



### FEATURES

- Industry standard footprint (1 inch X 1 inch)
- Regulated Outputs, Fixed Switching Frequency
- Up to 88 % Efficiency
- Low No Load Power Consumption
- Designed without tantalum capacitors
- -40°C to +85°C industrial temperature range
- Negative and positive On/Off logic control, Trim options
- Continuous Short Circuit Protection
- ULVO, over-current and output OV protection
- Sense Compensation, Over-temperature protection
- Designed to meet CE Mark 2004/108/EC and UL60950-1 and EN60950-1 safety
- Meets conductive EMI EN55022 class A without external components

### PRODUCT OVERVIEW

This AA series offer 15 watts of output power in standard 1.00 x 1.00 x 0.4 inches packages. This series features high efficiency and 1500 Volts of DC isolation. This AA series provides a 4:1 wide input voltage range of 9 to 36 or 18 to 75VDC, and delivers precise regulated output. These modules operate over the ambient operating temperature range of -40°C to +85°C. All devices offer input Under Voltage Lock Out (UVLO), output over-current, and they are protected against over-voltage, continuous short circuit conditions and over-temperature. There are no tantalum capacitors inside these modules. In addition, the standard control functions of this series include Remote On/Off and adjustable output voltage.

### APPLICATIONS:

- Distributed Power Architectures
- Mobile telecommunication
- Industrial applications
- Battery operated equipment

### AVAILABLE OPTIONS

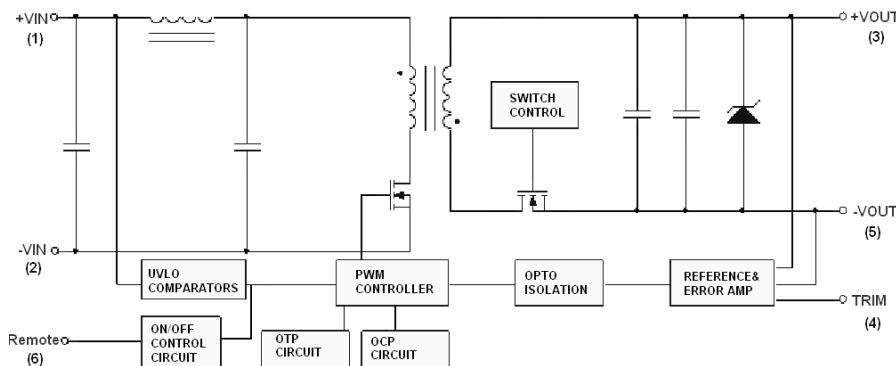
- Customizable output voltages
- CE Mark 2004/108/EC certification
- UL60950-1, EN60950-1, and IEC60950-1 safety

Contact DATEL for other series in 1" x 1" footprint

- 2:1 Input Ranges, Other input voltages, higher power
- Cost Savings, Lower Power, Other Voltage outputs, etc.

MODEL NUMBER	INPUT VOLTAGE	OUTPUT VOLTAGE	OUTPUT CURRENT MAX	EFFICIENCY %	LOAD REGULATION	OPTIONS
AA22S3.3-4	9-36 VDC	3.3VDC	4 A	87	± 0.2 %	N/A
AA22S5-3	9-36 VDC	5.0 VDC	3 A	87	± 0.2 %	N/A
AA22S12-1.25	9-36 VDC	12 VDC	1.25 A	87	± 0.2 %	N/A
AA22S15-1	9-36 VDC	15 VDC	1.0 A	88	± 0.2 %	N/A
AA22D5-1.5	9-36 VDC	±5.0 VDC	±1.5 A	85	± 0.5 %	N/A
AA22D12-0.62	9-36 VDC	±12 VDC	±0.625 A	87	± 0.5 %	N/A
AA22D15-0.5	9-36 VDC	±15 VDC	±0.5 A	88	± 0.5 %	N/A
AA45S3.3-4	18-75VDC	3.3 VDC	4 A	88	± 0.2 %	N/A
AA45S5-3	18-75VDC	5 VDC	3A	88	± 0.2 %	N/A
AA45S12-1.25	18-75VDC	12 VDC	1.25 A	87	± 0.2 %	N/A
AA45S15-1	18-75VDC	15 VDC	1.0 A	87	± 0.2 %	N/A
AA45D5-1.5	18-75VDC	±5.0 VDC	±1.5 A	85	± 0.5 %	N/A
AA45D12-0.62	18-75VDC	±12 VDC	±0.625 A	87	± 0.5 %	N/A
AA45D15-0.5	18-75VDC	±15 VDC	±0.5 A	87	± 0.5 %	N/A

### FUNCTIONAL BLOCK DIAGRAM



### ABSOLUTE MAXIMUM RATINGS

Parameters	Conditions	Model	Min.	Typical	Max.	Units
<b>Input Voltage</b>						
Continuous	DC	24V <sub>in</sub>	-0.3		36	Volts
		48V <sub>in</sub>	-0.3		75	
Transient	100ms, DC	24V <sub>in</sub>			50	Volts
		48V <sub>in</sub>			100	
Operating Ambient Temperature	Derating, Above 55°C	All	-40		+85	°C
Case Temperature		All			105	°C
Storage Temperature		All	-55		+125	°C
Input / Output Isolation Voltage	1 minute	All			1500	Volts

### INPUT CHARACTERISTICS

Note: All specifications are typical at nominal input, full load at 25°C unless otherwise noted

Parameters	Conditions	Model	Min.	Typical	Max.	Units
Operating Input Voltage		24V <sub>in</sub>	9	24	36	Volts
		48V <sub>in</sub>	18	48	75	
<b>Input Under Voltage Lockout</b>						
Turn-On Voltage Threshold		24V <sub>in</sub>	8	8.5	8.8	Volts
		48V <sub>in</sub>	16.5	17	17.5	
Turn-Off Voltage Threshold		24V <sub>in</sub>	7.7	8	8.3	Volts
		48V <sub>in</sub>	15.5	16	16.5	
Lockout Hysteresis Voltage		24V <sub>in</sub>		0.5		Volts
		48V <sub>in</sub>		1		
Maximum Input Current	Full Load, V <sub>in</sub> =9V	24V <sub>in</sub>			2100	mA
	Full Load, V <sub>in</sub> =18V	48V <sub>in</sub>			1000	
No-Load Input Current	V <sub>in</sub> =Nominal input	AA22S3.3-4		60		mA
		AA22S5-3		70		
		AA22S12-1.25		30		
		AA22S15-1		30		
		AA22D5-1.5		30		
		AA22D12-0.62		30		
		AA22D15-0.5		30		
		AA45S3.3-4		40		
		AA45S5-3		40		
		AA45S12-1.25		20		
		AA45S15-1		20		
		AA45D5-1.5		20		
		AA45D12-0.62		20		
AA45D15-0.5		20				
Off Converter Input Current	Shutdown input idle current	All		4	10	mA
Inrush Current (I <sup>2</sup> t)	As per ETS300 132-2	All			0.1	A <sup>2</sup> s
Input Reflected-Ripple Current	P-P thru 12uH inductor, 5Hz to 20MHz	All			30	mA

