Lambda's new X Series Power Modules are ideally suited for Telecommunications and Network applications.

X Series

Application Manual

Table of Contents

1. Product Description

X10/15/20 DC-DC CONVERTERS: The X series DC-DC converters provide regulated output at power levels up to 20 watts. It accepts a wide range DC input and provides a fully isolated, regulated output. In forced air applications, full output power can be maintained as long as the case temperature, as measured per figure 4, is maintained at less than or equal to 100°C.

2. Electrical Specifications

Table 1. Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. These are absolute stress ratings only. Functional operation of the device is not implied at these or any other conditions in excess of those given in the Table 1. Exposure to absolute maximum ratings for extended periods can adversely affect device reliability.

Parameter	Module	Symbol	Min	Typ	Max	Unit
Input Voltage:						
Continuous	X10/15/20-24	Vi	0	–	50	Vdc
	X10/15/20-48	Vi	0	–	80	Vdc
Transient (100 ms)	X10/15/20-48	Vi, trans	0	–	100	V
Operating Case Temperature	All	Tc	-40	–	105*	°C
Storage Temperature	All	Tstg	-55	–	125	°C
I/O Isolation	All	–	–	–	1500	Vdc

*Maximum case temperature varies based on power dissipation. Refer to the Section 12 for all characteristic charts.

Fusing Considerations

CAUTION: This power module is not internally fused. An input line fuse must always be used.

The safety agencies require a normal-blow, dc fuse with a maximum rating of 5 A (see Safely Considerations section). Based on the information provided in this data sheet on inrush energy and maximum dc input current, the same type of fuse with a lower rating can be used. Refer to the fuse manufacturer's data for further information.

IMPORTANT LIMITATIONS OF USE

Lambda products are not authorized for use as critical components in nuclear control systems, life support systems or equipment for use in hazardous environments without the express written approval of the Managing Director/President of the Lambda Group manufacturer of the product concerned.

Table 2. Input Specifications

Parameter	Module	Symbol	Min	Typ	Max	Unit
Operating Input Voltage	X10/15/20-24	Vi	18	24	36	Vdc
	X10/15/20-48	Vi	36	48	75	Vdc
Maximum Input Current	X10/15/20-24	Ii, max	–	–	1.6	A
(Vi=0 to Vi, max; Io=Io, max;	X10/15/20-48	Ii, max	–	–	800	mA
Inrush Transient	All	I^2t	–	–	0.2	A^2s
Undervoltage Lockout	X10/15/20-24	Vuvlo	11	14	–	V
	X10/15/20-48	Vuvlo	20	27	–	V
Input reflected-ripple Current	All	Ii	–	7	–	mAp-p
(5 Hz to 20 MHz; 12 µH source impedance;						
Input Ripple Rejection (100 Hz-120 Hz)	All	–	–	45	–	dB

* Refer to Section 12 all characteristic charts.

Table 3. Isolation Specifications

Parameter	Min	Typ	Max	Unit
Isolation Capacitance	–	600	–	pF
Isolation Resistance	10	–	–	MΩ

Table 4. Output Specifications

Parameter	Module Suffix	Symbol	Min	Typ	Max	Unit
Output Voltage Set Point	S1.8	Vo, set	1.73	1.8	1.87	Vdc
(Vi=Vi, nom; Io=Io, max;	S02	Vo, set	1.92	2.0	2.08	Vdc
TA = 25 °C)	S2.5	Vo, set	2.4	2.5	2.6	Vdc
	S03	Vo, set	3.17	3.3	3.43	Vdc
	S05	Vo, set	4.8	5.0	5.20	Vdc
	S12	Vo, set	11.52	12.0	12.48	Vdc
	D12	Vo1, set	11.4	12.0	12.6	Vdc
		Vo2, set	-11.4	-12.0	-12.6	Vdc
Output Voltage	S1.8	Vo, set	1.71	–	1.89	Vdc
(Over all line, load, and tempera-	S02	Vo, set	1.9	2.0	2.1	Vdc
ture conditions until end of life; see figures 7 and 9)	S2.5	Vo, set	2.37	2.5	2.63	Vdc
	S03	Vo, set	3.13	–	3.47	Vdc
	S05	Vo, set	4.75	–	5.25	Vdc
	S12	Vo, set	11.40	–	12.60	Vdc
	D12	Vo,set	10.8	–	13.2	Vdc
			-10.8	–	-13.2	Vdc
Output Regulation						
Line (Vi=Vi, min to Vi, max)	S1.8,S02,S2.5,S03,S05	–	–	–	5	mV
	S12	–	–	0.01	0.1	%VO
Load (Io=Io, min to Io, max)	S1.8,S02,S2.5,S03,S05	–	–	–	15	mV
Output Ripple and Noise						
(Across 2x 0.47 µF ceramic capaci-						
tors; see figures 6 and 8)	S1.8,S02,S2.5,S03,S05,	–	–	–	30	mVrms
RMS	S12	–	–	–	35	mVrms
	D12	–	–	–	50	mVrms
External Load Capacitance	All	–	–	–	10000	µF

Parameter	Module Suffix	Symbol	Min	Typ	Max	Unit
Output Current	X10-S03	Io	0.15	-	2.42	A
(At Io<Io, min, the modules may exceed output ripple specifications, but operation is guaranteed.)	S05	Io	0.1	-	2.0	A
	S12	Io	0.08	-	0.83	A
	D12	Io1,Io2	0.06	-	0.42	A
	X15-S1.8, S02, S2.5	Io	0.35	-	3.0	A
	S03	Io	0.25	-	3.0	A
	S05	Io	0.15	-	3.0	A
	S12	Io	0.12	-	1.25	A
	X20-S1.8	Io	0.5	-	7.0	A
	S2.5	Io	0.5	-	6.0	A
	S03	Io	0.35	-	5.5	A
	S05	Io	0.2	-	4.0	A
Output Current-limit Inception	X10-S03	Io	-	-	5	A
(Vo=90% Vo, set;	S05	Io	-	-	4	A
	S12	Io	-	-	2.5	A
	D12	Io1, Io2	-	-	2.5	A
	X15-S1.8, S02, S2.5	Io	-	-	7.5	A
	S03	Io	-	-	6.5	A
	S05	Io	-	-	6.0	A
	S12	Io	-	-	3.1	A
	X20-S1.8	Io	-	-	14	A
	S2.5	Io	-	-	12	A
	S03	Io	-	-	11	A
	S05	Io	-	-	8	A

Parameter	Module Suffix	Symbol	Min	Typ	Max	Unit
Output Short-circuit Current (Vo=0.25 V)	X10-S03	Io	-	-	7.5	A
	S05	Io	-	-	6	A
	S12	Io	-	-	3.5	A
	D12	Io1, Io2	-	-	3.5	A
	X15-S1.8, S02, S2.5	Io	-	-	8.5	A
	S03	Io	-	-	8.5	A
	S05	Io	-	-	7.5	A
	S12	Io	-	-	4.5	A
	X20-S1.8	Io	-	-	17.5	A
	S2.5	Io	-	-	15	A
	S03	Io	-	-	14	A
	S05	Io	-	-	10	A
Output Overvoltage Clamp	S1.8	Vo clamp	2.3	-	4.0	V
	S02	Vo clamp	2.60	-	4.0	V
	S2.5	Vo clamp	3.1	-	4.0	V
	S03	Vo clamp	3.7	-	5.7	V
	S05	Vo clamp	5.6	-	7.0	V
	S12	Vo clamp	13.2	-	16.0	V
	D12	Vo1 clamp	13.2	-	18.0	V
		Vo2 clamp	-13.2	-	-18.0	V

Parameter	Module Suffix	Symbol	Min	Typ	Max	Unit
Efficiency	X1024-S03	ç	76	78	-	%
(Vi=Vi, nom; Io = Io, max; TA = 25 °C	S05,S12	ç	78	80	-	%
	D12	ç	79	81	-	%
	X1048-S03	ç	76	78	-	%
	S05,S12	ç	79	81	-	%
	D12	ç	80	82	-	%
	X1524-S1.8,S02,S2.5	ç	73	75	-	%
	S03	ç	77	79	-	%
	S05	ç	80	82	-	%
	S12	ç	75	77	-	%
	X1548-S1.8,S02,S2.5	ç	74	76	-	%
	S03	ç	77	79	-	%
	S05	ç	82	84	-	%
	S12	ç	77	79	-	%
	X20-S1.8,S2.5	ç	71	74	-	%
	S03	ç	81	84	-	%
	S05	ç	84	86	-	%
Switching Frequency	X10/15	f_{sw}	-	265	-	kHz
	X20	f_{sw}	-	200	-	kHz
Output Voltage Set-point Adjustment Range (optional: single outputs only)	S1.8, S02, S2.5		90	_	125	%Vo
	S03,S05,S12	-	90	-	110	%Vo

Parameter	Module Suffix	Symbol	Min	Typ	Max	Unit
Dynamic Response (for duals; Io1 or Io2=Io max; DIo/Dt=1A/10 ms; Vi=Vi, nom; TA=25°C; Co<1000uF, 12v Co<200uF): Load Change from Io=50% to 75% of Io, max:						
Peak Deviation	S1.8, S02, S2.5	-	-	100	-	mV
	S03, S05	-	-	100	-	mV
	S12,D12	-	-	2	-	%Vo.set
Settling Time (Vo < 10% of peak deviation)	X10/15	-	-	0.8	-	mS
	X20	-	-	0.4	-	mS
Load Change from Io =50% to 25% of Io, max:						
Peak Deviation	S1.8, S02, S2.5	-	-	100	-	mV
	S03, S05	-	-	100	-	mV
	S12,D12	-	-	2	-	%Vo.set
Settling Time	X10/15	-	-	0.8	-	mS
(Vo < 10% of peak deviation)	X20	-	-	0.4	-	mS

Table 5 - General Specifications

Parameter	Min	Typ	Max	Unit
Calculated MTBF (Io = 80% of Io, max; Tc = 25°C, Bellcore method):	–	2,400,000	–	Hours
Weight	–	–	28.3 (1.0)	g. (oz.)
Hand Soldering (soldering iron 3 mm (0.125 in.) tip, 425°C)	–	–	12	s

*Refer to the Section 12 for all characteristic charts.

Table 6. Feature Specifications

Parameter	Module Suffix	Symbol	Min	Typ	Max	Unit
Remote On/Off Signal (optional): Vi= 0 V to Vi, max; open collector or equivalent compatible; signal referenced to Vi (-) terminal.						
Positive Logic-Device Code Suffix/P:						
Logic Low-Module Off						
Logic High-Module On						
Negative Logic-Device Code Suffix/N:						
Logic Low-Module On						
Logic High-Module Off						
Module Specifications:						
On/Off Current-Logic Low	All	Ion/off	–	–	1.0	mA
On/Off Voltage:						
Logic Low	All	Von/off	-0.7	–	1.2	V
Logic High (Ion/off=0)	All	Von/off	–	–	10	V
Open Collector Switch Specifications:						
Leakage Current During Logic High (Von/off=10 V)	All	Ion/off	–	–	50	µA
Output Low Voltage During Logic Low (Ion/off = 1 mA)	All	Von/off	–	–	1.2	V

*Refer to the Section 12 for all characteristic charts.

Parameter	Module Suffix	Symbol	Min	Typ	Max	Unit
Turn-on Delay and Rise Times (At 80% of Io, Co<200uF, max; TA= 25 °C						
Case 1: On/Off Input is Set for Unit on an Input Power is Applied (delay for point at which Vi=Vi, min until Vo =10% of Vo, nom,) .	All	Tdelay	–	5	20	ms
Case 2: Input Power is Applied for at Least One Second, and then the On/ Off Input is Set to Turn the Module On (delay from point at which on/off input is toggled until Vo = 10% of Vo,nom).	All	Tdelay	–	1	10	ms
Output Voltage Rise Time (Time for Vo to rise from 10% of Vo,nom to 90% of Vo,nom)	All	Trise	–	0.2	5	ms
Output Voltage Overshoot at 80% of Io, max TA = 25 °C)	All	–	–	–	5	%

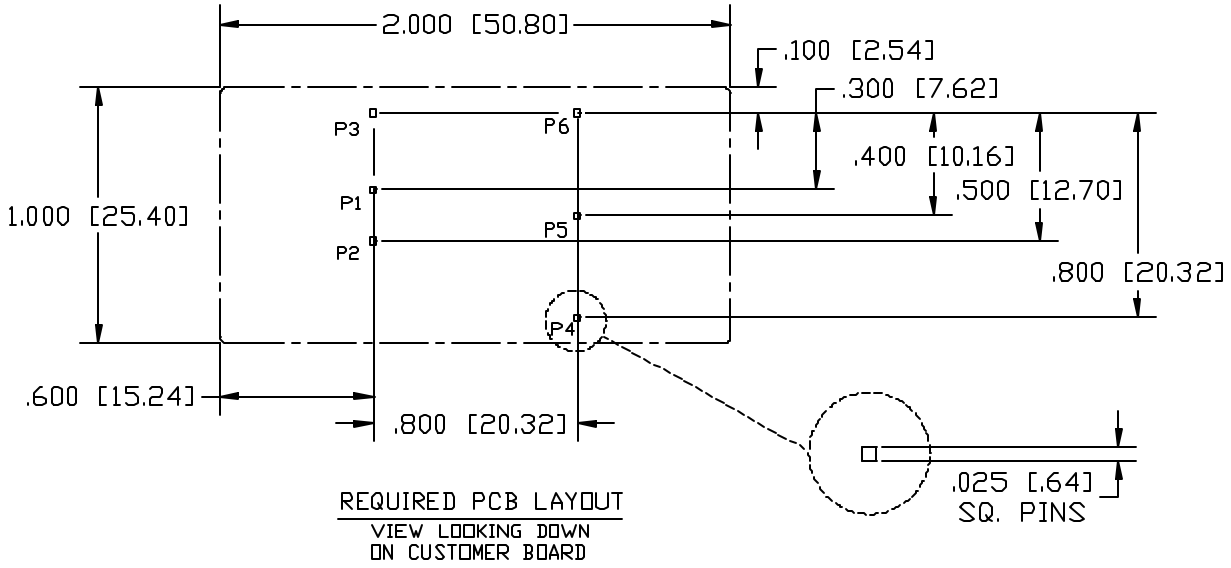
*

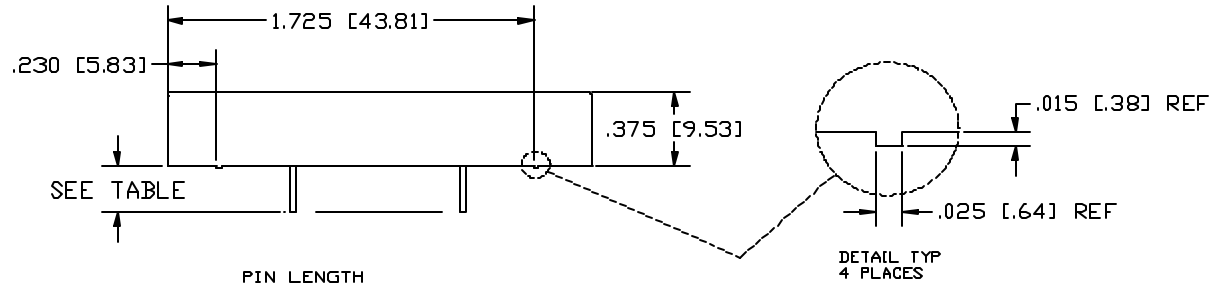
Refer to the Section 12 for all characteristic charts.

3. Outline Diagram/Recommended Hole Pattern

Dimensions are in inches and mm. Tolerance: .xx ± 0.01 (.25 mm), .xxx ± .005 (.13 mm)

If slightly lower height is needed, the four standoffs can be dropped through holes on the user's PWB. By dropping the standoffs through the PWB, the module height will be decreased to 9.5 mm (0.375 in.) typical height.





PIN LENGTH

MODEL	LENGTH
STD.	.230 [5.84]+.010 [.25]
/2	.110 [2.80]+.010 [.25]

Unless specified as an option, all units come with the standard pin .230 [5.84] + 0.010 [.25].

Maximum Height including tolerance is 0.405"

Pin	Function	Pin	Function
P1	Vi(-)	P4	Vo(+) or Vo1(+)
P2	Vi(+)	P5	COMMON (dual outputs) or TRIM (optional on single outputs) Pin is not present on single outputs unless option is specified. Pin is always present on dual outputs.
P3	ON/OFF (optional) Pin is not present unless option is specified.	P6	Vo(-) or Vo2(-)

4. Part Number Description

X	20	48	S	03	/xxx
Series	Output Power	Input Voltage	Output Type	Output Voltage	Option Code
	10 = 10 Watt	24 = 24V	S = Single Output	1.8 = 1.8V	(see table 7)
	15 = 15 Watt	48 = 48V	D = Dual Output	02 = 2.0V	
	20 = 20 Watt			2.5 = 2.5V	
				03 = 3.3V	
				05 = 5V	
				12 = 12V	

Table 7. Option Codes

Optional features may be ordered using the device code suffixes shown below. Some options are not available on dual

Option	Model Suffix
Output voltage adjustment*	/T
Short pin: 2.8 mm ± 0.25 mm (0.110 in. ± 0.010 in.)	/2
Positive logic remote on/off	/P
Negative logic remote on/off	/N
Positive logic remote on/off and short pin [2.8mm ± .25 mm (0.110 in. ± 0.010 in.)]	/P2
Output voltage adjustment and short pin [2.8mm ± .25 mm (0.110 in. ± 0.010 in.)]	/T2
Positive logic remote on/off and output voltage adjustment*	/PT
Positive logic remote on/off, output voltage adjustment and short pin [2.8mm ± .25 mm (0.110 in.± 0.010 in.)]*	/PT2
Negative Logic remote on/off and short pin [2.8mm ± .25 mm (0.110 in. ± 0.010 in.)]	/N2
Negative logic remote on/off and output voltage adjustment*	/NT
Negative logic remote on/off, output voltage adjustment and short pin [2.8mm ± .25 mm (0.110 in. ± 0.010 in.)]*	/NT2

5. Design Considerations

Input Source Impedance

The power module should be connected to a low ac-impedance input source. Highly inductive source impedances can affect the stability of the power module. If the source inductance exceeds 4 mH, a 33 µF electrolytic capacitor (ESR < 0.7 at 100 kHz) mounted close to the power module helps ensure stability of the unit.

6. Safety Considerations

Units are components within customers end-use system. Input to converter is 75VDC maximum. For safety agency approval of the end use system to safety standards (such as UL-1950 Third Edition, CAN CSA C22.2 No. 950-95, DIN EN60950/VDE 0805: 1997-11+A11:1998-08 and IEC 60950:1991 +A1:1992 +A2:1993 +A3:1995 +A4:1996, EN60950:1992 +A1:1993 +A2:1993 +A3:1995 +A4:1997 +A11:1997 the following considerations has to be made:

a) If the input meets all the requirements for ELV, then the output may be considered ELV

b) If the input meets all the requirements for SELV, then the output may be considered SELV

c) If the input meets all the requirements for TNV, then the output may be considered TNV

The input and output are to be both floating or both grounded. The converter is to be protected by a 5 Amp fuse, provided in the ungrounded leg. The CE mark on the product is applied to show conformance to the requirements outlined in the European Union's Low Voltage Directive (72/23/EEC) as amended by the CE mark directive (93/68/EEC). Any NON-SELV input must be provided with reinforced insulation from any other hazardous voltages, including the ac mains, and must have a SELV reliability test performed on it in combination with the converter.

Anmerkungen (Notes)

1. Die maximale Umgebungstemperatur betraegt 70°c.

   (Maximum operating temperature 70°c).

2. Überstrom Schutz in dem nicht geerdeten Teil des Eingangbereichs sollte im End-Produkt vorhanden sein.

   Empfohlener Sicherungswert: F 5.0 A.

   (Overcurrent protection in the ungrounded side of the input supply, shall be provided in the end product.

   Recommended fuse: F 5.0 AH)

   Nenndaten (Fuse rating): F5.0A H 250V.

   Warnung: Fuer kontinuierlichen Feuerschutz, sollten die Sicherungen nur mit einer gleichen Typs und der gleichen

   Einstufung ersetzt werden .

   (Warning: For continued protection against fire, replace with same type and rating of fuse).

3. Das Schaltnetzteil ist ein Geraet der Schutzklasse 1.

   (Power supply is class 1 equipment).

4. Das Netzteil ist nur zum Einbau fuer IT- Geräte nach EN 60950 bestimmt.

   (Power supply is EN60950 equipment. End user to meet all EN60950 requirements when installing power supply into end use product).

1. Feature Descriptions

Output Overvoltage Clamp

The output overvoltage clamp consists of control circuitry, independent of the primary regulation loop that monitors the voltage on the output terminals. This control loop has a higher voltage set point than the primary loop (see Feature Specifications table). In a fault condition, the overvoltage clamp ensures that the output voltage does not exceed $V_{o, clamp, max}$. This provides a redundant voltage-control that reduces the risk of output overvoltage.

Current Limit

To provide protection in a fault (output overload) condition, the unit is equipped with internal current-limiting circuitry and can endure current limiting for an unlimited duration. At the point of current-limit inception, the unit shifts from voltage control to current control. If the output voltage is pulled very low during a severe fault, the current-limit circuit exhibits tailout characteristics (output-current increase). The unit operates normally once the output current is brought back into its specified range.

Remote On/Off (Optional)

Two remote on/off options are available:

- Device code suffix/P, positive logic remote on/off, turns the module on during a logic-high voltage on the remote ON/OFF pin, and off during a logic low.
- Device code suffix/N, negative logic remote on/off, turns the module off during a logic high and on during a logic low.

To turn the power module on and off, the user must supply a switch to control the voltage between the on/off terminal and the Vi (-) terminal (Von/off). The switch may be an open collector or equivalent (see figure 1). A logic low is Von/off = -0.7 V to +1.2 V. The maximum Ion/off during a logic low is 1mA. The switch should maintain a logic-low voltage while sinking 1 mA.

During a logic high, the maximum Von/off generated by the power module is 10 V. The maximum

allowable leakage current of the switch at Von/off = 10 V is 50 µA.

The module has internal capacitance to reduce noise at the ON/OFF pin. Additional capacitance is not generally needed and may degrade the start-up characteristics of the module.

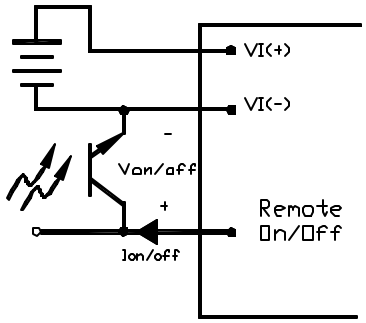


Figure 1. Remote On/Off Implementation

Output Voltage Adjustments (optional on Single-Output Units)

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 Vo(+) or Vo(-) pins. With an external resistor between the TRIM and Vo(+) pins ($R_{adj\text{-}down}$), the output voltage set point ($V_{o,adj}$) decreases (see Figure 2). The following equation determines the required external resistor value to obtain an output voltage change from $V_{o,nom}$ to $V_{o,adj}$:

$$R_{adj\text{-}down} = \frac{(V_{o\ adj} - L) * G}{(V_{o\ nom} - V_{o\ adj})} - H$$

Where Radj-down is the resistance value connected between TRIM and Vo(+), and G,H, and L are defined in the following table.

