AA SERIES (1 x 1 Package)

Up to 30 Watt DC-DC Converter

FEATURES

- Industry standard footprint (1 inch X 1 inch)
- Regulated Outputs, Fixed Switching Frequency
- Up to 90 % Efficiency
- Low No Load Power Consumption
- Designed for use 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 conductive EMI EN55022 class A without external components

PRODUCT OVERVIEW

The AA series offer 30 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. The AA series provides a 4:1 wide input voltage range of 9 to 36 or 18 to 75VDC, and delivers a precisely 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 are protected against over-voltage, continuous short circuit conditions and over-temperature. They are designed to be used without tantalum capacitors. 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

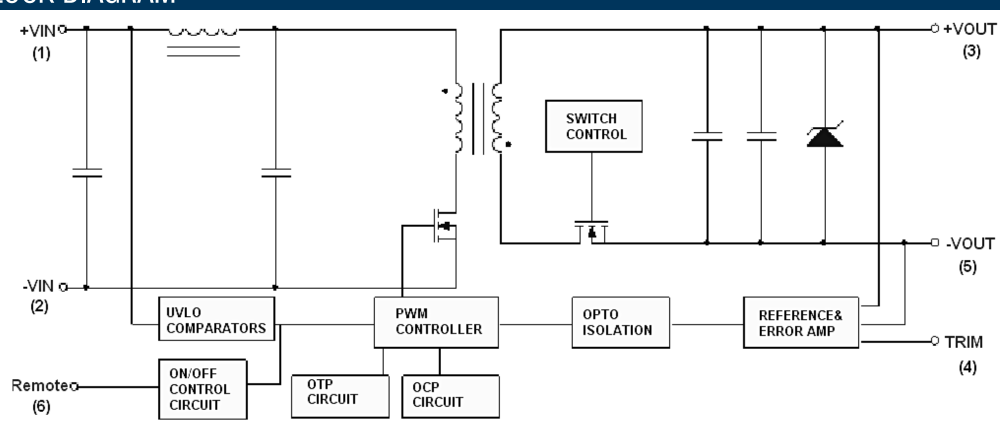
- Customizable output voltages
- CE Mark 2004/108/EC certification
- UL60950-1, EN60950-1, and IEC60950-1 safety

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

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

MODEL NUMBER	INPUT VOLTAGE	OUTPUT VOLTAGE	OUTPUT CURRENT MAX	EFFICIENCY %	LOAD REGULATION	OPTIONS
AA22S3.3-7	9-36 VDC	3.3VDC	7.5 A	88	± 0.1 %	N
AA22S5-6	9-36 VDC	5.0 VDC	6 A	90	± 0.1 %	N
AA22S12-2.5	9-36 VDC	12 VDC	2.5 A	89	± 0.1 %	N
AA22S15-2	9-36 VDC	15 VDC	2 A	89	± 0.1 %	N
AA22D12-1.25	9-36 VDC	±12 VDC	±1.25 A	88	± 0.5 %	N
AA22D15-1	9-36 VDC	±15 VDC	±1.0 A	88	± 0.5 %	N
AA45S3.3-7	18-75VDC	3.3 VDC	7.5 A	88	± 0.1 %	N
AA45S5-6	18-75VDC	5 VDC	6 A	90	± 0.1 %	N
AA45S12-2.5	18-75VDC	12 VDC	2.5 A	89	± 0.1 %	N
AA45S15-2	18-75VDC	15 VDC	2 A	89	± 0.1 %	N
AA45D12-1.25	18-75VDC	±12 VDC	±1.25 A	88	± 0.5 %	N
AA45D15-1	18-75VDC	±15 VDC	±1.0 A	89	± 0.5 %	N

FUNCTIONAL BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Parameters	Conditions	Model	Min.	Typical	Max.	Units
Input Voltage						
Continuous	DC	$24V_{in}$ $48V_{in}$	-0.3 -0.3		36 75	Volts
Transient	100ms, DC	$24V_{in}$ $48V_{in}$			50 100	Volts
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		$24V_{in}$ $48V_{in}$	9 18	24 48	36 75	Volts
Input Under Voltage Lockout						
Turn-On Voltage Threshold		$24V_{in}$ $48V_{in}$	8 16.5	8.5 17	8.8 17.5	Volts
Input Over Voltage Lockout						
Turn-Off Voltage Threshold		$24V_{in}$ $48V_{in}$		40 80		Volts
Lockout Hysteresis Voltage		$24V_{in}$ $48V_{in}$		0.5 1		Volts
Maximum Input Current	100% Load, V_{in} =9V	24Vin			3900	mA
	100% Load, V_{in} =18V	48Vin			1950	mA
No-Load Input Current	V_{in} =Nominal input	AA22S3.3-7 AA22S5-6 AA22S12-2.5 AA22S15-2 AA22D12-1.25 AA22D15-1 AA45S3.3-7 AA45S5-6 AA45S12-2.5 AA45S15-2 AA45D12-1.25 AA45D15-1		10 10 10 10 10 10 8 8 8 8 8 8		mA
Off Converter Input Current	Shutdown input idle current	All		4	10	mA
Inrush Current (I^2t)	As per ETS300 132-2	All			0.1	A^2s
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} =Nominal V_{in} , I_o = I_{o_max}, Tc=25°C	Vo=3.3 Vo=5.0 Vo=12 Vo=15 Vo=±12 Vo=±15	3.2505 4.925 11.82 14.775 11.82 14.775	3.3 5 12 15 12 15	3.3495 5.075 12.18 15.225 12.18 15.225	Volts
Output Voltage Balance	V_{in} =nominal, Io= I_{o_max}, Tc=25°C	Dual			±1.5	%
Output Voltage Regulation						
Line Regulation	V_{in} =High line to Low line Full Load	Single Dual Triple (primary) (Auxilliary)			±0.5 ±0.5 ±0.5 ±1	% % % % %
Load Regulation	I_o = Full Load to min. Load	Single Dual Triple			±10 ±1.0 ±1	% % %
Cross Regulation	Load cross variation 10%/100%	Dual			±5	%
Temperature Coefficient	TC=-40°C to 80°C				±0.03	%/°C
Output Voltage Ripple and Noise	5Hz to 20MHz bandwidth					
Peak-to-Peak	Full Load, 20MHz bandwidth 10uF tantalum and 1uF ceramic capacitor	Vo=3.3V Vo=5V			75	mV
		Vo=15V Vo=12V Vo=±15V Vo=±12V			100	
Operating Output Current Range		Vo=3.3V Vo=5V Vo=12V Vo=15V Vo=±12V Vo=±15V	0 0 0 0 0 0		7500 6000 2500 2000 ±1250 ±1000	mA
Output DC Current-Limit Inception	Output Voltage=90% $V_{O,\ nominal}$		110	140	170	%
Maximum Output Capacitance	Full load, Resistance	Vo=3.3V Vo=5V Vo=12V Vo=15V Vo=±12V Vo=±15V			7500 6000 2500 2000 1250 1000	μF