### OUTPUT CHARACTERISTIC

Parameters	Conditions	Model	Min.	Typical	Max.	Units
Output Voltage Set Point	$V_{in} = \text{Nominal } V_{in}, I_o = I_{o\_max}, T_c = 25^\circ\text{C}$	$V_o = 3.3$	3.2505	3.3	3.3495	Volts
		$V_o = 5.0$	4.925	5	5.075	
		$V_o = 12$	11.82	12	12.18	
		$V_o = 15$	14.775	15	15.225	
		$V_o = \pm 5$	4.925	5	5.075	
		$V_o = \pm 12$	11.82	12	12.18	
Output Voltage Balance	$V_{in} = \text{nominal}, I_o = I_{o\_max}, T_c = 25^\circ\text{C}$	Dual			$\pm 2.0$	%
Output Voltage Regulation						
Line Regulation	$V_{in} = \text{High line to Low line Full Load}$	Single Dual			$\pm 0.2$ $\pm 0.5$	% %
Load Regulation	$I_o = \text{Full Load to min. Load}$	Single Dual			$\pm 0.2$ $\pm 1.0$	% %
Cross Regulation	Load cross variation 10%/100%	Dual			$\pm 5$	%
Temperature Coefficient	$T_c = -40^\circ\text{C to } +85^\circ\text{C}$				$\pm 0.03$	%/ $^\circ\text{C}$
Output Voltage Ripple and Noise 5Hz to 20MHz bandwidth						
Peak-to-Peak	Full Load, 20MHz Bandwidth 10uF tantalum and 1uF ceramic capacitor	$V_o = 3.3\text{V}$ $V_o = 5\text{V}$ $V_o = \pm 5\text{V}$			75	mV
		$V_o = 15\text{V}$ $V_o = 12\text{V}$ $V_o = \pm 15\text{V}$ $V_o = \pm 12\text{V}$			100	
Operating Output Current Range		$V_o = 3.3\text{V}$	0		4000	mA
		$V_o = 5\text{V}$	0		3000	
		$V_o = 12\text{V}$	0		1250	
		$V_o = 15\text{V}$	0		1000	
		$V_o = \pm 5\text{V}$	0		$\pm 1500$	
		$V_o = \pm 12\text{V}$ $V_o = \pm 15\text{V}$	0 0		$\pm 625$ $\pm 500$	
Output DC Current-Limit Inception	Output Voltage = 90% $V_{o\_nominal}$		110	140	160	%
Maximum Output Capacitance	Full load, Resistance	$V_o = 3.3\text{V}$			4000	$\mu\text{F}$
		$V_o = 5\text{V}$			3000	
		$V_o = 12\text{V}$			1250	
		$V_o = 15\text{V}$			1000	
		$V_o = \pm 5\text{V}$			1500	
		$V_o = \pm 12\text{V}$ $V_o = \pm 15\text{V}$			625 470	

### DYNAMIC CHARACTERISTICS

Parameters	Conditions	Model	Min.	Typical	Max.	Units
Output Voltage Current Transient						
Step Change in Output Current	75% to 100% of $I_{o\_max}$	All			$\pm 5$	%
Setting Time (within 1% $V_{o\_nominal}$ )	$di/dt = 0.1\text{A/us}$	All			250	$\mu\text{s}$
Turn-On Delay and Rise Time						
Turn-On Delay Time, From On/Off Control	$V_{on/off}$ to 10% $V_{o\_set}$	All		10		ms
Turn-On Delay Time, From Input	$V_{in\_min}$ to 10% $V_{o\_set}$	All		10		ms
Output Voltage Rise Time	10% $V_{o\_set}$ to 90% $V_{o\_set}$	All		10		ms

**FEATURE CHARACTERISTICS**

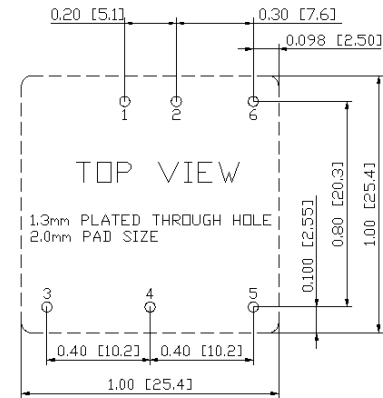
Parameters	Conditions	Model	Min.	Typical	Max.	Units
Efficiency Full Load	$V_{in} = 24 \text{ Vdc}$ , $I_o = I_{o\_max}$ , $T_c = 25^\circ\text{C}$	AA22S3.3-4		87		%
		AA22S5-3		87		
		AA22S12-1.25		87		
		AA22S15-1		88		
		AA22D5-1.5		85		
		AA22D12-1.25		87		
Efficiency Full Load	$V_{in} = 48 \text{ Vdc}$ , $I_o = I_{o\_max}$ , $T_c = 25^\circ\text{C}$	AA22D15-1		88		%
		AA45S3.3-4		88		
		AA45S5-3		88		
		AA45S12-1.25		87		
		AA45S15-1		87		
		AA45D5-1.5		85		
AA45D12-1.25		87				
AA45D15-1		87				
<b>ISOLATION CHARACTERISTICS</b>						
Input to Output	1 minutes	All	1500			Volts
Isolation Resistance		All	1000			MΩ
Isolation Capacitance		All		1000		pF
Switching Frequency		$V_o = 3.3\text{V}$ , $V_o = 5\text{V}$		400		KHz
		Others		400		
<b>On/Off Control, Positive Remote On/Off logic</b>						
Logic High (Module On)	$V_{on/off}$ at $I_{on/off} = 0.1\text{uA}$	All	3.5 or Open Circuit		75	Volts
Logic Low (Module Off)	$V_{on/off}$ at $I_{on/off} = 1.0\text{mA}$	All			1.2	Volts
Off Current Input	Shutdown	All		4	10	mA
Output Voltage Trim Range	Full Load	All	-10		10	%
On/Off Current (for both remote on/off logic)	$I_{on/off}$ at $V_{on/off} = 0\text{V}$	All		0.3	1	mA
Leakage Current (for both remote on/off logic)	Logic High, $V_{on/off} = 15\text{V}$				30	uA
Output Over Voltage Protection	Zener or TVS Clamp	$V_o = 3.3\text{V}$		3.9		Volts
		$V_o = 5.0\text{V}$		6.2		
		$V_o = 12\text{V}$		15		
		$V_o = 15\text{V}$		18		
		$V_o = \pm 5\text{V}$		$\pm 6.2$		
		$V_o = \pm 12\text{V}$		$\pm 15$		
$V_o = \pm 15\text{V}$		$\pm 18$				
MTBF	$I_o = 100\%$ of $I_{o\_max}$ , $T_a = 25^\circ\text{C}$ per MIL-HDBK-217F	All		TBD		M hours
Weight		All		8.8		grams

## Operating Temperature Range

This AA series of converters operate over a wide ambient temperature ranging from -40°C to +85°C and its derating starts above +68°C. The module operate normally up to +105°C.

