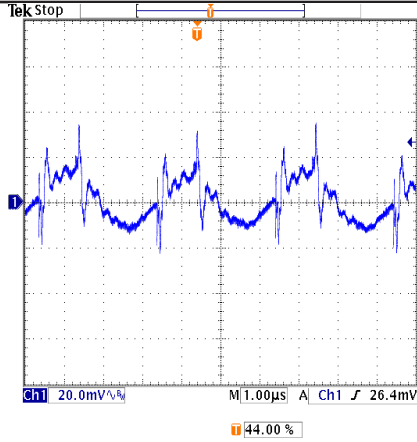
Typical Output Ripple and Noise.
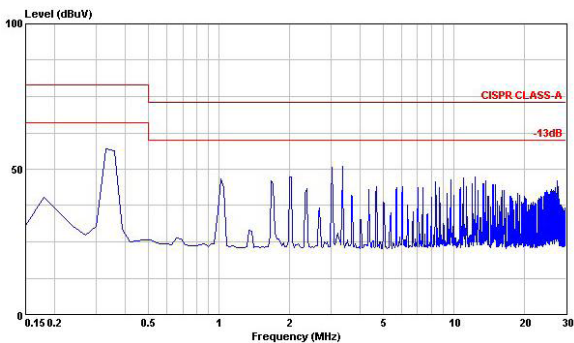**Vin = Vin(nom), Full Load**
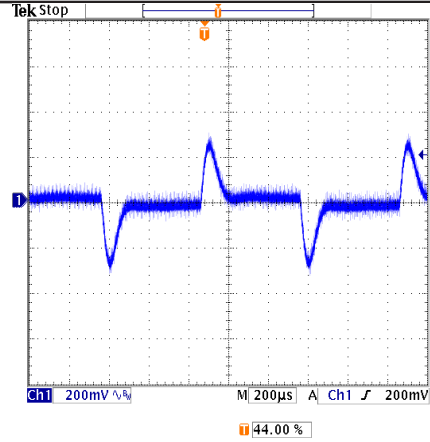
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load, Vin = Vin(nom)
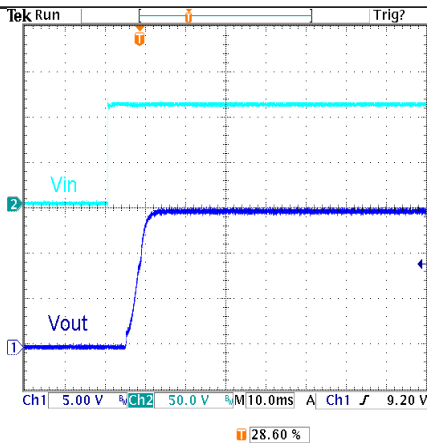
Typical Input Start-Up and Output Rise Characteristic
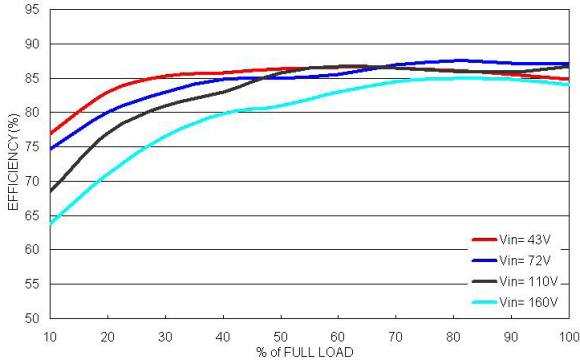**Vin = Vin(nom), Full Load**
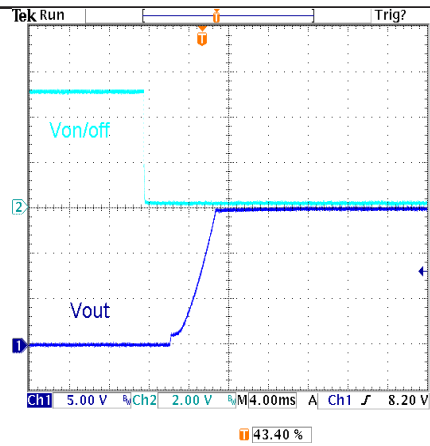
Using ON/OFF Voltage Start-Up and Vo Rise Characteristic
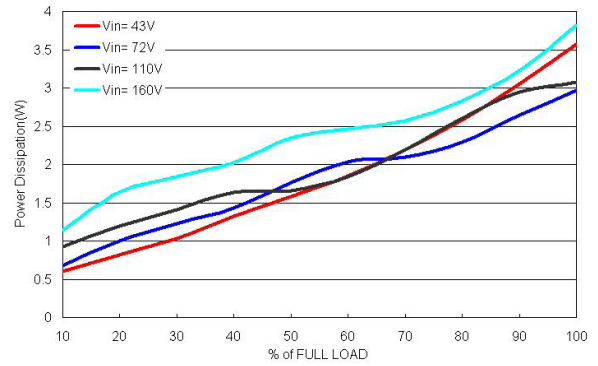**Vin = Vin(nom), Full Load**
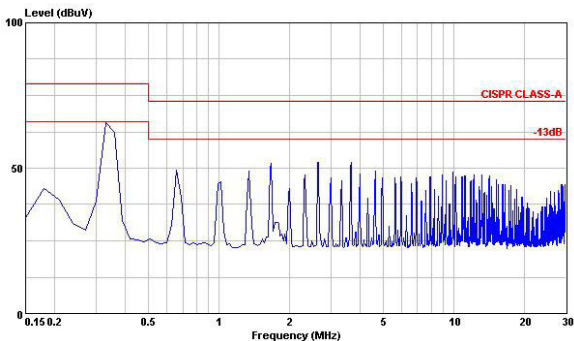
Conduction Emission of EN55022 Class A
Vin = Vin(nom), Full Load