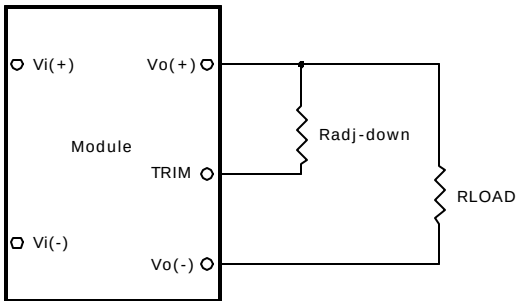


Figure 2. Circuit Configuration to Decrease Output Voltage

With an external resistor between the TRIM and Vo(-) pins (Radj-up), the output voltage set point (Vo,adj) increases (see Figure 3). The following equation determines the required external resistor value to obtain an output voltage from $V_{o,nom}$ to $V_{o,adj}$:

$$R_{adj\text{-}up} = \left[\left[\frac{G \cdot L}{((V_{o\_adj} - L) - K)} \right] - H \right] \Omega$$

where $R_{adj\text{-}up}$ is the resistance value connected between TRIM and Vo (-), and the values of G, H, K, and L are shown in the following table:

	G	H	K	L
X15-S1.8	5110	2050	.54	1.25
X15 S2.0	5110	2050	.77	1.25
X15 S2.5	5110	2050	1.25	1.25
X15 S03	5110	2050	.77	2.5
X15 S05	5110	2050	2.5	2.5
X15-S12	10000	5110	9.5	2.5

The combination of the output voltage adjustment and the output voltage tolerance cannot exceed 110%

(115% for the S1.8,S02,S2.5) of the nominal output voltage between the Vo(+) and Vo(-) terminals.

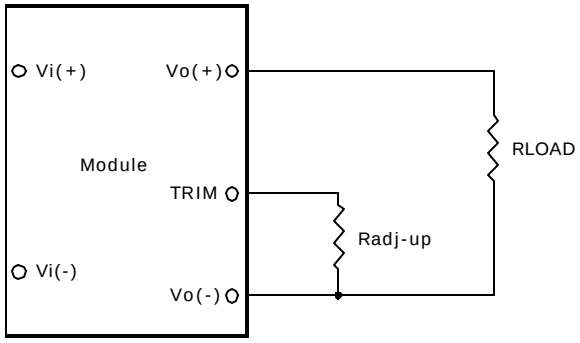


Figure 3. Circuit Configuration to Increase Output Voltage.

The X series power modules have a fixed current-limit set point. Therefore, as the output voltage is adjusted down, the available output power is reduced. In addition, the minimum output current is a function of the output voltage. As the output voltage is adjusted down, the minimum required output current can increase (i.e. minimum power is constant).

8. Thermal Considerations

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-dissipating components inside the unit are thermally coupled to the case. Heat is removed by conduction, convention, and radiation to the surrounding environment. Proper cooling can be verified by measuring the case temperature. The case temperature (Tc) should be measured at the position indicated in Figure 4

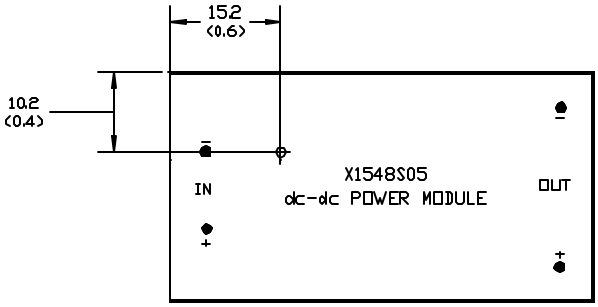


Figure 4. X10/15 Case Temperature Measurement Location

Note that the view in Figure 4 is of the surface of the module. The temperatures at this location should

not exceed the maximum case temperature indicated on the derating curve. The output power of the module should not exceed the rated power for the module as listed in the ordering information table.

9. Layout Considerations

Copper paths must not be routed beneath the power module standoffs.

10. Test Configurations

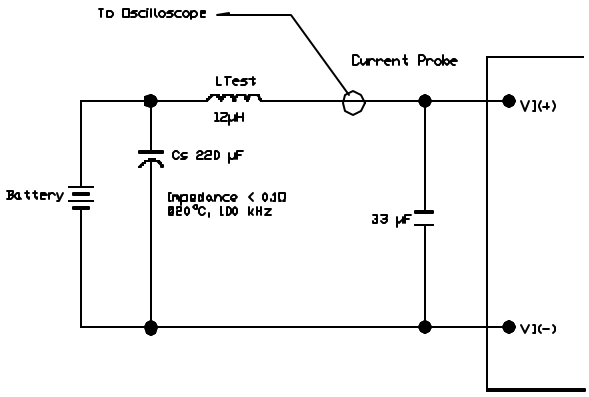


Figure 5. Input reflected Ripple Test Setup.

Note: Input reflected ripple current is measured with a simulated source impedance of 12uH. Capacitor Cs offsets possible battery impedance. Current is measured at the input of the module.

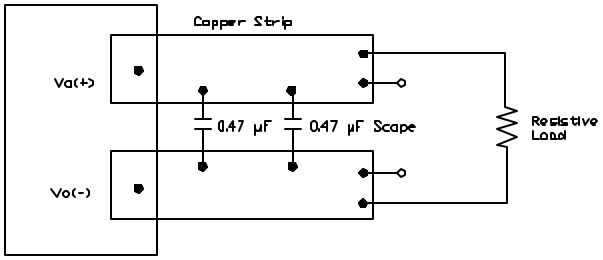
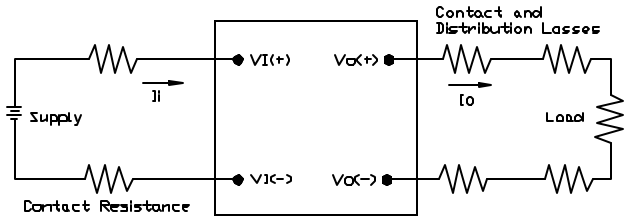


Figure 6. Peak to Peak Output Noise Measurement Test Setup for Single Output Units.

Note: Use two 0.47uF ceramic capacitors. Scope measurement should be made using a BNC socket. Position the load between 50 mm and 75mm (2in and 3in.) from the module.



$$\eta = \left(\frac{[Vo(+)-Vo(-)]Io}{[Vi(+)-Vi(-)]Ii} \right) \times 100$$

Figure 7. Output Voltage and Efficiency Measurement Test Setup for Single Output Units.

Note: All measurements are taken at the module terminals. When socketing, place Kelvin connections at module terminals to avoid measurement errors due to socket contact resistance.

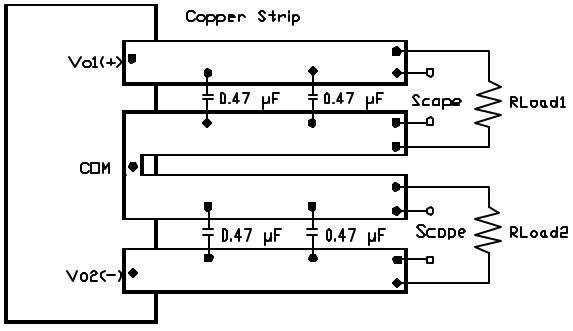
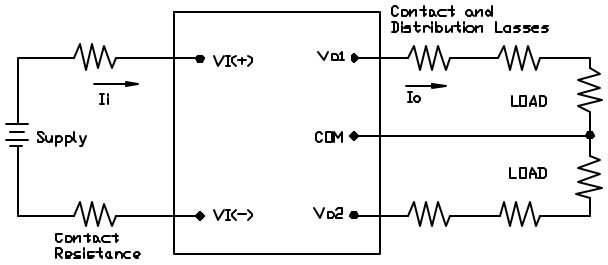


Figure 8. Peak to Peak Output Noise Measurement Test Setup for Dual Output Units.

Note: Use two 0.47uF ceramic capacitors. Scope measurement should be made using a BNC socket. Position the load between 50mm and 75mm (2in. And 3in.) from the module.

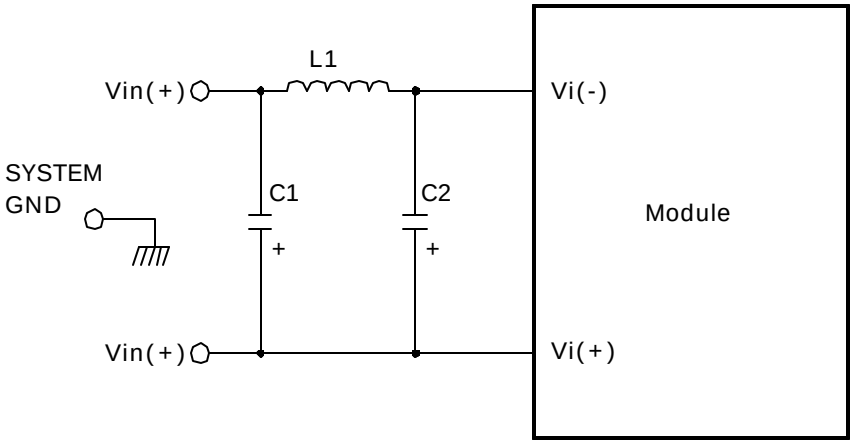


$$\eta = \left[\frac{\sum_{j=1}^{2} |[Voj\text{-}COM]Ioj|}{[Vi(+)\text{-}Vi(-)]Ii} \right] \times 100$$

Figure 9. Output Voltage and Efficiency Measurement Test Setup for Dual Output Units.

Note: All measurements are taken at the module terminals. When sockeitng, place Kelvin connections at module terminals to avoid measurement errors due to socket contact resistance.

22 Recommended EMI Filter



The following table allows to specify EMI compliance necessary to meet EN55022 Level B.

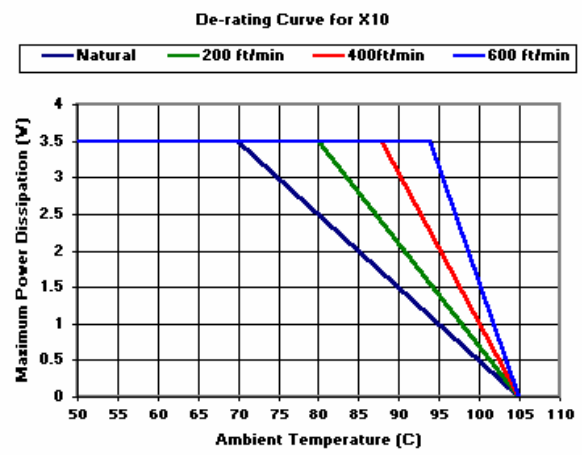
	24V Input Models				48V Input Models			
	Value	Rating	Vendor	Part #	Value	Rating	Vendor	Part #
C1,C2	22uF	100V	Nichicon	UPJ2A220MPH	22uF	100V	Nichicon	UPJ2A220MPH
L1	10uH	1.4A	TDK	SLF7032T-100M1R4-2	10uH	1.4A	TDK	SLF7032T-100M1R4-2

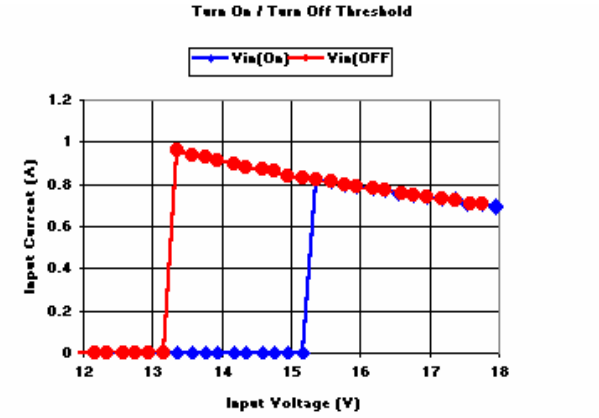
12. Characteristic Curves Index

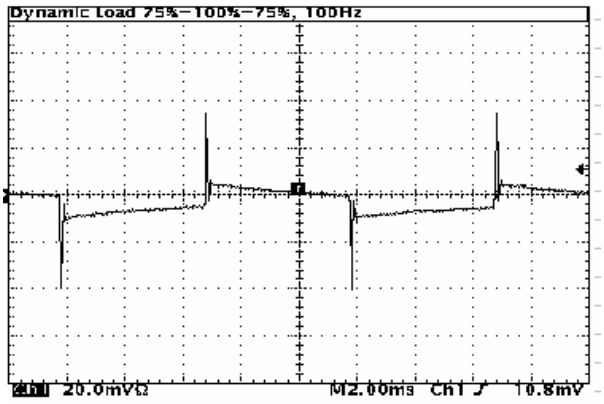
Characteristic Charts. All figures and waveforms reflect typical performance of models. Use the chart below to locate the applicable performance chart based on the particular model of interest.

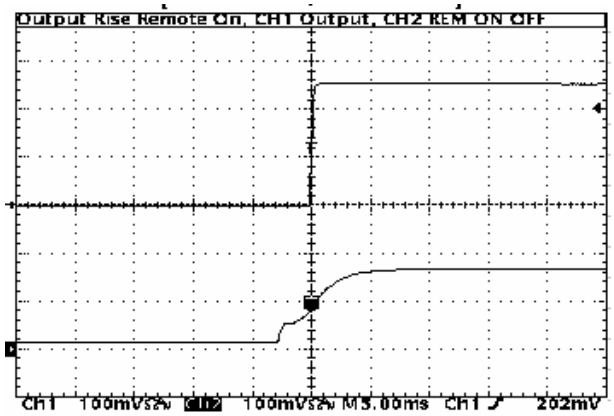
	Suffix	X1024	X1048	X1524	X1548	X2024	X2048
Starting Page/Derating Curves	All	25	30	35	41	47	52
25C Ambient							
Power Dissipation	S1.8,S2.5			35	42	48	53
Power Dissipation	S02			35	42		
Power Dissipation	S03	26	31	38	44	50	55
Power Dissipation	S05	27	32	39	45	51	56
Power Dissipation	S12	28	33	40	46		
Power Dissipation	D12	29	34				
Efficiency	S1.8			36	42	48	53
Efficiency	S02			36	42		
Efficiency	S2.5			37	43	49	54
Efficiency	S03	26	31	38	44	50	55
Efficiency	S05	27	32	39	45	51	56
Efficiency	S12	28	33	40	46		
Efficiency	D12	29	34				
V/I characteristic	S1.8,S2.5			37	43	48	53
V/I characteristic	S02			37	43		
V/I characteristic	S03,S05	26	31	38	44	50	55
V/I characteristic	S12	28	33	40	46		
V/I characteristic	D12	29	34				
70C Ambient							
Power Dissipation	S1.8,S2.5			36	42	48	53
Power Dissipation	S02			36	42		
Power Dissipation	S03	26	31	38	44	50	55
Power Dissipation	S05	27	32	39	45	51	56
Power Dissipation	S12	28	33	40	46		
Power Dissipation	D12	29	34				
Efficiency	S1.8			36	42	48	53
Efficiency	S02			36	42		
Efficiency	S2.5			37	43	49	54
Efficiency	S03	26	31	38	44	50	55
Efficiency	S05	27	32	39	45	51	56
Efficiency	S12	28	33	40	46		
Efficiency	D12	29	34				
V/I characteristic	S1.8,S2.5			37	43	48	53
V/I characteristic	S02			37	43		
V/I characteristic	S03,S05	26	31	38	44	50	55
V/I characteristic	S12	28	33	40	46		
V/I characteristic	D12	23	50				
Input V/I characteristic	All	25	30	37	43	48	53
Output Voltage Waveforms	S05	25	30	35	41	47	52

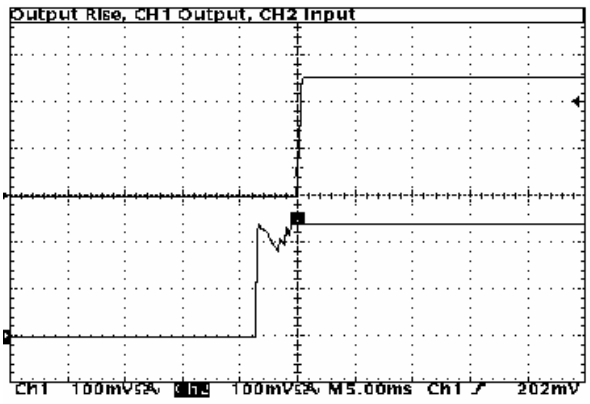
X1024 Characteristic Waveforms and Curves

