AS SERIES (2.00” x 1.6” Package)

Up to 20 Watt DC-DC Converter

FEATURES

- Industry standard footprint (2 inch X 1.6 inch)
- Regulated Outputs, Fixed Switching Frequency
- Up to 84 % Efficiency
- 4:1 Input Range
- Up to 20 Watts of Power
- -25°C to +71°C temperature range
- Remote On/Off logic control
- Metal shielding case (six-sided)
- Continuous Short Circuit Protection

PRODUCT OVERVIEW

The AS series offer up to 20 watts of output power in standard 2.00 x 1.60 x 0.45 inches packages. This series 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 72VDC, and delivers precise regulated output. These modules operate over the ambient operating temperature range of –25°C to +71°C. All devices offer output over-current and short circuit protection. 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

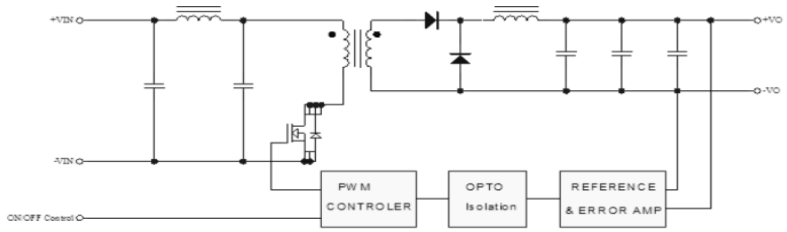
- Customizable output voltages
- CE Mark 2004/108/EC certification
- UL60950-1, EN60950-1, and IEC60950-1 safety

Contact DATEL for other series in 2.00" x 1.60" footprint

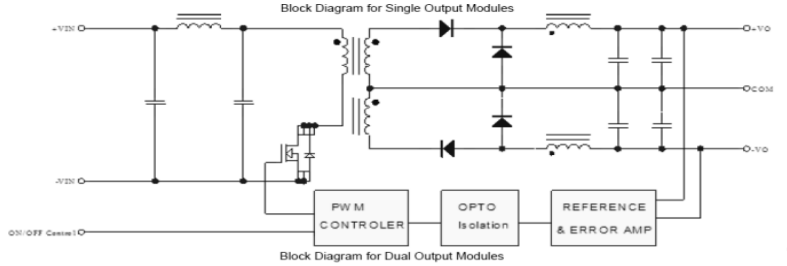
- Cost Savings, Higher Power, Other Voltage outputs, Higher Efficiency, etc.

MODEL NUMBER	INPUT VOLTAGE	OUTPUT VOLTAGE	OUTPUT CURRENT MAX	EFFICIENCY %	LOAD REGULATION	LINE REGULATION
AS22S3.3-4	9-36 VDC	3.3VDC	4 A	78	± 0.5 %	± 0.5 %
AS22S5-4	9-36 VDC	5.0 VDC	4 A	81	± 0.5 %	± 0.5 %
AS22S12-1.67	9-36 VDC	12 VDC	1.67 A	83	± 0.5 %	± 0.5 %
AS22S15-1.33	9-36 VDC	15 VDC	1.33 A	83	± 0.5 %	± 0.5 %
AS22D5-2	9-36 VDC	±5 VDC	±2 A	83	± 0.5 %	± 0.5 %
AS22D12-0.83	9-36 VDC	±12 VDC	±0.833 A	83	± 0.5 %	± 0.5 %
AS22D15-0.66	9-36 VDC	±15 VDC	±0.666 A	83	± 0.5 %	± 0.5 %
AS45S3.3-4	18-72VDC	3.3 VDC	4 A	78	± 0.5 %	± 0.5 %
AS45S5-4	18-72VDC	5 VDC	4 A	82	± 0.5 %	± 0.5 %
AS45S12-1.67	18-72VDC	12 VDC	1.67 A	84	± 0.5 %	± 0.5 %
AS45S15-1.33	18-72VDC	15 VDC	1.33 A	84	± 0.5 %	± 0.5 %
AS45D5-2	18-72VDC	±5 VDC	±2 A	84	± 0.5 %	± 0.5 %
AS45D12-1.25	18-72VDC	±12 VDC	±0.833 A	84	± 0.5 %	± 0.5 %
AS45D15-0.66	18-72VDC	±15 VDC	±0.666 A	84	± 0.5 %	± 0.5 %