Characteristic Curves
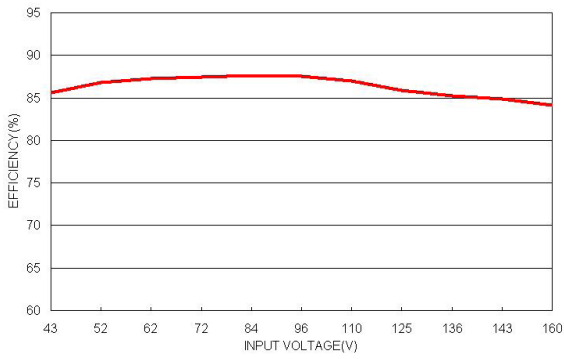
All test conditions are at 25°C. The figures are identical for TEN 20-7222WIR

Efficiency versus Output Current

Power Dissipation versus Output Current

Efficiency versus Input Voltage. Full Load

Derating Output Current versus Ambient Temperature with Airflow, Vin = Vin(nom)

Derating Output Current Versus Ambient Temperature with Heat-sink and Airflow, Vin = Vin(nom)

Characteristic Curves

All test conditions are at 25°C. The figures are identical for TEN 20-7222WIR (Continued)

Typical Output Ripple and Noise.
Vin = Vin(nom), Full Load

Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load, Vin = Vin(nom)

Typical Input Start-Up and Output Rise Characteristic
Vin = Vin(nom), Full Load

Using ON/OFF Voltage Start-Up and Vo Rise Characteristic
Vin = Vin(nom), Full Load

Conduction Emission of EN55022 Class A
Vin = Vin(nom), Full Load

Characteristic Curves

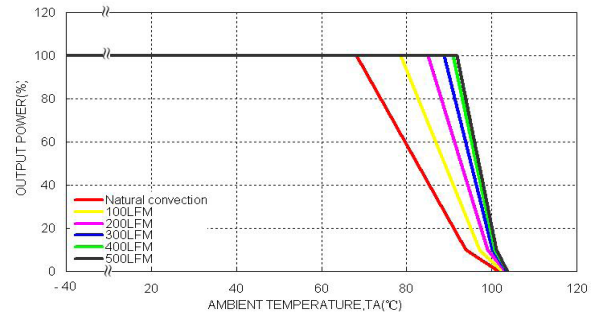All test conditions are at 25°C. The figures are identical for TEN 20-7223WIR


Efficiency versus Output Current
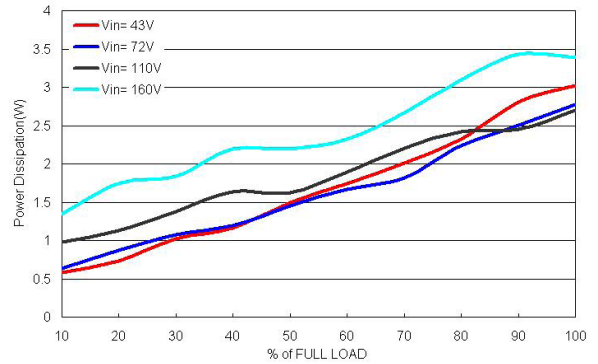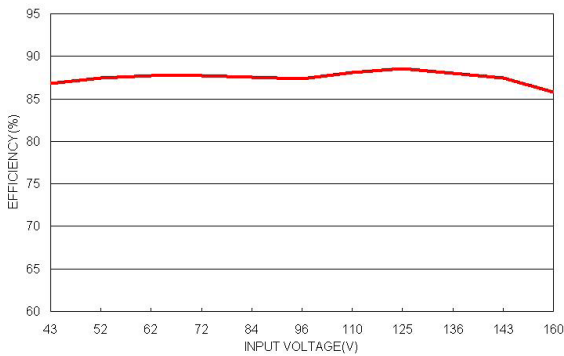
Power Dissipation versus Output Current

**Efficiency versus Input Voltage. Full Load**
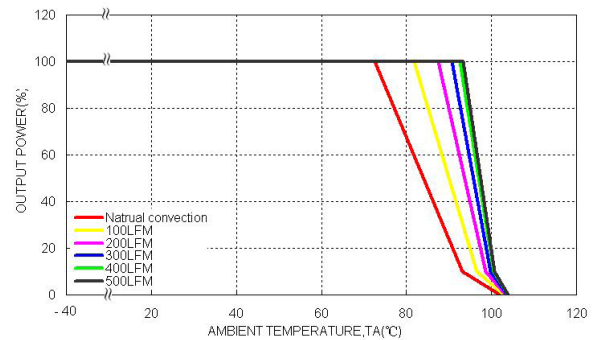
Derating Output Current versus Ambient Temperature with Airflow, Vin = Vin(nom)
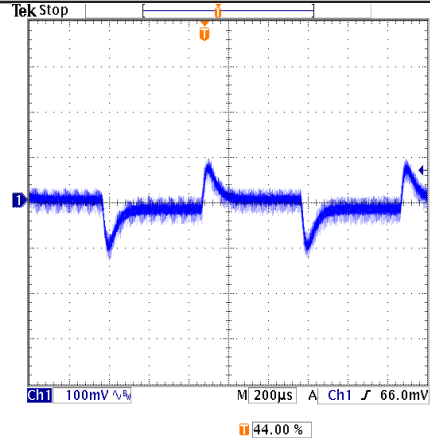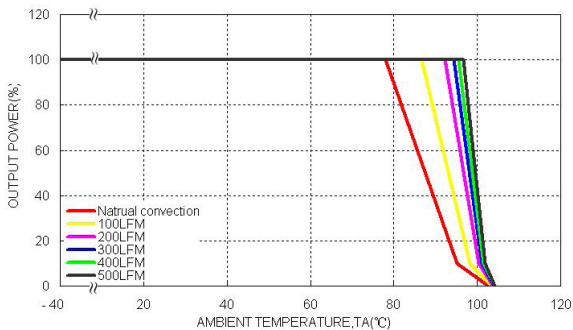