## Remote On/Off

This AA series offers a Remote On/Off feature in order for the user to switch the module on and off electronically. All standard models are available as “positive logic” versions. The converter turns on if the Remote On/Off pin is high (above 3.5VDC to 75VDC or open circuit). When the Remote On/Off pin is low (below 1.2VDC) the converter will turn off. The signal level of the Remote On/Off input is defined with respect to ground. If not using the Remote On/Off pin, leave the pin open and the converter will be on.



## UVLO (Under Voltage Lock Out)

The input Under Voltage Lock Out feature is standard for the AA series. The converter will shut down when the input voltage drops below the threshold and it operates in normal condition when the input voltage goes above the upper threshold.

## Over Current and Short Circuit Protection

All AA models have internal Over Current and Continuous Short Circuit protection. The unit operates normally once the fault condition is removed. At the point of current limit inception, the converter will go into hiccup mode protection.

## Over Voltage Protection

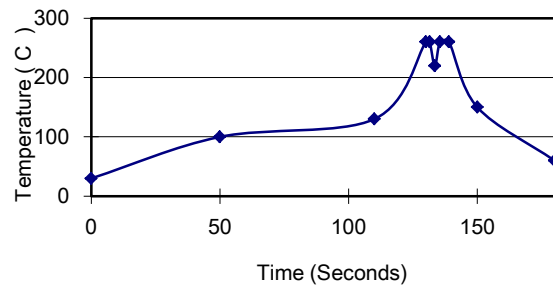
The Over Voltage protection feature consists of a Zener diode to limiting the out voltage.

## Recommended Layout PCB Footprints and Soldering Information

The end user of the converter must ensure that the other components and metal in the vicinity of the converter meet the spacing requirements to which the system is approved. Low resistance and low inductance PCB layout traces should be used where possible. Careful consideration must also be given to proper low impedance tracks between power module, input and output grounds. The recommended footprints and soldering profiles are shown in the next two figures

## Recommended PCB Layout Footprints, Dimensions are in inches (millimeters)

### Lead Free Wave Soldering Profile



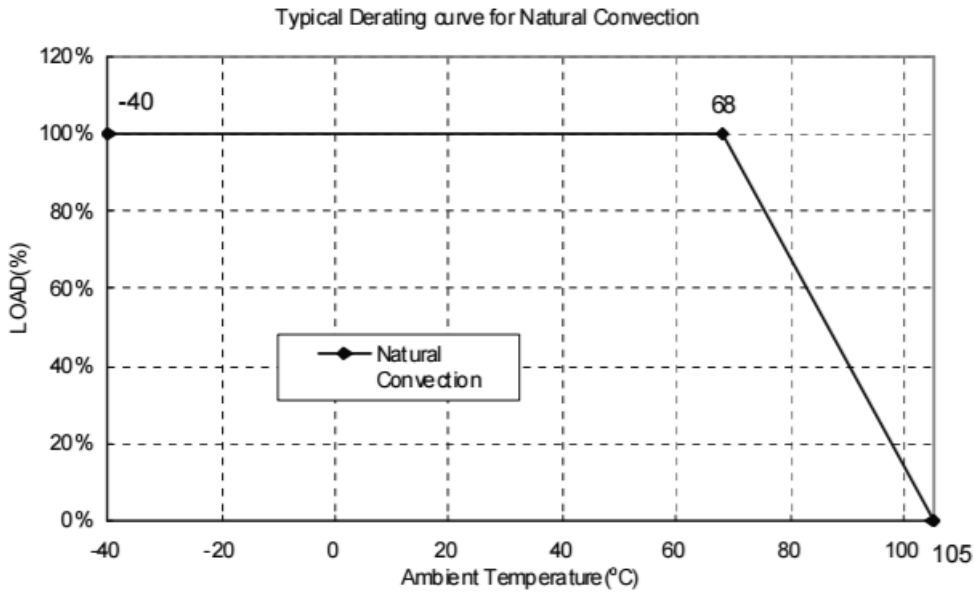
### Wave Soldering Profiles

Note :