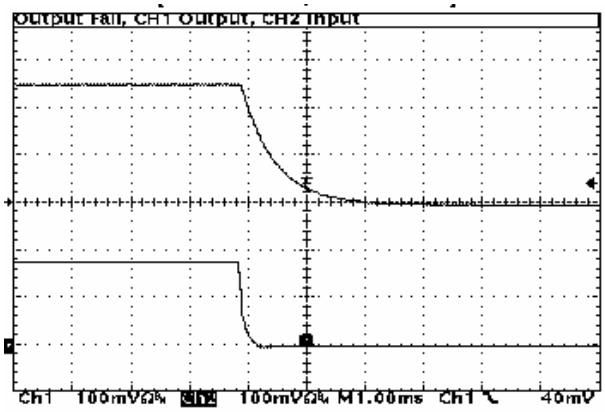




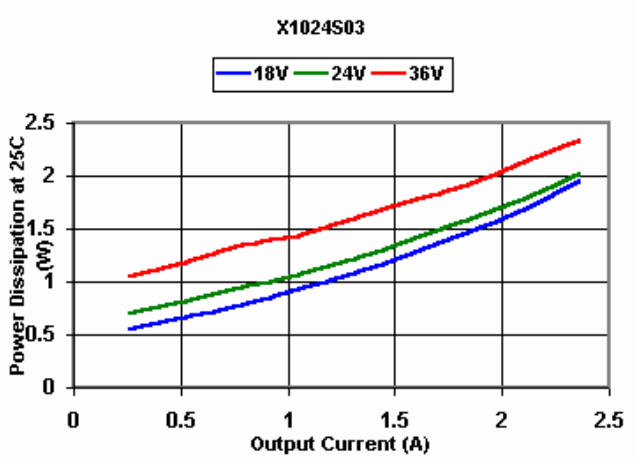


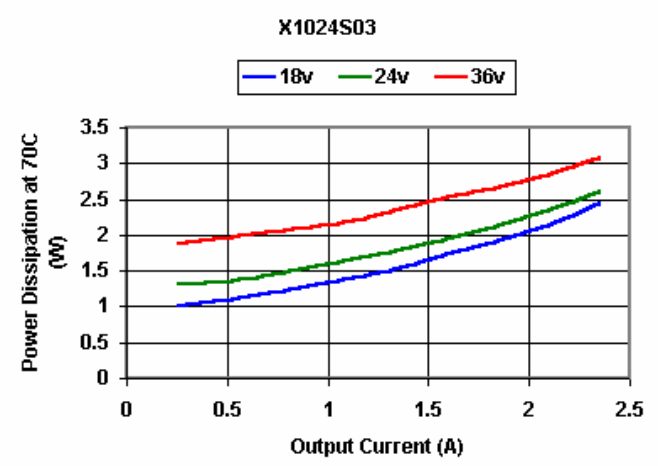


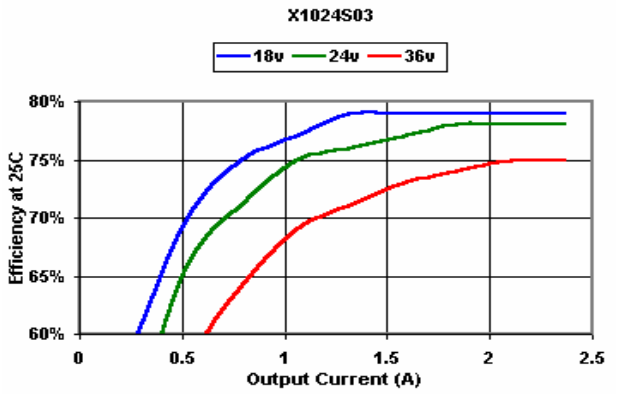


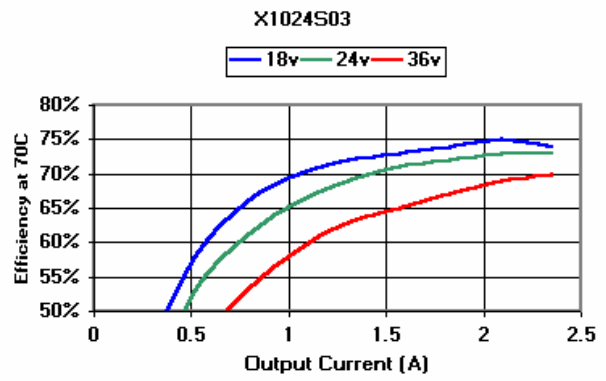


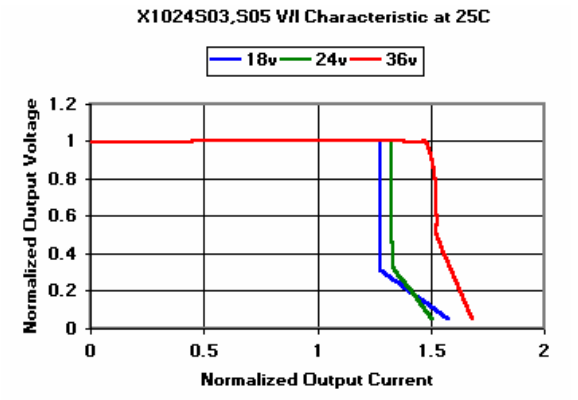
X1024S03 - 24V input, 3.3V output

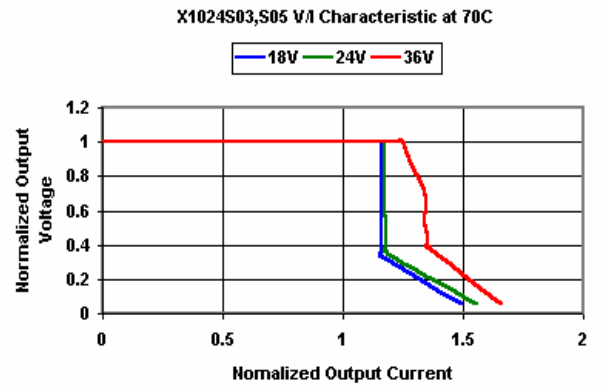




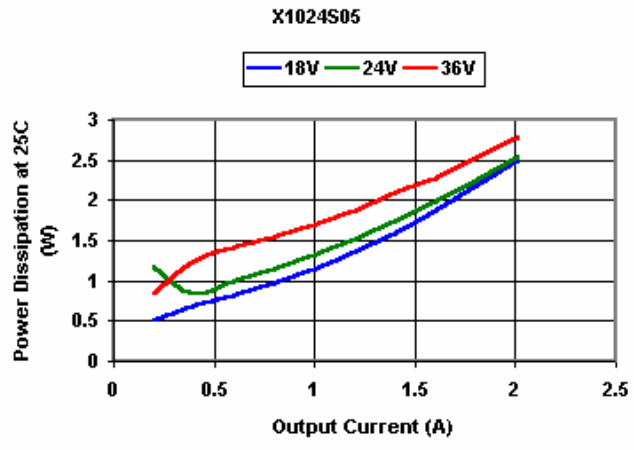


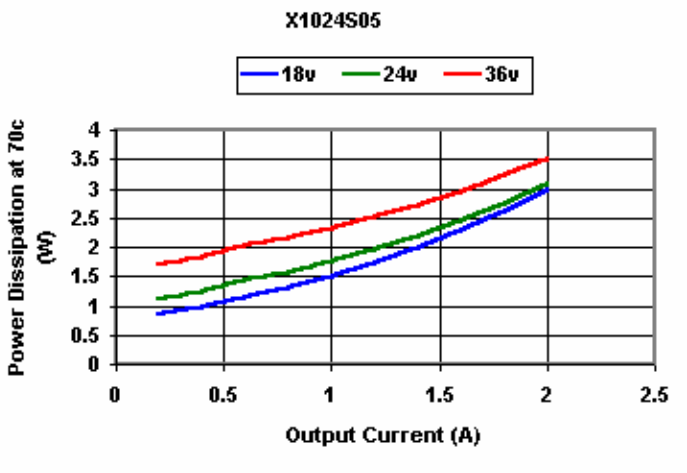


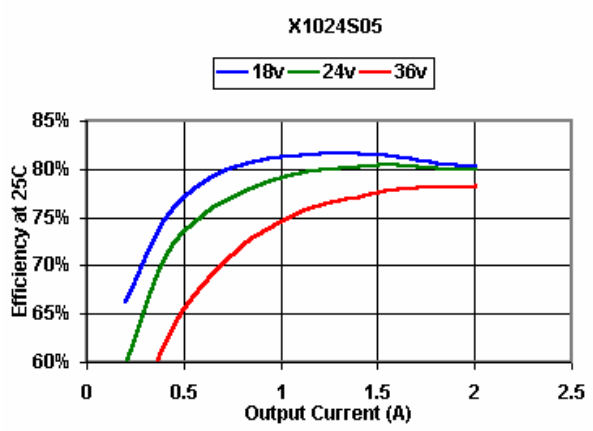


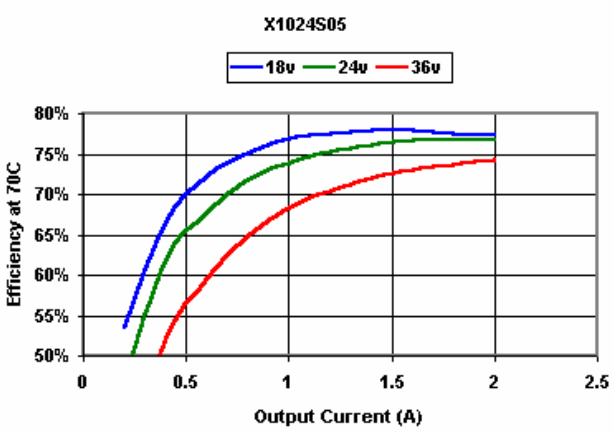


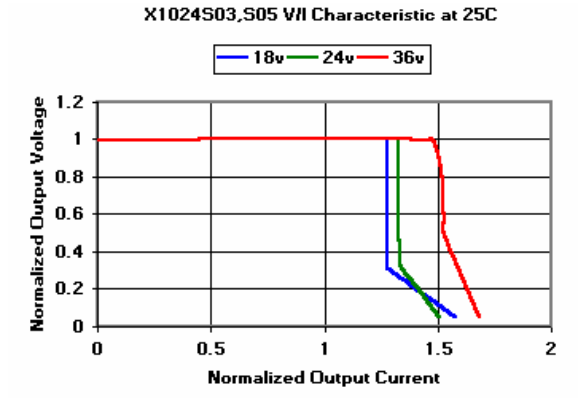
X1024S05 - 24V input, 5V output

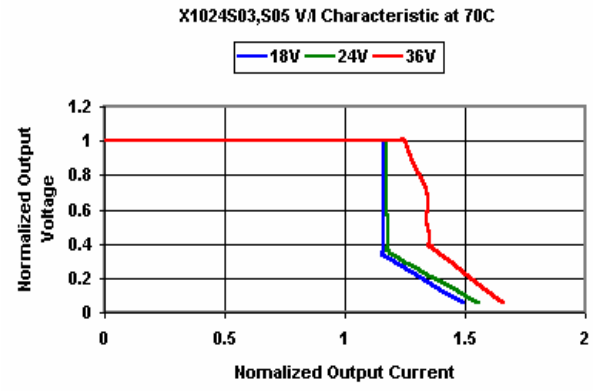




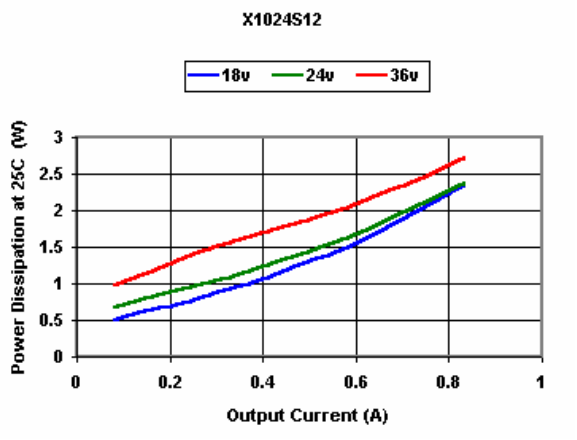


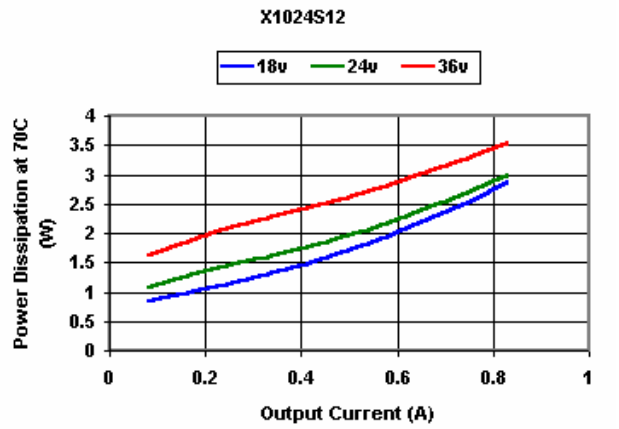


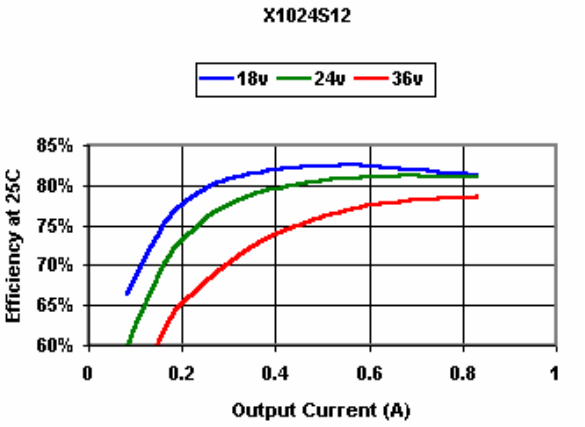


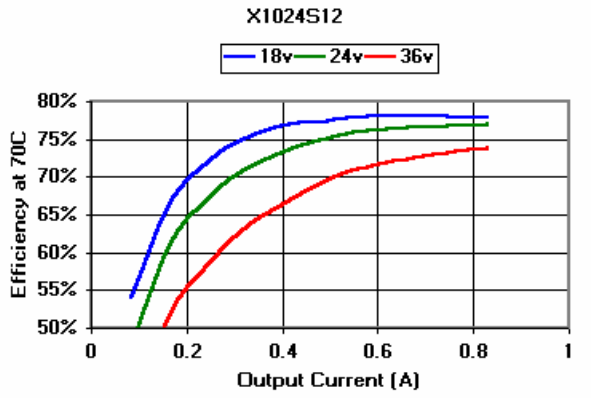


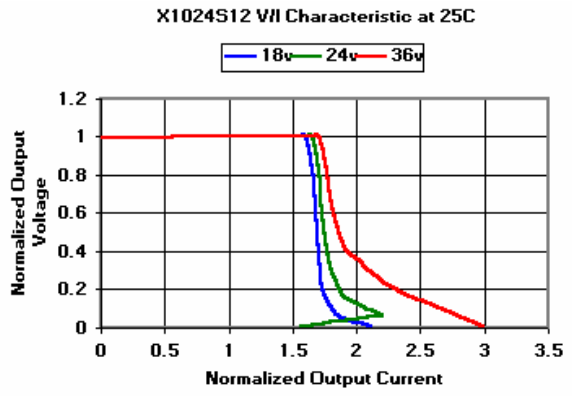
X1024S12 - 24V input, 12V output

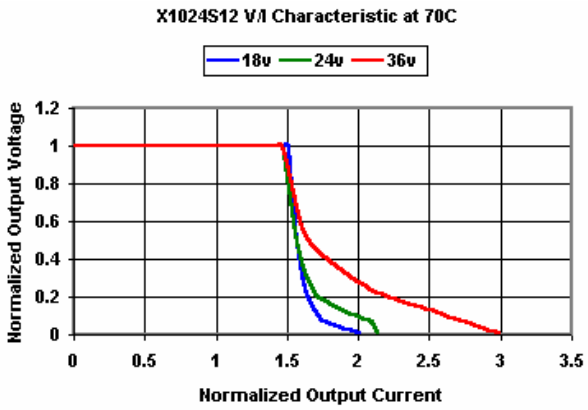




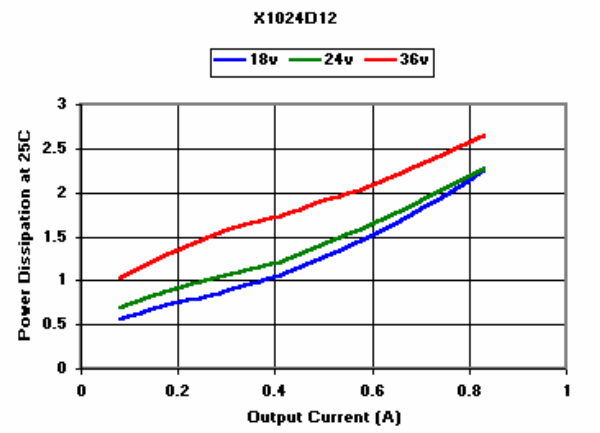


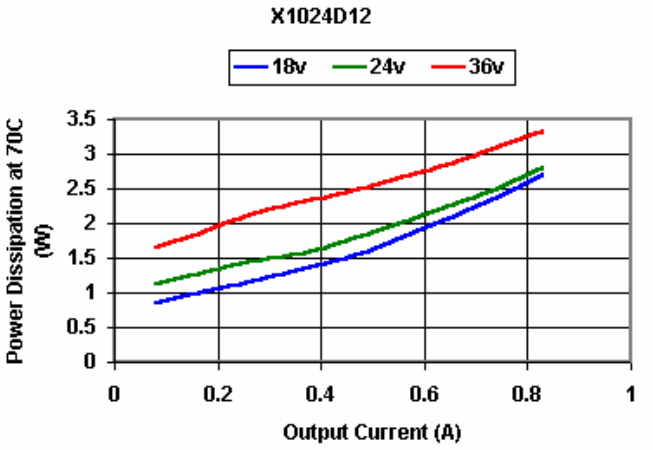


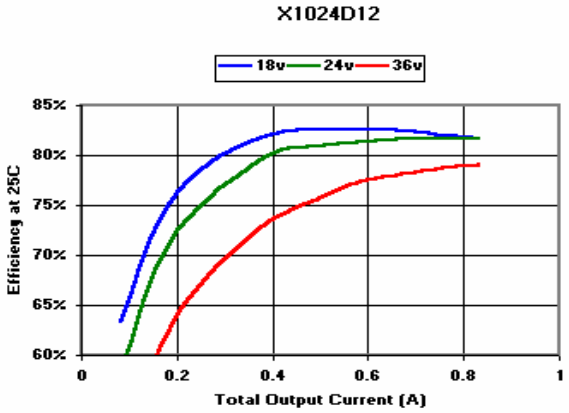


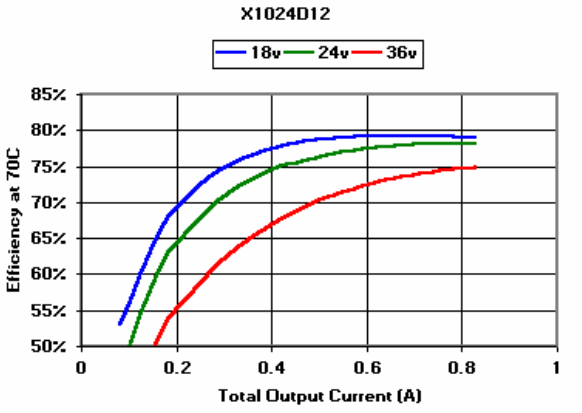


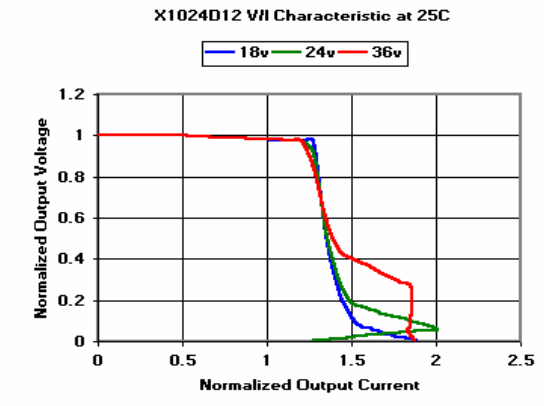
X1024D12 - 24V input, Dual 12V output

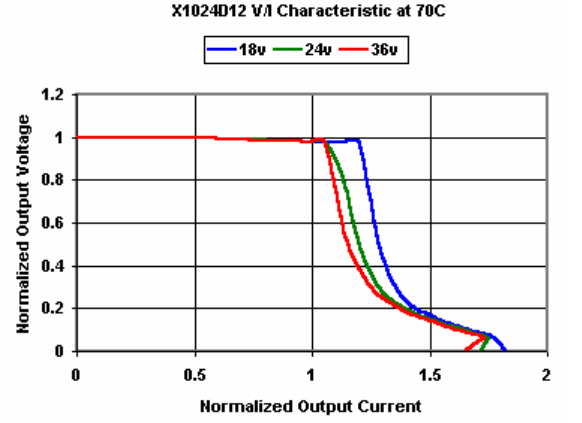




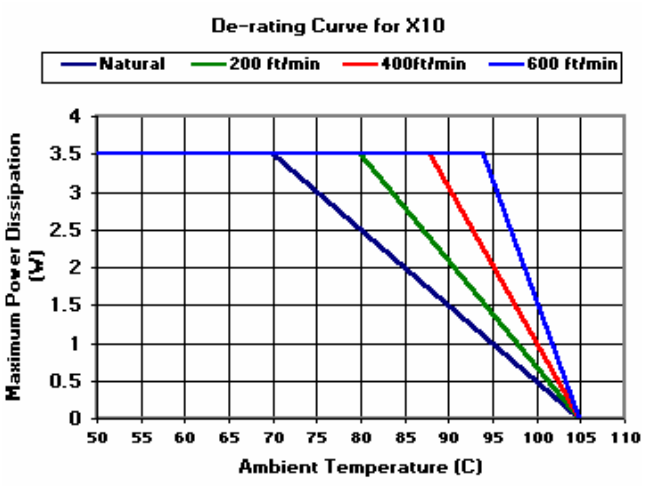


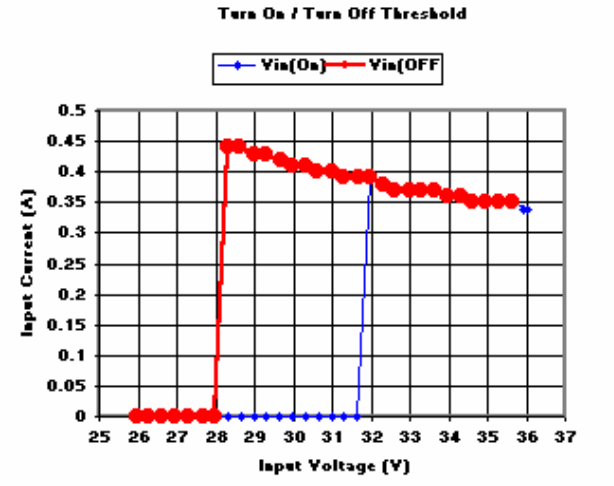


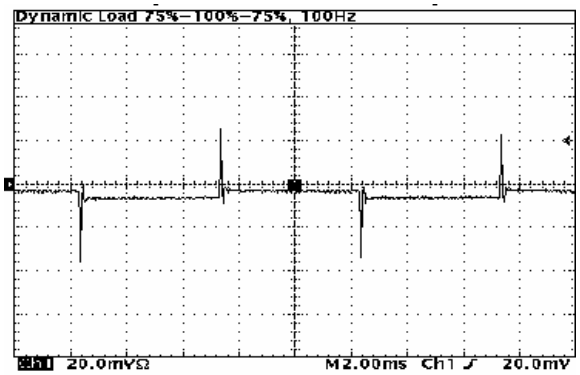


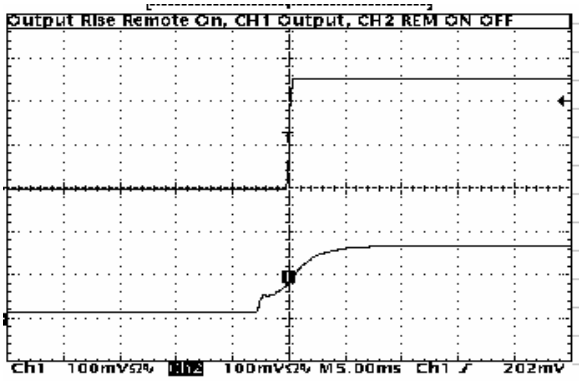


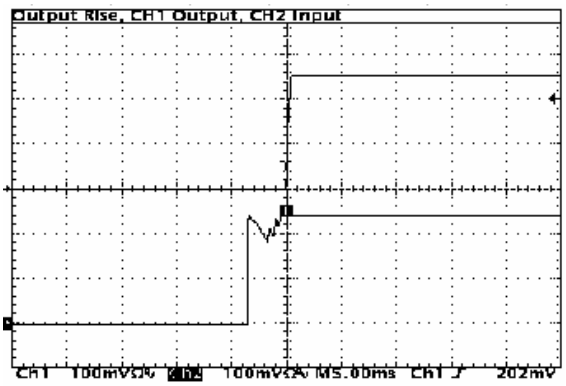
X1048 Characteristic Waveforms and Curves