Derating Output Current Versus Ambient Temperature with Heat-sink and Airflow, Vin = Vin(nom)
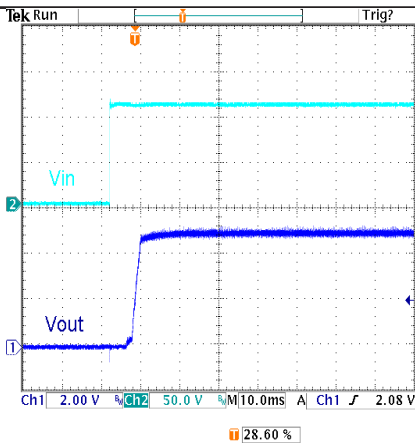
Characteristic Curves

All test conditions are at 25°C. The figures are identical for TEN 20-7223WIR (Continued)
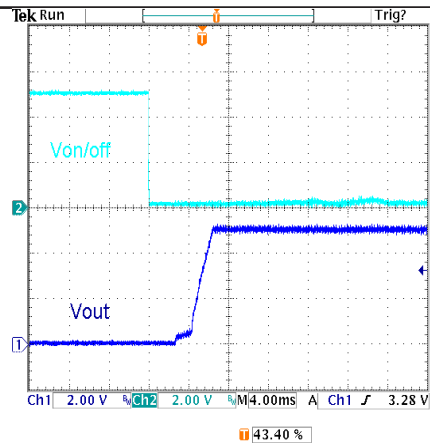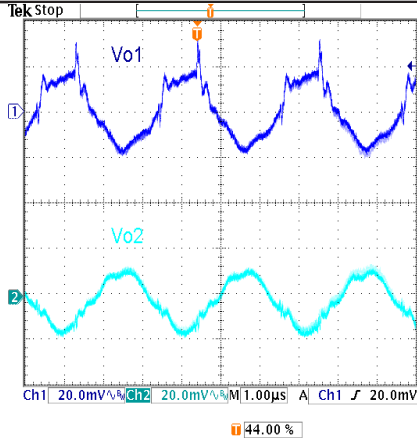

Typical Output Ripple and Noise.
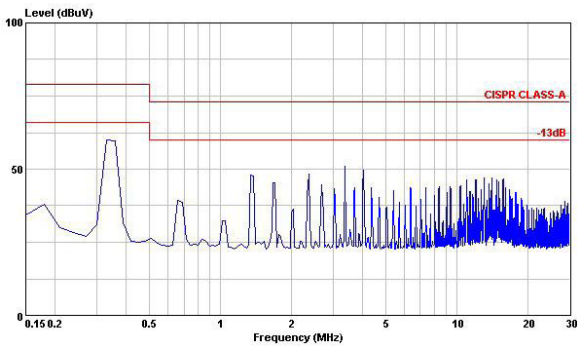**Vin = Vin(nom), Full Load**
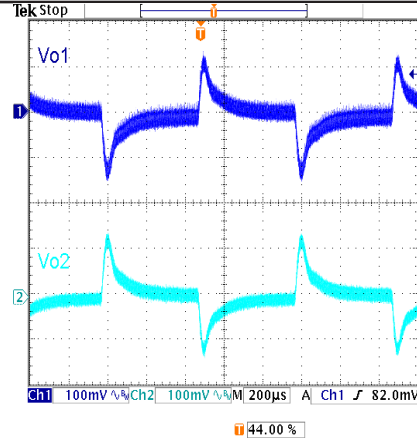
Transient Response to Dynamic Load Change from
100% to 75% to 100% of Full Load, Vin = Vin(nom)
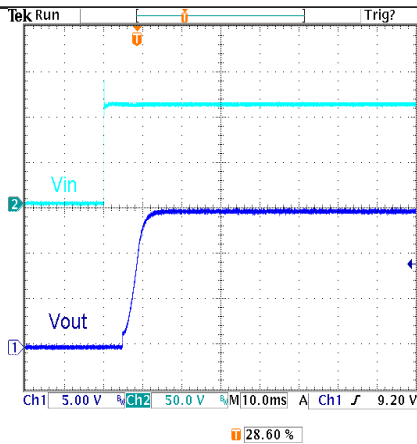
Typical Input Start-Up and Output Rise Characteristic
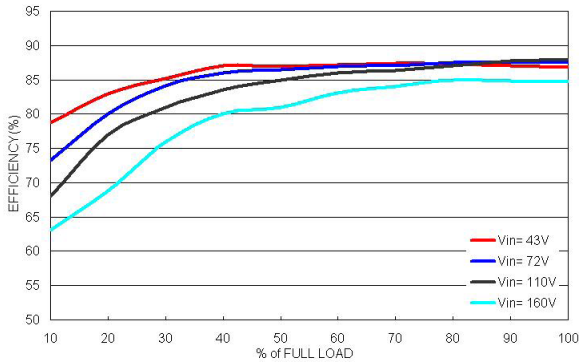**Vin = Vin(nom), Full Load**
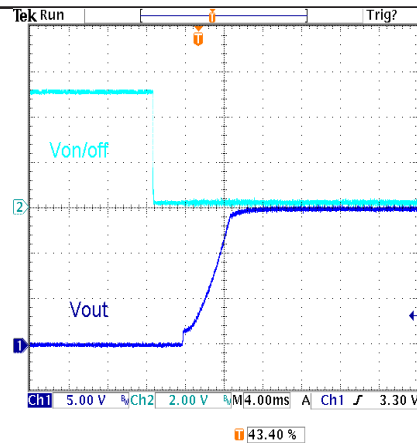
**Using ON/OFF Voltage Start-Up and Vo Rise Characteristic**
Vin = Vin(nom), Full Load
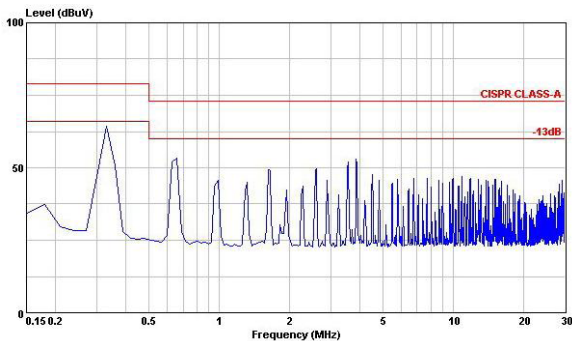
Conduction Emission of EN55022 Class A
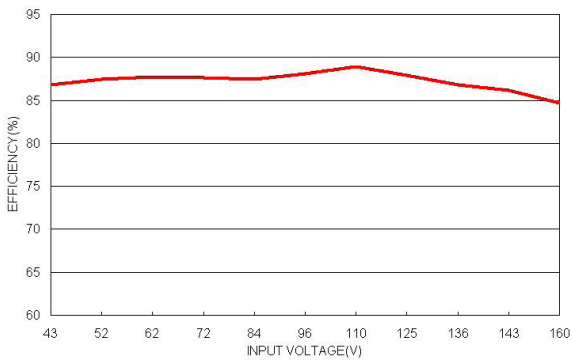**Vin = Vin(nom), Full Load**