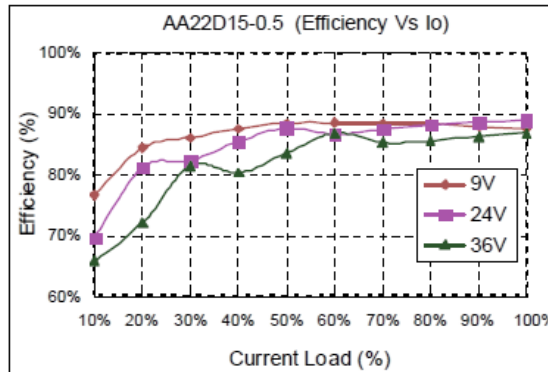
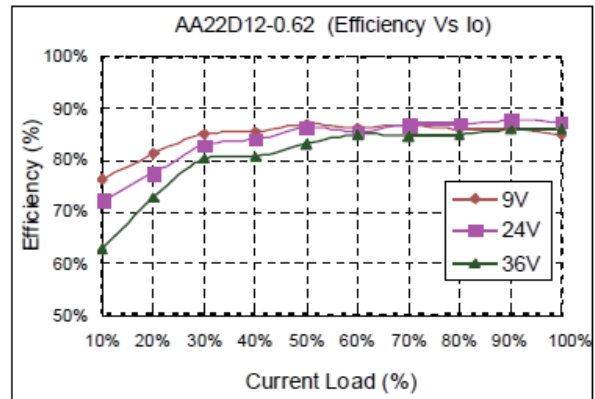
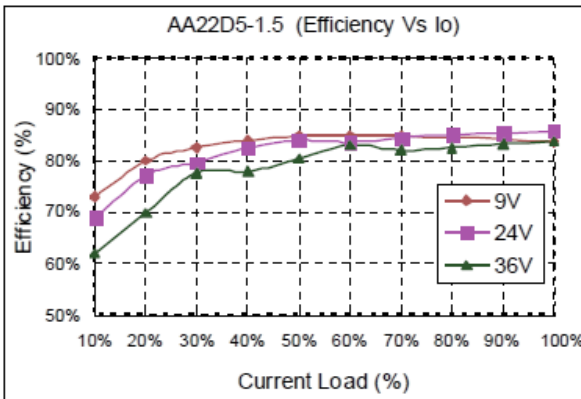
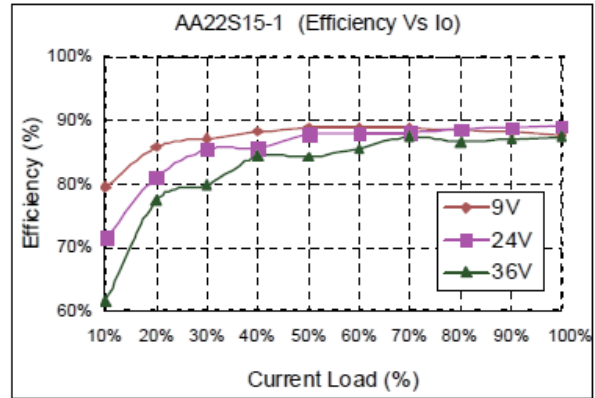
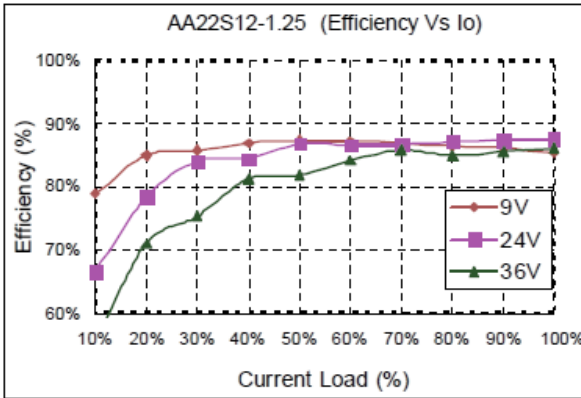
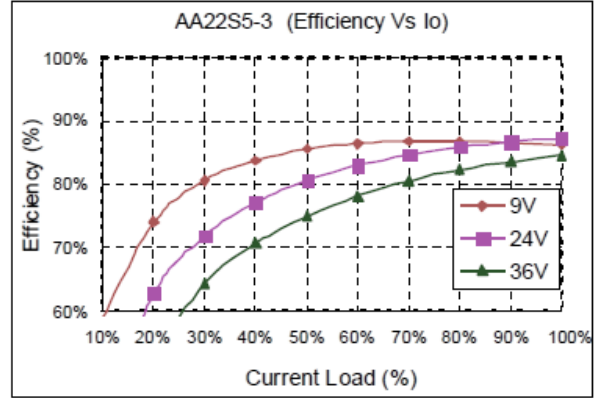
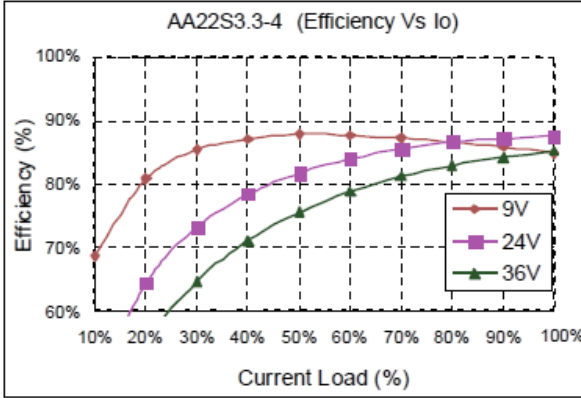
1. Soldering Materials: Sn/Cu/Ni
2. Ramp up rate during preheat: 1.4 °C/Sec (From 50°C to 100°C)
3. Soaking temperature: 0.5 °C/Sec (From 100°C to 130°C), 60±20 seconds
4. Peak temperature: 260°C, above 250°C 3~6 Seconds
5. Ramp up rate during cooling: -10.0 °C/Sec (From 260°C to 150°C)