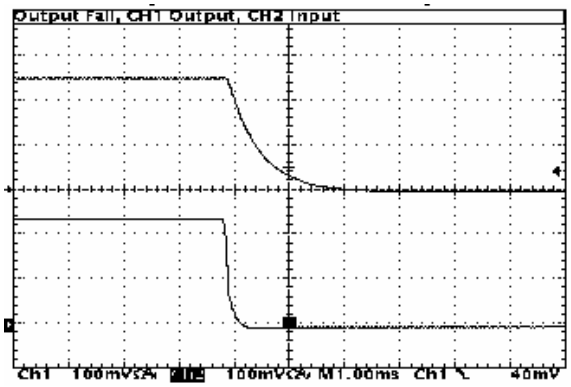




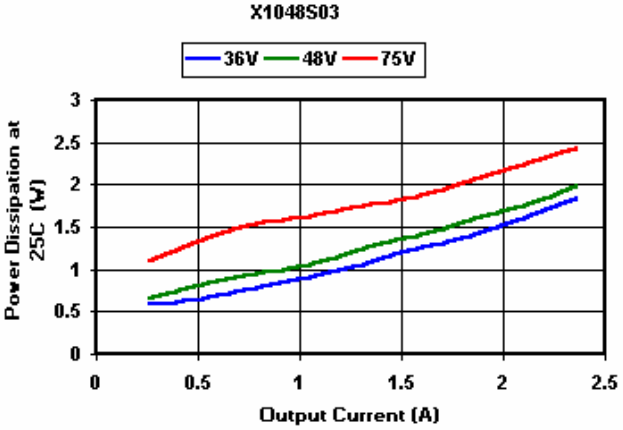


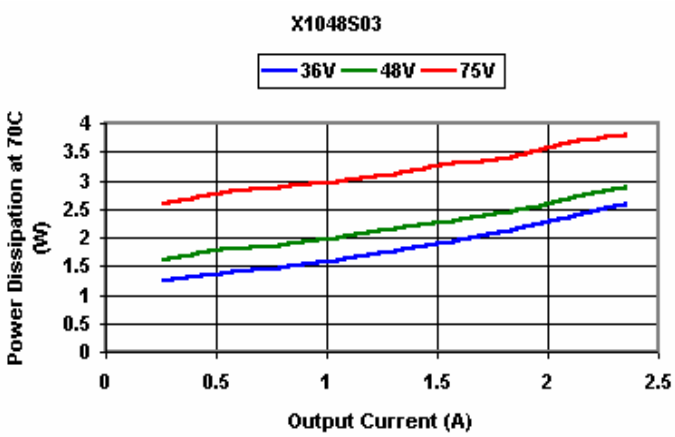


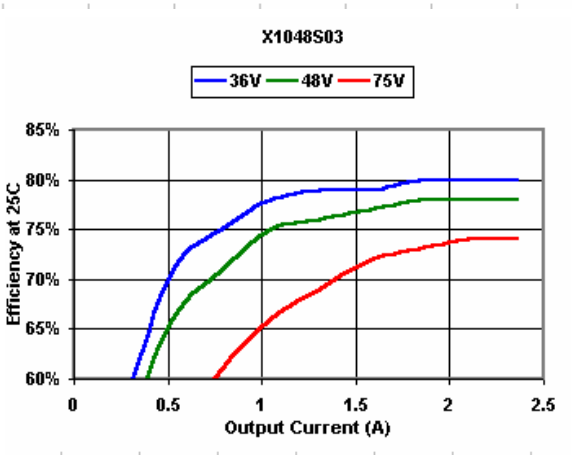


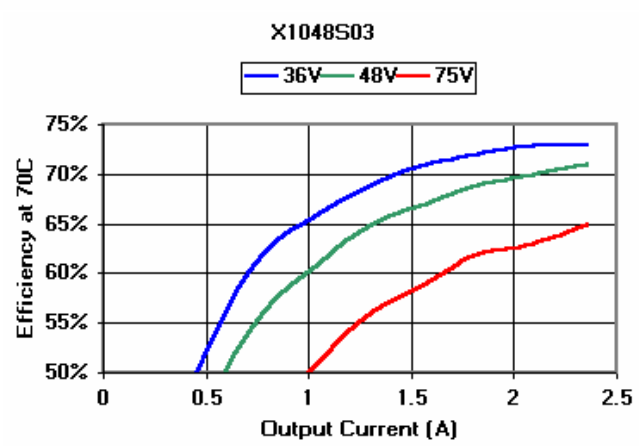


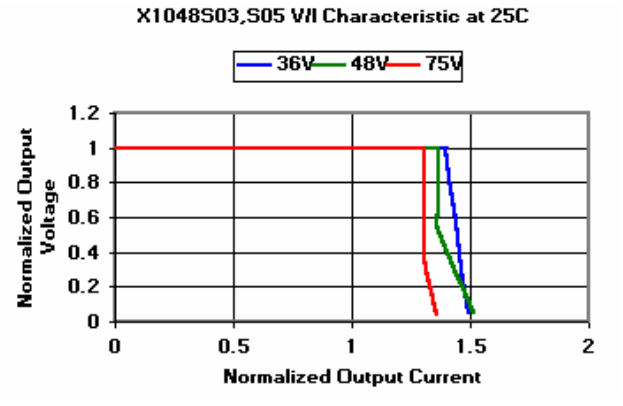
X1048S03 - 48V input, 3.3V output

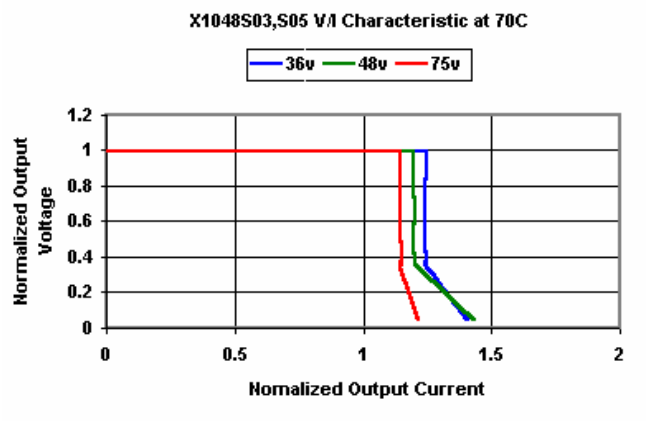




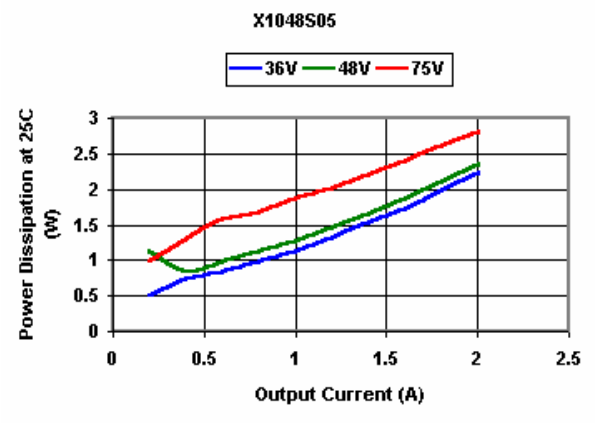


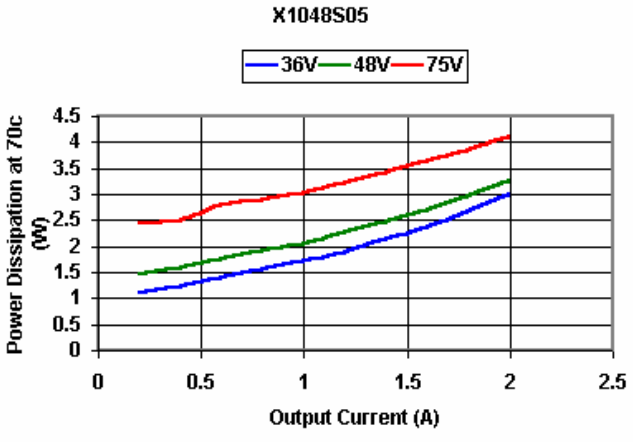


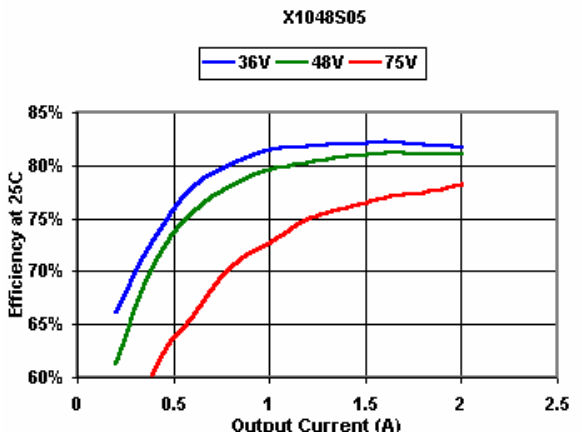


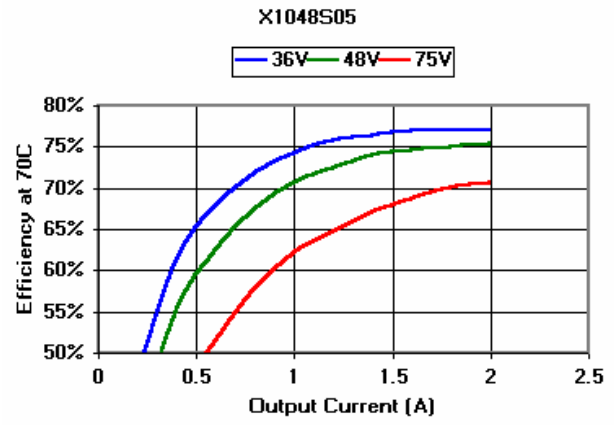


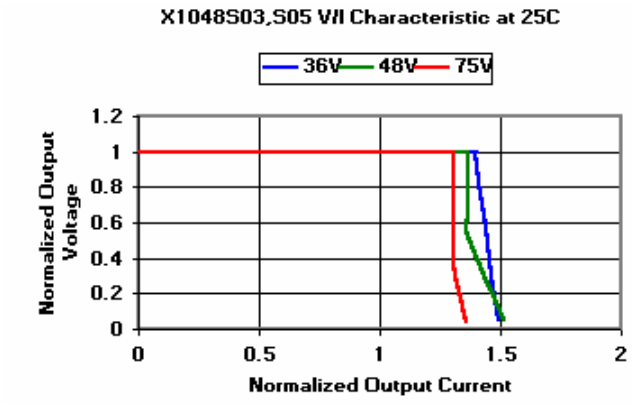
X1048S05 - 48V input, 5V output

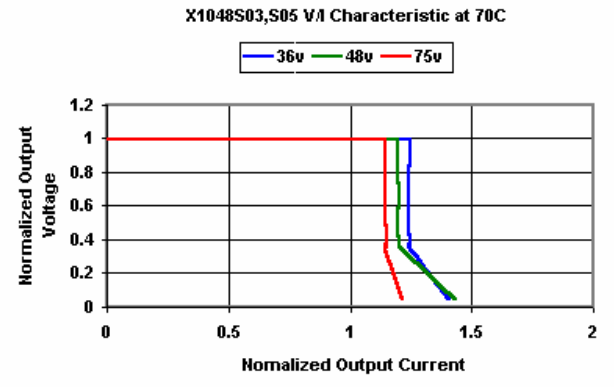




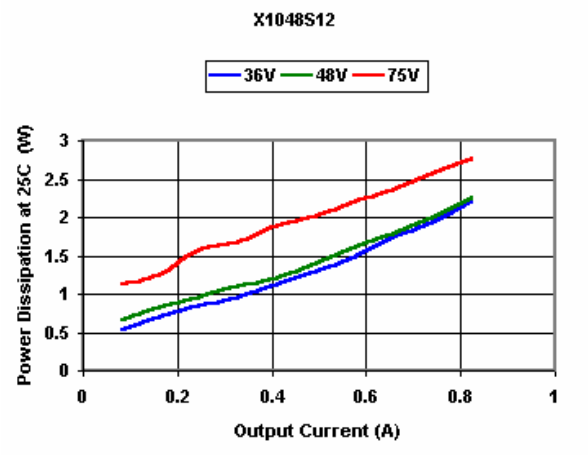


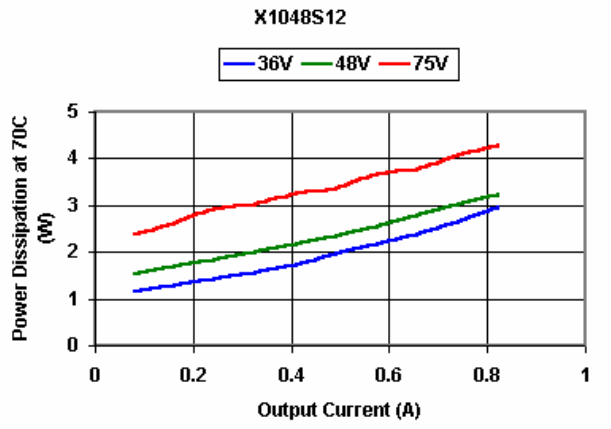


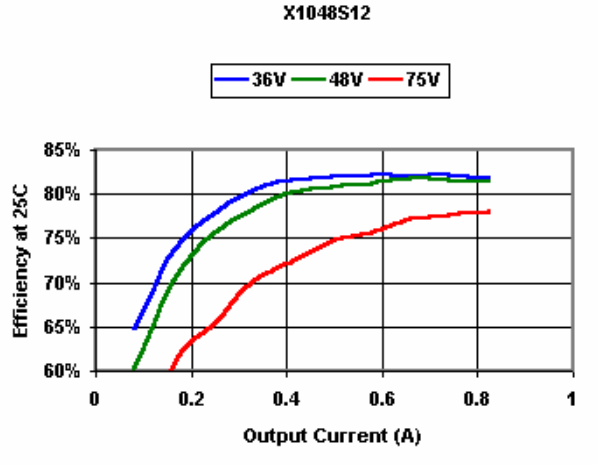


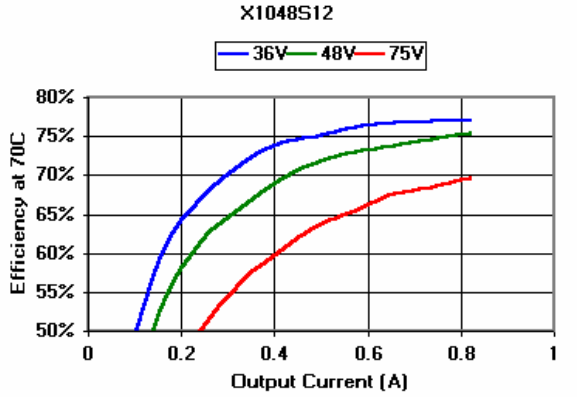


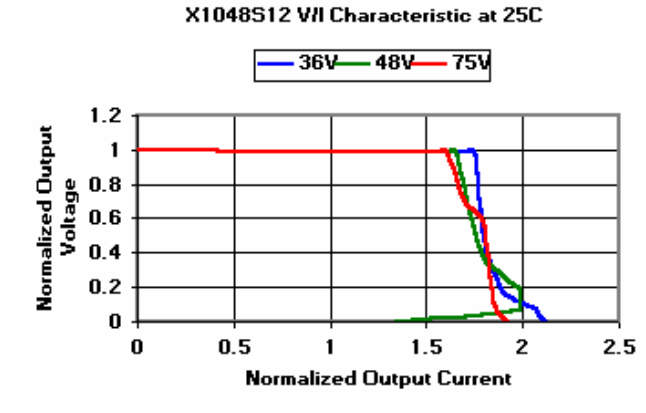
X1048S12 - 48V input, 12V output

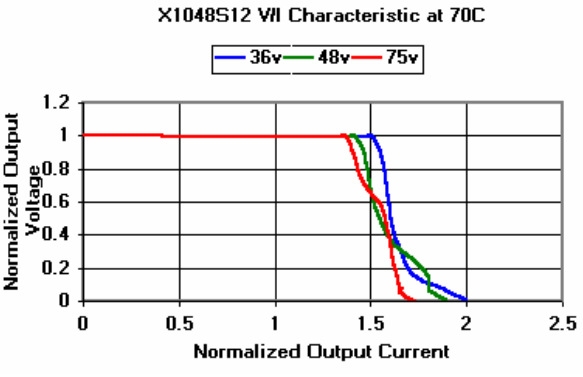






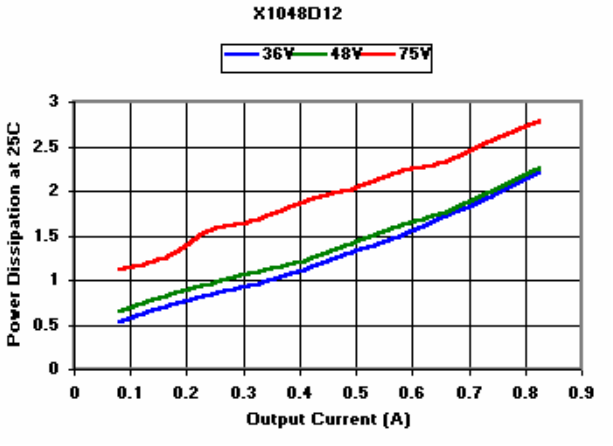


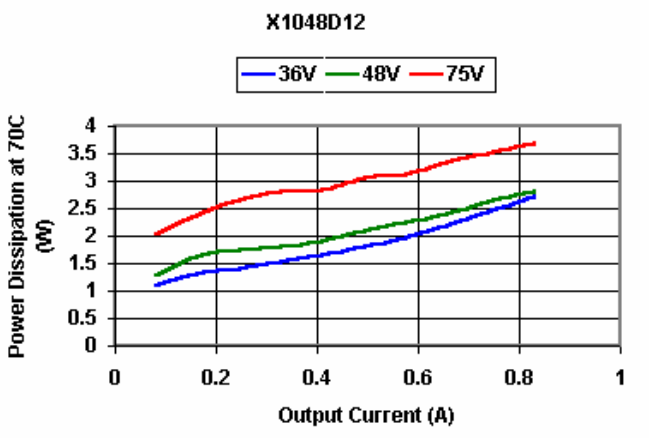


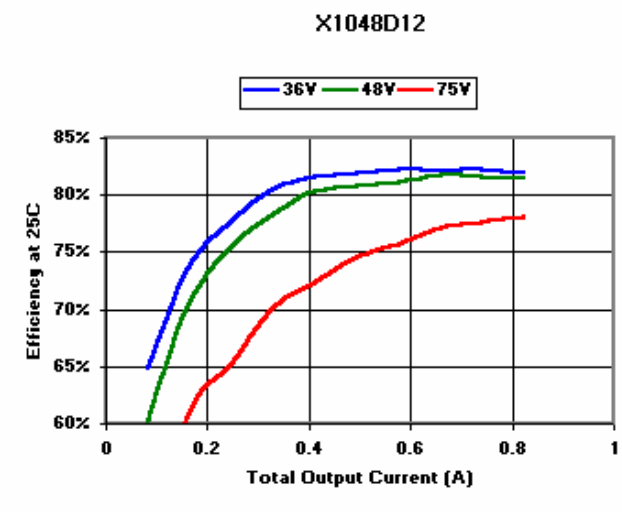


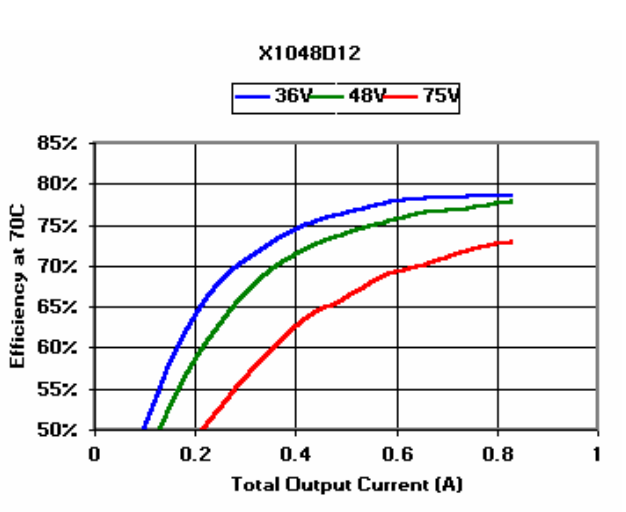
output models.

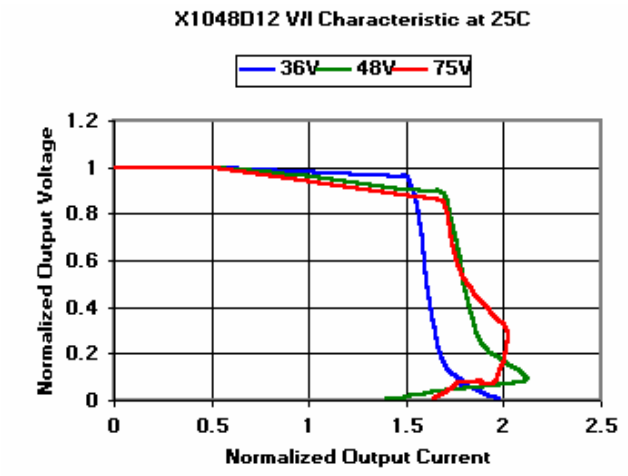
X1048D12 - 48V input, Dual 12V output

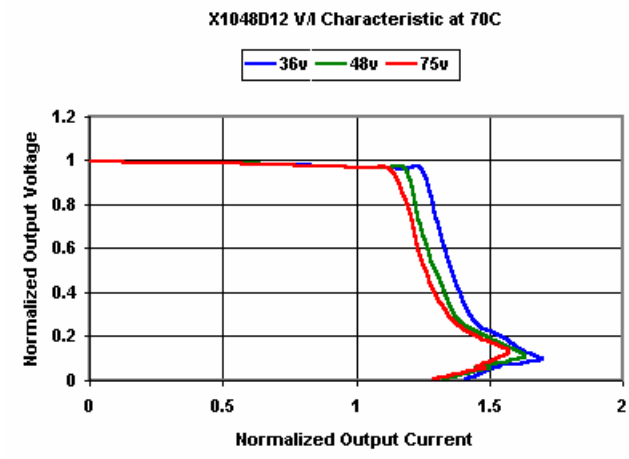




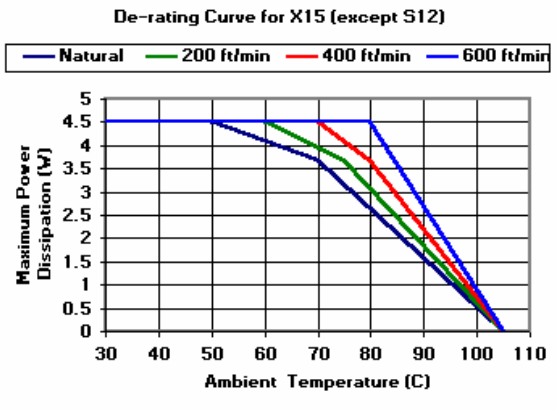


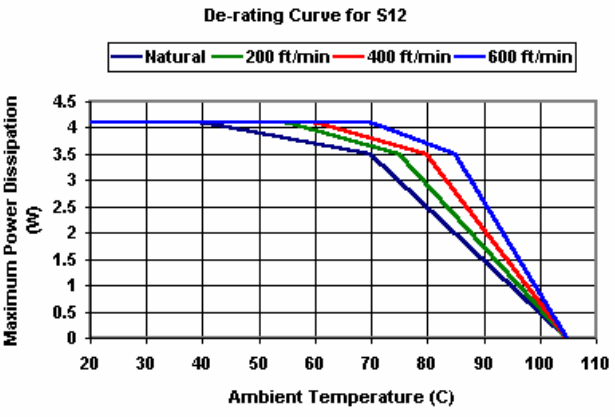


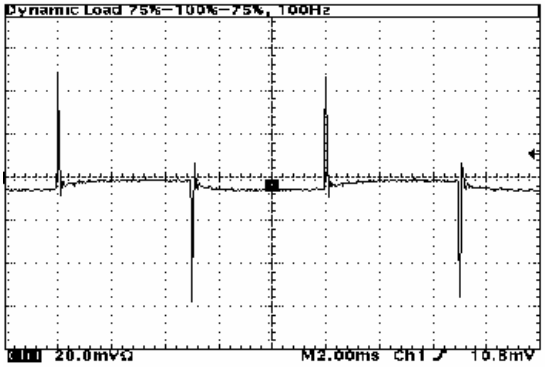


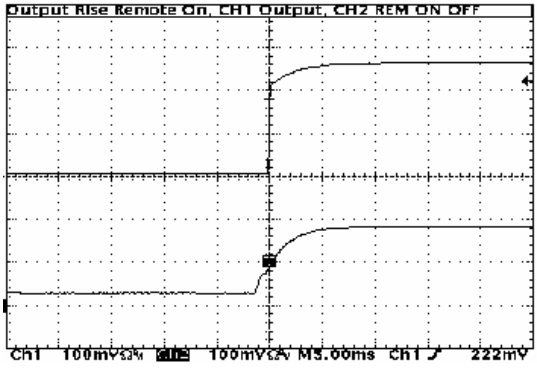


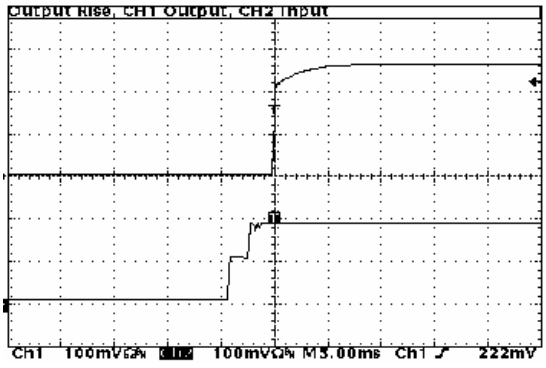
X1524 Characteristic Waveforms and Curves

