AS SERIES (2.00” x 1.6” Package)

Up to 30 Watt DC-DC Converter

PRODUCT OVERVIEW

The AS series offer up to 30 watts of output power in a standard 2.00 x 1.60 x 0.45 inches package. This family features high efficiency and 1500 Volts of DC isolation. The AS 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 (de-rating above 60°C). All devices offer input under-voltage lockout plus output over-current, over-voltage, over-temperature and short circuit protection. In addition, the standard control functions of this series include Remote On/Off and adjustable output voltage.

FEATURES

- Industry standard footprint (2 inch X 1.6 inch)
- Regulated Outputs, Fixed Switching Frequency
- Up to 91 % Efficiency
- 4:1 Input Range
- Up to 30 Watts of Power
- -40°C to +85°C temperature range
- Input Voltage Lock Out (UVLO)
- Remote On/Off logic control
- Metal shielding case (six-sided)
- Continuous Short Circuit Protection

APPLICATIONS:

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

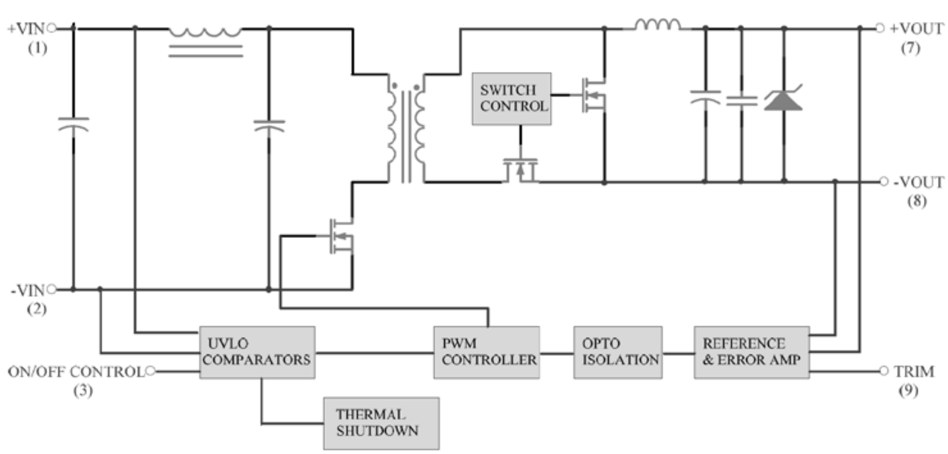
AVAILABLE OPTIONS

- Customizable and multi-output voltages
- CE Mark 2004/108/EC certification
- UL60950-1, EN60950-1, and IEC60950-1 safety
- Cost Savings, Higher Power, Other Voltage outputs, Higher Efficiency, etc.

Contact DATEL for other series in 2.00" x 1.60" footprint including lower power or 2:1Vin range, as well as other customizable options.

MODEL NUMBER	INPUT VOLTAGE	OUTPUT VOLTAGE	OUTPUT CURRENT MAX	EFFICIENCY %	LOAD REGULATION	LINE REGULATION
AS22S3.3-7.5	9-36 VDC	3.3VDC	7.5 A	88	± 0.5 %	± 0.5 %
AS22S5-6	9-36 VDC	5.0 VDC	6 A	89	± 0.5 %	± 0.5 %
AS22S12-2.5	9-36 VDC	12 VDC	2.5 A	91	± 0.5 %	± 0.5 %
AS22S15-2	9-36 VDC	15 VDC	2 A	91	± 0.5 %	± 0.5 %
AS45S3.3-7.5	18-75VDC	3.3 VDC	7.5 A	78	± 0.5 %	± 0.5 %
AS45S5-6	18-75VDC	5 VDC	6 A	82	± 0.5 %	± 0.5 %
AS45S12-2,5	18-75VDC	12 VDC	2.5 A	84	± 0.5 %	± 0.5 %
AS45S15-2	18-75VDC	15 VDC	2 A	84	± 0.5 %	± 0.5 %