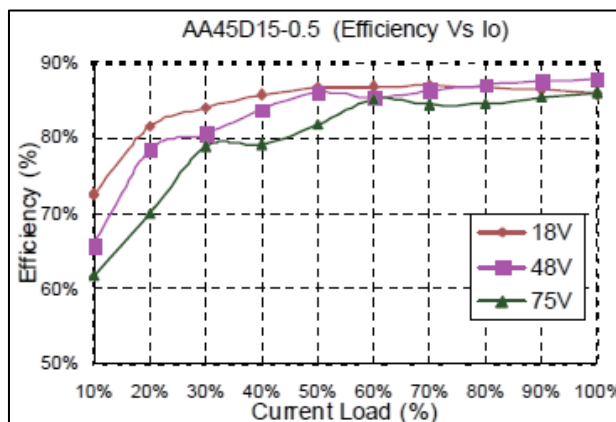
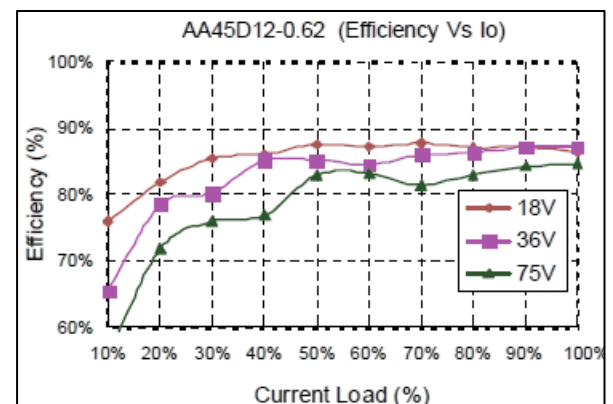
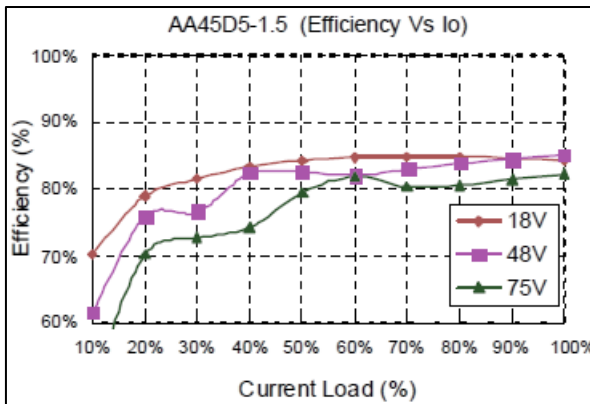
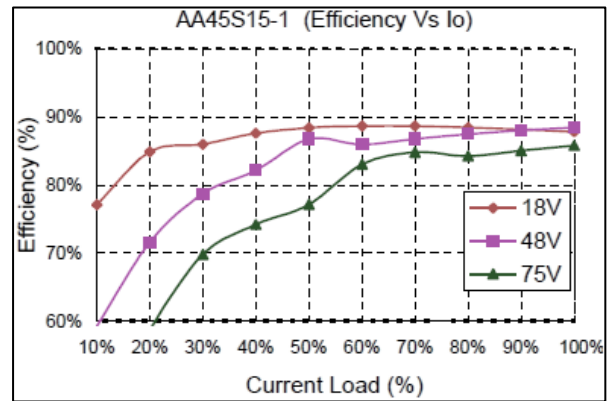
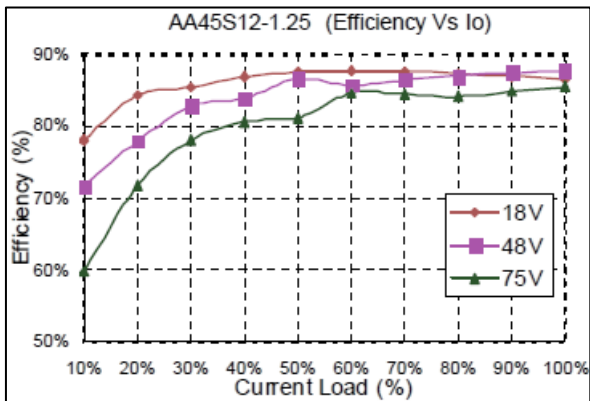
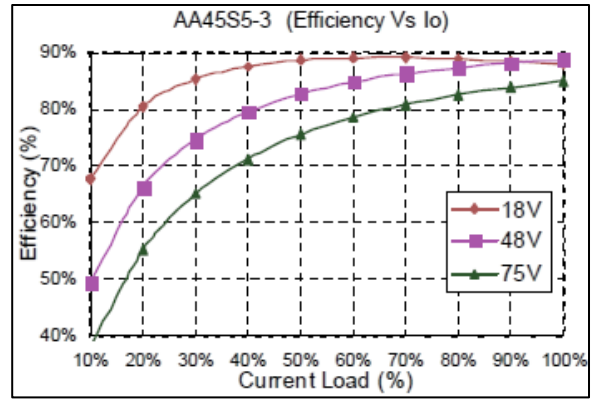
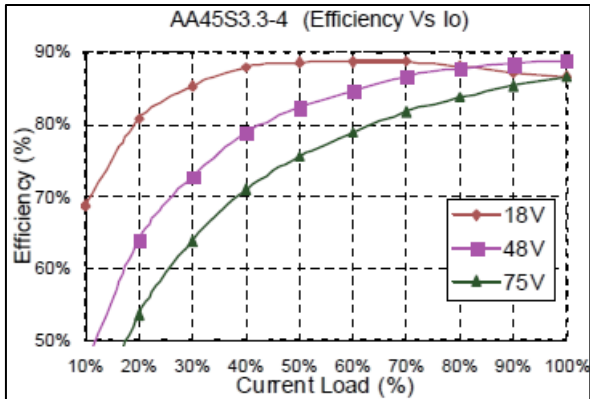
### AA Series power de-rating Curves

Note that the converter operating ambient temperature range is -40°C to + 85°C with derating above +68°C. Also, maximum case temperature under any operating condition should not exceed +105°C.



**Efficiency vs. Load Curves**

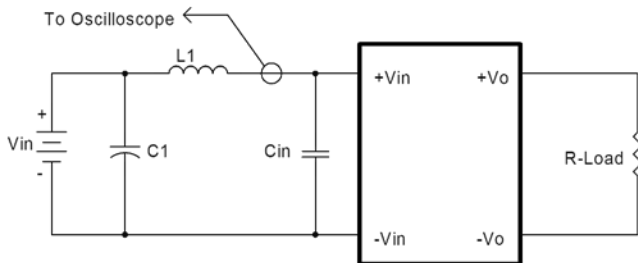






### Input Capacitance at the Converter

In order to avoid problems with loop stability, the converter must be connected to a low impedance AC source and a low inductance source. The input capacitors (C<sub>in</sub>) should be placed close to the converter input pins to de-couple distribution inductance. The external input capacitors should have low ESR in order to quiet any ripple. Circuit as shown in the figure below represents typical measurement methods for reflected ripple current. The capacitor C1 and inductor L1 simulate the typical DC source impedance. The input reflected-ripple current is measured by a current probe oscilloscope with a simulated source inductance (L1).



L1: 12uH  
C1: 220uF ESR < 0.1ohm @100KHz  
Cin: 33uF ESR < 0.7ohm @100KHz

**Input Reflected-Ripple Test Setup**

### Test Set-Up

The basic test set-up to measure efficiency, load regulation, line regulation and other parameters is shown in the next figure. When testing the converter under any transient conditions, the user should ensure that the transient response of the source is sufficient to power the equipment under test. Below is the calculation of :

- 1- Efficiency
- 2- Load regulation
- 3- Line regulation

The value of efficiency is defined as:

$$\eta = \frac{V_O \times I_O}{V_{IN} \times I_{IN}} \times 100\%$$

Where

V<sub>o</sub> is output voltage,  
I<sub>o</sub> is output current,  
V<sub>IN</sub> is input voltage,  
I<sub>IN</sub> is input current.

The value of load regulation is defined as:

$$Load.reg = \frac{V_{FL} - V_{NL}}{V_{NL}} \times 100\%$$

Where

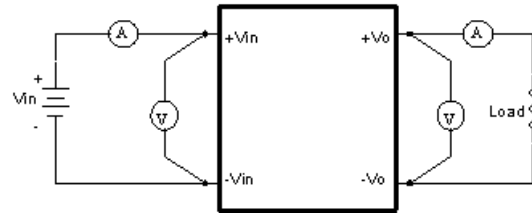
V<sub>FL</sub> is the output voltage at full load  
V<sub>NL</sub> is the output voltage at 10% load

The value of line regulation is defined as:

$$Line.reg = \frac{V_{HL} - V_{LL}}{V_{LL}} \times 100\%$$

Where

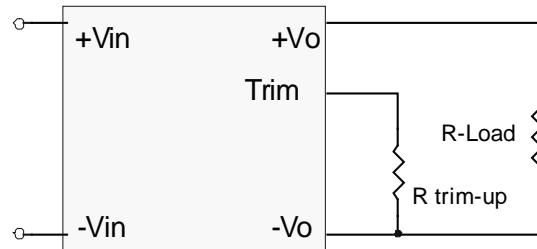
V<sub>HL</sub> is the output voltage of the maximum input voltage at full load.  
V<sub>LL</sub> is the output voltage of the minimum input voltage at full load.