FUNCTIONAL BLOCK DIAGRAM



Block Diagram for Single Output Modules



Block Diagram for Dual Output Modules

ABSOLUTE MAXIMUM RATINGS

Parameters	Conditions	Model	Min.	Typical	Max.	Units
Input Voltage						
Continuous	DC	$24V_{in}$ $48V_{in}$	-0.3 -0.3		36 72	Volts
Transient	100ms, DC	$24V_{in}$ $48V_{in}$			50 100	Volts
Operating Ambient Temperature	Derating, Above 60°C	All	-40		+71	°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 72	Volts
Maximum Input Current	100% Load, V_{in} =9V	24Vin		2780		mA
	100% Load, V_{in} =18V	48Vin		1390		
No-Load Input Current	V_{in} =Nominal input	AS22S3.3-4 AS22S5-4 AS22S12-1.67 AS22S15-1.33 A22D5-2 AS22D12-0.83 AS22D15-0.66 AS45S3.3-4 AS45S5-4 AS45S12-1.67 AS45S15-1.33 AS22D5-2 AS45D12-1.25 AS45D15-1		15 15 15 15 20 20 20 10 10 10 10 15 15 15		mA
Off Converter Input Current	Shutdown input idle current	All		4	10	mA
Inrush Current (I^2t)	As per ETS300 132-2	All			TBD	A^2s
Input Reflected-Ripple Current	P-P thru 12uH inductor, 5Hz to 20MHz	All			TBD	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=±5 Vo=±12 Vo=±15	3.267 4.95 11.89 14.85 4.9 11.76 14.7	3.3 5 12 15 5 12 15	3.333 5.05 12.12 15.15 5.05 12.12 15.15	Volts
Output Voltage Balance	V_{in} =nominal, Io= I_{o_max}, Tc=25°C	Dual			±1.0	%
Output Voltage Regulation						
Line Regulation	V_{in} =High line to Low line Full Load	Single Dual			±0.5 ±1.0	% %
Load Regulation	I_o = Full Load to min. Load	Single Dual			±0.5 ±1.0	% %
Temperature Coefficient	TC=-40°C to 80°C				±0.02	%/°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 Vo=15V Vo=12V Vo=±5V Vo=±15V Vo=±12V			75 75	mV
Operating Output Current Range		Vo=3.3V Vo=5V Vo=12V Vo=15V Vo=±5V Vo=±12V Vo=±15V	0 0 0 0 0 0 0		4000 4000 1670 1330 ±2000 ±833 ±666	mA
Output DC Current-Limit Inception	Output Voltage=90% $V_{0,\ nominal}$	All	120			%
Maximum Output Capacitance	Full load, Resistance	Vo=3.3V Vo=5V Vo=12V Vo=15V Vo=±5V Vo=±12V Vo=±15V			4000 4000 1670 1330 2000 833 666	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			500	µs
Turn-On Delay and Rise Time						
Turn-On Delay Time, From Input	$V_{in\ \_min}$ to 10%V_{o_set}	Vin=24V Vin=48V		180 140		ms
Output Voltage Rise Time	10% V_{o_set} to 90% V_{o_set}	Vin=24V Vin=48V		90 10		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	AS22S3.3-4		78		%
		AS22S5-4		81		
		AS22S12-1.67		83		
		AS22S15-1.33		83		
		AS22D5-2		83		
		AS22D12-0.83		83		
		AS22D15-0.66		83		
	V_{in} =48 Vdc, I_o = I_{o_max}, Tc=25°C	AS45S3.3-4		78		%
		AS45S5-4		82		
		AS45S12-1.67		84		
		AS45S15-1.33		84		
		AS45D5-2		84		
		AS45D12-0.83		84		
		AS45D15-0.666		84		
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		300		
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		72	Volts
Logic Low (Module Off)	$V_{on/off}$ at $I_{on/off}$=1.0mA	All			1.8	Volts
Logic Low (Module On)	$V_{on/off}$ at $I_{on/off}$=0.1uA	All			1.2	Volts
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		1500		M hours
Weight		All		53		grams

Operating Temperature Range

The AS series of converters operates over the wide temperature of -25°C to +71°C. Derating 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%.

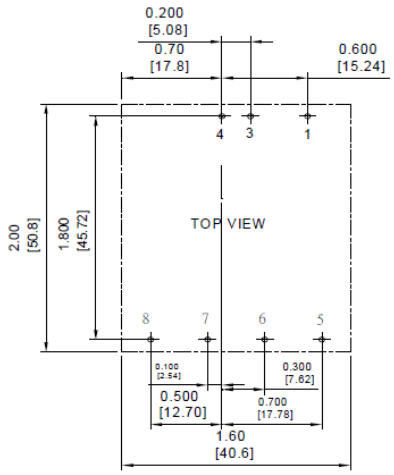
Recommended Layout PCB Footprints and Soldering Information

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

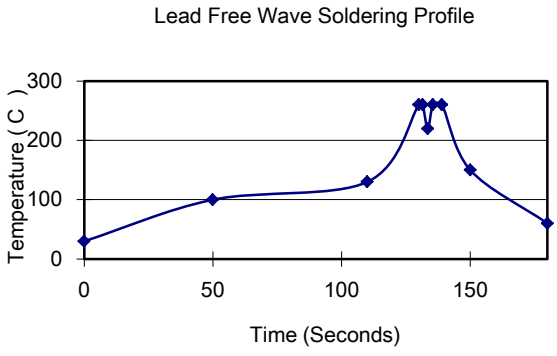
Note：

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)