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} di/dt=0.1A/us	All			±5	%
Setting Time (within 1% $Vo_{nominal}$)		All			250	μs
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
100% Load	V_{in} =12 V_{dc}, $I_o = I_{o\_max}$, Tc=25°C	AA22S3.3-7		88		%
		AA22S5-6		89		
		AA22S12-2.5		89		
		AA22S15-2		89		
		AA22D12-1.25		88		
		AA22D15-1		88		
	V_{in} =24 V_{dc}, $I_o = I_{o\_max}$, Tc=25°C	AA22S3.3-7		88		%
		AA22S5-6		90		
		AA22S12-2.5		89		
		AA22S15-2		89		
		AA22D12-1.25		88		
		AA22D15-1		88		
100% Load	V_{in} =24 Vdc, $I_o = I_{o\_max}$, Tc=25°C	AA45S3.3-7		88		%
		AA45S5-6		90		
		AA45S12-2.5		90		
		AA45S15-2		90		
		AA45D12-1.25		89		
		AA45D15-1		89		
	V_{in} =48 Vdc, $I_o = I_{o\_max}$, Tc=25°C	AA45S3.3-7		88		%
		AA45S5-6		90		
		AA45S12-2.5		89		
		AA45S15-2		89		
		AA45D12-1.25		88		
		AA45D15-1		89		
ISOLATION CHARACTERISTICS						
Input to Output	1 minutes	All	1500			Volts
Isolation Resistance		All	1000			MΩ
Isolation Capacitance		All		1500		pF
Switching Frequency		Vo=3.3V,Vo=5V		270		KHz
		Others		330		
On/Off Control, Positive Remote On/Off logic						
Logic High (Module On)	$V_{on/off}$ at $I_{on/off}$=0.1uA	All	3.5 or Open Circuit		75	Volts
Logic Low (Module Off)	$V_{on/off}$ at $I_{on/off}$=1.0mA	All			1.2	Volts
On/Off Control, Negative Remote On/Off logic						
Logic High (Module Off)	$V_{on/off}$ at $I_{on/off}$=1.0mA	All	3.5 or Open Circuit		75	Volts
Logic Low (Module On)	$V_{on/off}$ at $I_{on/off}$=0.1uA	All			1.2	Volts
On/Off Current (for both remote on/off logic)	$I_{on/off}$ at $V_{on/off}$=0V	All		0.3	1	mA
Leakage Current (for both remote on/off logic)	Logic High, $V_{on/off}$=15V				30	uA
Output Over Voltage Protection	Zener or TVS Clamp	Vo=3.3V		3.9		Volts
		Vo=5.0V		6.2		
		Vo=12V		15		
		Vo=15V		18		
		Vo=±12V		±15		
		Vo=±15V		±18		
MTBF	I_o =100%of I_{o_max};Ta=25°C per MIL-HDBK-217F	All		TBD		M hours
Weight		All		18		grams

Operating Temperature Range

The AA series converters operate over a wide ambient temperature ranging from -40°C to +85°C and derating starts above +55°C. The module operate normally up to +105°C.

Remote On/Off`

The 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. Models with part number suffix option "N" are the "negative logic" Remote On/Off version. For the N model, the converter turns off if the remote on/off pin is high (greater than 3.5VDC to 75VDC or open circuit). The converter is off by default. The converter turns on if the Remote On/Off pin input is low (less than 1.2VDC).

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

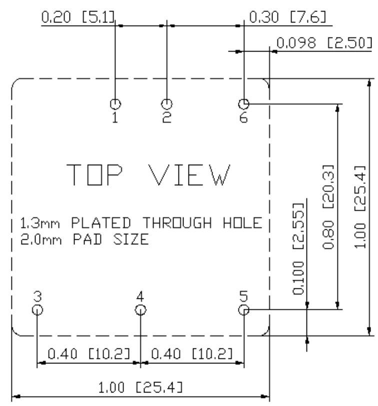
The Over Voltage protection feature consists of a Zener diode to limiting the out voltage.

Over-Temperature Protection (OTP)

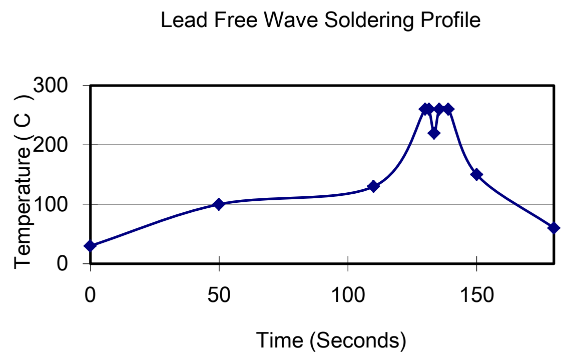
The AA series of converters are equipped with non-latching Over Temperature protection. If the temperature exceeds a threshold of +110°C (typical) the converter will shut down, disabling the output. When the temperature re-decreases the converter will automatically restart. The over-temperature condition can be induced by a variety of reasons such as external overload condition, a system fan failure or others.