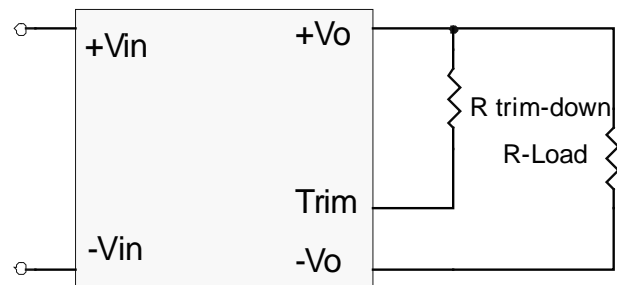
**AA Series Test Setup**

### Output Voltage Adjustment

In order to trim the voltage up or down, the user needs to connect the trim resistor either between the trim pin and -Vo for trim-up and between trim pin and +Vo for trim-down. The output voltage trim range is ±10%. This is shown in the next two figures:



**Trim-up Voltage Setup**



**Trim-down Voltage Setup**

1. The value of  $R_{trim-up}$  is defined as:

$$R_{trim-up} = \left( \frac{V_r \times R1 \times (R2 + R3)}{(V_o - V_{o,nom}) \times R2} \right) - R_t \text{ (K}\Omega\text{)}$$

Where

$R_{trim-up}$  is the external resistor in Kohm.

$V_{o,nom}$  is the nominal output voltage.

$V_o$  is the desired output voltage.

$R1, R_t, R2, R3$  and  $V_r$  are internal to the unit and are defined in the table below

Trim up and Trim down Resistor Values

Model Number	Output Voltage(V)	R1 (KΩ)	R2 (KΩ)	R3 (KΩ)	Rt (KΩ)	Vr (V)
AA22S3.3-4 AA45S3.3-4	3.3	2.74	1.8	0.27	9.1	1.24
AA22S5-3 AA45S5-3	5.0	2.32	2.32	0	8.2	2.5
AA22S12-1.25 AA45S12-1.25	12.0	6.8	2.4	2.32	22	2.5
AA22S15-1 AA45S15-0.5	15.0	8.06	2.4	3.9	27	2.5

For example, to trim-up the output voltage of the 5.0 Volts module (AA22S5-3) by 10% to 5.5V,  $R_{trim-up}$  is calculated as follows:

$$V_o - V_{o,nom} = 5.5 - 5.0 = 0.5V$$

$$R1 = 2.32 \text{ K}\Omega$$

$$R2 = 2.32 \text{ K}\Omega$$

$$R3 = 0 \text{ K}\Omega$$

$$R_t = 8.2 \text{ K}\Omega,$$

$$V_r = 2.5 \text{ V}$$

$$R_{trim-up} = \left( \frac{2.5 \times 2.32 \times (2.32 + 0)}{0.5 \times 2.32} \right) - 8.2 = 3.4 \text{ (K}\Omega\text{)}$$

2. The value of  $R_{trim-down}$  defined as:

$$R_{trim-down} = R1 \times \left( \frac{V_r \times R1}{(V_{o,nom} - V_o) \times R2} - 1 \right) - R_t \text{ (K}\Omega\text{)}$$

Where

$R_{trim-down}$  is the external resistor in Kohm.

$V_{o,nom}$  is the nominal output voltage.

$V_o$  is the desired output voltage.

$R1, R_t, R2, R3$  and  $V_r$  are internal to the unit and are defined in the table above.

For example, to trim-down the output voltage of 5.0V module (AA22S5-6) by 10% to 4.5V,  $R_{trim-down}$  is calculated as follows:

$$V_{o,nom} - V_o = 5.0 - 4.5 = 0.5V$$

$$R1 = 2.32 \text{ K}\Omega$$

$$R2 = 2.32 \text{ K}\Omega$$

$$R3 = 0 \text{ K}\Omega$$

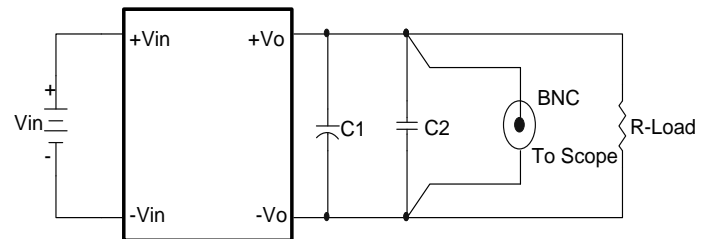
$$R_t = 8.2 \text{ K}\Omega$$

$$V_r = 2.5 \text{ V}$$

$$R_{trim-down} = 2.32 \times \left( \frac{(2.5 \times 2.32)}{0.5 \times 2.32} - 1 \right) - 8.2 = 1.08 \text{ (K}\Omega\text{)}$$

### Noise Measurement and Output Ripple

The test set-up for noise and ripple measurements is shown in the figure below. A coaxial cable was used to prevent impedance mismatch reflections disturbing the noise readings at higher frequencies. Measurements are taken with the output appropriately loaded and all ripple/noise specifications are from D.C. to 20MHz Bandwidth.



Note: C1: 10μF tantalum capacitor  
C2: 1μF ceramic capacitor

Output Voltage Ripple and Noise Measurement Set-Up

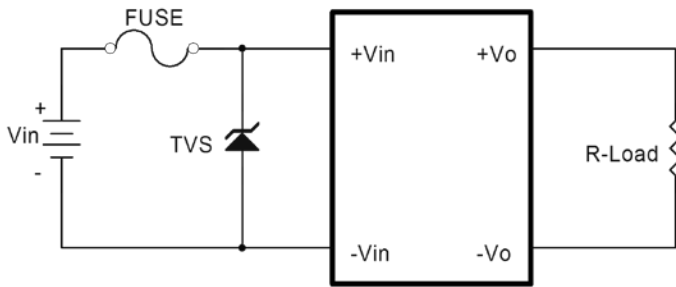
### Output Capacitance

The AA series converters provide unconditional stability with or without external capacitors. For good transient response, a low ESR output capacitors should be located close to the point of load.

## SAFETY and EMC

### Input Fusing and Safety Considerations

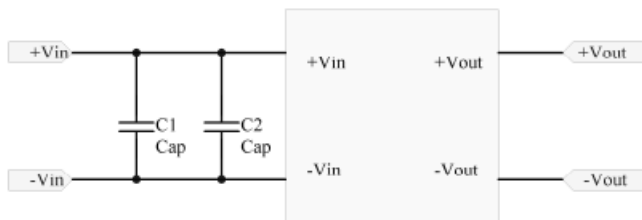
The AA series of converters do not have an internal fuse. However, to achieve maximum safety and system protection, always use an input line fuse. DATEL recommended a time delay fuse of 6A for 24Vin models and 3A for 48Vin modules. The circuit in the figure below is recommended by a Transient Voltage Suppressor diode across the input terminal to protect the unit against surge or spike voltage and input reverse voltage.



