AA SERIES (1 x 1 Package)

Up to 40 Watt DC-DC Converter

PRODUCT OVERVIEW

This AA series offer 40 watts of output power in standard 1.00 x 1.00 x 0.4 inches packages. This series features high efficiency up to 90% and 2250 Volts of DC isolation. This AA series provides a 4:1 wide input voltage range of 9-36 or 18-75 VDC, and delivers precise regulated outputs. These modules operate over the ambient operating temperature range of –40°C to +123°C with minimal Derating. 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. In addition, the standard control functions of this series include Remote On/Off and adjustable output voltage. These converters are the best choice for all military and ruggedized application that can use commercial off-the-shelf (COTS) products.

FEATURES

- Industry standard footprint (1 inch X 1 inch X 0.4 Inch)
- Regulated Outputs, Fixed Switching Frequency
- 4:1 input voltage range: 4.5 - 9, 9 - 36 or 18 - 75Vin
- No minimum load required
- -40 ^{0}C to +123 ^{0}C operation.
- Withstands up to 100 V input transients
- Fixed-frequency operation
- Full protection (OTP, OCP, OVP, UVLO and auto-restart)
- Remote ON/OFF - positive or negative
- Output voltage trim range: ±10%
- On-board input differential LC filter
- ROHS II Directive 2011/65/EU Compliant
- Meets UL94, V-0 flammability rating
- Compliant to REACH (EC) No 1907/2006
- Designed to meet UL/CSA60950-1, TUV per IEC/EN60950-1, 2nd edition
- Designed to meet Class B conducted emissions per FCC and EN55022 when used with external filter

APPLICATIONS:

- Distributed Power Architectures
- Instrumentation
- Data and Wireless Communications
- Servers
- “Bus” Converter Applications

AVAILABLE OPTIONS

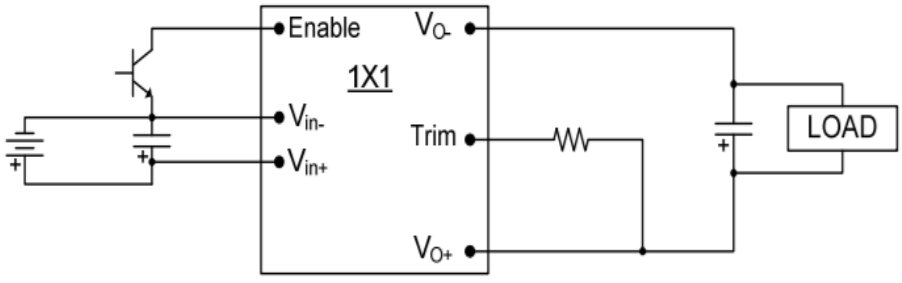
- Customizable Input / Output voltages
- SMT or Thru-Hole Mounting
- Higher Power
- Optional Baseplate

Contact DATEL for other series of (1 inch X 1 inch) footprint, lower power optimized for Cost Savings or higher performance

MODEL NUMBER	INPUT VOLTAGE	OUTPUT VOLTAGE	OUTPUT CURRENT MAX	EFFICIENCY %	LOAD REGULATION	OPTIONS
AA5S5-6	4.5-9 VDC	5 VDC	6 A	88	± 0.1 %	E, I , S, N, P*
AA22S3.3-9	9-36 VDC	3.3 VDC	9 A	88	± 0.1 %	E, I , S, N, P*
AA22S5-8	9-36 VDC	5 VDC	8 A	89	± 0.1 %	E, I , S, N, P*
AA22S12-3.3	9-36 VDC	12 VDC	3.3 A	88	± 0.1 %	E, I , S, N, P*
AA45S5-8	18-75 VDC	5 VDC	8 A	88	± 0.1 %	E, I , S, N, P*
AA45S12-3.3	18-75 VDC	12 VDC	3.3 A	88	± 0.1 %	E, I , S, N, P*

***Note: For Option descriptions, please see last page of this data sheet**

CONNECTION DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Please note: stresses above the absolute maximum ratings can cause permanent damage to the device.

Parameters	Conditions	Model	Min.	Typical	Max.	Units
Input Voltage						
Continuous	DC	$5V_{in}$ $24V_{in}$ $48V_{in}$	0 0 0		**9** 36 75	Volts
Operating Ambient Temperature	With Derating	Open Frame	-40		+123	**°C**
Operating Ambient Temperature	With Derating	Encapsulated	-40		+105	**°C**
Storage Temperature		All	-55		+125	**°C**

ELECTRICAL SPECIFICATIONS

Note: All specifications are typical at nominal input, full load at 25°C, Airflow=300 LFM, V_{in} = Nominal VDC, Cin=100µF for 24 V_{in} and Cin=33µF for 48 V_{in}, unless otherwise noted

INPUT CHARACTERISTICS

Parameters	Conditions	Model	Min.	Typical	Max.	Units
Operating Input Voltage		$5V_{in}$ $24V_{in}$ $48V_{in}$	4.5 9 18	5 24 48	9 36 75	Volts
Input Under Voltage Lockout						
Turn-On Voltage Threshold		$5V_{in}$ $24V_{in}$ $48V_{in}$	4.3 9.1 17.5	4.4 9.3 17.8	4.5 9.5 18.1	Volts
Turn-Off Voltage Threshold		$5V_{in}$ $24V_{in}$ $48V_{in}$	3.3 8.4 15.6	3.5 8.6 16.0	3.7 8.9 16.5	Volts
Maximum Input Current	100% Load, V_{in} =5V 100% Load, V_{in} =9V 100% Load, V_{in} =18V	5Vin 24Vin 48Vin			8000 5400 2600	mA
No-Load Input Current	V_{in} = Nominal input	AA5S5-6 AA22S3.3-9 AA22S5-8 AA22S12-3.3 AA45S5-8 AA45S12-3.3		160 75 60 35 30 35		mA
Off Converter Input Current	Shutdown input idle current	All		5	20	mA
Inrush Current (I^2t)	As per ETS300 132-2	All		0.1	1	A^2/s
Input Voltage Transient		5 V_{in} 24 V_{in} 48 V_{in}			15 50 100	VDC
Short Circuit Input Current	RMS	5 Vin Others		100 10	200	mA
Input Voltage Ripple Rejection	120 HZ			50		dB
Input Reflected-Ripple Current	5Hz to 50MHz	5 Vin Others			100 30	mA_{PK-PK}