Recommended Layout PCB Footprints and Soldering Information

The end user of the converter must ensure that 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)



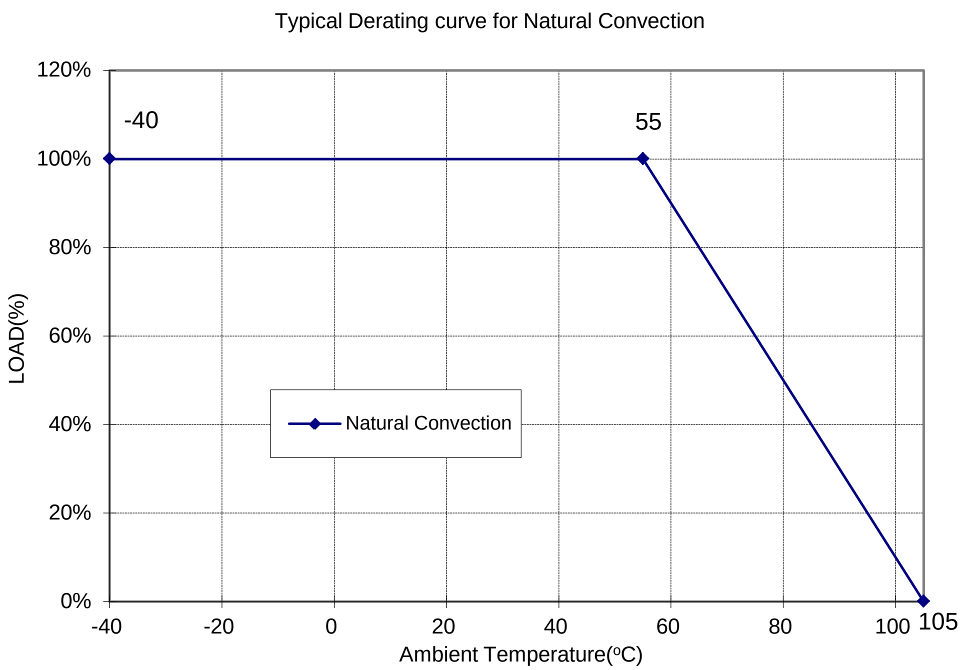
Wave Soldering Profiles

Note：

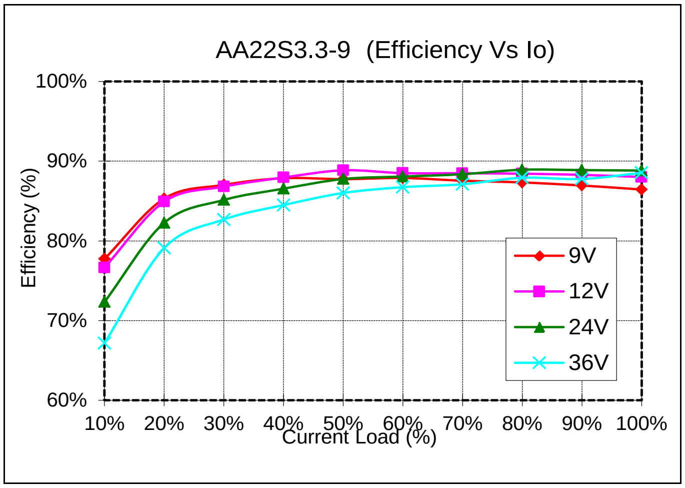
1. Soldering Materials: Sn/Cu/Ni
2. Ramp up rate during preheat: 1.4 °C/Sec (From 50°C to 100°C)
3. Soaking temperature: 0.5 °C/Sec (From 100°C to 130°C), 60±20 seconds
4. Peak temperature: 260°C, above 250°C 3~6 Seconds
5. Ramp up rate during cooling: -10.0 °C/Sec (From 260°C to 150°C)

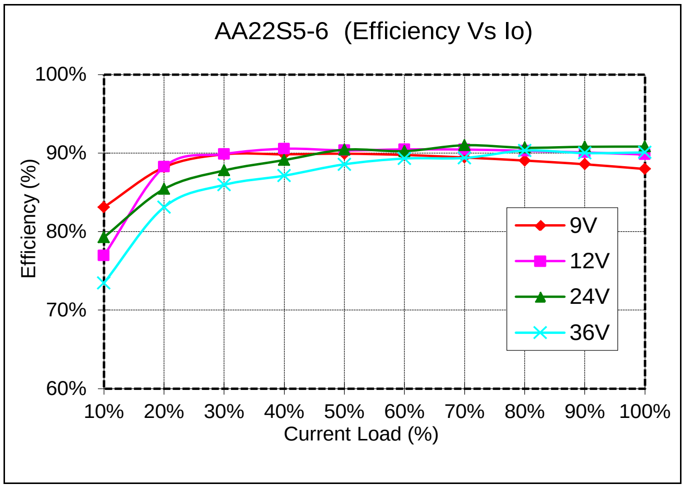
AA Series power de-rating Curves

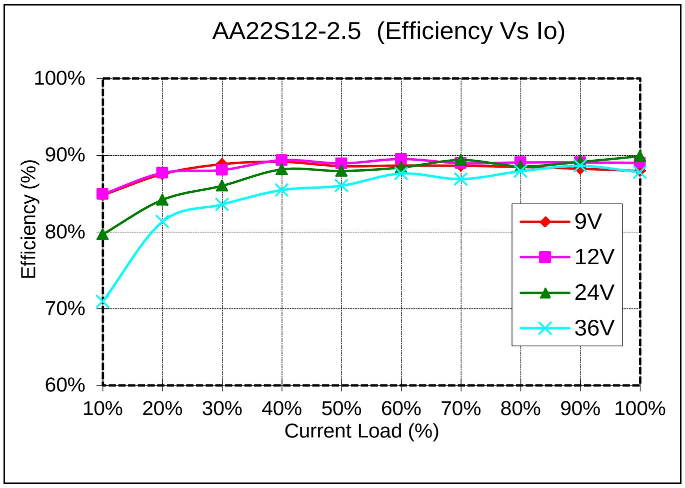
Note that the converter operating ambient temperature range is -40°C to + 85°C with derating above +55°C. Also, maximum case temperature under any operating condition should not exceed +105°C.