1.3mm PLATED THROUGH HOLE
2.0mm PAD SIZE



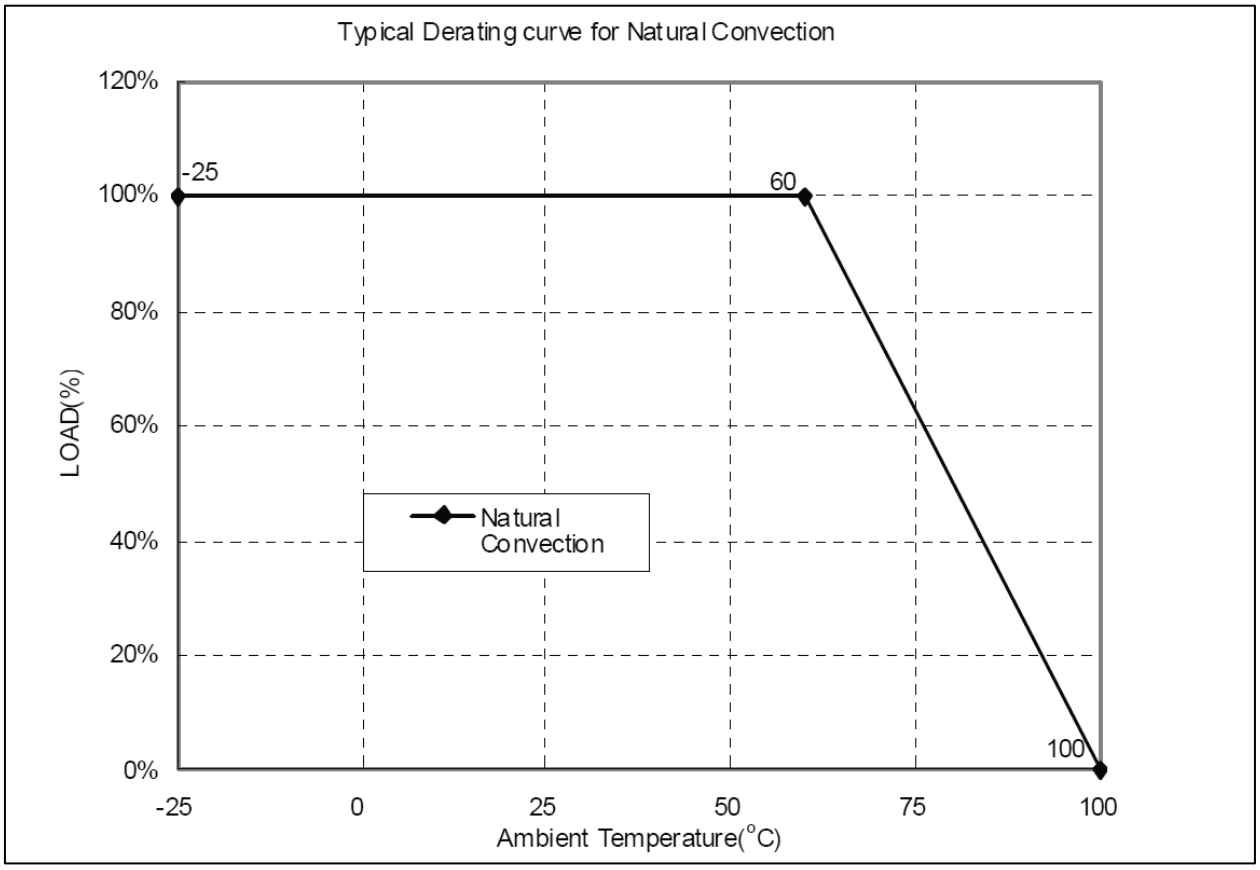
Recommended PCB Layout Footprints, Dimensions are in inches (millimeters)