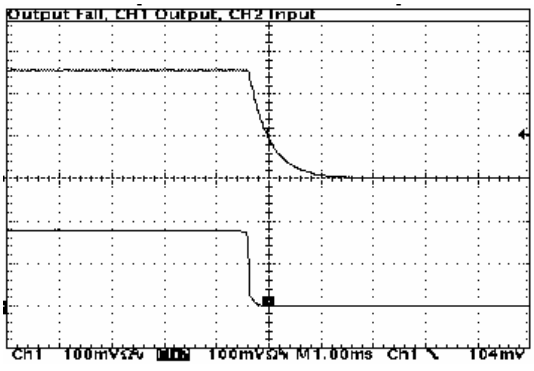




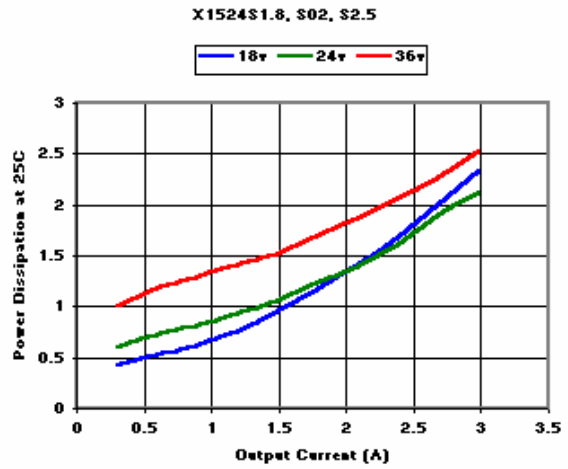


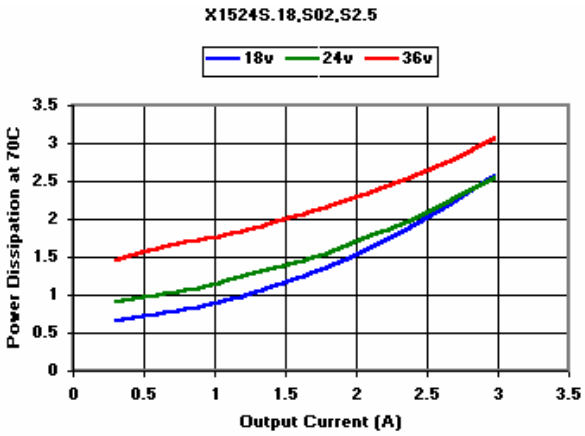


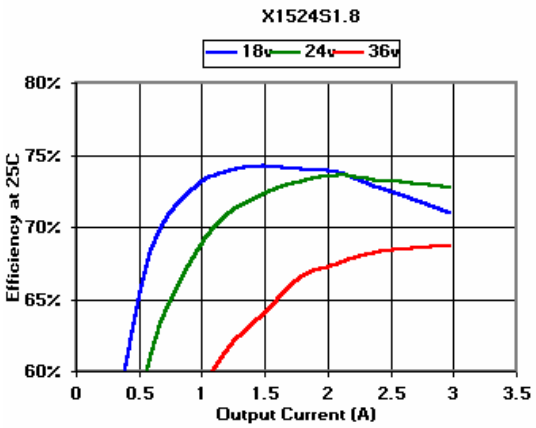


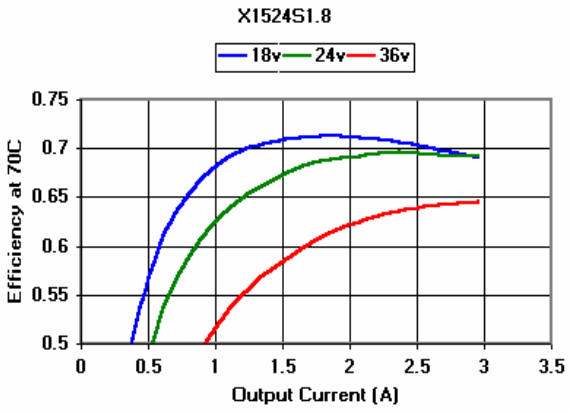


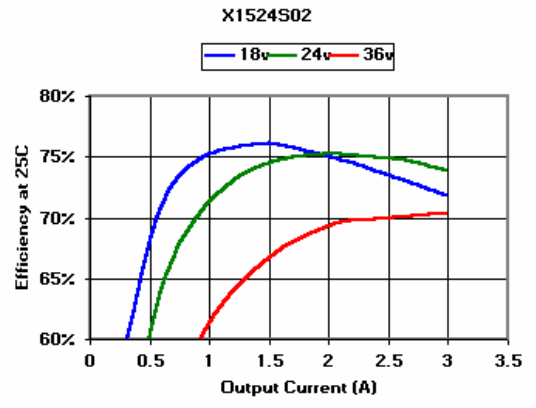
X1524S1.8, S02, S2.5 - 24V input, 1.8V, 2V, 2.5V output

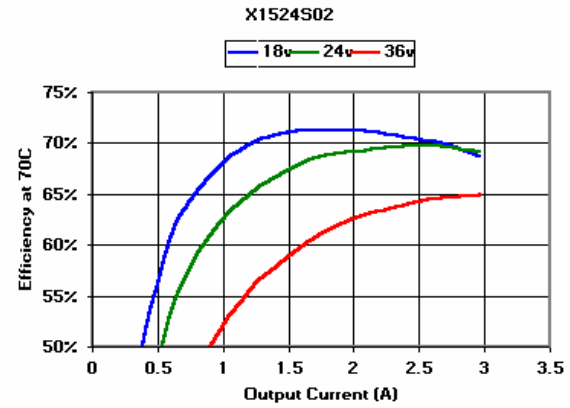




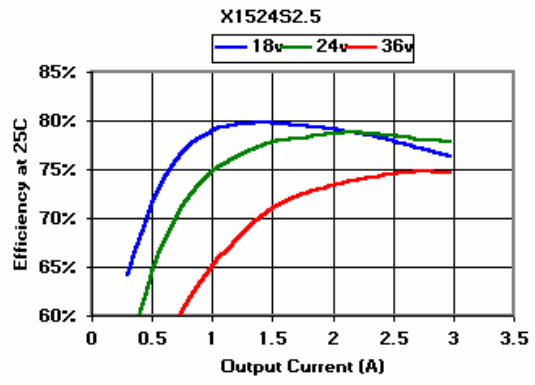


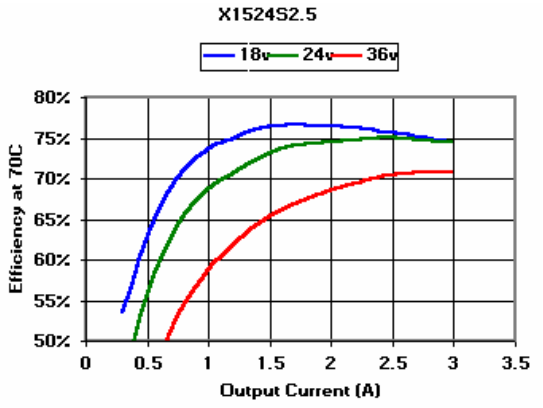


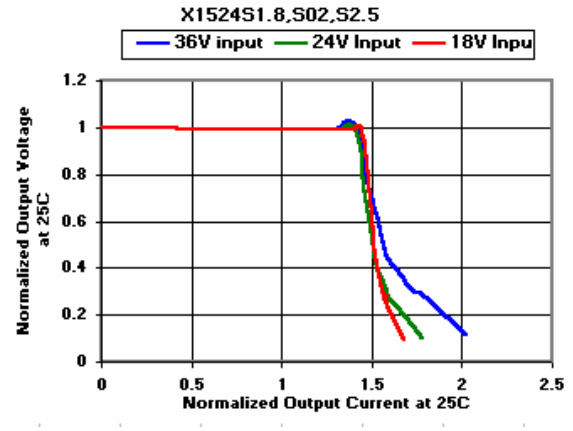


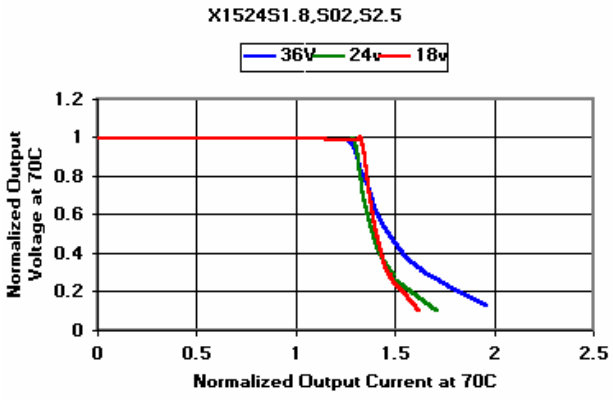


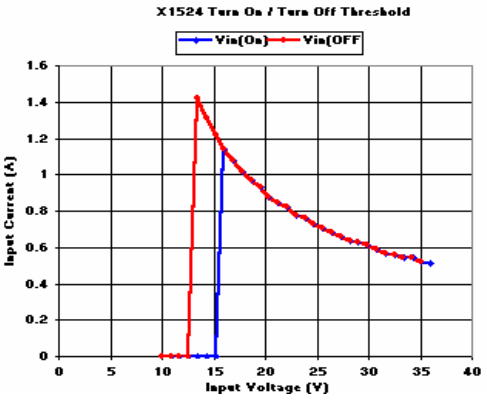
X1524S1.8, S02, S2.5 - 24V input, 1.8V, 2V, 2.5V output