FUNCTIONAL BLOCK DIAGRAM



Electrical Block Diagram

ABSOLUTE MAXIMUM RATINGS

Parameters	Conditions	Model	Min.	Typical	Max.	Units
Input Voltage						
Continuous	DC	$24V_{in}$ $48V_{in}$	0 0		36 75	Volts
Transient	100ms, DC	$24V_{in}$ $48V_{in}$			50 100	Volts
Operating Ambient Temperature	Derating, Above 60°C	All	-40		+85	°C
Case Temperature		All			+100	°C
Storage Temperature		All	-55		+105	°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
Maximum Input Current	100% Load, V_{in} =9V	24Vin		3850		mA
	100% Load, V_{in} =18V	48Vin		1900		
No-Load Input Current	V_{in} =Nominal input	AS22S3.3-7.5 AS22S5-6 AS22S12-2.5 AS22S15-2 AS45S3.3-7.5 AS45S5-6 AS45S12-2.5 AS45S15-2		50 60 80 50 30 30 40 50		mA
Input Under Voltage Lockout						
Turn-On Voltage Threshold		Vin = 24V	8	8.5	8.8	Volts
		Vin = 48V	16.5	17	17.5	Volts
Turn-Off Voltage Threshold		Vin = 24V	7.7	8	8.3	Volts
		Vin = 48V	15.5	16	16.5	Volts
Lockout Hysteresis Voltage	100% Load, V_{in} =9V	Vin = 24V		0.6		Volts
	100% Load, V_{in} =18V	Vin = 48V		0.9		Volts
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	3.2505 4.925 11.82 14.775	3.3 5 12 15	3.3495 5.075 12.18 15.225	Volts
Output Voltage Regulation						
Line Regulation	V_{in} =High line to Low line Full Load	All			±0.5	%
Load Regulation	I_o = Full Load to min. Load	Single			±0.5	%
Temperature Coefficient	TC=-40°C to 85°C				±0.02	%/°C
Output Voltage Ripple and Noise	5Hz to 20MHz bandwidth					
Peak-to-Peak	Full Load, 0.1uF ceramic capacitor	Vo=3.3V Vo=5V			75	mV
		Vo=15V Vo=12V			100	
Operating Output Current Range		Vo=3.3V Vo=5V Vo=12V Vo=15V	0 0 0 0		7500 6000 2500 2000	mA
Output DC Current-Limit Inception	Output Voltage=90% $V_{O,\ nominal}$	All	110	130	150	%
Maximum Output Capacitance	Full load, Resistance	Vo=3.3V Vo=5V Vo=12V Vo=15V			7500 6000 2500 2000	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			300	µs
Turn-On Delay and Rise Time						
Turn-On Delay Time, From Input	V_{in_min} to 10%V_{o_set}	All		3		ms
Turn-On Delay Time, From On/Off Control	Von/off to 10%V_{o_set}	All		1		ms
Output Voltage Rise Time	10% V_{o_set} to 90% V_{o_set}	All		5		ms

FEATURE CHARACTERISTICS

Parameters	Conditions	Model	Min.	Typical	Max.	Units
Efficiency 100% Load	V_{in} =24 Vdc, $I_o = I_{o\_max}$, Tc=25°C	AS22S3.3-7.5 AS22S5-6 AS22S12-2.5 AS22S15-2		88 89 91 91		%
	V_{in} =48 Vc, $I_o = I_{o\_max}$, Tc=25°C	AS45S3.3-7.5 AS45S5-6 AS45S12-2.5 AS45S15-2		88 90 91 91		%
ISOLATION CHARACTERISTICS						
Input to Output	1 minutes	All	1500			Volts
Isolation Resistance		All	100			MΩ
Isolation Capacitance		All		1000		pF
Switching Frequency		Vin=24V		300		KHz
		Vin=48		250		
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 Current (for both remote on/off logic)	Ion/off at Von/off=0.0V			0.3	1	mA
Leakage Current (for both remote on/off logic)	Logic high, Von/off=15V				30	μA
Off Converter Input Current	Shutdown input idle current			4	10	mA
Output Over Voltage Protection	Zener or TVS clamp	Vo=3.3		3.9		Volts
		Vo=5		6.2		Volts
		Vo=12		15		Volts
		Vo=15		18		Volts
Over-Temperature Shutdown		All		110		°C
Output Voltage Trim range	At rated Power	All	-10		+10	%
MTBF	I_o =100%of I_{o_max};Ta=25°C per MIL-HDBK-217F	All		650		K hours
Weight		All		50		grams

Operating Temperature Range

This AS series of converters is designed to operate over the wide temperature of -25°C to +85°C. The Derating of this module starts above +60°C. The module operate normally up to +100°C case temperature.

Output Voltage Adjustment

The output voltage on all models is adjustable within the range of -10% to +10%.

UVLO (Under Voltage Lock Out)

Input Under Voltage Lock Out is standard on this AS series. The unit will shut down when the input voltage drops below a threshold, and the unit will operate when the input voltage goes above the upper threshold.

Over Voltage Protection

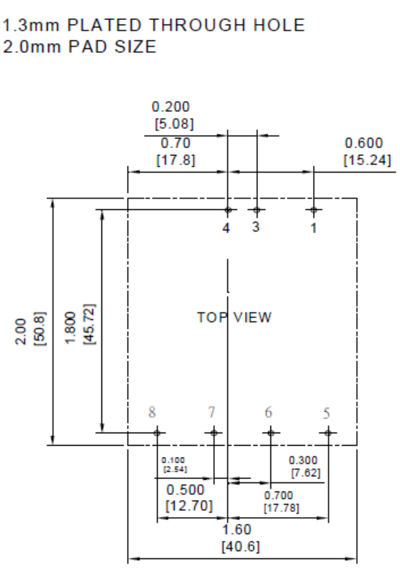
The over-voltage protection consists of a zener diode that limits the output voltage.