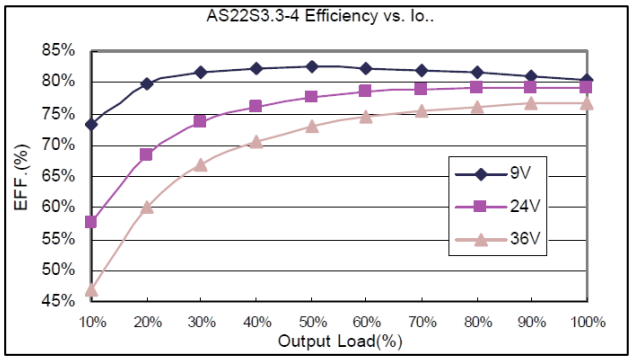
Wave Soldering Profiles

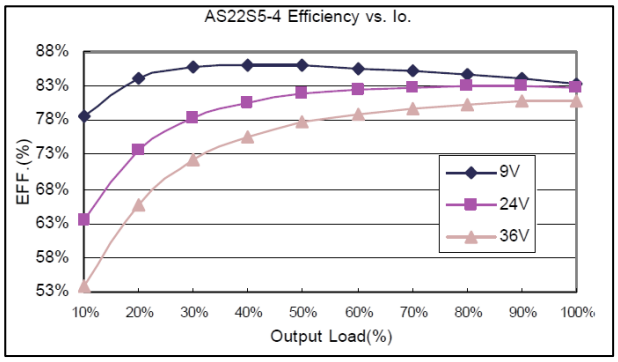
AS Series power de-rating Curves

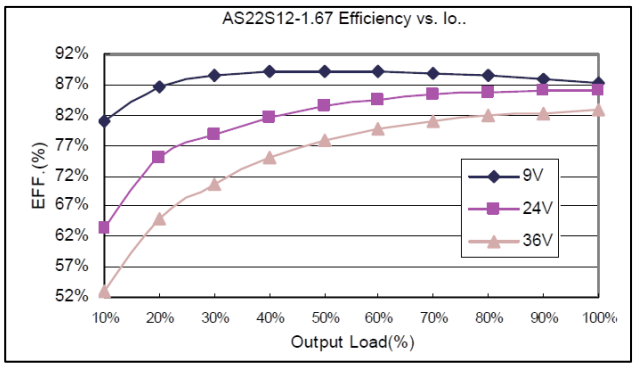
Note that the converter operating ambient temperature range is -25°C to + 71°C with derating above +60°C. Also, maximum case temperature under any operating condition should not exceed +100°C.