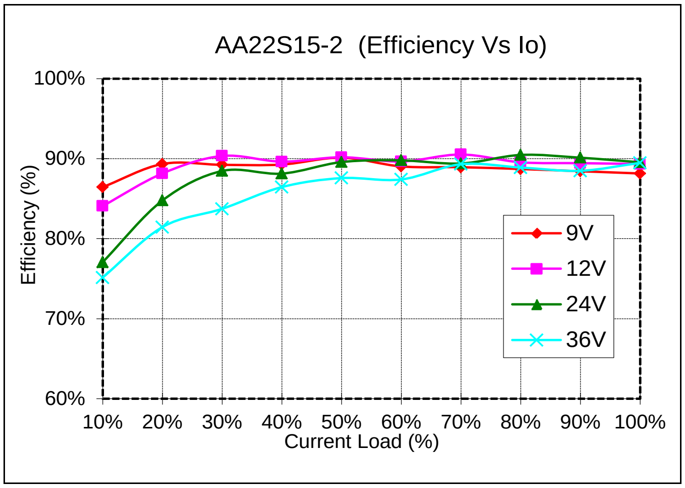


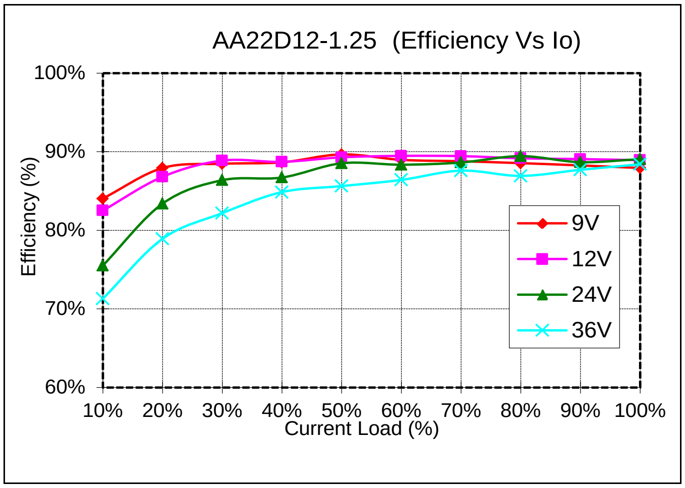
Efficiency vs. Load Curves

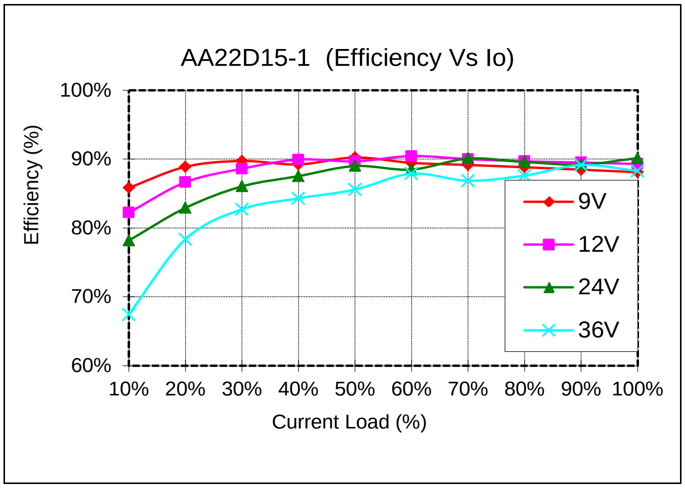


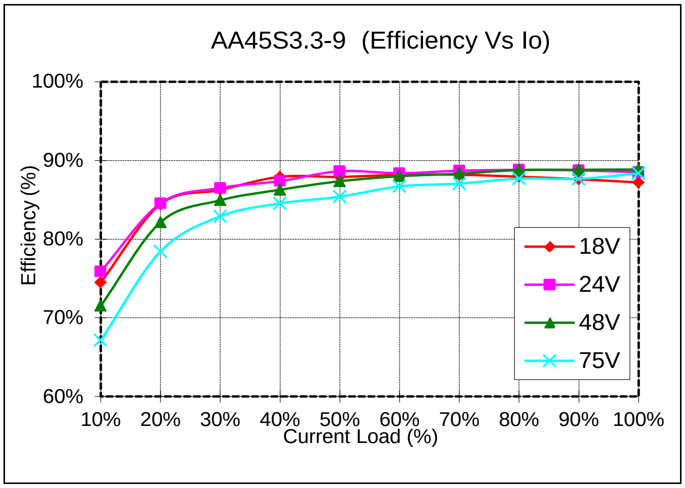


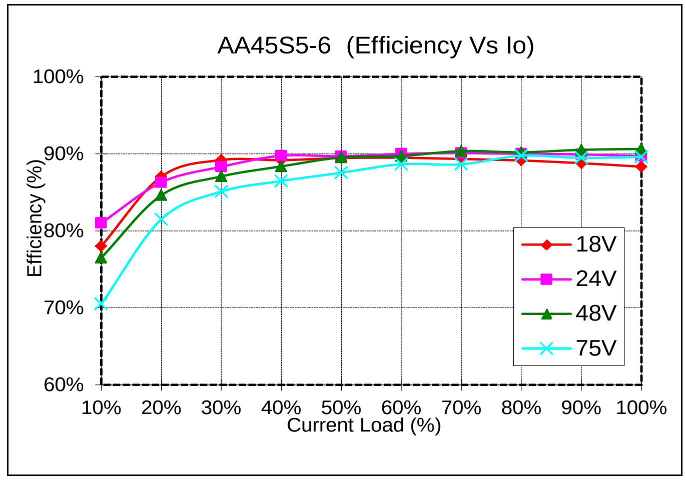


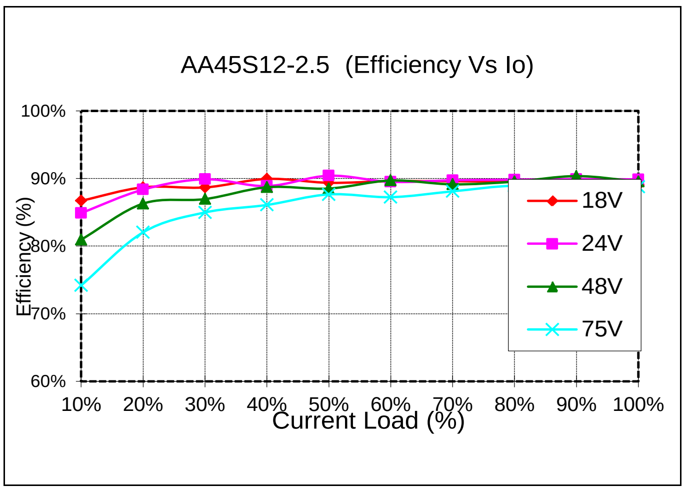


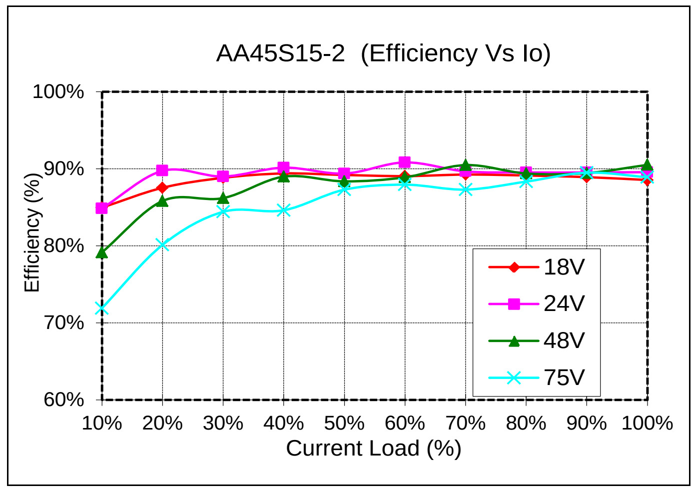


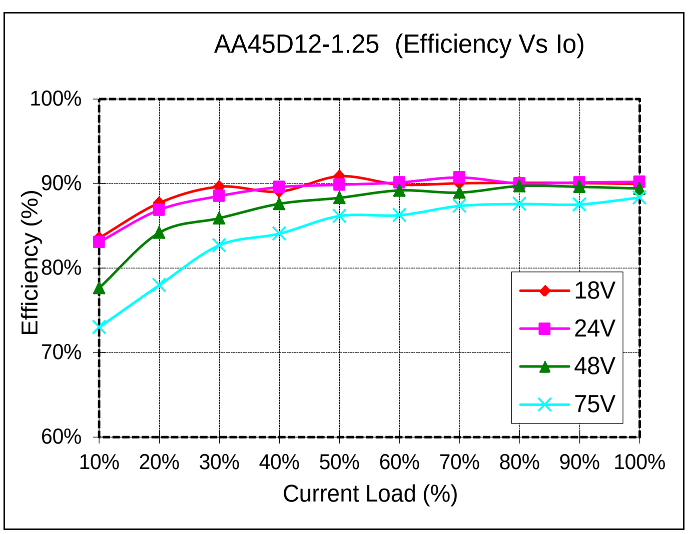


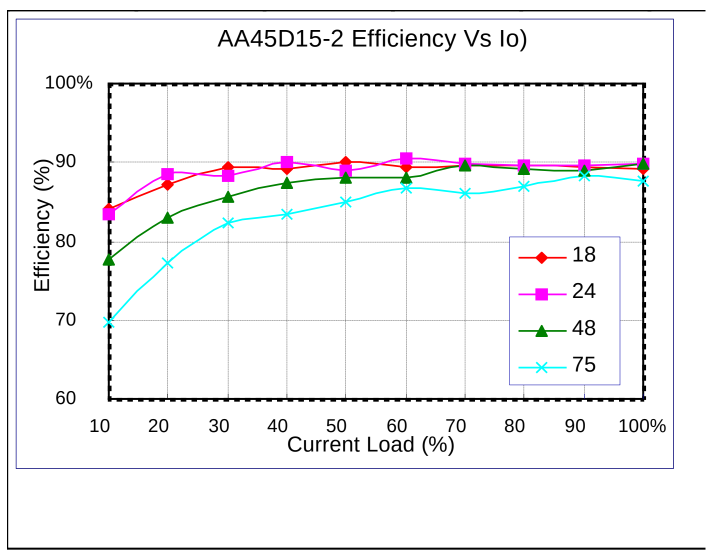

AA45S3.3-9 (Efficiency Vs Io)
Efficiency (%)
Current Load (%)
18V
24V
48V
75V


AA45S5-6 (Efficiency Vs Io)
Efficiency (%)
Current Load (%)
18V
24V
48V
75V


AA45S12-2.5 (Efficiency Vs Io)
Efficiency (%)
Current Load (%)
18V
24V
48V
75V

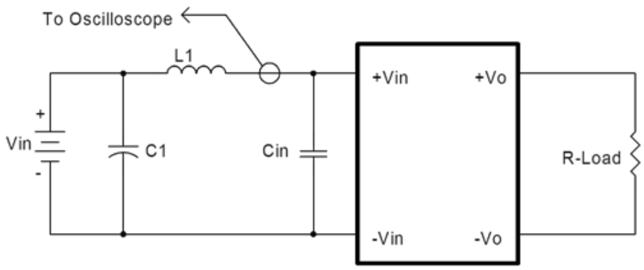

AA45S15-2 (Efficiency Vs Io)
Efficiency (%)
Current Load (%)
18V
24V
48V
75V


AA45D12-1.25 (Efficiency Vs Io)
Efficiency (%)
Current Load (%)
18V
24V
48V
75V