Input Protection Circuit

### EMC Considerations

EMI Test standard: EN55022 Class A Conducted Emission  
 Test Condition: Input Voltage: Nominal, Output Load: Full Load

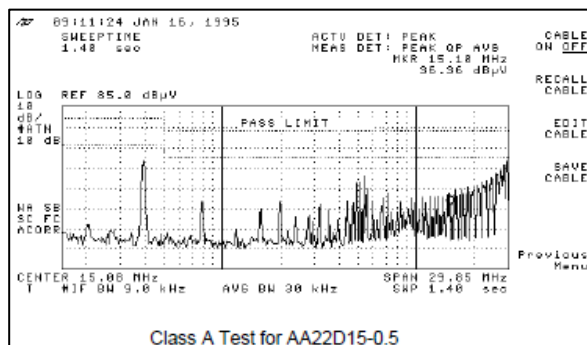
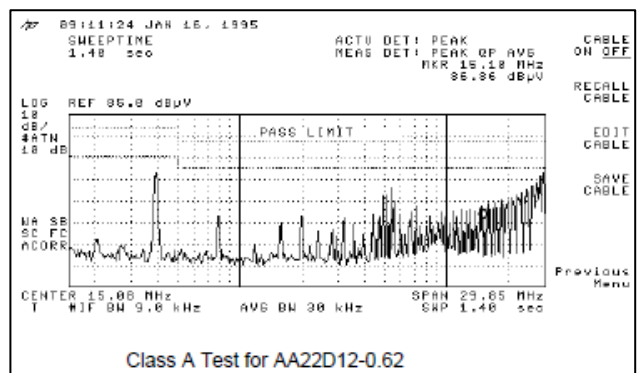
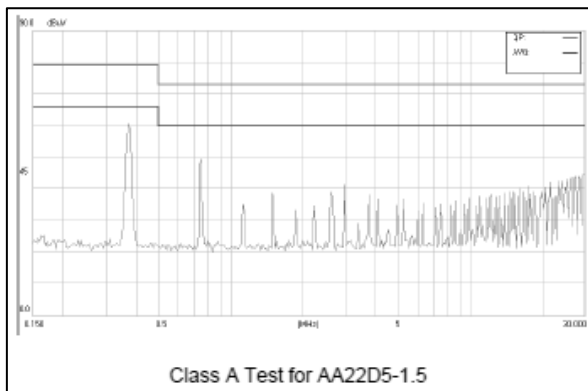
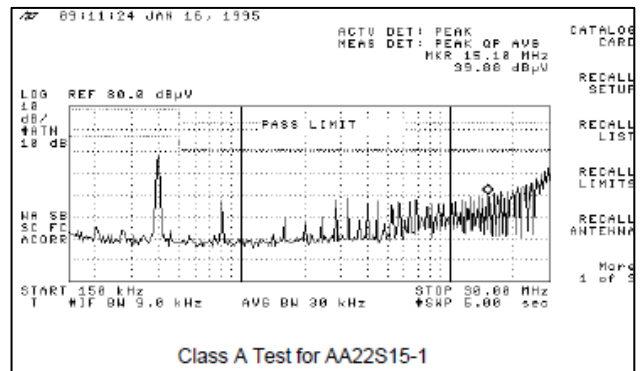
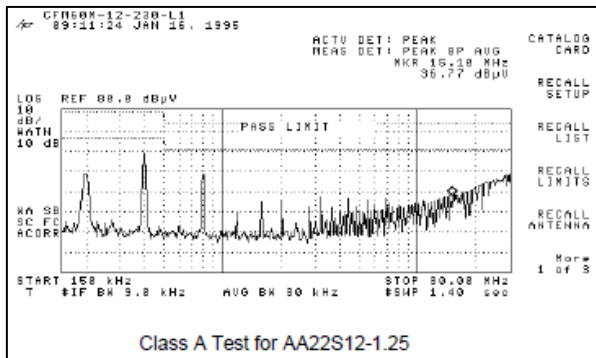
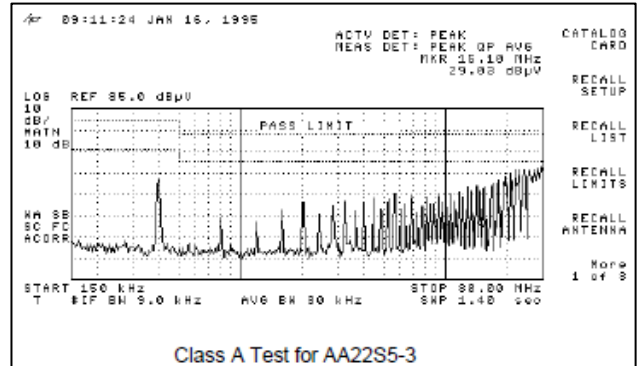
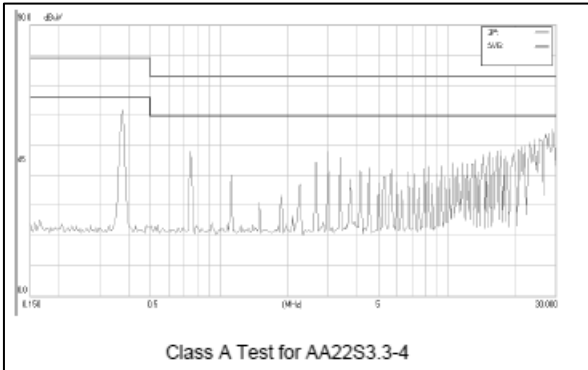