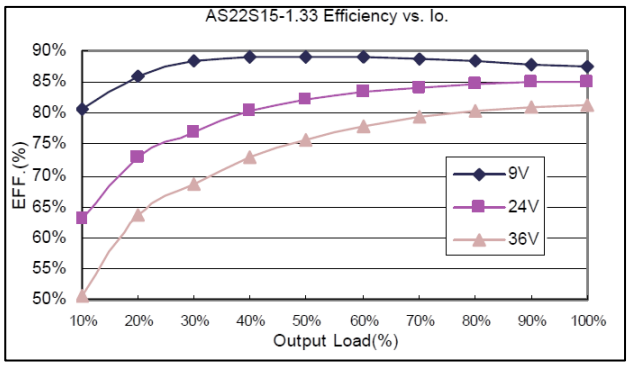


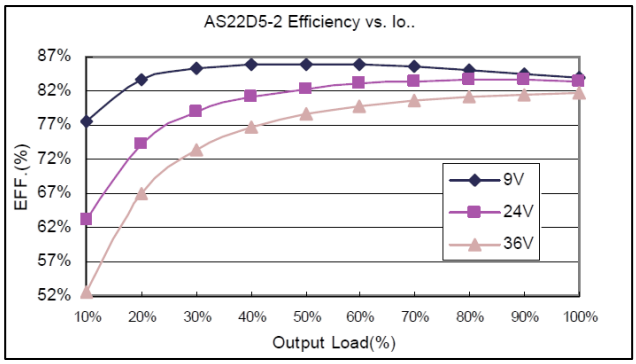
Efficiency vs. Load Curves

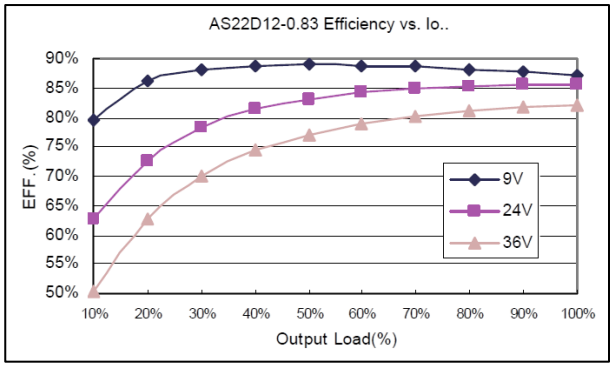


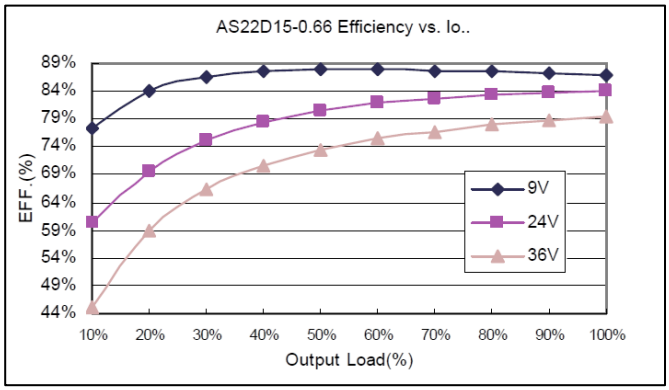


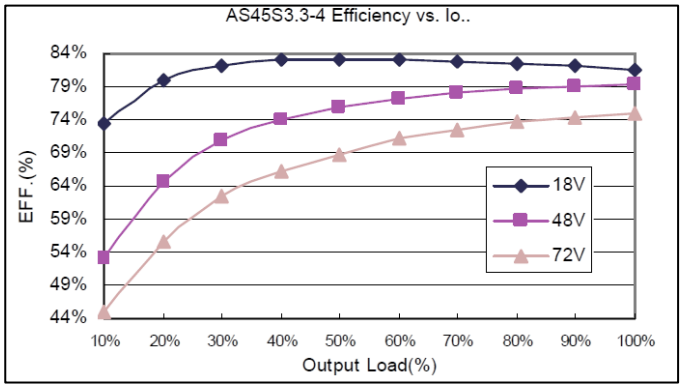


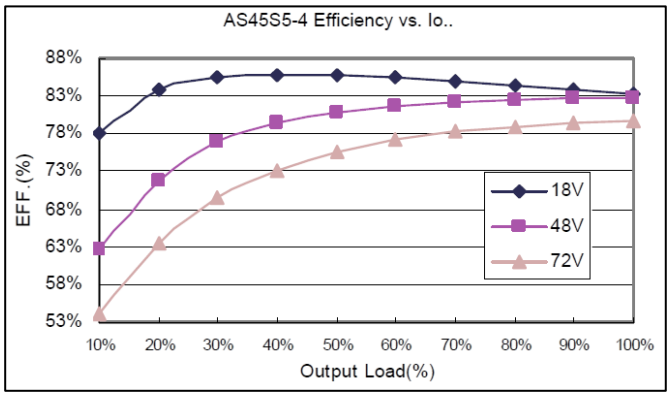


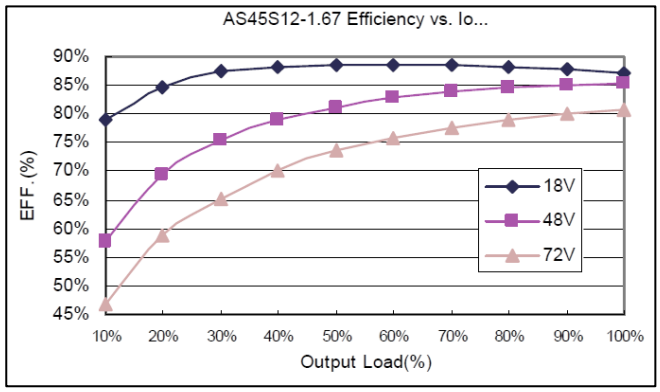


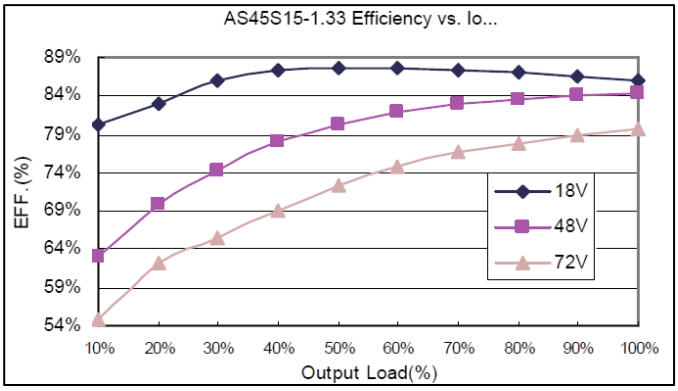


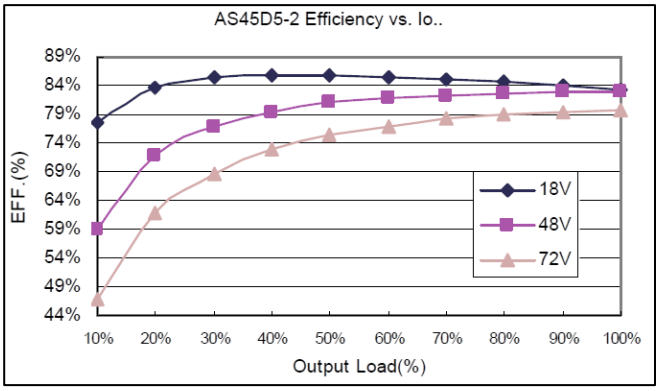

AS22D15-0.66 Efficiency vs. Io..
EFF.(%)
89%
84%
79%
74%
69%
64%
59%
54%
49%
44%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Output Load(%)
9V
24V
36V

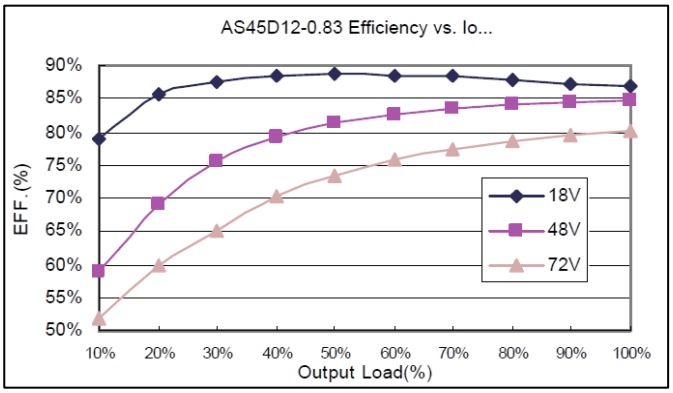

AS45S3.3-4 Efficiency vs. Io..
EFF.(%)
84%
79%
74%
69%
64%
59%
54%
49%
44%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Output Load(%)
18V
48V
72V