AA45D15-2 Efficiency Vs Io)
Efficiency (%)
Current Load (%)
18
24
48
75

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 (Cin) 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: 33μF 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_O is output voltage,
I_O is output current,
V_{IN} is input voltage,
I_{IN} is input current.

The value of load regulation is defined as:

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

Where

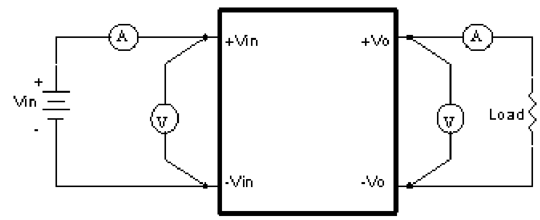
V_{FL} is the output voltage at full load
V_{NL} is the output voltage at 10% load

The value of line regulation is defined as:

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

Where

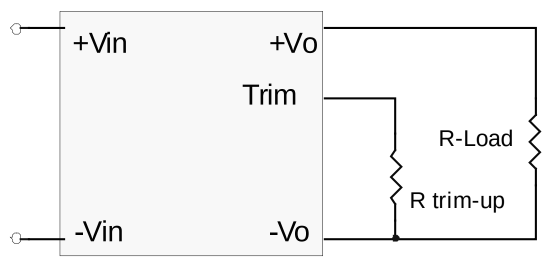
V_{HL} is the output voltage of the maximum input voltage at full load.
V_{LL} is the output voltage of the minimum input voltage at full load.