Testing Configurations

Input reflected-ripple current measurement test up

To input ripple current measure device

+INPUT

-INPUT

L

BATTERY
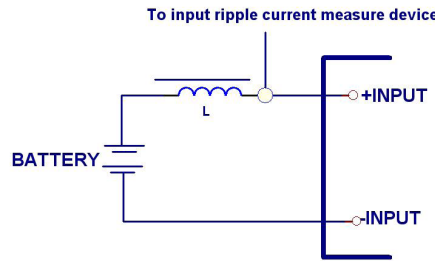
TEN 20-241xWIR, TEN 20-481xWIR

Component	Value	Voltage	Reference
L	SHORT	----	----

TEN 20-721xWIR

Component	Value	Voltage	Reference
L	2.2mh	----	----

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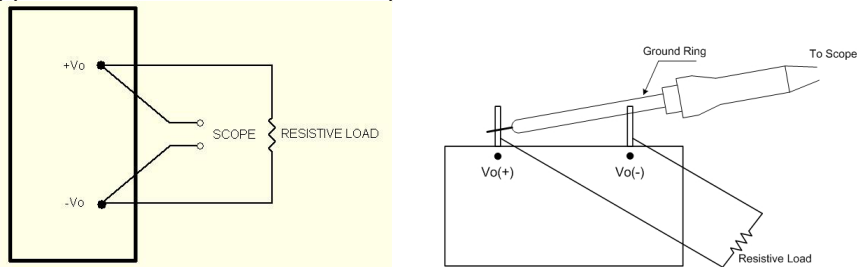
+Vo

SCOPE   RESISTIVE LOAD

-Vo

Ground Ring   To Scope

Vo(+)   Vo(-)

Resistive Load

Output voltage and efficiency measurement test up

I_IN   +Vin   +Vout   I_OUT

CONRACT AND DISTRIBUTION LOSSES   CONRACT AND DISTRIBUTION LOSSES

BATTERY   V_IN   V_OUT   LOAD

-Vin   -Vout

DC/DC
CONVERTER

Note: All measurements are taken at the module terminals.

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

Testing Configurations

Input reflected-ripple current measurement test up

To input ripple current measure device

+INPUT

BATTERY

L
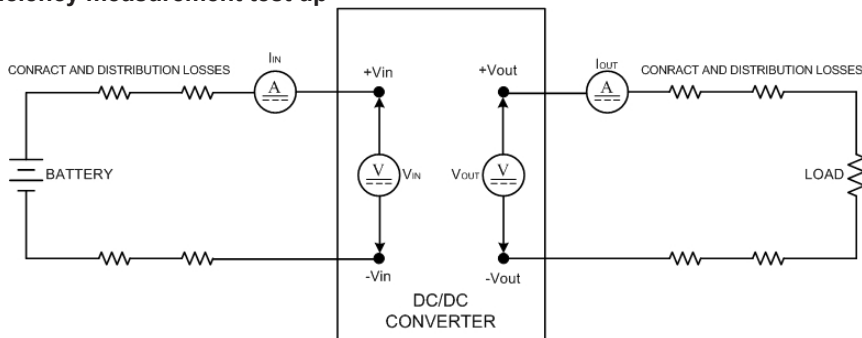
-INPUT
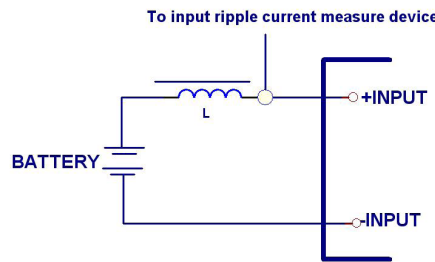
TEN 20-242xWIR, TEN 20-482xWIR