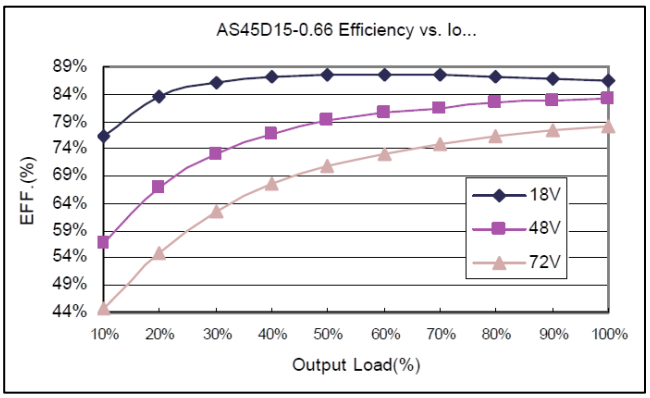

AS45S5-4 Efficiency vs. Io..
EFF.(%)
88%
83%
78%
73%
68%
63%
58%
53%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Output Load(%)
18V
48V
72V


AS45S12-1.67 Efficiency vs. Io...
EFF.(%)
90%
85%
80%
75%
70%
65%
60%
55%
50%
45%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Output Load(%)
18V
48V
72V


AS45S15-1.33 Efficiency vs. Io...
EFF.(%)
89%
84%
79%
74%
69%
64%
59%
54%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Output Load(%)
18V
48V
72V

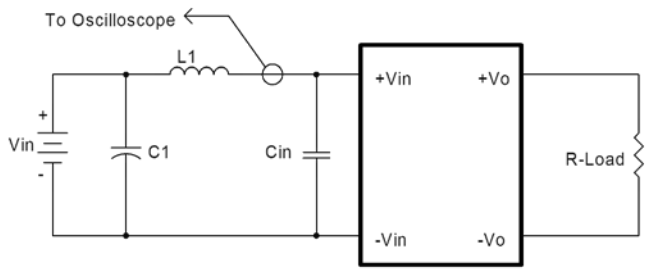

AS45D5-2 Efficiency vs. Io..
EFF.(%)
89%
84%
79%
74%
69%
64%
59%
54%
49%
44%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Output Load(%)
18V
48V
72V


AS45D12-0.83 Efficiency vs. Io...
EFF.(%)
90%
85%
80%
75%
70%
65%
60%
55%
50%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Output Load(%)
18V
48V
72V


AS45D15-0.66 Efficiency vs. Io...
EFF.(%)
89%
84%
79%
74%
69%
64%
59%
54%
49%
44%
10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Output Load(%)
18V
48V
72V

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

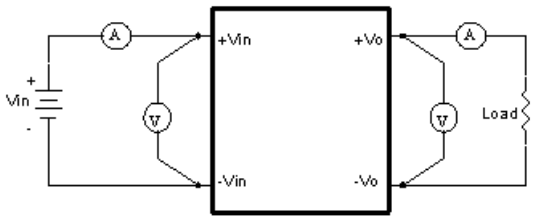
V_{FL} is the output voltage at full load
V_{NL} is the output voltage at 10% load

The value of line regulation is defined as:

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

Where

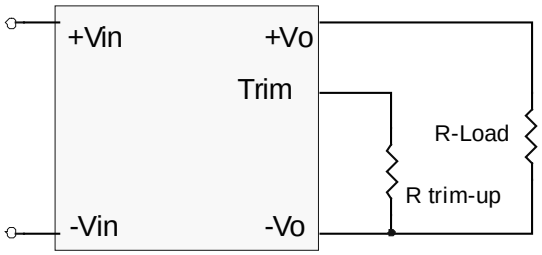
V_{HL} is the output voltage of the maximum input voltage at full load.
V_{LL} is the output voltage of the minimum input voltage at full load.



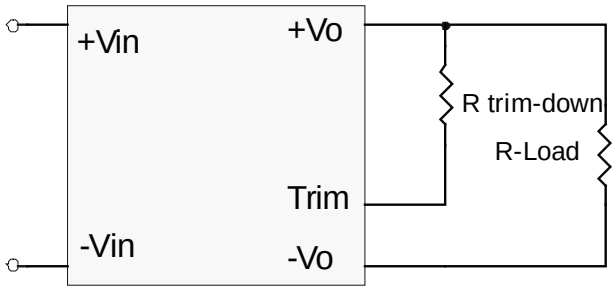
AS Series Test Setup

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 $R_{trim-up}$ is defined as:

$$R_{trim-up} = \frac{(R1 - R2 \times (Vo - V_{o,nom}))}{(Vo - V_{o,nom})} \ (K\Omega)$$

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.