Over-Temperature Protection (OTP)

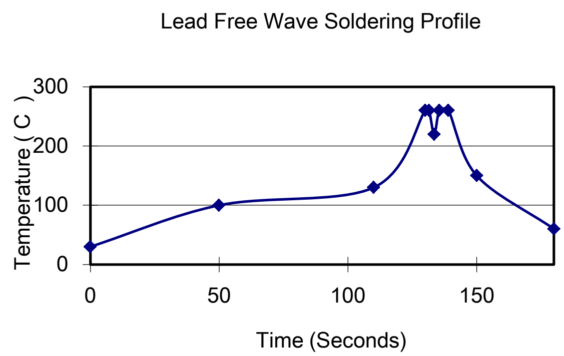
This AS series of converters is equipped with non-latching over-temperature protection. If the temperature exceeds a threshold of 110°C (typical) the converter will shut down, disabling the output. When the temperature decreases, the converter will automatically restart. The over-temperature condition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

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)



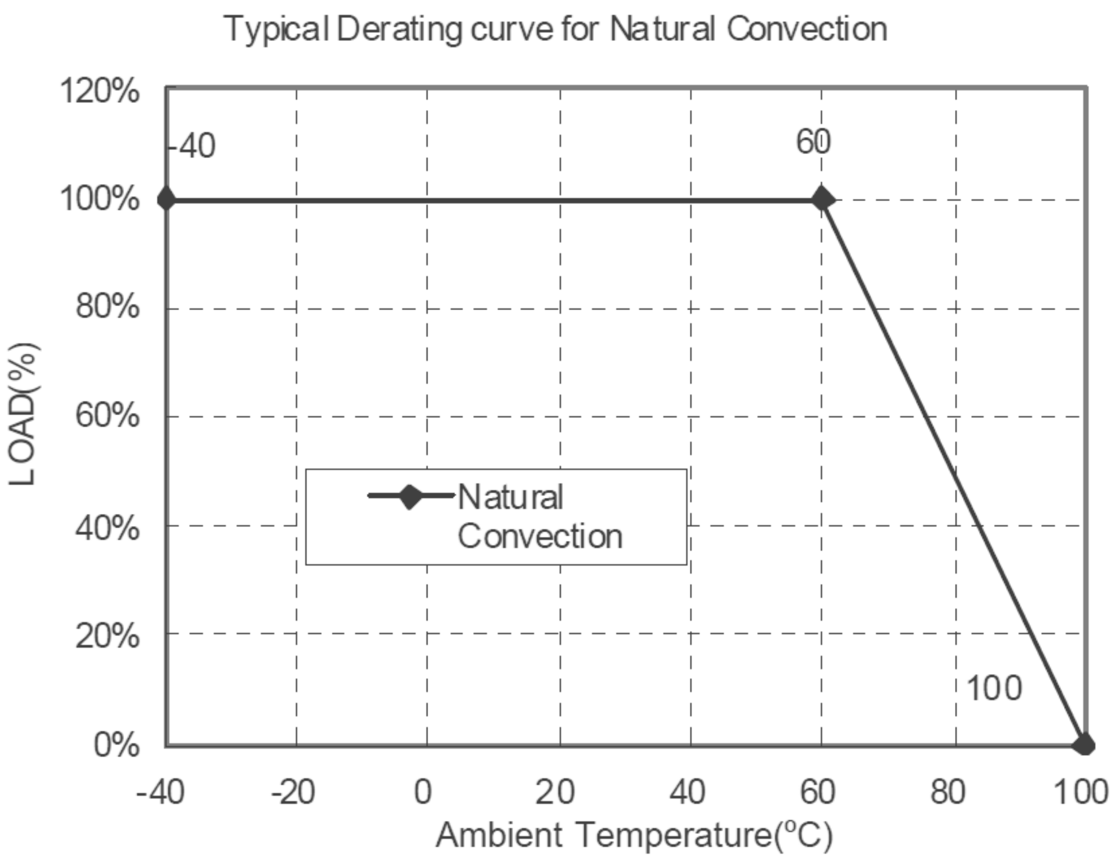
Wave Soldering Profiles

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)

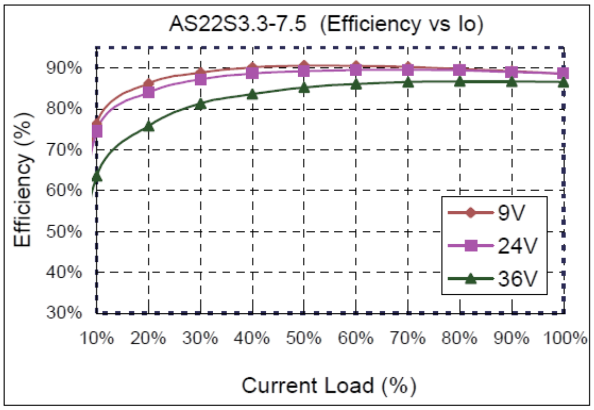
AS Series power de-rating Curves

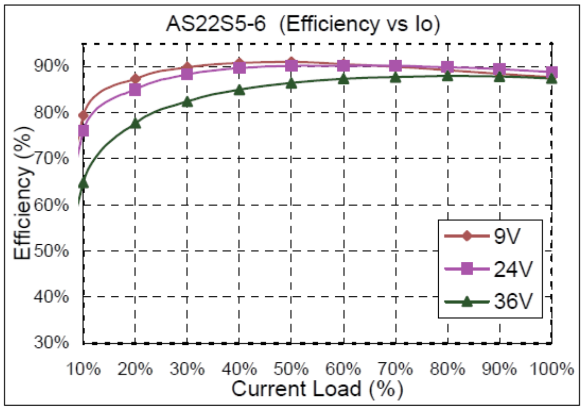
Note that the converter operating ambient temperature range is -25°C to + 85°C with derating above +60°C. Also, maximum case temperature under any operating condition should not exceed +100°C.