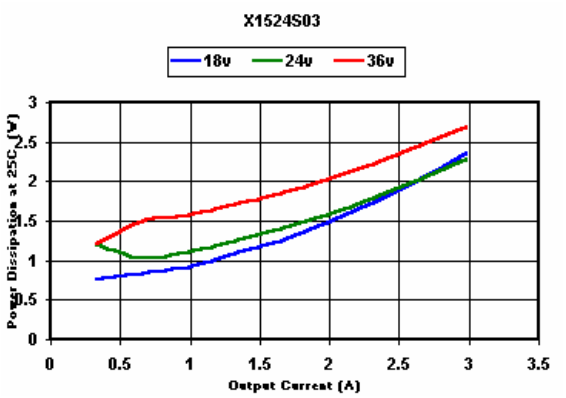


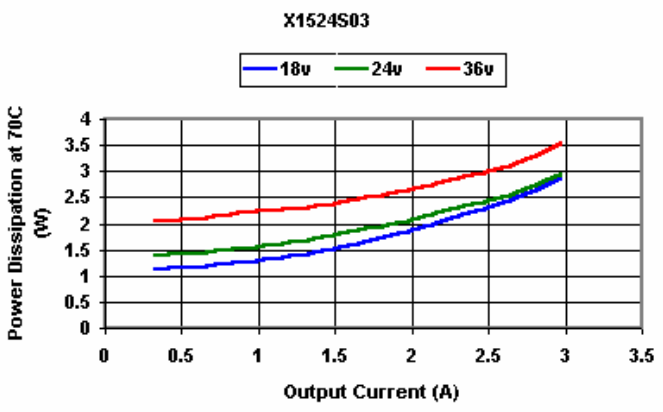


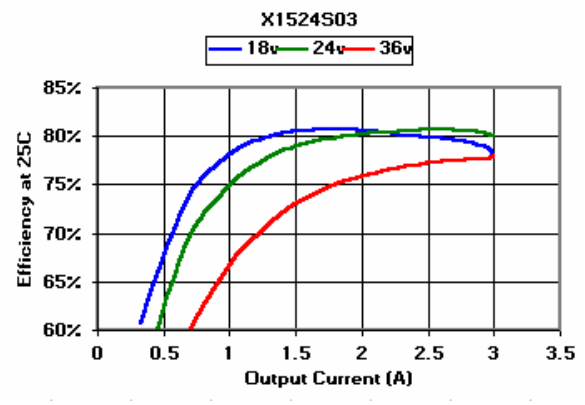


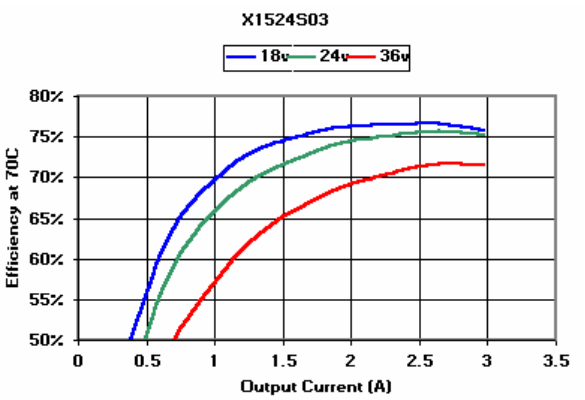


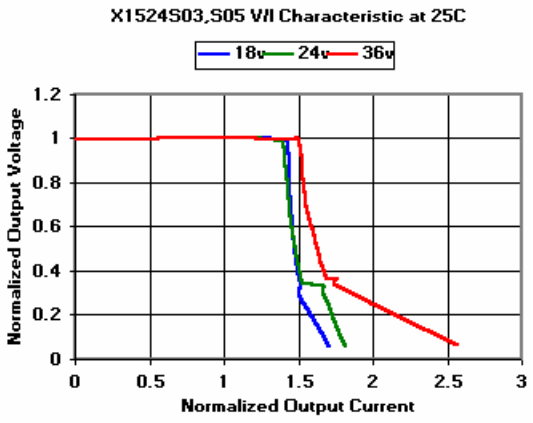
X1524S03 - 24V input, 3.3V output

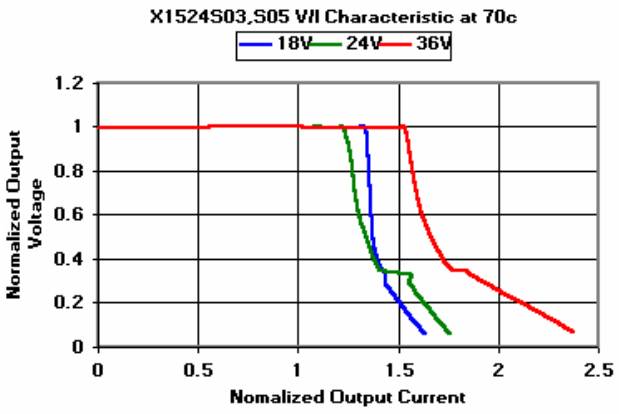




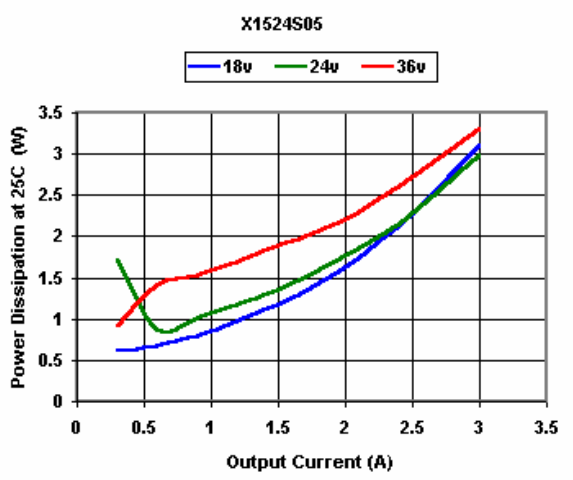


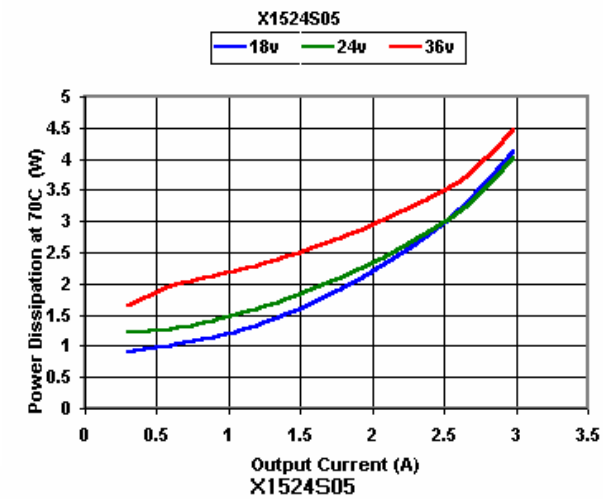


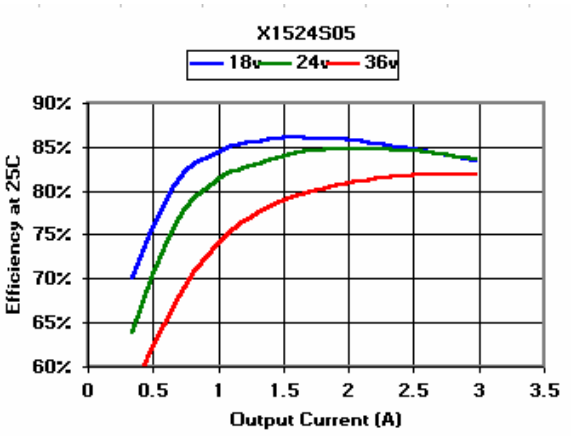


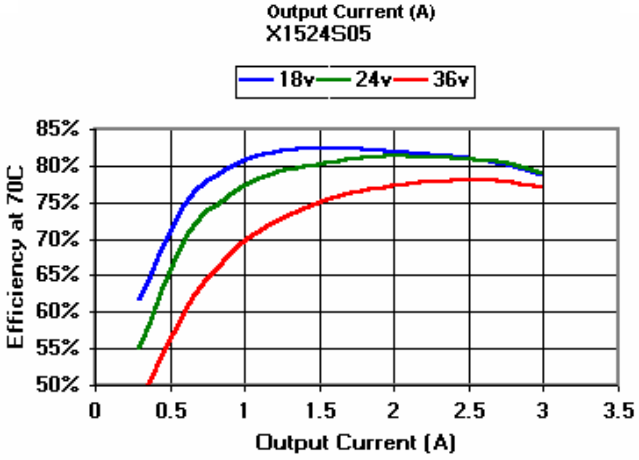


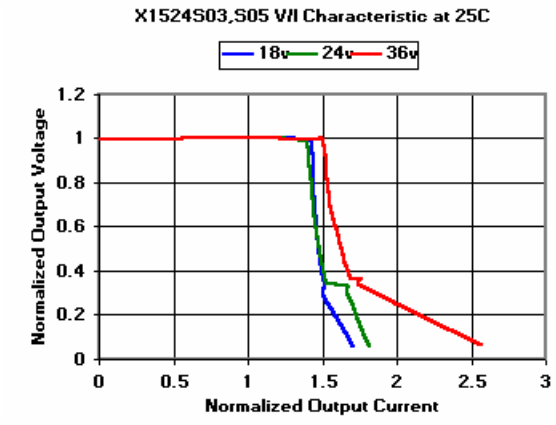
X1524S05 - 24V input, 5V output

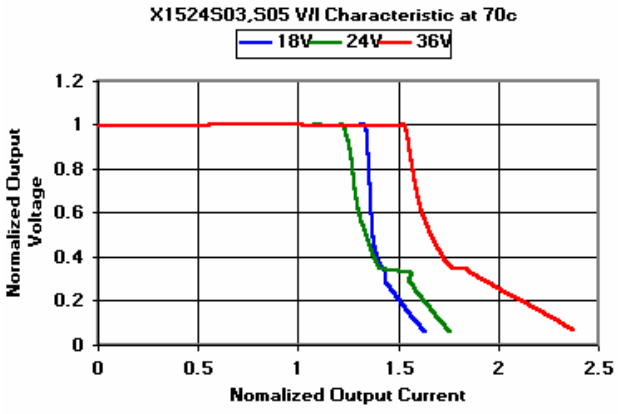




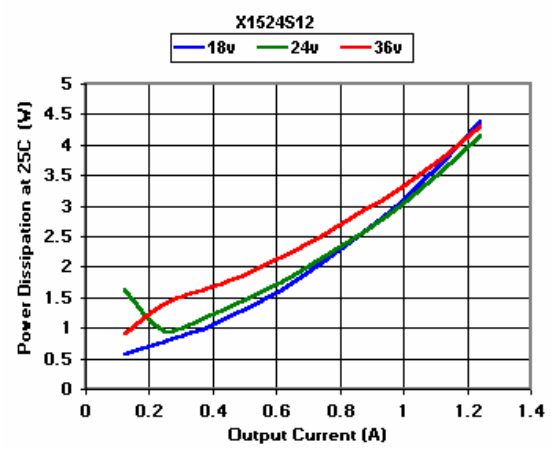


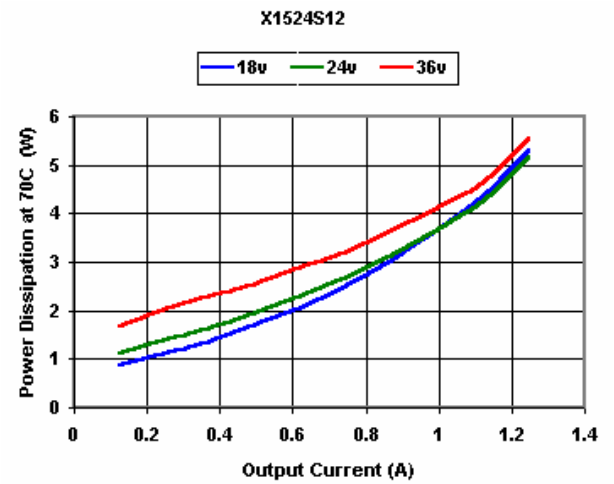


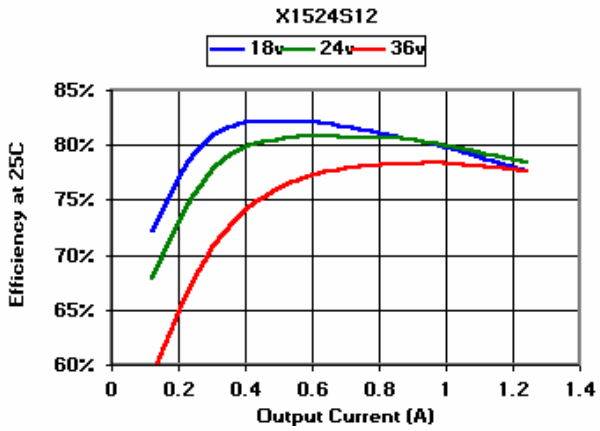


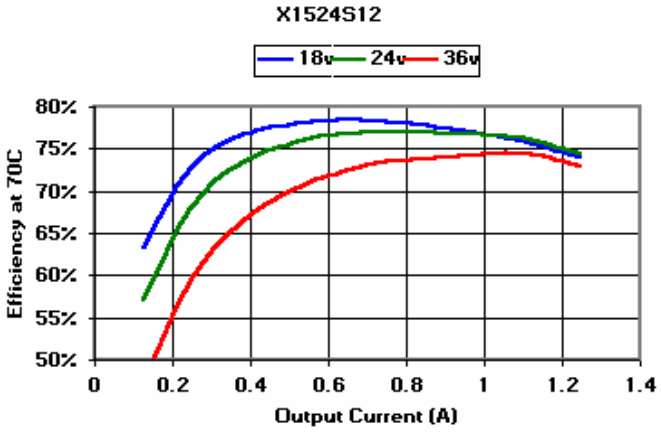


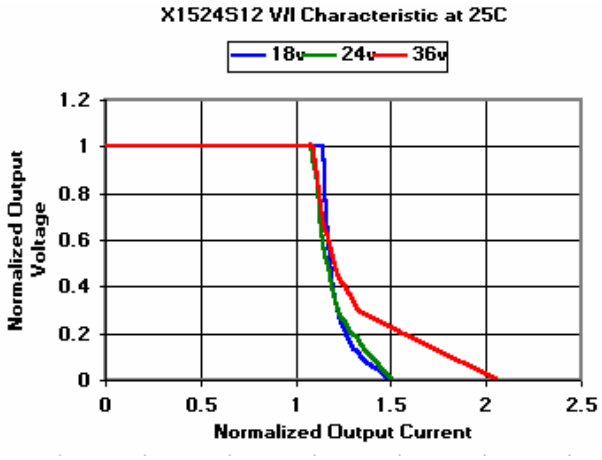
X1524S12 - 24V input, 12V output

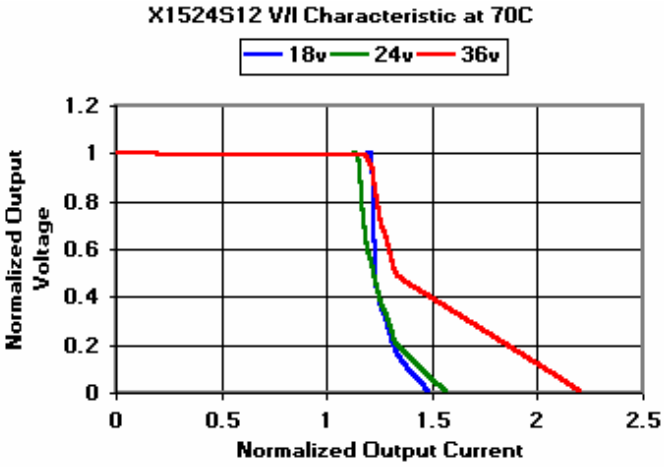




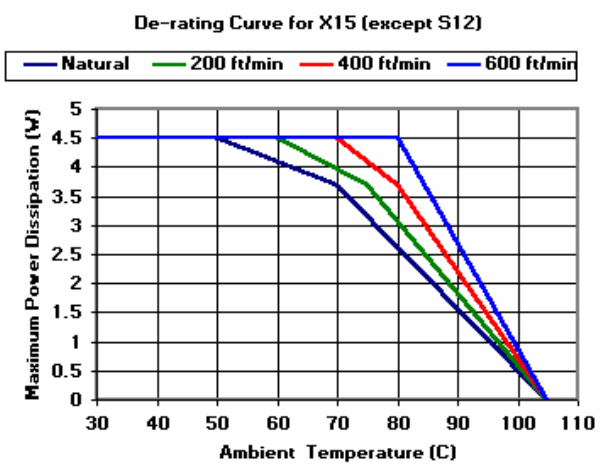


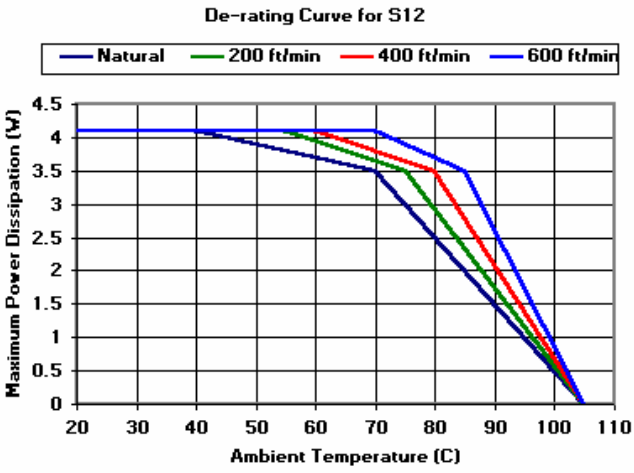


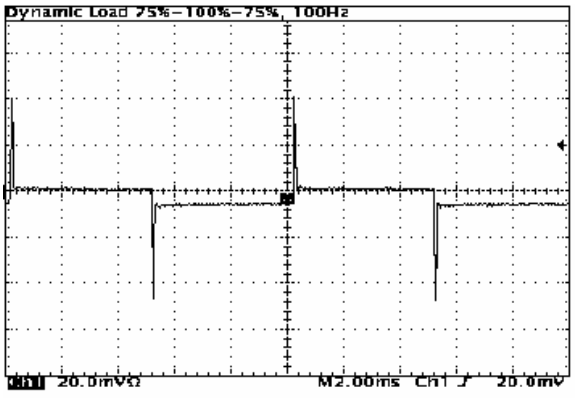


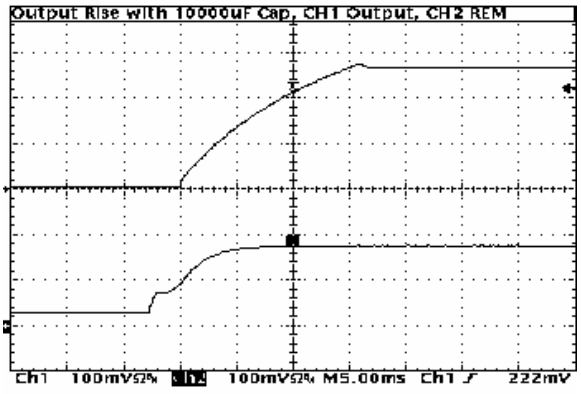


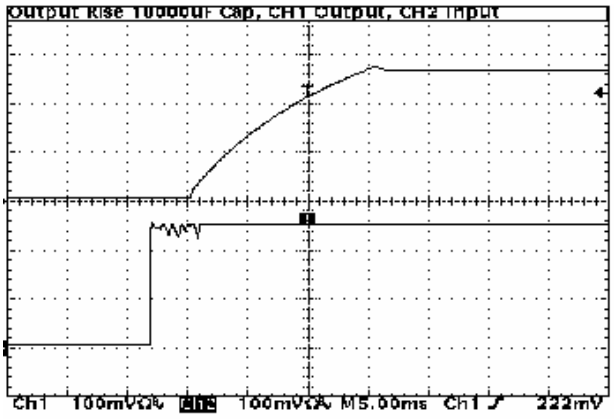
X1548 Characteristic Waveforms and Curves

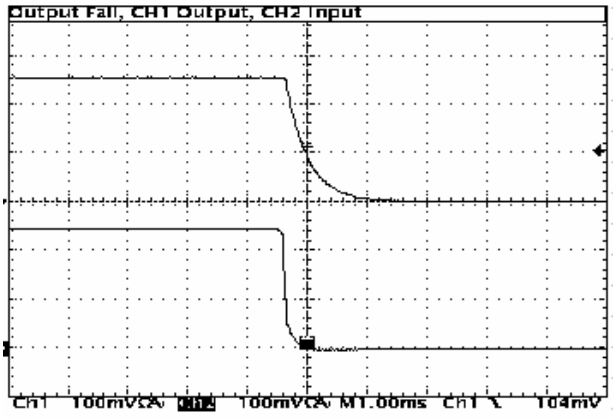




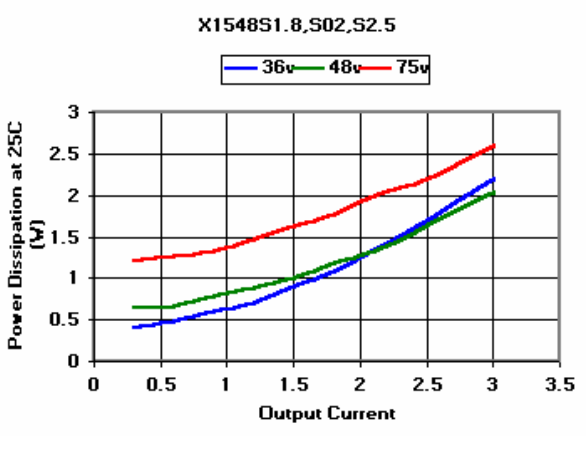


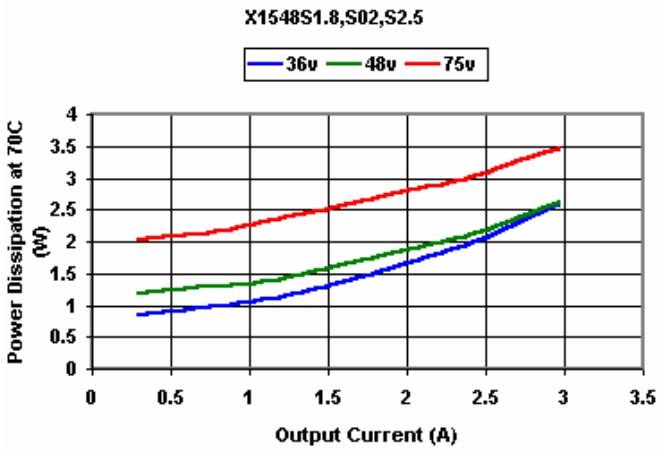


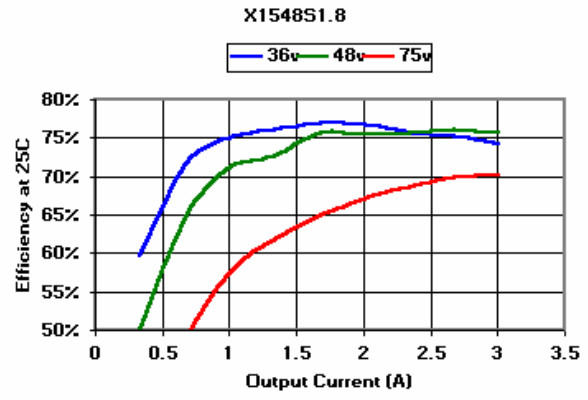


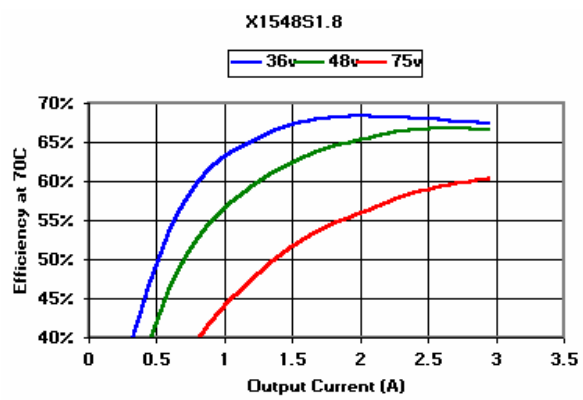


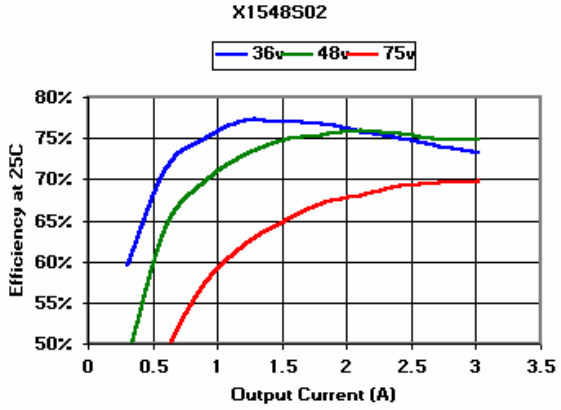
X1548S1.8, S02, S2.5 - 48V input, 1.8V, 2V, 2.5V output

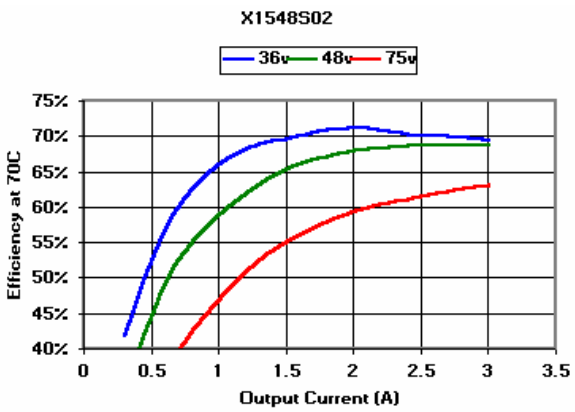




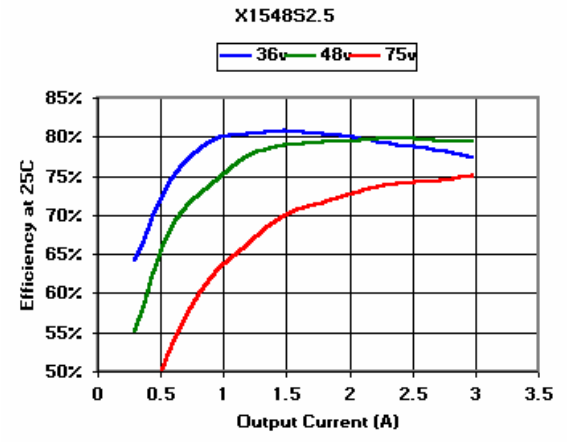


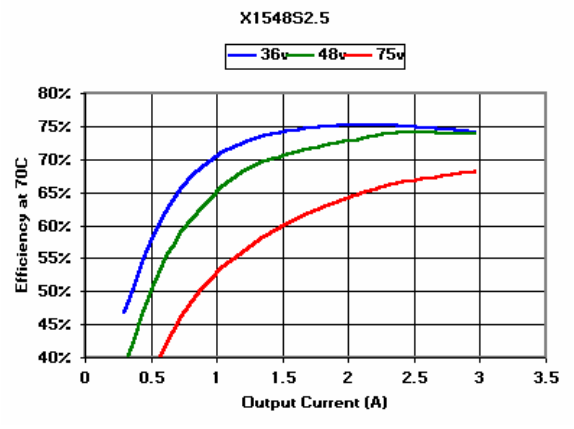


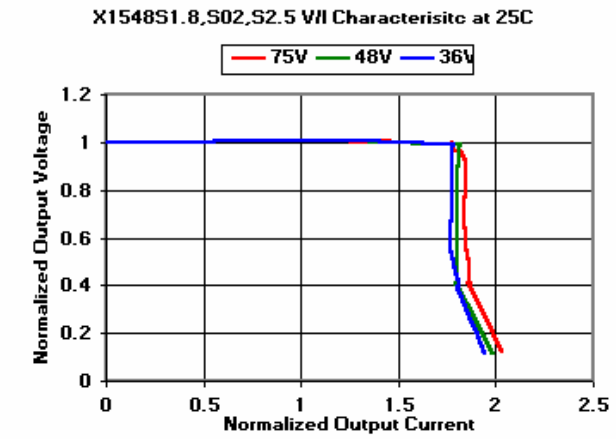


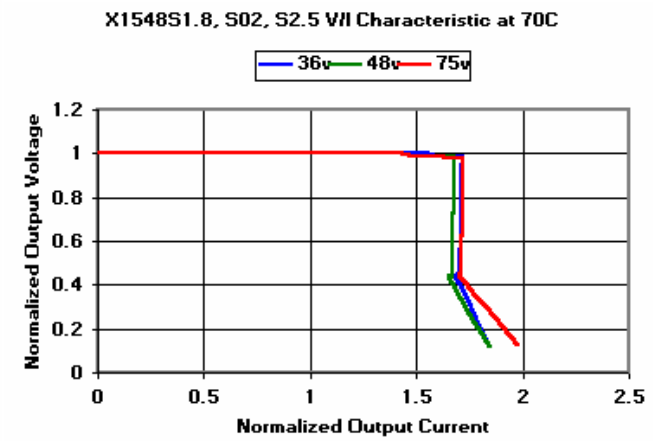


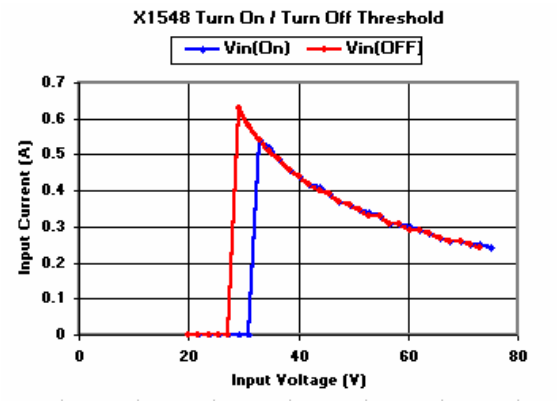
X1548S1.8, S02, S2.5 - 48V input, 1.8V, 2V, 2.5V output