Component	Value	Voltage	Reference
L	SHORT	----	----

TEN 20-722xWIR

Component	Value	Voltage	Reference
L	2.2µH	----	----

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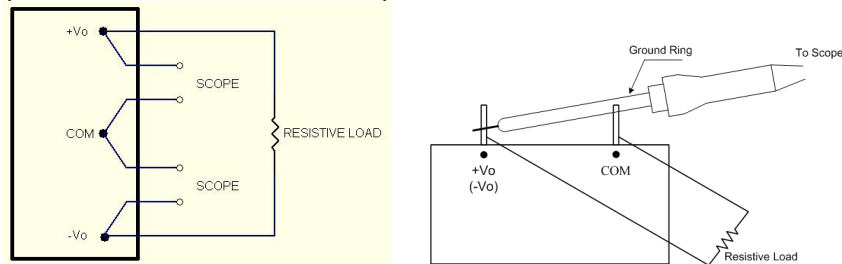
+Vo

SCOPE

COM

RESISTIVE LOAD

SCOPE

-Vo

Ground Ring   To Scope

+Vo
(-Vo)   COM

Resistive Load

Output voltage and efficiency measurement test up

CONRACT AND DISTRIBUTION LOSSES   I_IN   +Vin   +Vout   I_OUT   CONRACT AND DISTRIBUTION LOSSES

V_OUT1

BATTERY   V_IN   COM   LOAD

V_OUT2

LOAD

-Vin   -Vout   I_OUT   CONRACT AND DISTRIBUTION LOSSES

DC/DC
CONVERTER
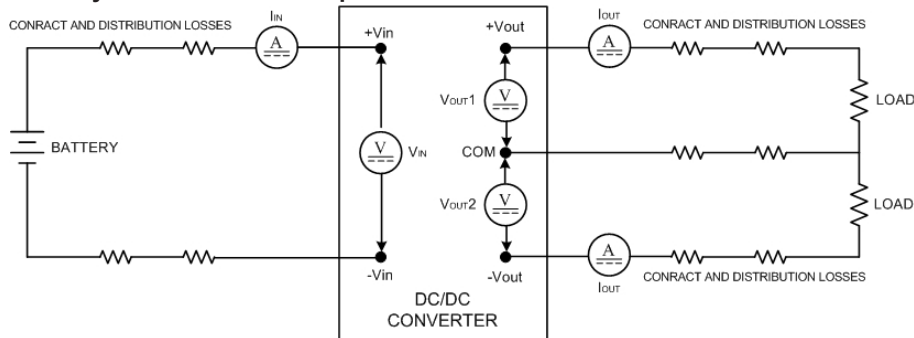
Note: All measurements are taken at the module terminals.

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

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 inductor is recommended to minimize input reflected ripple current. The inductor is simulated source impedance of 2.2µH. The inductor 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 power supplies. Normally, overload current is maintained at approximately about 150 percent of rated current for TEN 20WIR single output series.
Hiccup-mode is a method of operation in a power supply whose purpose is to protect the power supply from being damaged during an over-current fault condition. It also enables the power supply to restart when the fault is removed.
One of the problems resulting from over current is that excessive heat may be generated in power devices, especially MOSFET and Schottky diodes and the temperature of those devices may exceed their specified limits. A protection mechanism has to be used to prevent those power devices from being damaged.

Output Over Voltage Protection

The output over-voltage protection consists of a Zener diode that monitors the output voltage on the feedback loop. If the voltage on the output terminals exceeds the over-voltage protection threshold, then the Zener diode will send a current signal to the control IC to limiting the output voltage.

Short Circuitry Protection

Continuous, hiccup and auto-recovery mode.
During short circuit, converter still shut down. The average current during this condition will be very low and the device can be safety in this condition.

Output Voltage Adjustment

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

- **Trim up equation**

$$R_U = \left[\frac{G \times L}{\left(V_{O,up} - L - K\right)} - H \right] \Omega$$

- **Trim down equation**

$$R_D = \left[\frac{\left(V_{O,down} - L\right) \times G}{\left(V_O - V_{O,down}\right)} - H \right] \Omega$$

- **Trim constants**

Module	G	H	K	L
TEN 20-xx10WIR	5110	2050	0.8	2.5
TEN 20-xx11WIR	5110	2050	2.5	2.5
TEN 20-xx12WIR	10000	5110	9.5	2.5
TEN 20-xx13WIR	10000	5110	12.5	2.5
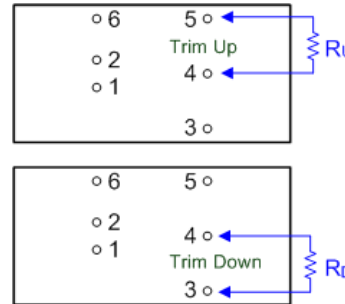
TRIM TABLE

TEN 20-xx10WIR

Trim up (%)	1	2	3	4	5	6	7	8	9	10
Vout (Volts)=	3.333	3.366	3.399	3.432	3.465	3.498	3.531	3.564	3.597	3.630
R_U (K Ohms)=	385.071	191.511	126.990	94.730	75.374	62.470	53.253	46.340	40.963	36.662