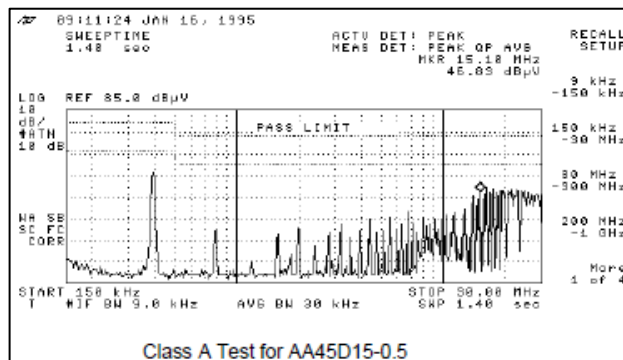
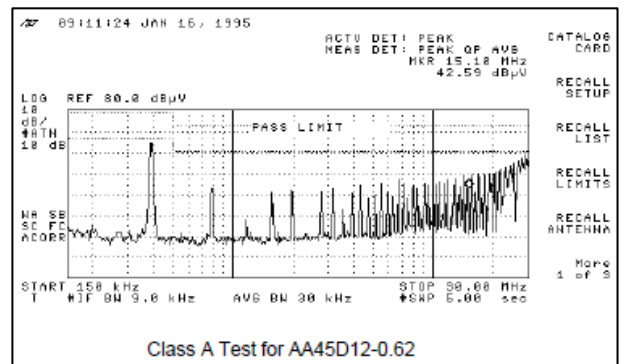
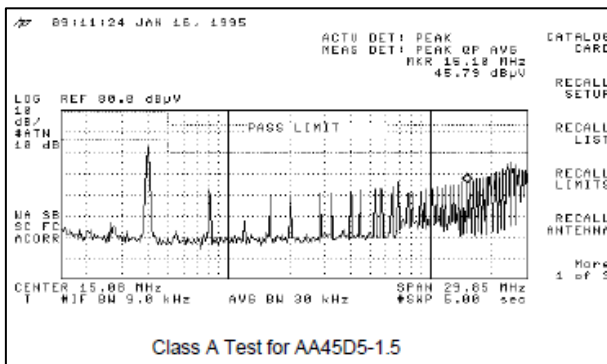
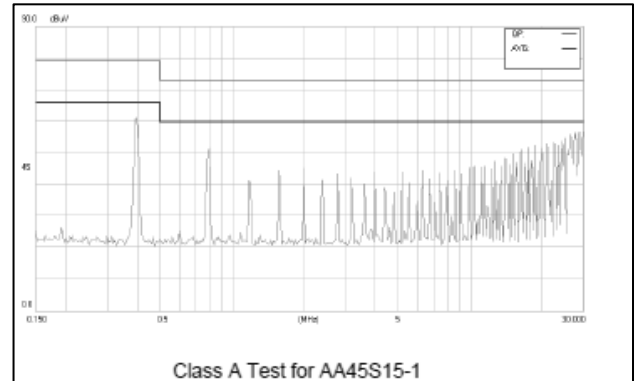
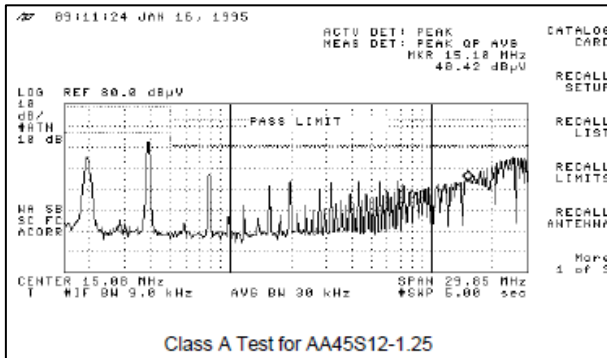
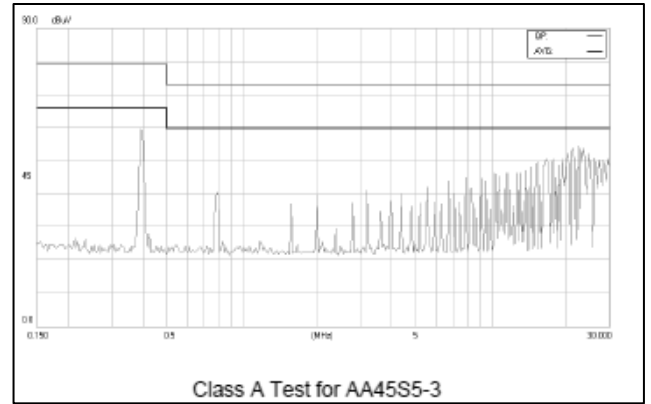
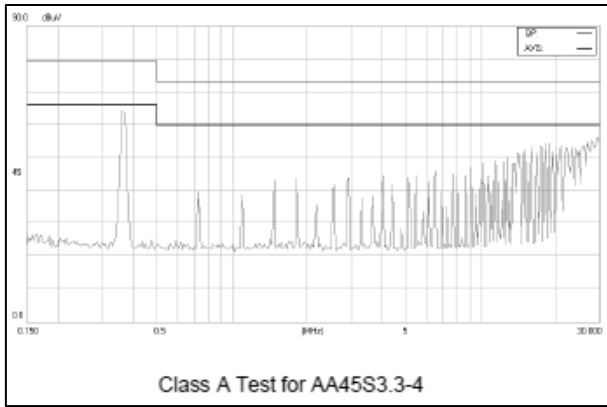
Connection circuit for conducted EMI testing

EN55022 class A					
Model No.	C1	C2	Model No.	C1	C2
AA22S3.3-4	6.8μF/50V	6.8μF/50V	AA45S3.3-4	2.2μF/100V	2.2μF/100V
AA22S5-3	6.8μF/50V	6.8μF/50V	AA45S5-3	2.2μF/100V	2.2μF/100V
AA22S12-1.25	6.8μF/50V	6.8μF/50V	AA45S12-1.25	2.2μF/100V	2.2μF/100V
AA22S15-1	6.8μF/50V	6.8μF/50V	AA45S15-1	2.2μF/100V	2.2μF/100V
AA22D5-1.5	6.8μF/50V	6.8μF/50V	AA45D5-1.5	2.2μF/100V	2.2μF/100V
AA22D12-0.62	6.8μF/50V	6.8μF/50V	AA45D12-0.62	2.2μF/100V	2.2μF/100V
AA22D15-0.5	6.8μF/50V	6.8μF/50V	AA45D15-0.5	2.2μF/100V	2.2μF/100V

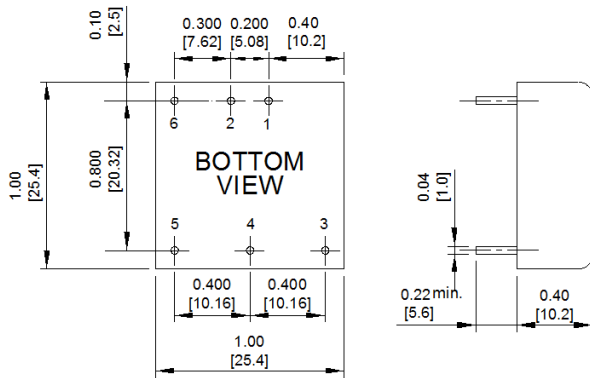
Note: All of capacitors are CHEMI-CON KMF aluminum capacitors.

**EMI TESTING**





**MECHANICAL DIMENSIONS Inches (mm)**



Note: All dimensions are in inches (millimeters). Tolerance: x.xx ±0.02 in. (0.5mm), x.xxx ±0.010 in. (0.25 mm) unless otherwise noted

**PIN CONNECTIONS**

Pin Connections		
PIN	SINGLE OUTPUT	DUAL OUTPUT
1	+ V Input	+ V Input
2	- V Input	- V Input
3	+ V Output	+ V Output
4	Trim	Common
5	- V Output	- V Output
6	Remote	Remote

**PART NUMBER AND ORDERING INFORMATION**