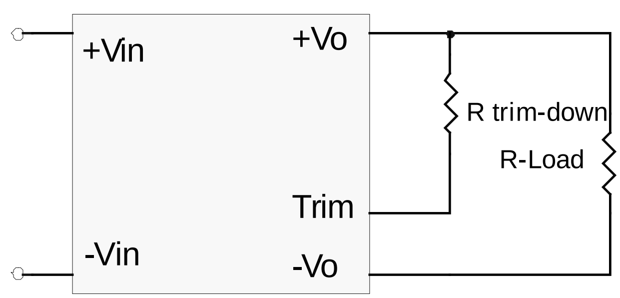
AA Series Test Setup

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:

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

Where

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

$V_{0,nom}$ is the nominal output voltage.

V_0 is the desired output voltage.

R1, Rt, R2, R3 and Vr 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)
AA22S3.3-9 AA45S3.3-9	3.3	2.74	1.8	0.27	9.1	1.24
AA22S5-6 AA45S5-6	5.0	2.32	2.32	0	8.2	2.5
AA22S12-2.5 AA45S12-2.5	12.0	6.8	2.4	2.32	22	2.5
AA22S15-2 AA45S15-2	15.0	8.06	2.4	3.9	27	2.5

For example, to trim-up the output voltage of the 5.0 Votls module (AA22S5-6) 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 KΩ

R2 = 2.32 KΩ

R3 = 0 KΩ

Rt = 8.2 KΩ,

Vr= 2.5 V

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

2. The value of R trim-down defined as:

$$R_{trim-down} = R1 \times \left(\frac{Vr \times R1}{(V_{o,nom} - Vo) \times R2} - 1\right) - Rt \ \ (K\Omega)$$

Where

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

$V_{0,nom}$ is the nominal output voltage.

V_0 is the desired output voltage.

R1, Rt, R2, R3 and Vr 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:

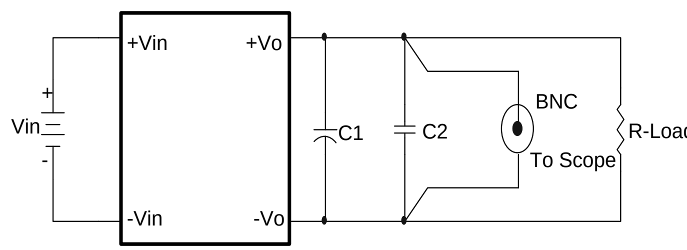
$V_{0,nom} - Vo = 5.0 - 4.5 = 0.5V$

R1 = 2.32 KΩ
R2 = 2.32 KΩ
R3 = 0 KΩ
Rt = 8.2 KΩ
Vr= 2.5 V

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

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

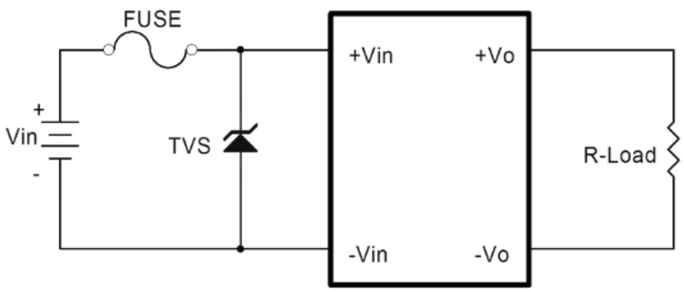
Output Capacitance

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

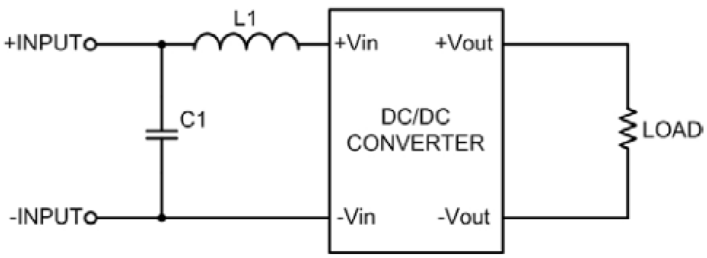
The AA series of converters do not have an internal fuse. However, to achieve maximum safety and system protection, always use an input line fuse. DATEL recommended a time delay fuse of 6A for 24Vin models and 3A for 48Vin modules. The circuit in the figure below is recommended by a Transient Voltage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



Input Protection Circuit

EMC Considerations

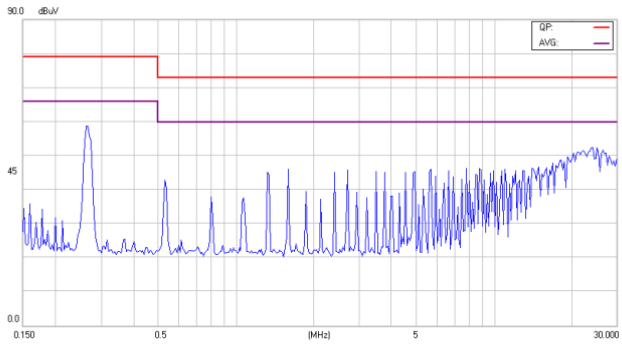
EMI Test standard: EN55022 Class A Conducted Emission
Test Condition: Input Voltage: Nominal, Output Load: Full Load



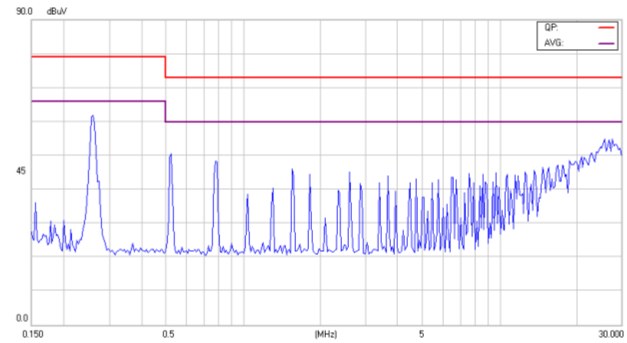
Connection circuit for conducted EMI testing