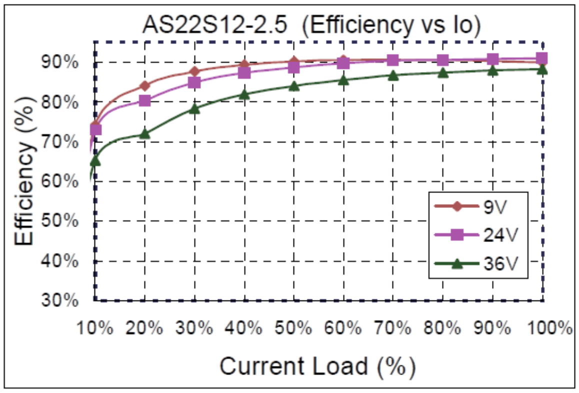


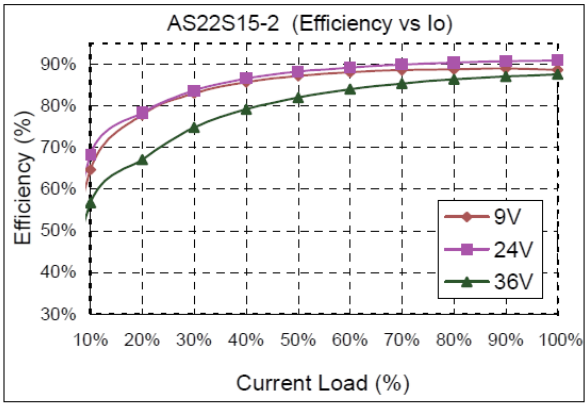
Typical Power De-rating Curve for AS Series