Trim down (%)	1	2	3	4	5	6	7	8	9	10
Vout (Volts)=	3.267	3.234	3.201	3.168	3.135	3.102	3.069	3.036	3.003	2.970
R_D (K Ohms)=	116.719	54.779	34.133	23.810	17.616	13.486	10.537	8.325	6.604	5.228

TEN 20-xx11WIR

Trim up (%)	1	2	3	4	5	6	7	8	9	10
Vout (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)=	253.450	125.700	83.117	61.825	49.050	40.533	34.450	29.888	26.339	23.500

Trim down (%)	1	2	3	4	5	6	7	8	9	10
Vout (Volts)=	4.950	4.900	4.850	4.800	4.750	4.700	4.650	4.600	4.550	4.500
R_D (K Ohms)=	248.340	120.590	78.007	56.715	43.940	35.423	29.340	24.778	21.229	18.390

TEN 20-xx12WIR

Trim up (%)	1	2	3	4	5	6	7	8	9	10
Vout (Volts)=	12.120	12.240	12.360	12.480	12.600	12.720	12.840	12.960	13.080	13.200
R_U (K Ohms)=	203.223	99.057	64.334	46.973	36.557	29.612	24.652	20.932	18.038	15.723

Trim down (%)	1	2	3	4	5	6	7	8	9	10
Vout (Volts)=	11.880	11.760	11.640	11.520	11.400	11.280	11.160	11.040	10.920	10.800
R_D (K Ohms)=	776.557	380.723	248.779	182.807	143.223	116.834	97.985	83.848	72.853	64.057

TEN 20-xx13WIR

Trim up (%)	1	2	3	4	5	6	7	8	9	10
Vout (Volts)=	15.150	15.300	15.450	15.600	15.750	15.900	16.050	16.200	16.350	16.500
R_U (K Ohms)=	161.557	78.223	50.446	36.557	28.223	22.668	18.700	15.723	13.409	11.557

Trim down (%)	1	2	3	4	5	6	7	8	9	10
Vout (Volts)=	14.850	14.700	14.550	14.400	14.250	14.100	13.950	13.800	13.650	13.500
R_D (K Ohms)=	818.223	401.557	262.668	193.223	151.557	123.779	103.938	89.057	77.483	68.223

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.

TEMPERATURE MEASURE POINT
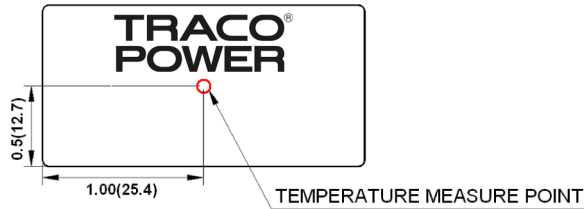
Measurement shown in inch(mm)   TOP VIEW

Heat-sink Consideration

Equip Heat-sink for lower temperature and higher reliability of the module.

Order Code:
TEN-HS1: Heat-sink + Clamps
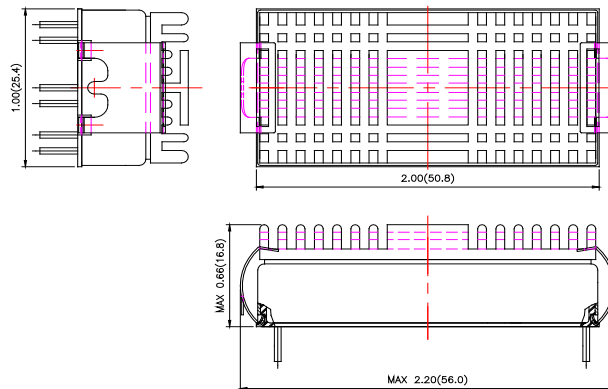
Measurement shown in inch and (millimeters)

Remote ON/OFF Control

The CTRL 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 -INPUT. 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 CTRL pin signal maximum voltage is allowable leakage current of the switch at 15V is 50 µA.

Remote ON/OFF Implementation Circuits
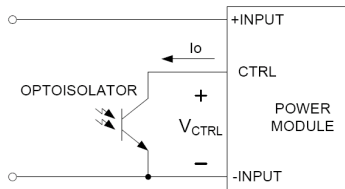
Isolated-Closure Remote ON/OFF
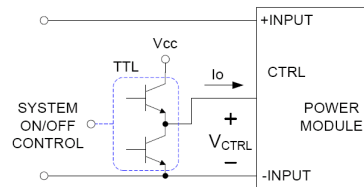
Level Control Using TTL Output
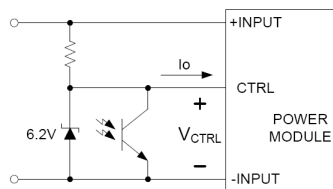
Level Control Using Line Voltage

There are two remote control options available, positive logic and negative logic.
a. The Positive logic structure turned on of the DC/DC module when the CTRL pin is at high-level logic and low-level logic is turned off it.
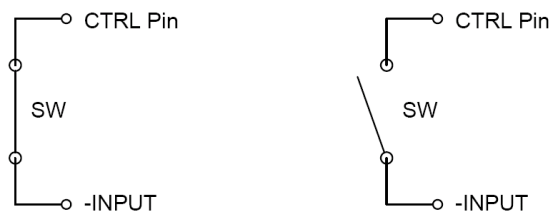
When TEN 20WIR module is turned off at Low-level logic
When TEN 20WIR module is turned on at High-level logic

b. The Negative logic structure turned on of the DC/DC module when the CTRL pin is at low-level logic and turned off when at high-level logic.
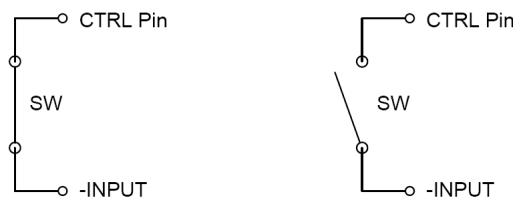
When TEN 20WIR module is turned on at Low-level logic
When TEN 20WIR module is turned off at High-level logic