EN55022 class A					
Model No.	**C1**	**L1**	**Model No.**	**C1**	**L1**
AA22S3.3-9	100µF/50V	0.47µH	**AA45S3.3-9**	47µF/100V	2.2µH
AA22S5-6	100µF/50V	0.47µH	**AA45S5-6**	47µF/100V	2.2µH
AA22S12-2.5	100µF/50V	0.47µH	**AA45S12-2.5**	47µF/100V	2.2µH
AA22S15-2	100µF/50V	0.47µH	**AA45S15-2**	47µF/100V	2.2µH
AA22D12-1.25	100µF/50V	0.47µH	**AA45D12-1.25**	47µF/100V	2.2µH
AA22D15-1	100µF/50V	0.47µH	**AA45D15-1**	47µF/100V	2.2µH

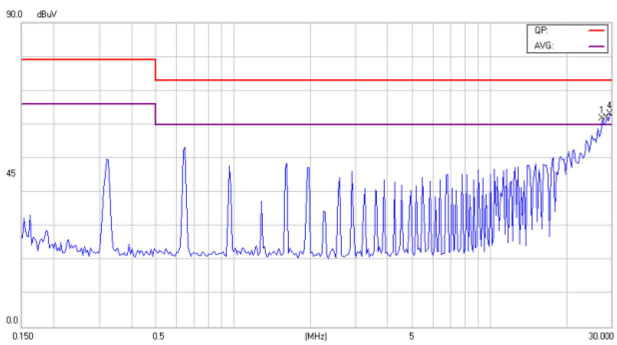
Note: All of capacitors are CHEMI-CON KMF aluminum capacitors.