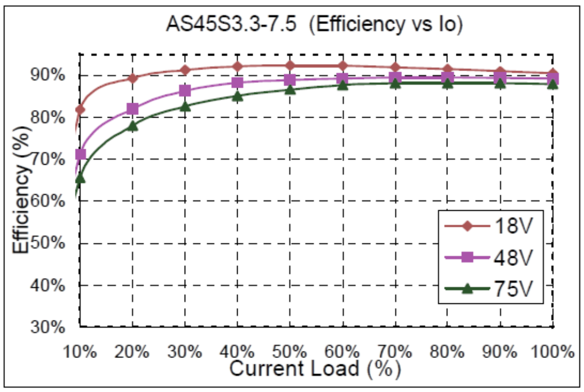
Efficiency vs. Load Curves

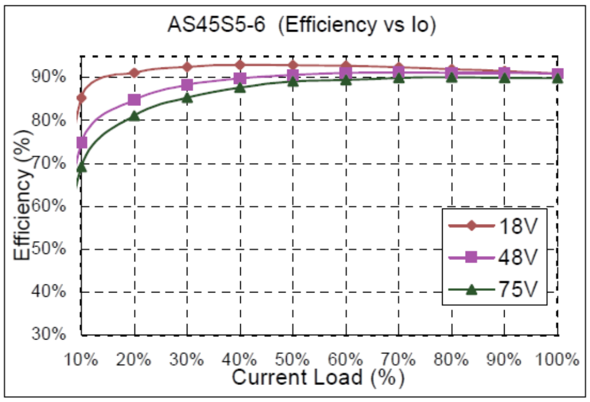


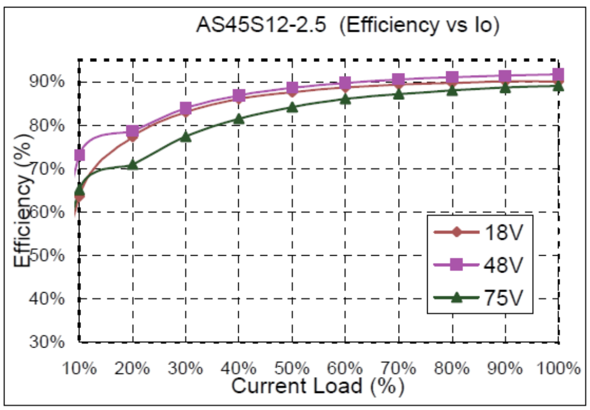


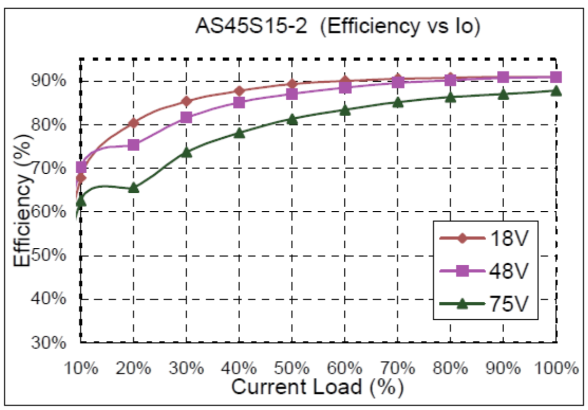






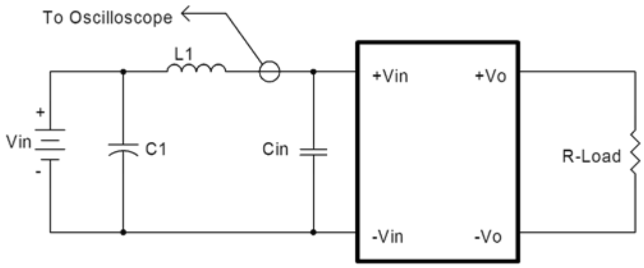






Input Capacitance at the Converter

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 (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

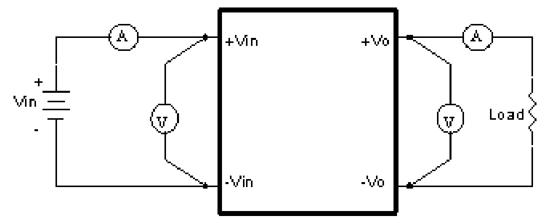
V_{FL} is the output voltage at full load
V_{NL} is the output voltage at 10% load

The value of line regulation is defined as:

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

Where

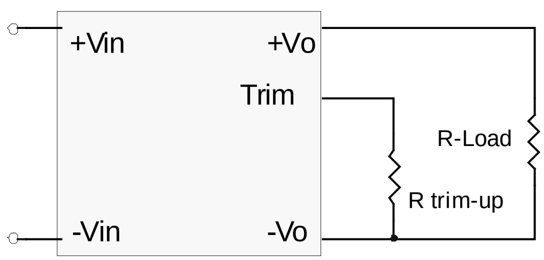
V_{HL} is the output voltage of the maximum input voltage at full load.
V_{LL} is the output voltage of the minimum input voltage at full load.



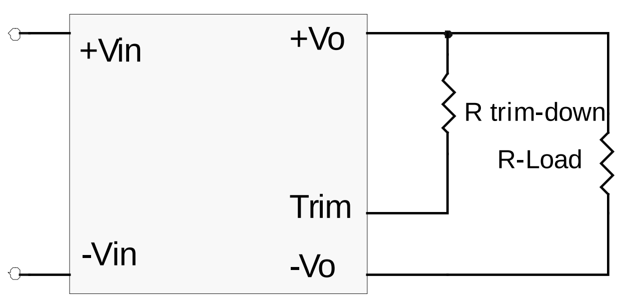
AS Series Test Setup

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 Rtrim-up is defined as:

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

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

Model Number	Output Voltage(V)	R1 (KΩ)	R2 (KΩ)	R3 (KΩ)	Rt (KΩ)	Vr (V)
AS22S3.3-7.5 AS45S3.3-7.5	3.3	2.74	1.8	0.27	9.1	1.24
AS22S5-6 AS45S5-6	5.0	2.32	2.32	0	8.2	2.5
AS22S12-2.5 AS45S12-2.5	12.0	6.8	2.4	2.32	22	2.5
AS22S15-2 AS45S15-2	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 (AS22S5-6) 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 K

R2 = 2.32 K

R3 = 0 K

Rt = 8.2 K,

Vr= 2.5 V

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

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

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

Where:

Rtrim-down is the external resistor in Kohm.

Vo, nom is the nominal output voltage.

Vo is the desired output voltage.

R1, Rt, R2, R3 and Vr are internal to the unit and are defined in the above Table.

For example, to trim-down the output voltage of 5.0V module (AS22S5-6) by 10% to 4.5V, R trim-down is calculated as follows:

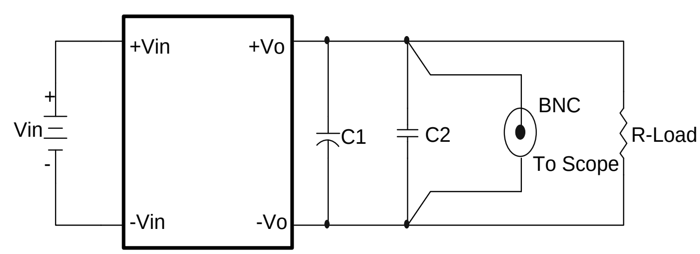
$V_{0,nom} - Vo = 5.0 - 4.5 = 0.5V$

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

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

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 5Hz to 20MHz Bandwidth.