R1and R2 are internal to the unit and are defined in the table below Trim up Resistor Values

Model Number	Output Voltage(V)	R1 (KΩ)	R2 (KΩ)
AS22S3.3-4 AS45S3.3-4	3.3	3.484	7.511
AS22S5-4 AS45S5-4	5.0	5.788	8.25
AS22S12-1.67 AS45S12-1.67	12.0	19.763	14.366
AS22S15-1.33 AS45S15-1.33	15.0	25.585	14.516
AS22D5-2 AS45D5-2	±5V	20.657	19.5
AS22D12-0.83 AS45D12-0.83	±12V	42.141	13.793
AS22D15-0.66 AS45D15-0.66	±15V	56.644	17.647

For example, to trim-up the output voltage of the 5.0 Votls module (AS22S5-4) by 8% to 5.4V, R trim-up is calculated as follows:

$V_o - V_{o,nom} = 5.4 - 5.0 = 0.4V$

R1 = 5.788 KΩ

R2 = 8.25 KΩ

$$R_{trim-up} = \frac{5.788 - 8.25 \times 0.4}{0.4} = 6.22 \ (K\Omega)$$

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

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

Where

Rtrim-down is the external resistor in Kohm.

VO, nom is the nominal output voltage.

VO is the desired output voltage.

R1, R2, are internal to the unit and are defined in the table below.

Model Number	Output Voltage(V)	R1 (KΩ)	R2 (KΩ)
AS22S3.3-4 AS45S3.3-4	3.3	6.18	12.1
AS22S5-4 AS45S5-4	5.0	5.788	10.57
AS22S12-1.67 AS45S12-1.67	12.0	86.496	60.1
AS22S15-1.33 AS45S15-1.33	15.0	150	87
AS22D5-2 AS45D5-2	±5V	68.296	48.1
AS22D12-0.83 AS45D12-0.83	±12V	430	120
AS22D15-0.66 AS45D15-0.66	±15V	743	177

For example, to trim-down the output voltage of 5.0V module (AS22S5-6) by 8% to 4.6V, $R_{trim-down}$ is calculated as follows:

$V_{O,nom} - Vo = 5.0 - 4.6 = 0.4V$

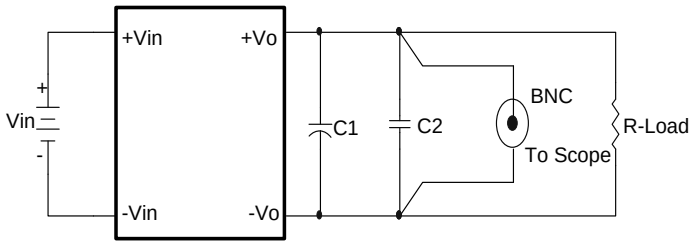
R1 = 5.788 KΩ

R2 = 10.57 KΩ

$$R_{trim-down} = \frac{5.788 - 10.57 \times 0.4}{0.4} = 3.9 \ (K\Omega)$$

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

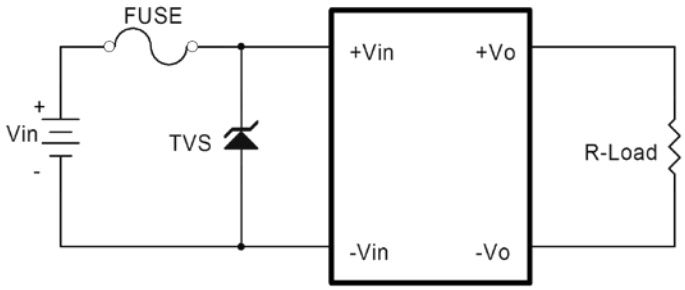
Output Capacitance

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

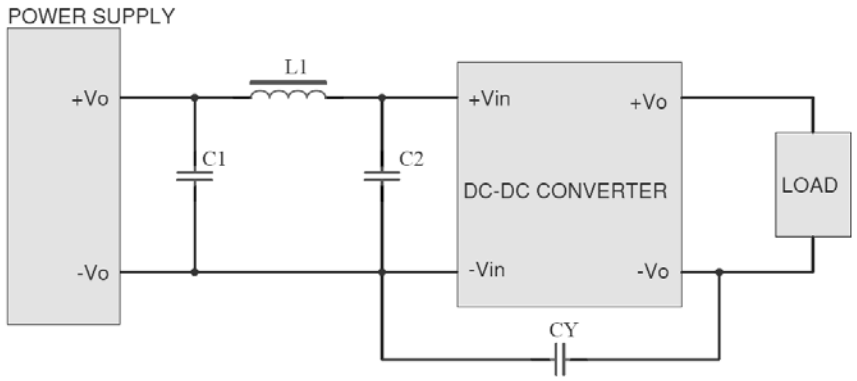
This AS series of converters does not have an internal fuse. However, to achieve maximum safety and system protection, always use an input line fuse. DATEL recommended a time delay fuse of 4A for 24Vin models and 2A for 48Vin modules. The circuit in the figure below is recommended by a Transient Voltage 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 B Conducted Emission
Test Condition: Nominal Input, Full Load at 25°C