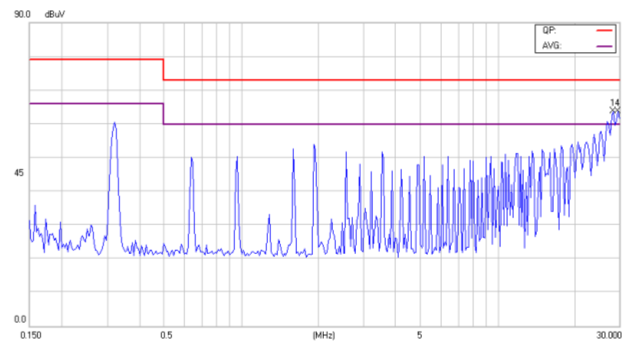
Class A test conducted for AA22S3.3-9



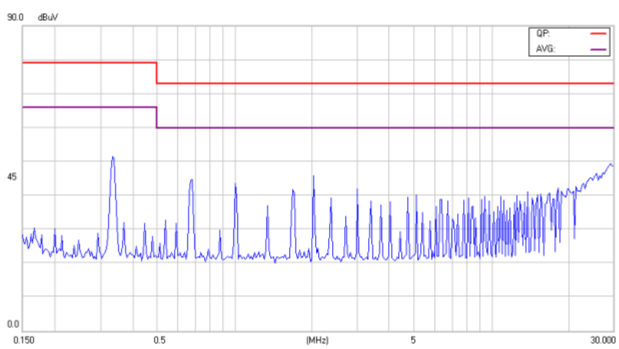
Class A test conducted for AA22S5-6



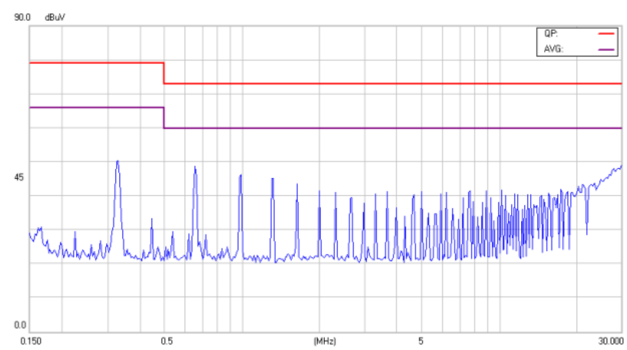
Class A test conducted for AA22S12-2.5



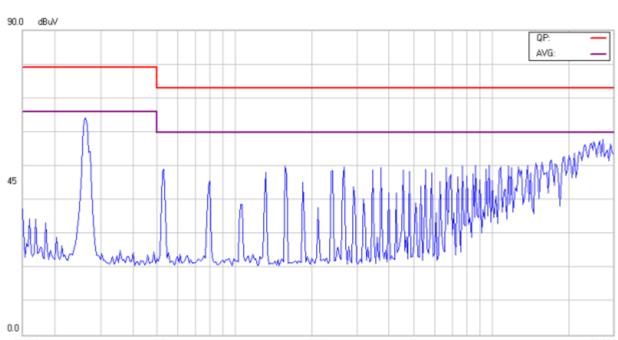
Class A test conducted for AA22S15-2



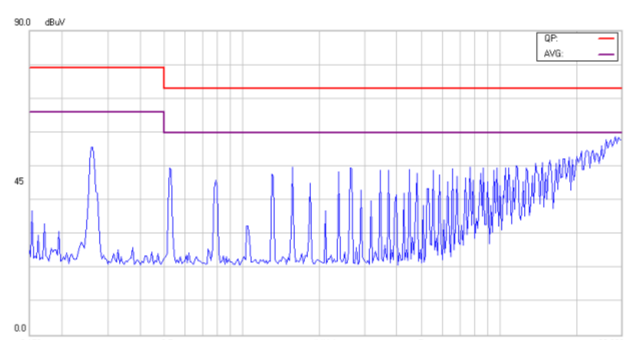
Class A test conducted for AA22D12-1.25



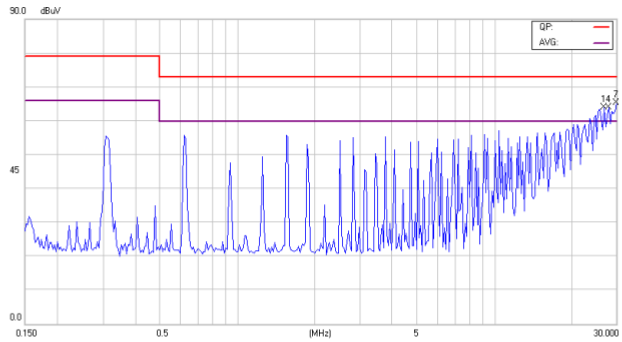
Class A test conducted for AA22D15-1



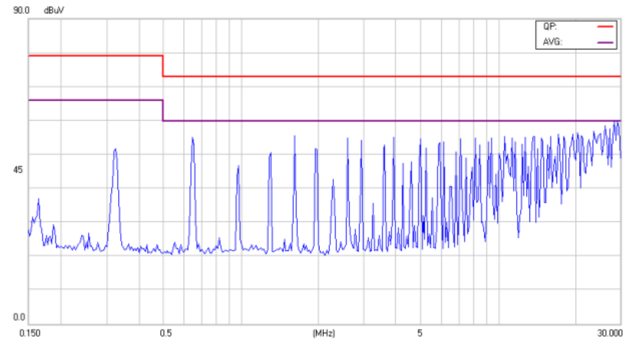
Class A test conducted for AA45S3.3-9



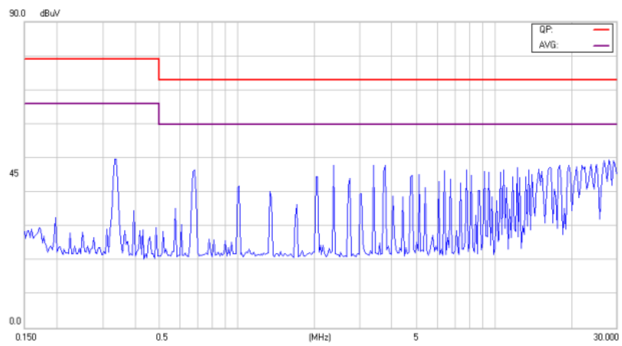
Class A test conducted for AA45S5-6



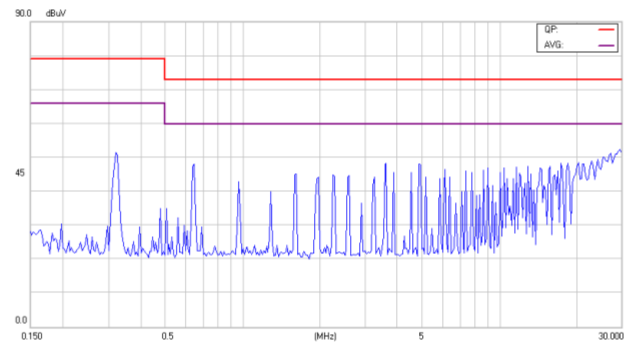
Class A test conducted for AA45S12-2.5



Class A test conducted for AA45S15-2

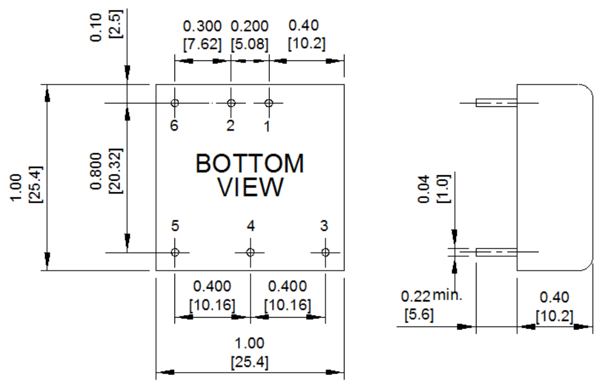


Class A test conducted for AA45D12-1.25



Class A test conducted for AA45D15-1

MECHANICAL DIMENSIONS Inches (mm)

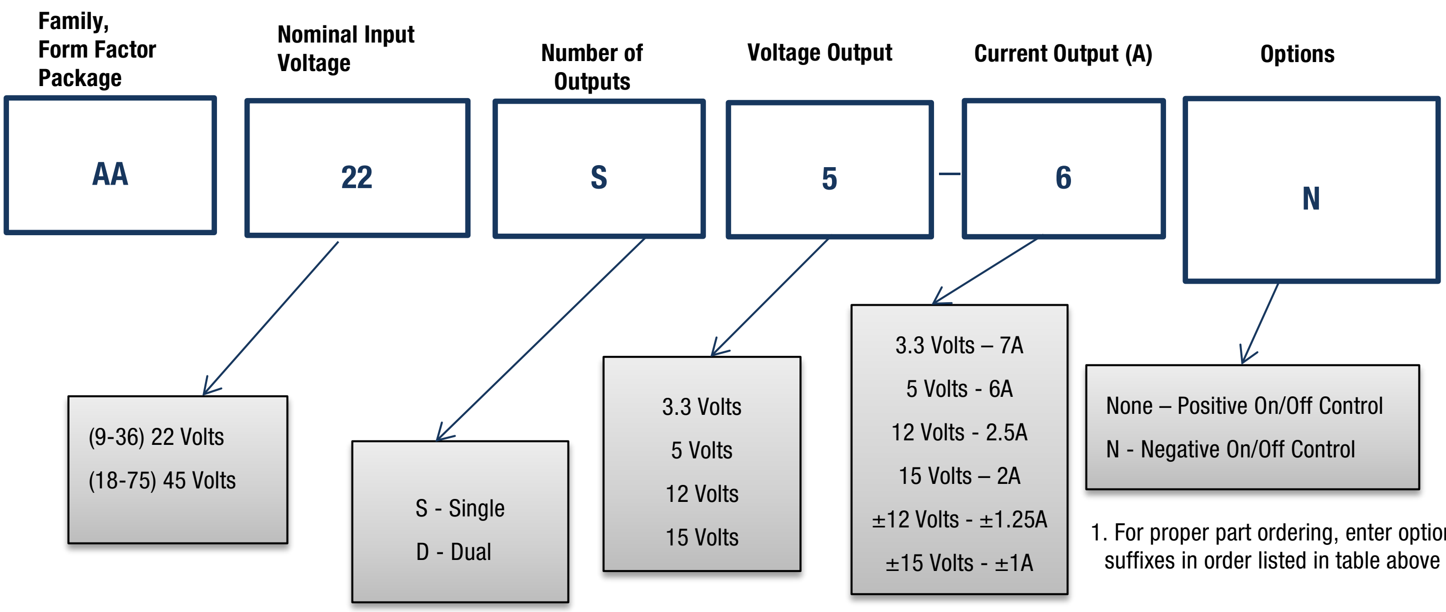


Note: All dimensions are in inches (millimeters). Tolerance: x.xx ±0.02 in. (0.5mm), x.xxx ±0.010 in. (0.25 mm) unless otherwise noted

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



1. For proper part ordering, enter option suffixes in order listed in table above