Mechanical Data

PIN Connection	
PIN	**SINGEL**
1	+Input
2	-Input
3	+Output
4	Trim
5	-Output
6	Ctrl
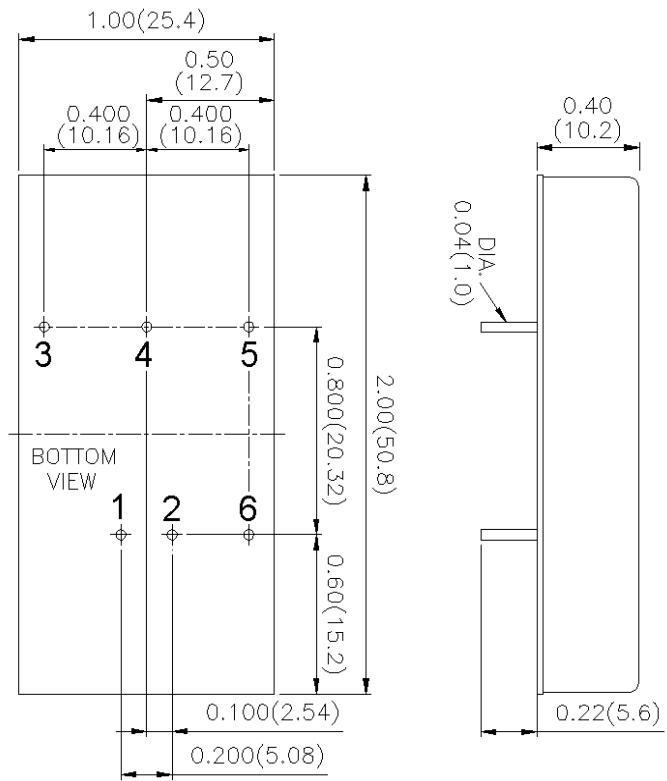
1. All dimensions in Inch (mm)
   Tolerance: X.XX±0.02 (X.X±0.5)
   X.XXX±0.01 (X.XX±0.25)
2. Pin pitch tolerance ±0.01(0.25)
3. Pin dimension tolerance ±0.004 (0.1)

EXTERNAL OUTPUT TRIMMING

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

PRODUCT STANDARD TABLE	
Option	Suffix
Negative logic remote ON/OFF(Standard)	
Positive logic remote ON/OFF	-A
Without ON/OFF logic pin	-B
Negative remote logic ON/OFF without TRIM pin	-C
Without ON/OFF logic &TRIM pin	-D
Positive remote logic ON/OFF without TRIM pin	-E

Recommended Pad Layout
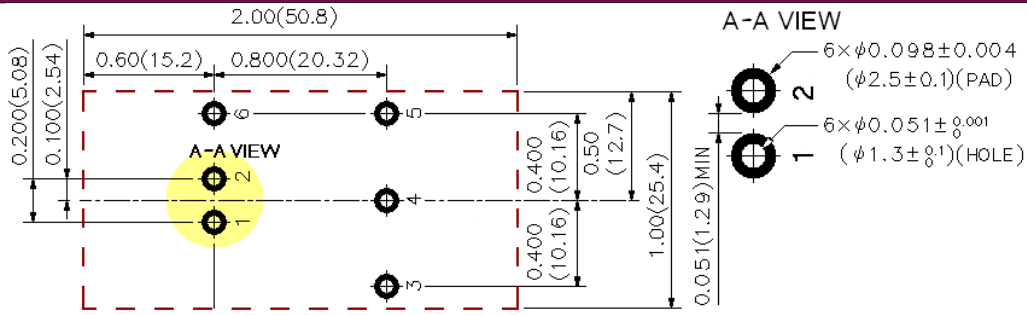
1. All dimensions in Inch (mm)
   Tolerance:x.xx±0.02 (x.x±0.5)
   x.xxx±0.01 (x.xx±0.25)
2. Pin pitch tolerance ±0.01(0.25)

Soldering Considerations

Lead free wave solder profile for TEN 20WIR-SERIES
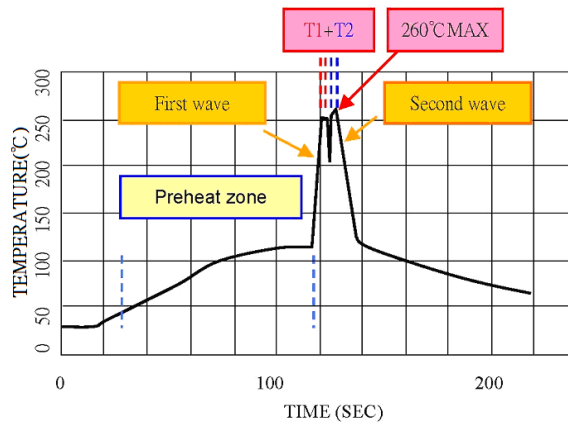
Zone	Reference Parameter.
Preheat zone	Rise temp. speed: 3°C/sec max.
	Preheat temp.100~130°C
Actual heating	Peak temp. :250~260°C
	Peak time(T1+T2 time):4~6 sec

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

Packaging Information

11.42(290.0)