Output Voltage Ripple and Noise Measurement Set-Up

Note: C1: None
C2: 0.1µF ceramic capacitor

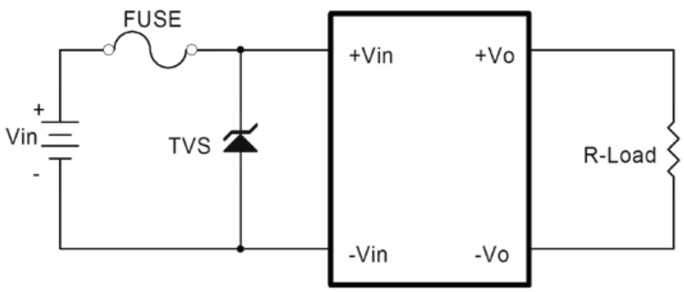
Output Capacitance

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

SAFETY and EMC

Input Fusing and Safety Considerations

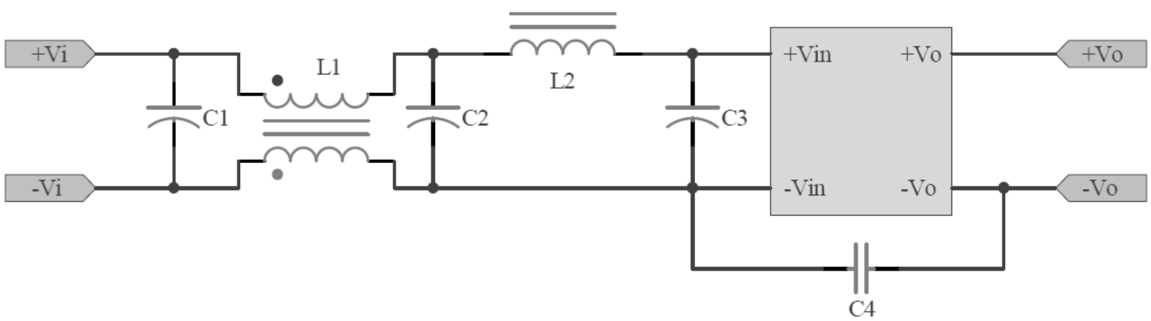
The AS series of converters does not have an internal fuse. However, to achieve maximum safety and system protection, always use an input line fuse. DATEL recommended a time delay fuse of 6A for 24Vin models and 3A for 48Vin modules. The circuit in the figure below is recommended by a Transient Voltage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



Input Protection Circuit

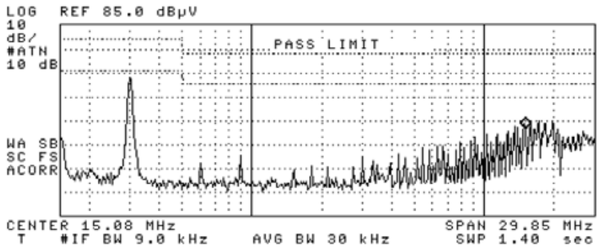
EMC Considerations

EMI Test standard: EN55022 Class A or Class B Conducted Emission
Test Condition: Nominal Input, Full Load at 25°C

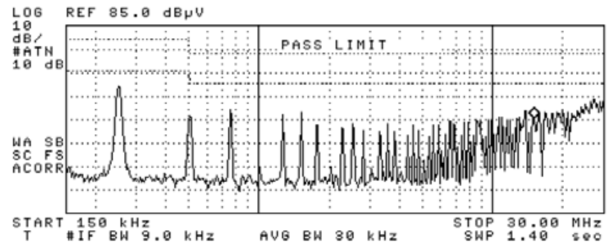


Connection circuit for conducted EMI testing

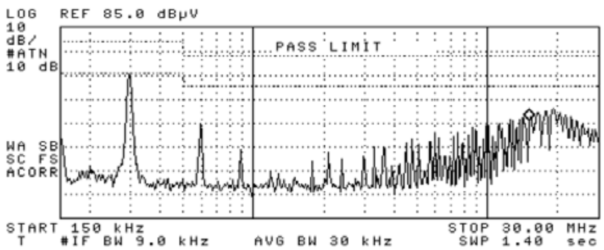
	EN55022 Class A						EN55022 Class B					
Model No.	**C1**	**C2**	**C3**	**C4**	**L1**	**L2**	**C1**	**C2**	**C3**	**C4**	**L1**	**L2**
AS22S3.3-7.5	NC	10μF/50V KY	22μF/50V KY	NC	Short	3.4μH	NC	100uF/100V PW	100uF/100V PW	2200pF	0.65mH	3.4μH
AS22S5-6	NC	10μF/50V KY	22μF/50V KY	NC	Short	3.4μH	NC	100uF/100V PW	100uF/100V PW	2200pF	0.65mH	3.4μH
AS22S12-2.5	NC	10μF/50V KY	22μF/50V KY	NC	Short	3.4μH	NC	100uF/100V PW	100uF/100V PW	2200pF	0.65mH	3.4μH
AS22S15-2	NC	10μF/50V KY	22μF/50V KY	NC	Short	3.4μH	NC	100uF/100V PW	100uF/100V PW	2200pF	0.65mH	3.4μH
AS45S3.3-7.5	NC	NC	220μF/100V KMF	NC	Short	Short	NC	100uF/100V PW	100uF/100V PW	2200pF	0.65mH	3.4μH
AS45S5-6	NC	NC	220μF/100V KMF	NC	Short	Short	NC	100uF/100V PW	100uF/100V PW	2200pF	0.65mH	3.4μH
AS45S12-2.5	NC	NC	220μF/100V KMF	NC	Short	Short	NC	100uF/100V PW	100uF/100V PW	2200pF	0.65mH	3.4μH
AS45S15-2	NC	NC	220μF/100V KMF	NC	Short	Short	NC	100uF/100V PW	100uF/100V PW	2200pF	0.65mH	3.4μH