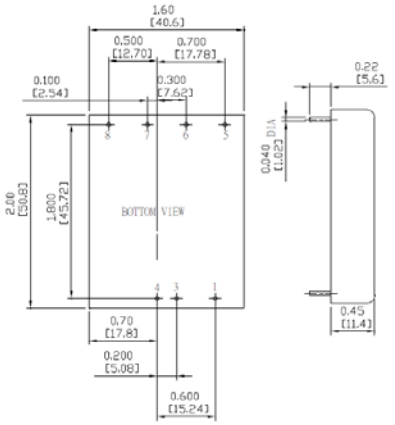


Connection circuit for conducted EMI testing

	EN55022 class A						
Model No.	**C1**	**L1**	**C2**	**Model No.**	**C1**	**L1**	**C2**
AS22S3.3-4	47µF/50V	1.25µH	47µF/50V	AS45S3.3-4	22µF/100V	3.5µH	22µF/100V
AS45S5-4	47µF/50V	1.25µH	47µF/50V	AS45S5-4	22µF/100V	3.5µH	22µF/100V
AS45S12-1.67	47µF/50V	1.25µH	47µF/50V	AS45S12-1.67	22µF/100V	3.5µH	22µF/100V
AS45S15-1.33	47µF/50V	1.25µH	47µF/50V	AS45S15-1.33	22µF/100V	3.5µH	22µF/100V
AS45D5-2	47µF/50V	1.25µH	47µF/50V	AS45D5-2	22µF/100V	3.5µH	22µF/100V
AS45D12-0.83	47µF/50V	1.25µH	47µF/50V	AS45D12-0.83	22µF/100V	3.5µH	22µF/100V
AS45D15-0.66	47µF/50V	1.25µH	47µF/50V	AS45D15-0.66	22µF/100V	3.5µH	22µF/100V

Note: All of capacitors are KY aluminum capacitors. CY is a No Connection.

MECHANICAL DIMENSIONS Inches (mm)

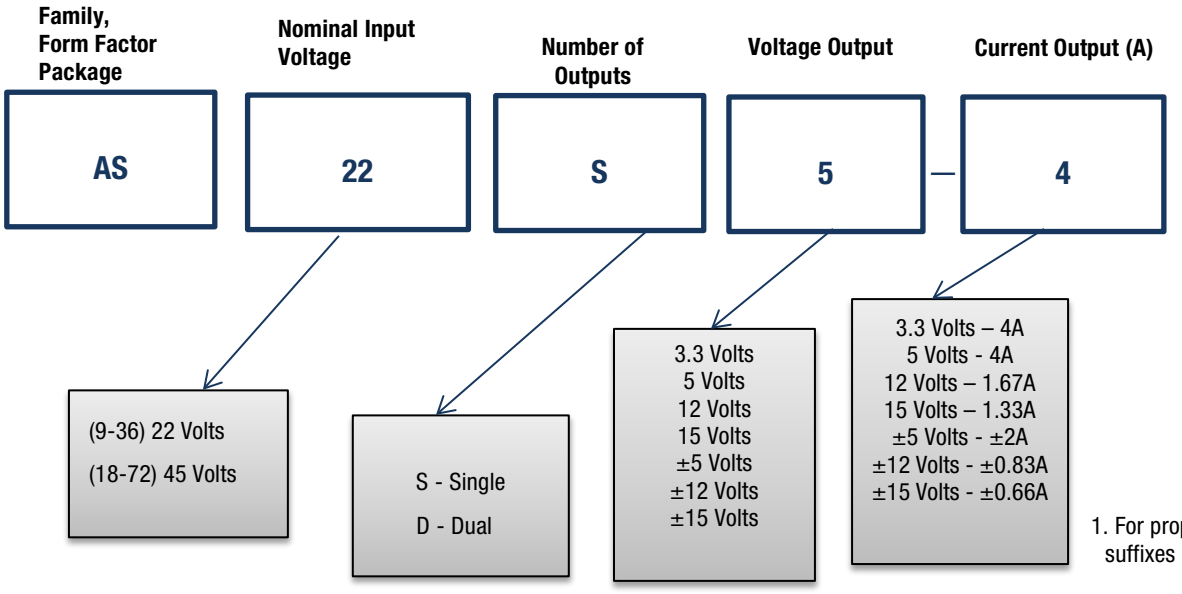


Note: All dimensions are in inches (millimeters). Tolerance: x.xx ±0.04 in. (0.5mm), x.xxx ±0.010 in. (0.25 mm) unless otherwise noted

PIN CONNECTIONS

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

PART NUMBER AND ORDERING INFORMATION



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