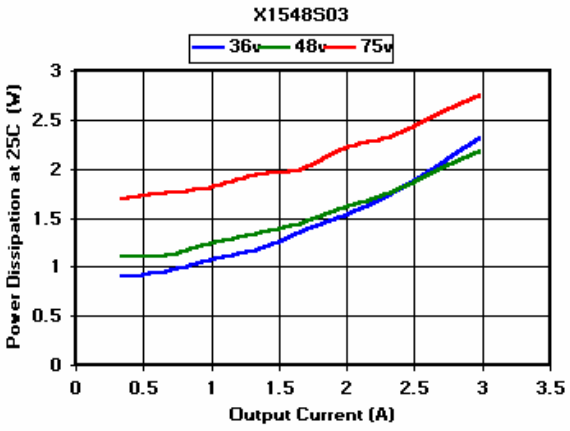


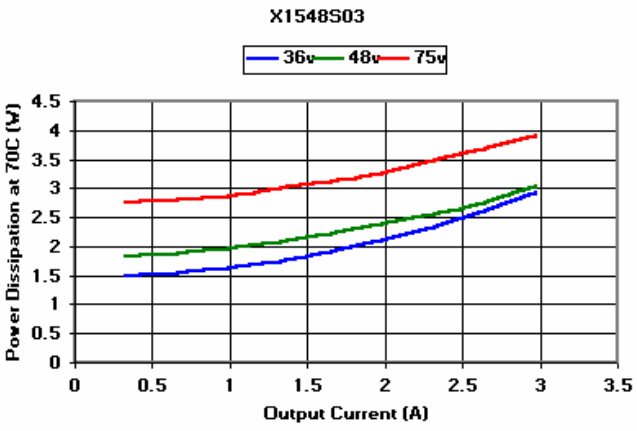


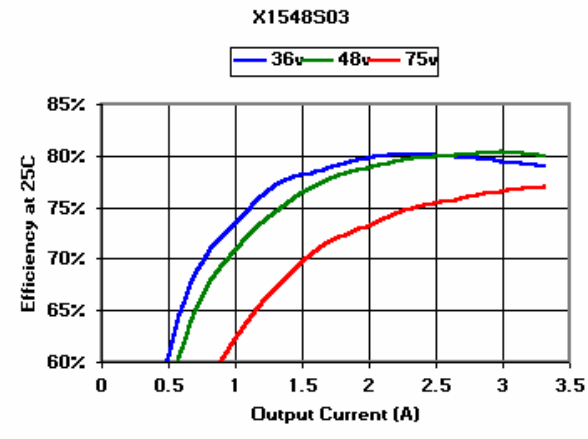


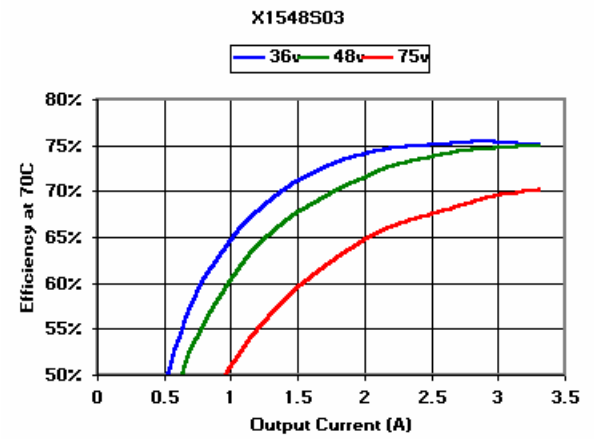


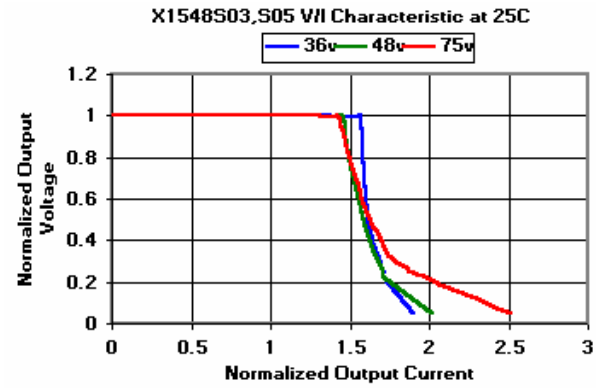
X1548S03 - 48V input, 3.3V output

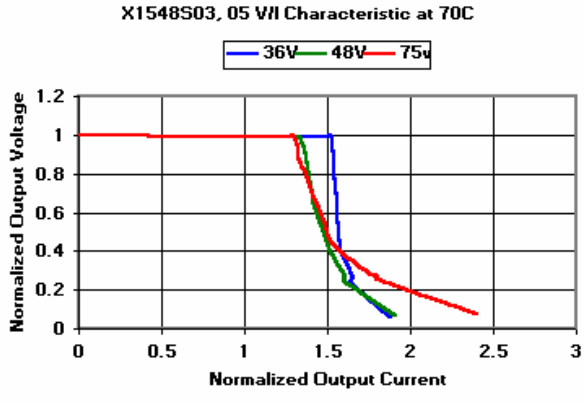




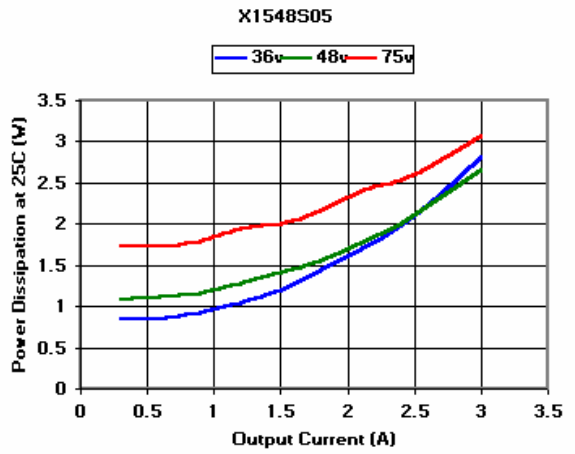


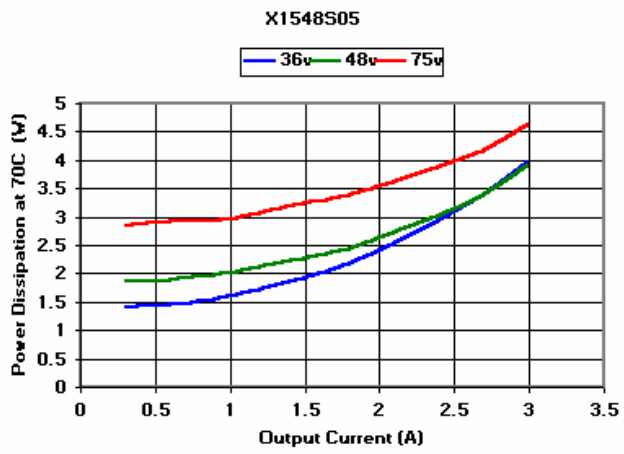


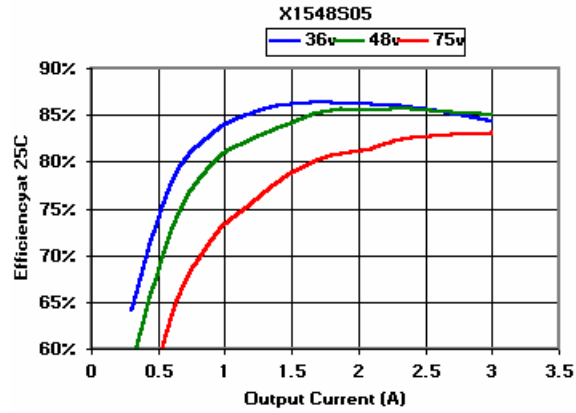


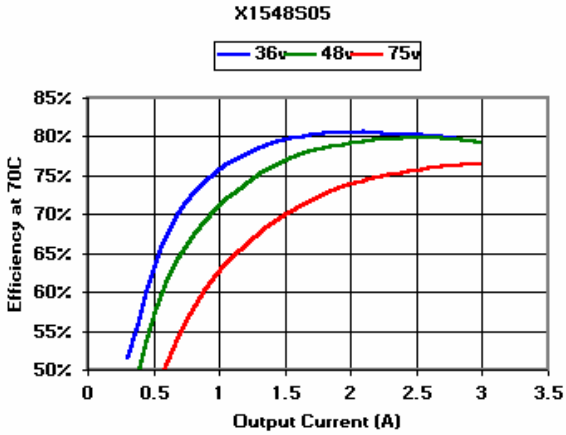


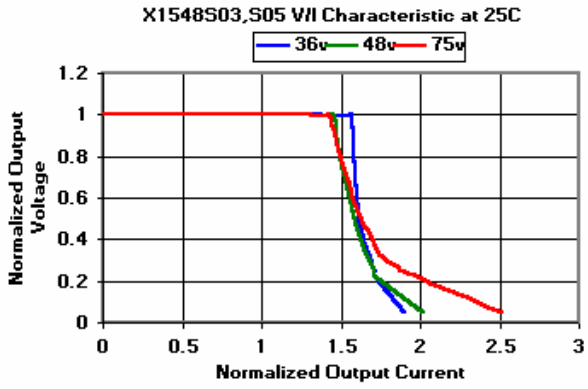
X1548S05 – 48V input, 5V output

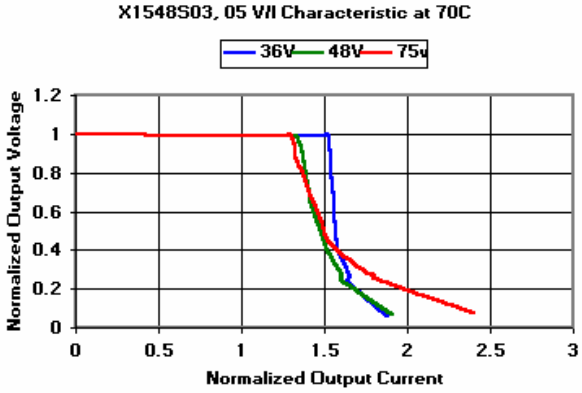




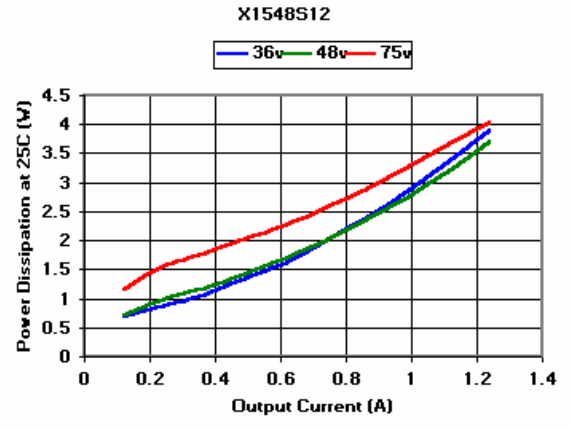


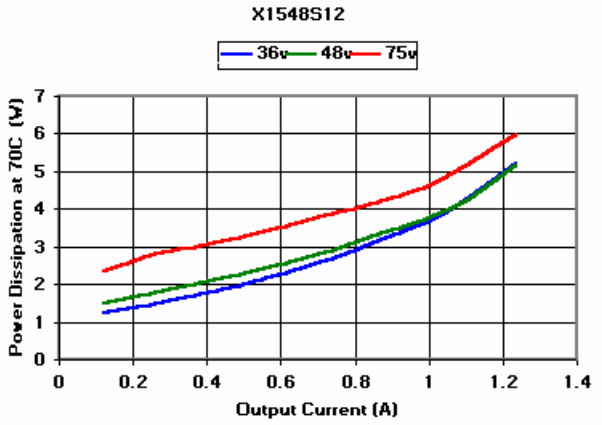


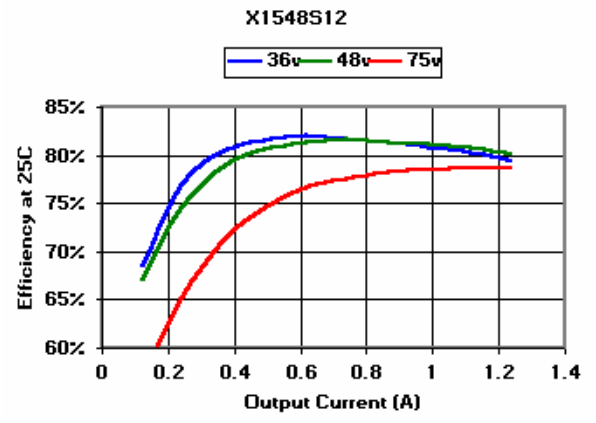


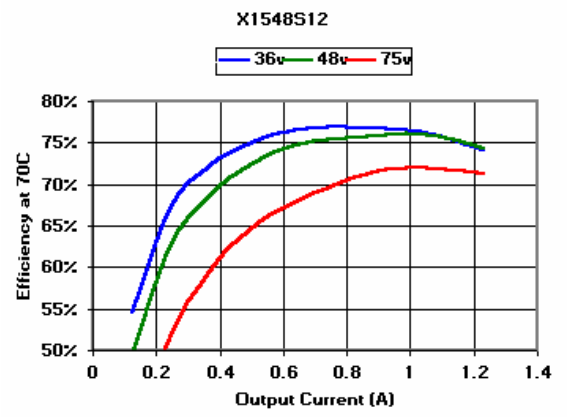


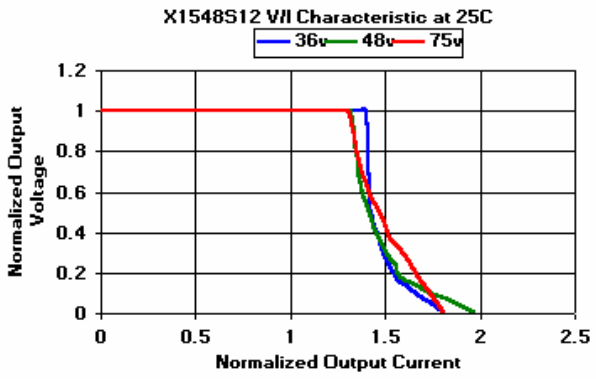
X1548S12 – 48V input, 12V output

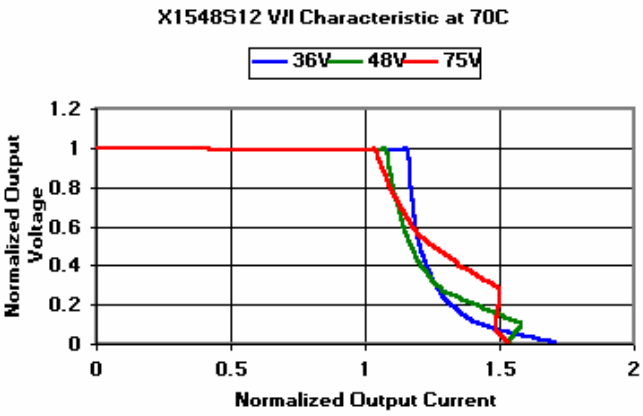




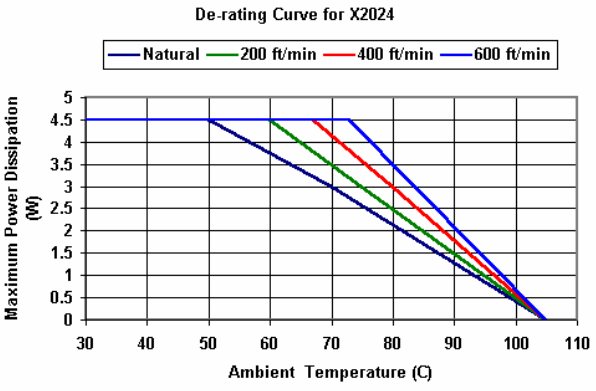


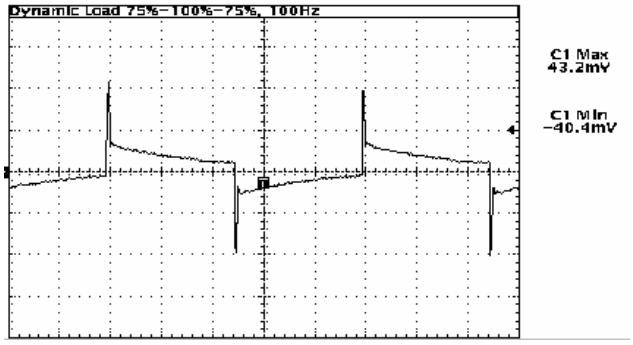


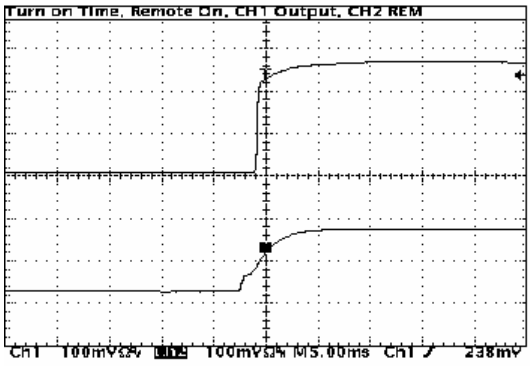


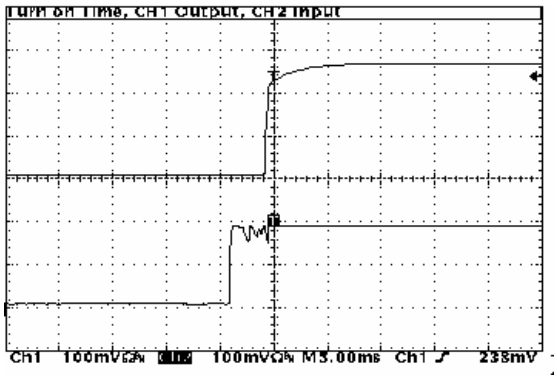


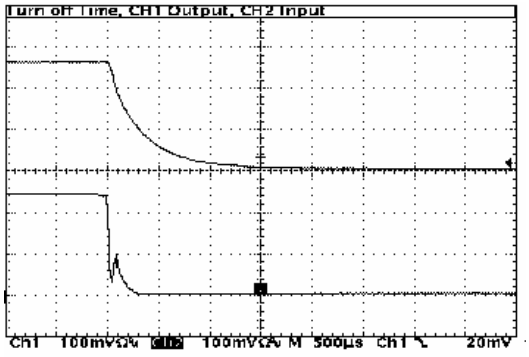
X2024 Characteristic Waveforms and Curves