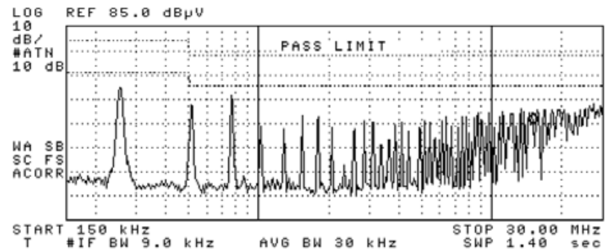
Conducted Class A test for AS22S3.3-7.5



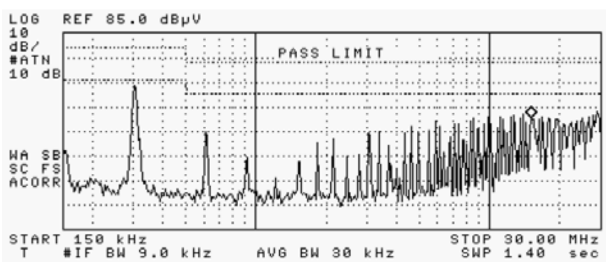
Conducted Class A test for AS45S3.3-7.5



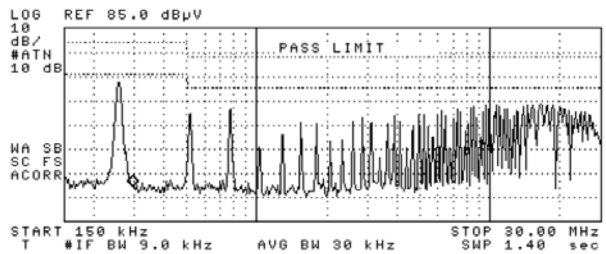
Conducted Class A test for AS22S5-6



Conducted Class A test for AS45S5-6



Conducted Class A test for AS22S12-2.5



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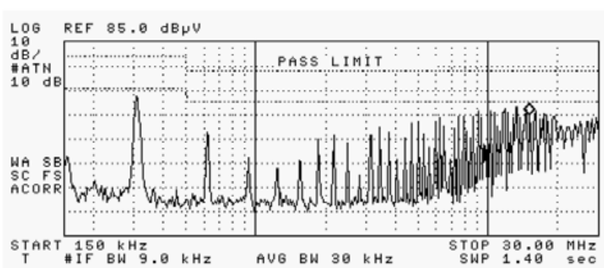
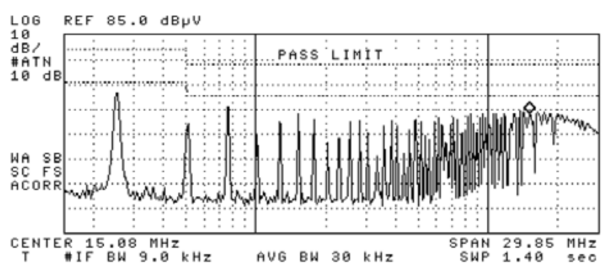


Conducted Class A test for AS22S15-2



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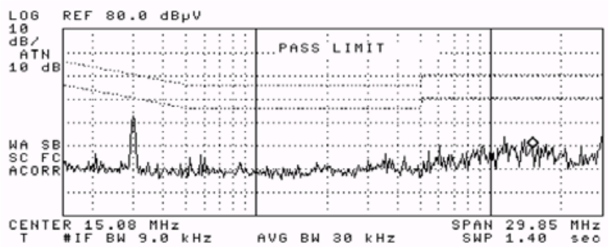
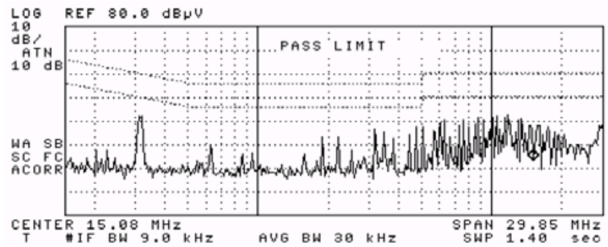
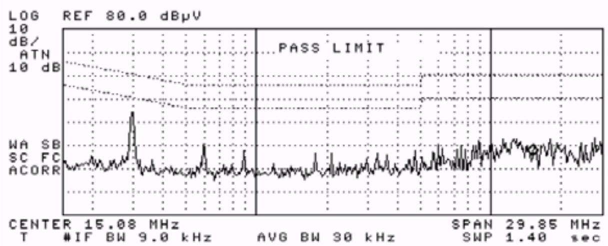