2.17(55.0)

0.85(21.5)
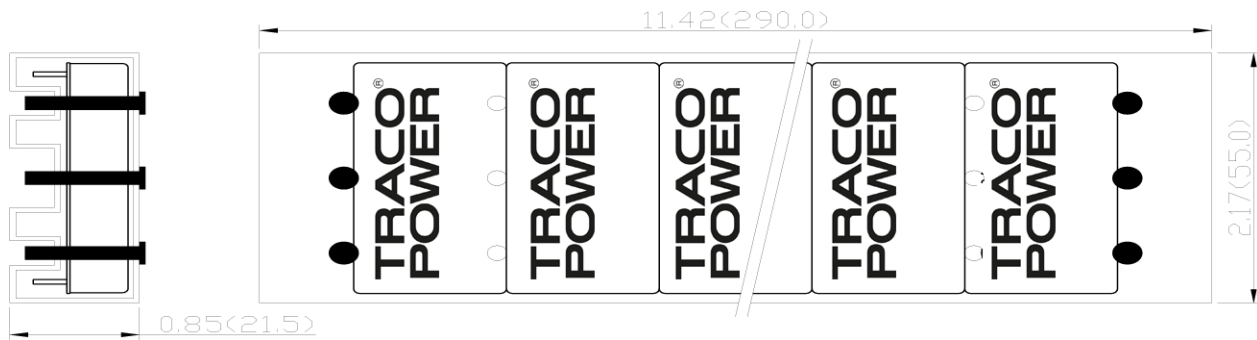
All dimensions in Inch (mm)

10 PCS per TUBE

Part Number Structure

TEN 20-2412WIR

| **Max. Output Power** 20W | **Input Voltage** 24: 9-36V 48: 18-75V 72: 43-160V | **Output Mode** 1: Single 2: Dual (±) | **Output Voltage** 0: 3.3V 1: 5V 2: 12V 3: 15V | **Feature** WI: Wide Input R: Railway |

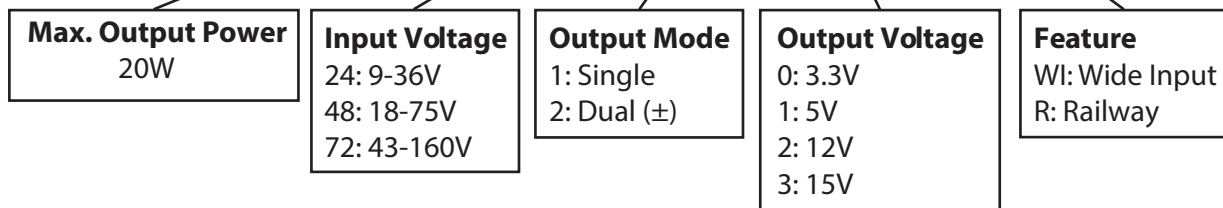| Model Number	Input Range	Output Voltage	Output Current Full Load	Input Current No Load (1)	Eff [2] (%)
TEN 20-2410WIR	9 ~ 36 VDC	3.3 VDC	4500mA	6mA	85
TEN 20-2411WIR	9 ~ 36 VDC	5 VDC	4000mA	6mA	88
TEN 20-2412WIR	9 ~ 36 VDC	12 VDC	1670mA	6mA	89
TEN 20-2413WIR	9 ~ 36 VDC	15 VDC	1330mA	6mA	88
TEN 20-2422WIR	9 ~ 36 VDC	±12 VDC	±833mA	6mA	88
TEN 20-2423WIR	9 ~ 36 VDC	±15 VDC	±667mA	6mA	89
TEN 20-4810WIR	18 ~ 75 VDC	3.3 VDC	4500mA	4mA	85
TEN 20-4811WIR	18 ~ 75 VDC	5 VDC	4000mA	4mA	88
TEN 20-4812WIR	18 ~ 75 VDC	12 VDC	1670mA	4mA	89
TEN 20-4813WIR	18 ~ 75 VDC	15 VDC	1330mA	4mA	89
TEN 20-4822WIR	18 ~ 75 VDC	±12 VDC	±833mA	4mA	88
TEN 20-4823WIR	18 ~ 75 VDC	±15 VDC	±667mA	4mA	89
TEN 20-7210WIR	43 ~ 160 VDC	3.3 VDC	4500mA	3mA	85
TEN 20-7211WIR	43 ~ 160 VDC	5 VDC	4000mA	3mA	87
TEN 20-7212WIR	43 ~ 160 VDC	12 VDC	1670mA	3mA	88
TEN 20-7213WIR	43 ~ 160 VDC	15 VDC	1330mA	3mA	88
TEN 20-7222WIR	43 ~ 160 VDC	±12 VDC	±833mA	3mA	88
TEN 20-7223WIR	43 ~ 160 VDC	±15 VDC	±667mA	3mA	89

Note 1. Typical value at nominal input and no load.   Note 2. Typical value at nominal input 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 4A for TEN 20-24xxWIR modules and 2A for TEN 20-48xxWIR modules and 1A for TEN 20-72xxWIR 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 20WIR SERIES of DC/DC converters has been calculated using
Bellcore TR-NWT-000332 Case I: 50% stress, Operating Temperature at 40C° (Ground fixed and controlled environment). The resulting figure for MTBF is $1.630×10^6$ hours. MIL-HDBK 217F NOTICE2 FULL LOAD, Operating Temperature at 25°C. The resulting figure for MTBF is $4.950×10^5$ hours.

Specifications can be changed without notice! Make sure you are using the latest documentation, downloadable at www.tracopower.com

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