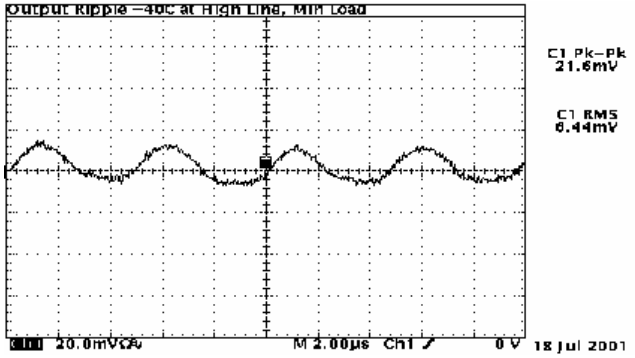




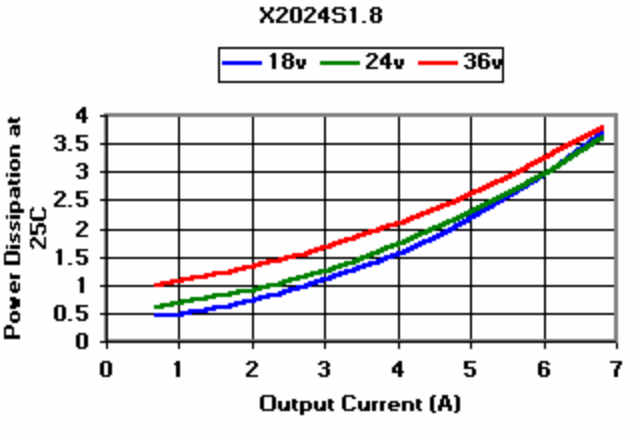


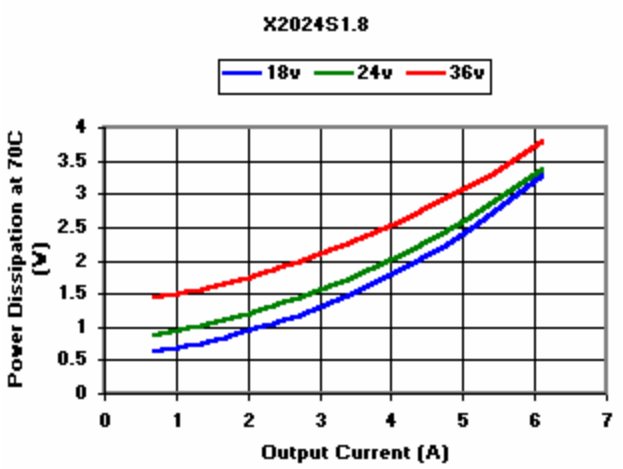


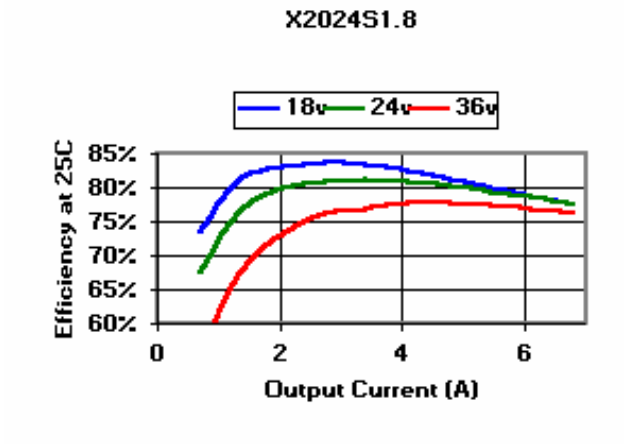


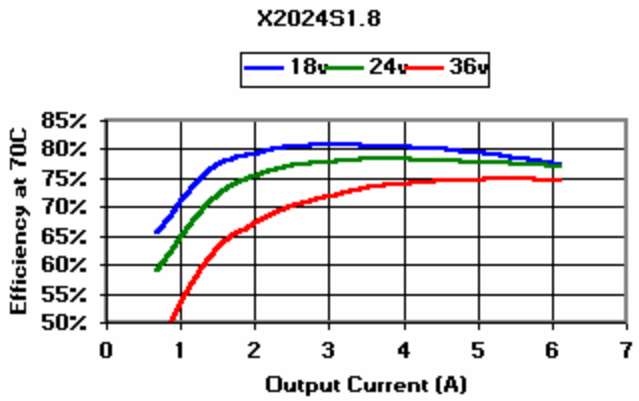


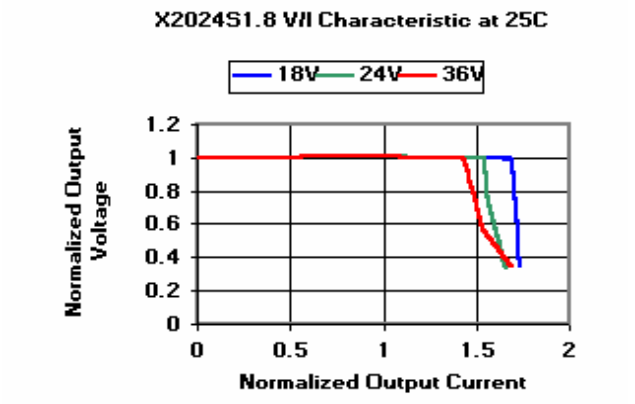
X2024S1.8 - 24V input, 1.8V output

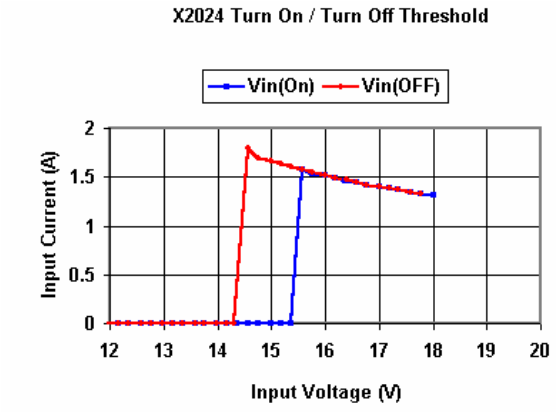




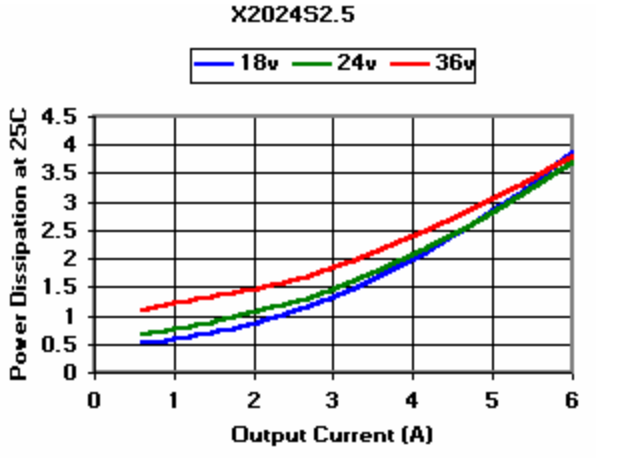


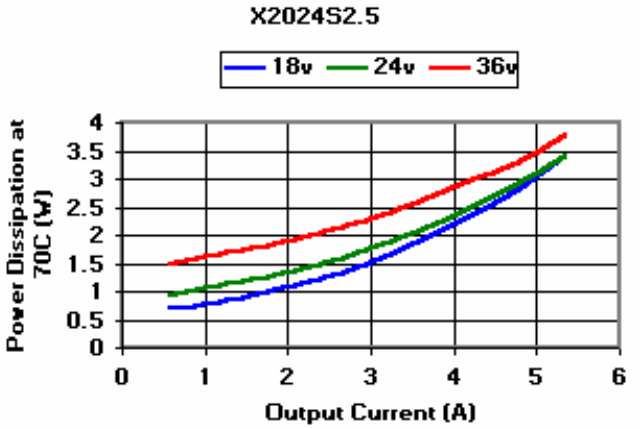


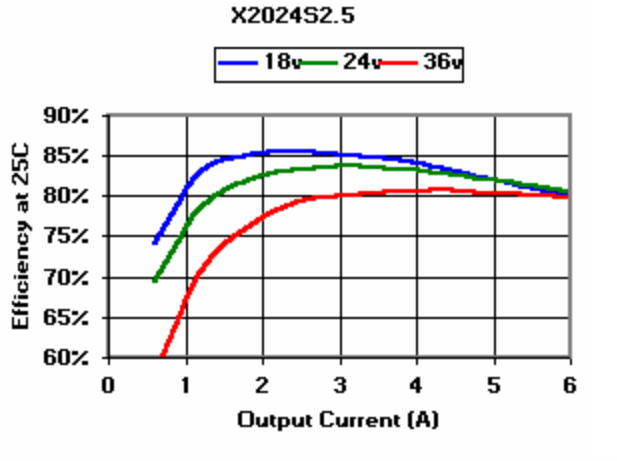


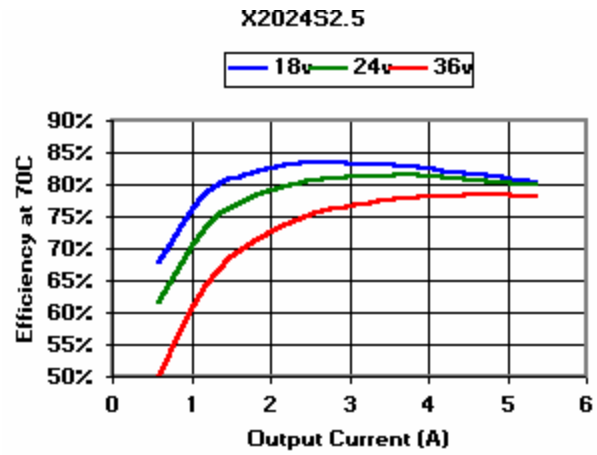


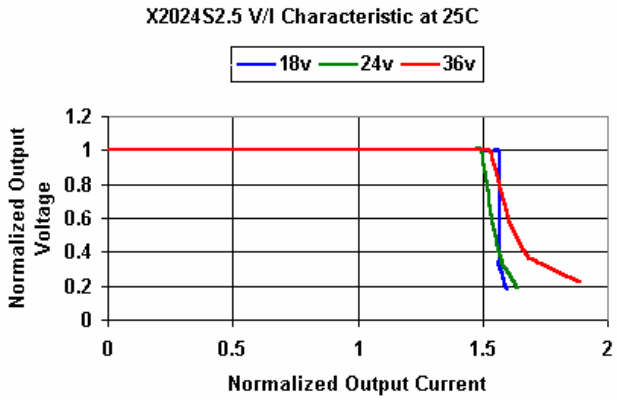
X2024S2.5 – 24V input, 2.5V output



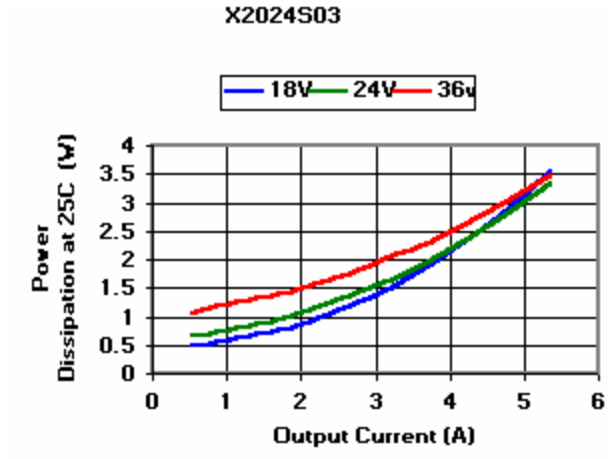


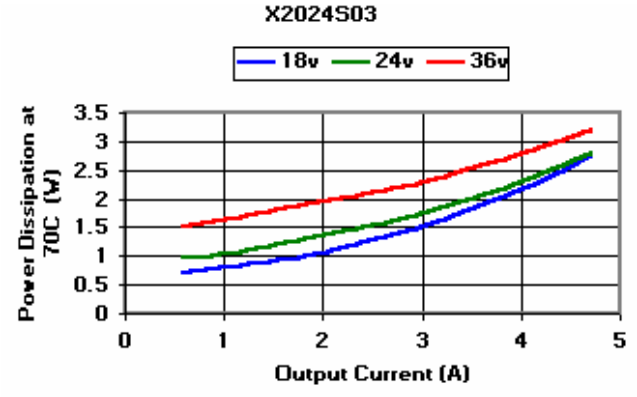


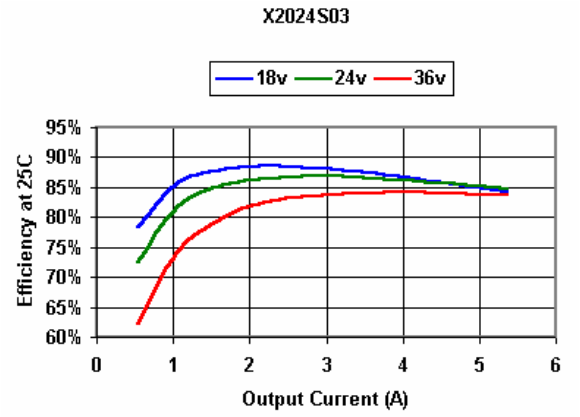


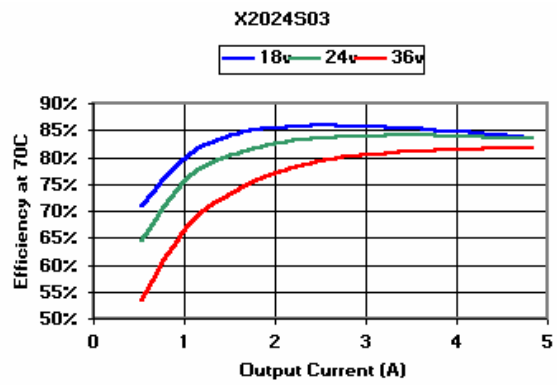


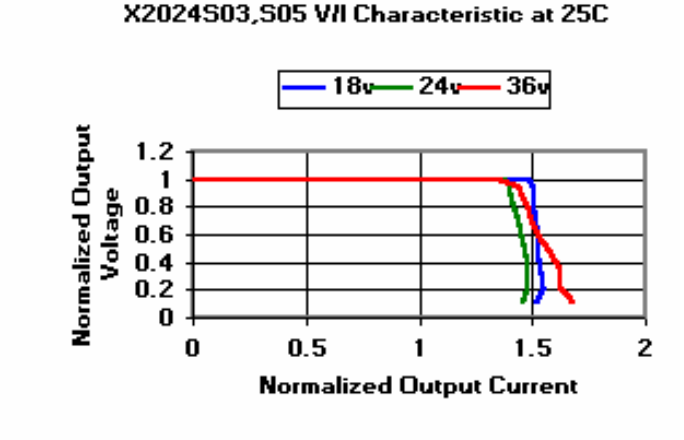
X2024S03 – 24V input, 3.3V output



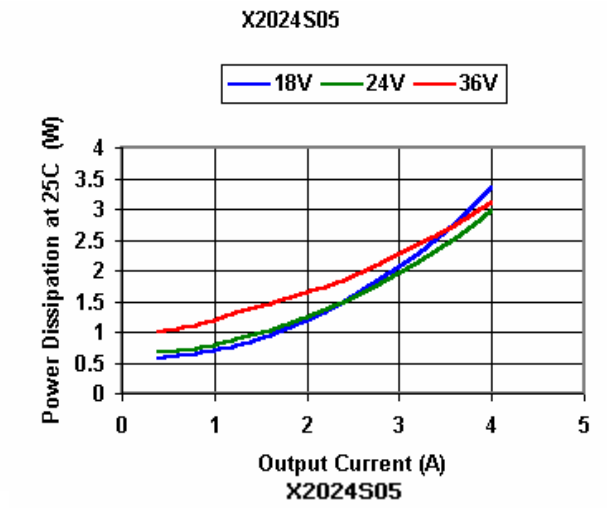


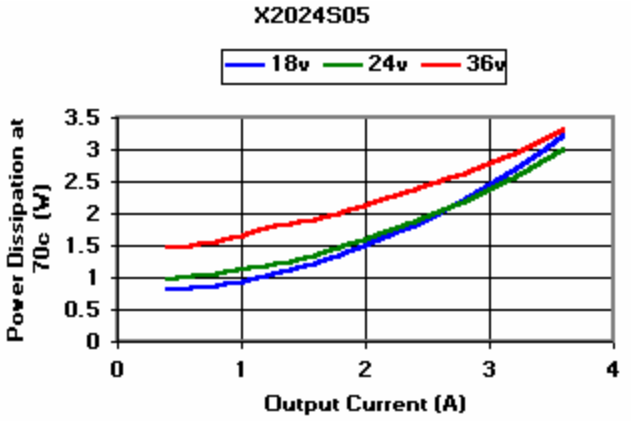


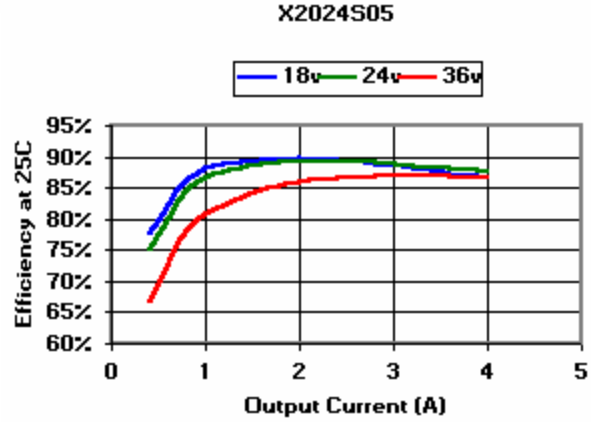


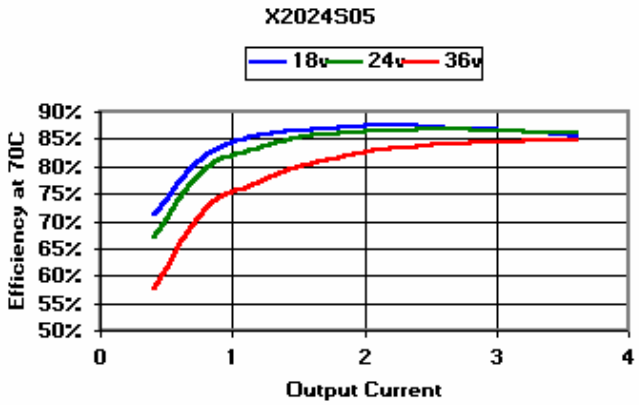


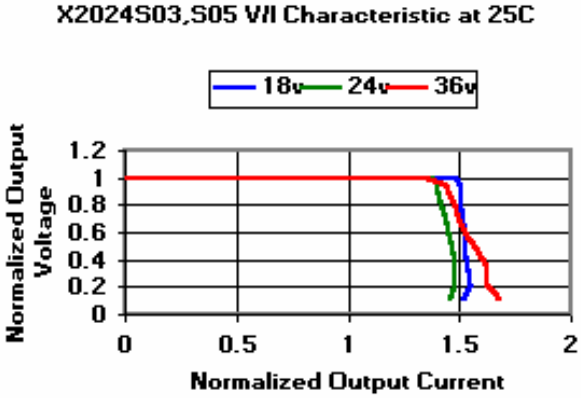
X2024S05 – 24V input, 5V output



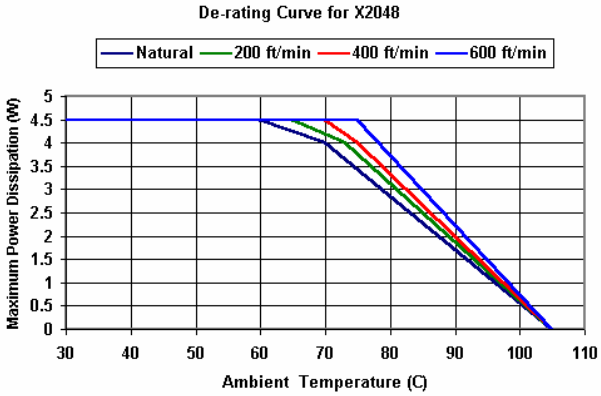


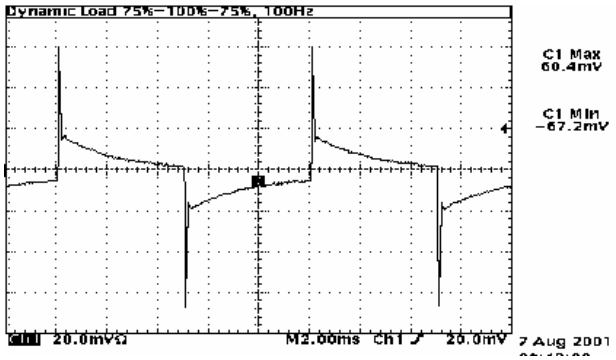


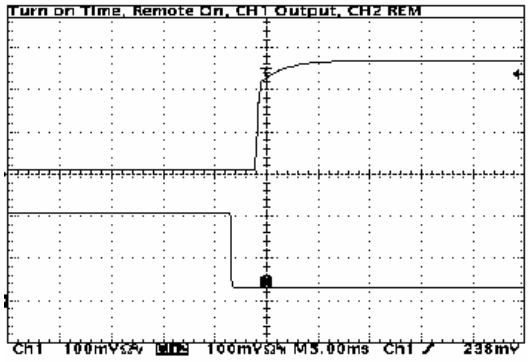


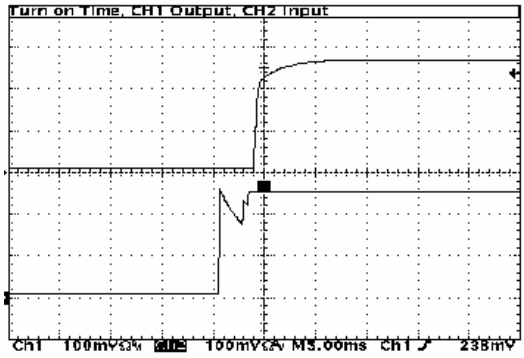


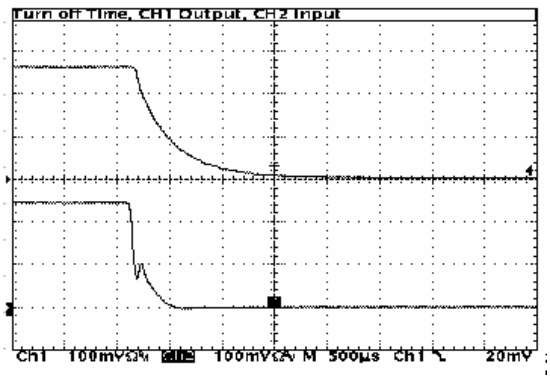
X2048 Characteristic Waveforms and Curves

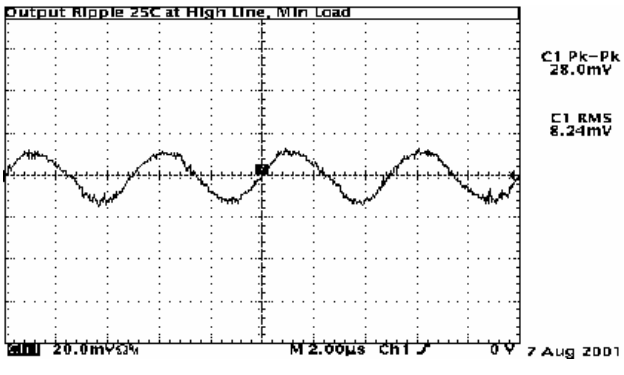




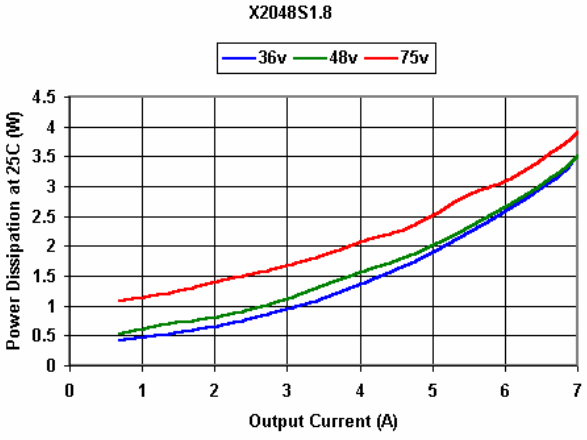


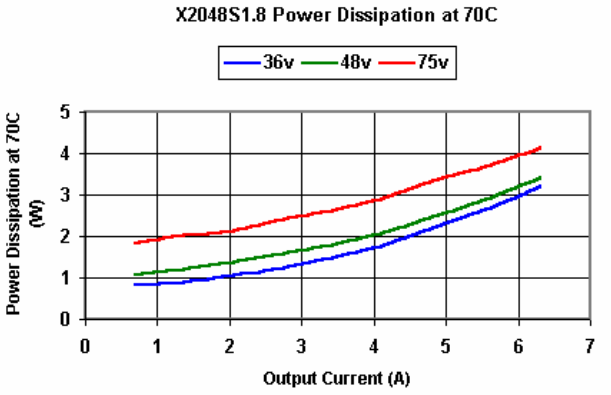


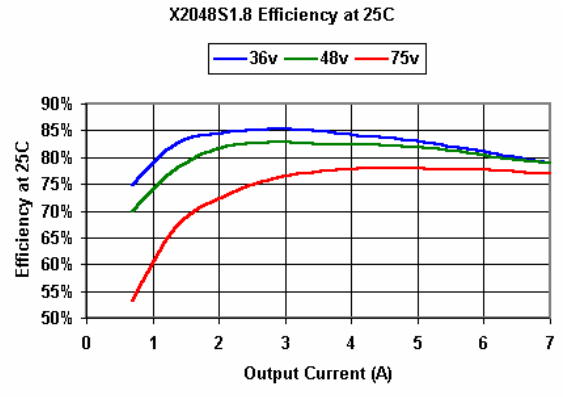


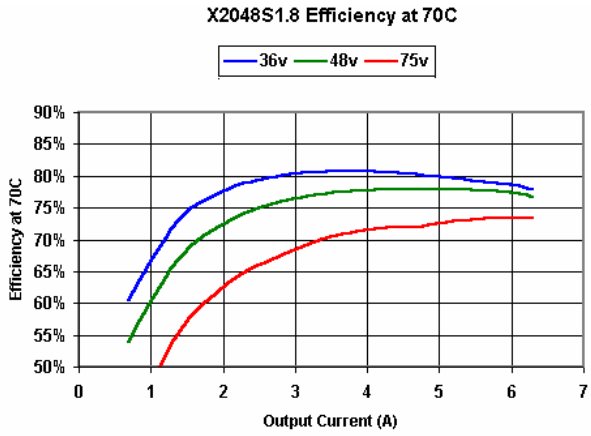


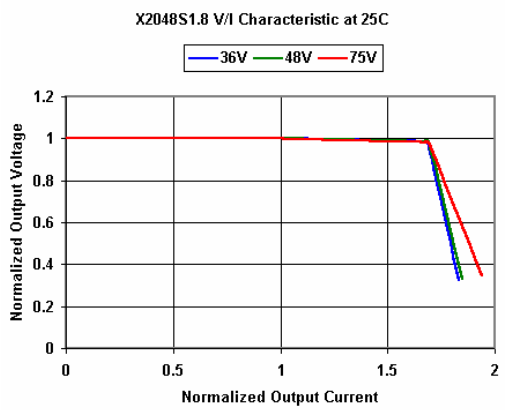
X20481.8 - 48V input, 1.8V output

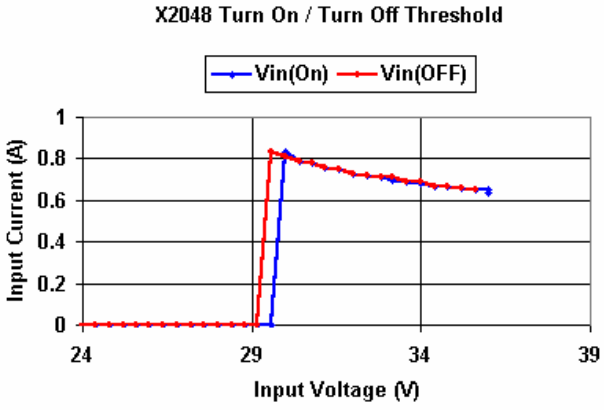




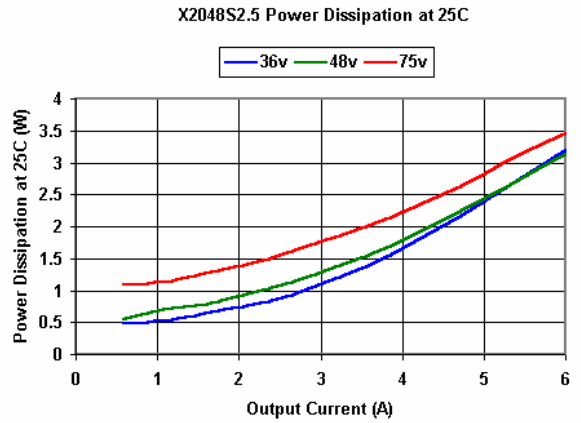


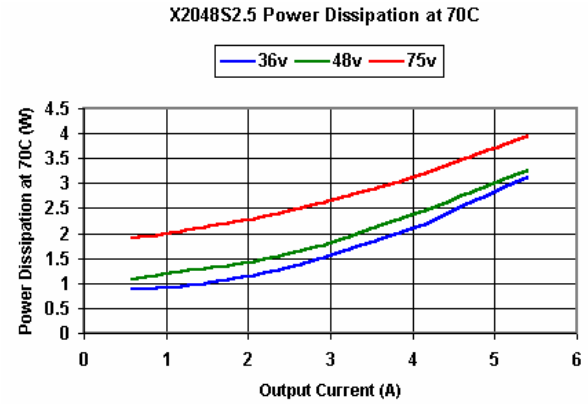


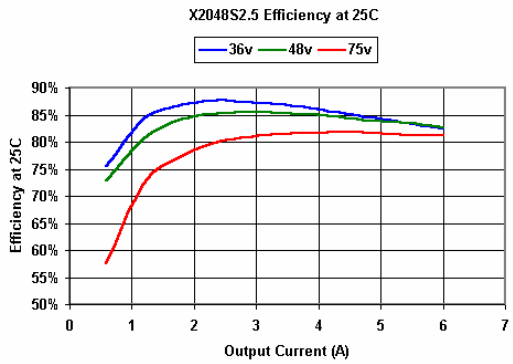


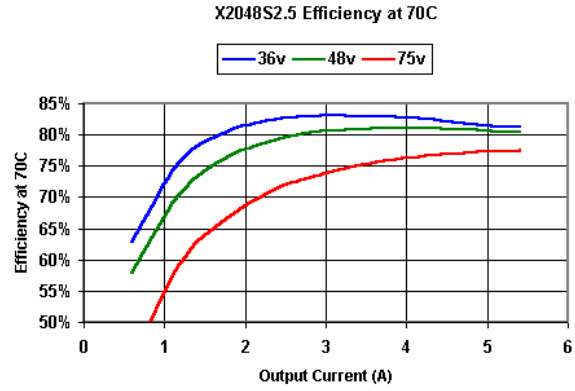


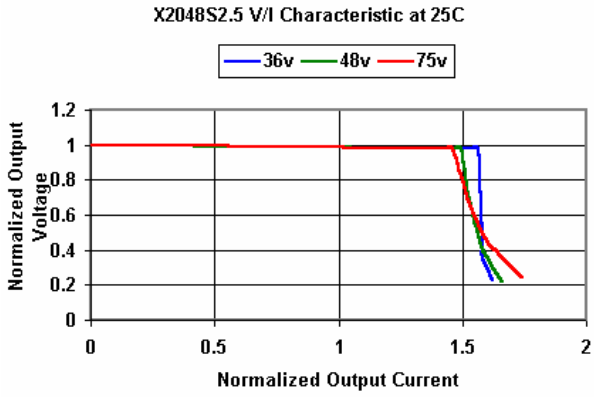
X2048S2.5 - 48V input, 2.5V output



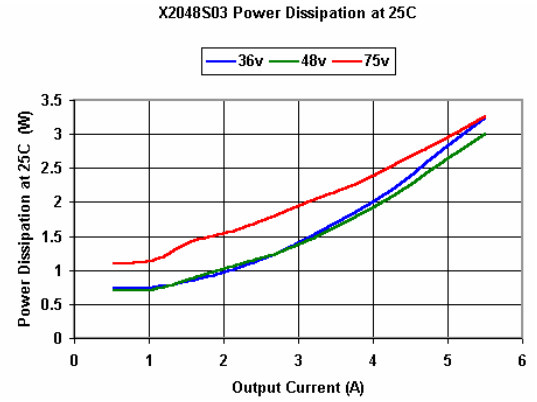


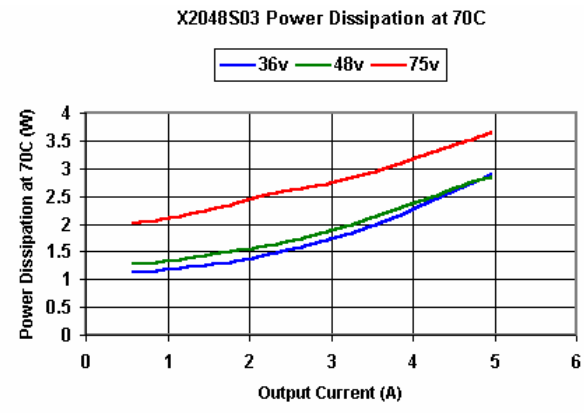


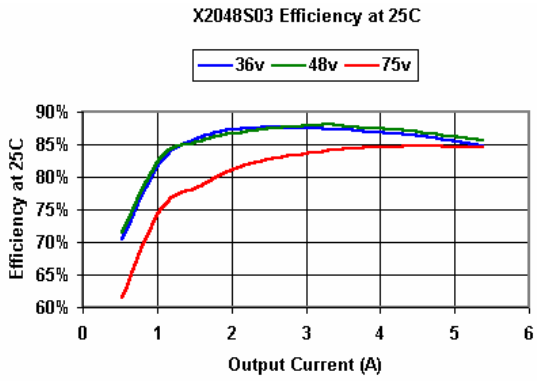


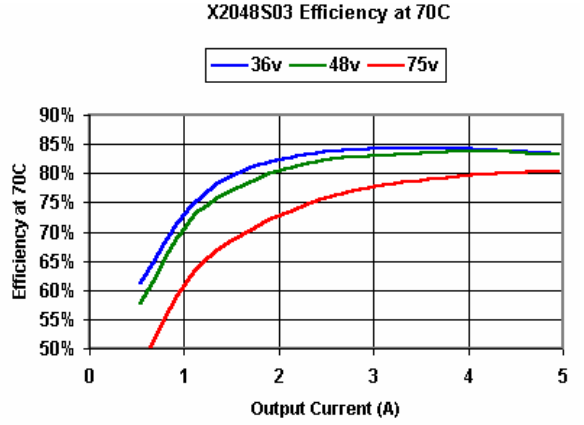


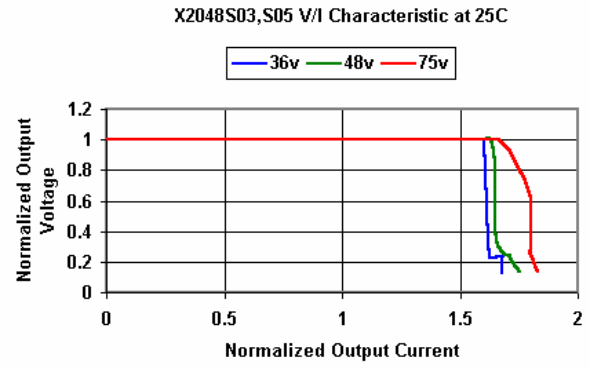
X2048S03—48V input, 3.3V output











X2048S05—48V input, 5V output