Conducted Class B test of AS22S3.3-7.5



Conducted Class B test of AS22S15-2



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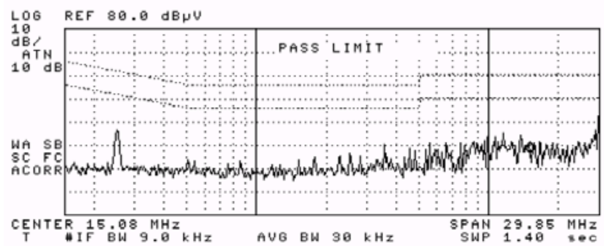
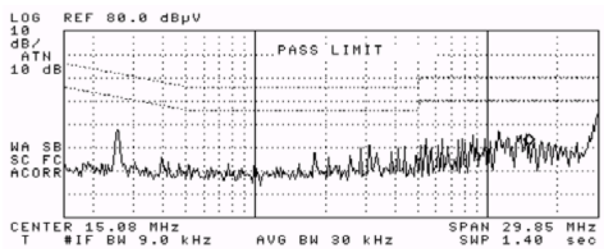


Conducted Class B test of AS45S3.3-7.5



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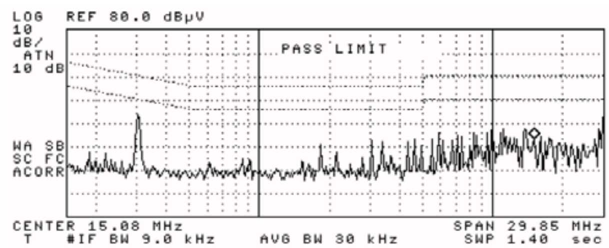

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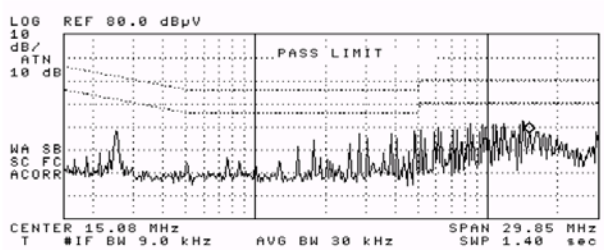

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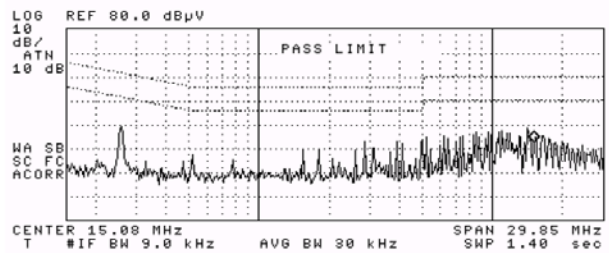
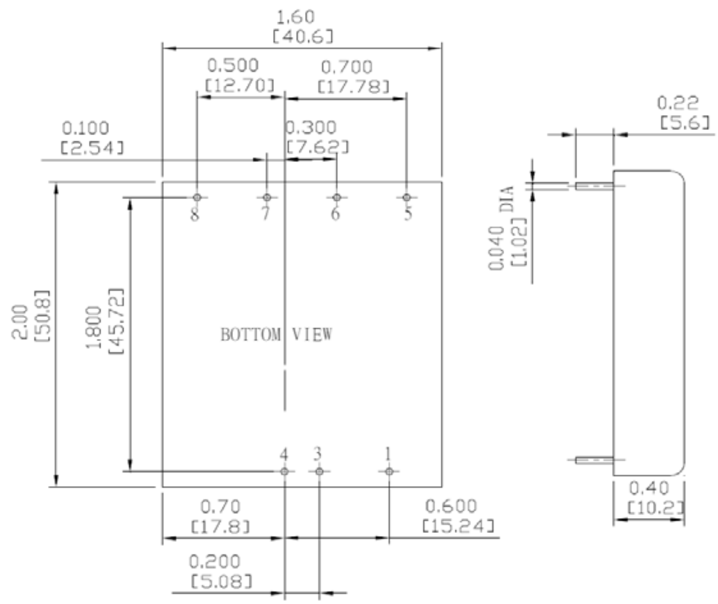


Conducted Class B test of AS45S15-2

MECHANICAL DIMENSIONS Inches (mm)



Note: All dimensions are in inches (millimeters). Tolerance: x.xx ±0.04 in. (0.5mm), x.xxx ±0.010 in. (0.25 mm) unless otherwise noted

PIN CONNECTIONS

Pin Connections	
PIN	**SINGLE OUTPUT**
1	On/Off Control
3	- V Input
4	+ V Input
5	Trim
6	- V Output
7	+ V Output
6	No Pin

PART NUMBER AND ORDERING INFORMATION

Family, Form Factor Package	Nominal Input Voltage	Number of Outputs	Voltage Output		Current Output (A)
AS	**22**	**S**	**5**	**-**	**6**

- Nominal Input Voltage: (9-36) 22 Volts; (18-72) 45 Volts
- Number of Outputs: S - Single
- Voltage Output: 3.3 Volts, 5 Volts, 12 Volts, 15 Volts
- Current Output (A): 3.3 Volts – 7.5A, 5 Volts - 6A, 12 Volts – 2.5A, 15 Volts – 2A

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