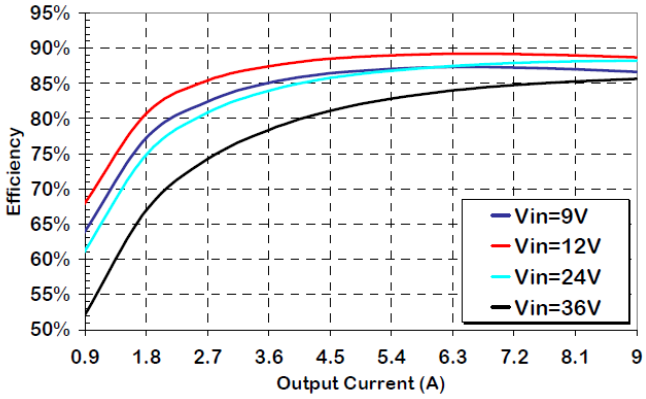
OUTPUT CHARACTERISTICS

Parameters	Conditions	Model	Min.	Typical	Max.	Units
Output Voltage Set Point		Vo=3.3V Vo=5.0V Vo=12V	3.251 4.925 11.82	3.30 5 12	3.349 5.075 12.18	Volts
Output Voltage Regulation						
Line Regulation	V_{in} =High line to Low line (9.5 V for 24 Volts Vin models) Full Load	Single			±0.1	%
Load Regulation	I_o = Full Load to min. Load	Single			±0.2	%
Output Voltage Ripple and Noise	5Hz to 20MHz bandwidth					
Peak-to-Peak	Full Load, 20MHz bandwidth 0.1µF and 22µF ceramic capacitor *3.3Vo is 1 µF Ceramic+10µF Tantalum	Vo=3.3V* Vo=5V Vo=12V			50 60 200	mV
Operating Output Current Range		S3.3-9 S5-6 S5-8 S12-3.3	0 0 0 0		9000 6000 8000 3300	mA
Output DC Current-Limit Inception	Output Voltage=90% $V_{O, nominal}$	Vo=3.3V@9A Vo=5V@6A Vo=5V@8A Vo=12V	10000 6500 9000 3400	12000 7500 11000 4300	17000 10000 16000 6500	mA
RMS Short-Circuit Current	10 mΩ Short	Vo=3.3V@9A Vo=5V@6A Vo=5V@8A Vo=12V			5 1.5 3 3	A
Peak Short-Circuit Current	10 mΩ Short	Vo=3.3V@9A Vo=5V@6A Vo=5V@8A Vo=12V			25 20 20 10	A
Maximum Output Capacitance	Full load, Resistance	Vo=3.3V@9A Vo=5V@6A Vo=5V@8A Vo=12V			4700 4700 4700 700	µF

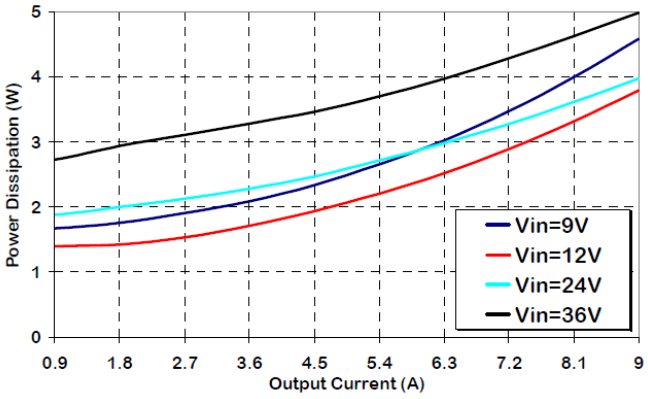
FEATURE CHARACTERISTICS

Parameter	Conditions	Model	Min	Typ	Max	Unit
Switching Frequency		Vo=3.3V@9A AA5S5-6 AA22S5-8 AA22S12-3.3 AA45S5-8 AA45S12-3.3		480 410 440 440 440 480		kHz
Output Voltage Trim Range		Vo=3.3 Vo= 5 Vo= 12	-10 -10 -10		+10 +10 +10	%
Output Over-voltage Protection	Non-latching	All	115	125	140	%
Over-temperature Protection	Avg. PCB temp, non- latching	All		135		°C
Peak Backdrive Output Current during startup into pre-biased output	C_{OUT}=220µF, aluminum Sinking current from external voltage source equal to V_{OUT} – 0.6V and connected to the output via 1Ω resistor.	All		350	500	mA
Backdrive Output Current in OFF state	Converter disabled			0	5	mA
Power On to Output Turn-ON Time	$V_{OUT} = 0.9*V_{OUT\ NOM}$				20	ms
Enable to Output Turn-ON Time	$V_{OUT} = 0.9*V_{OUT\ NOM}$				20	ms
Output Enable ON/OFF Negative Enable Converter ON Converter OFF Positive Enable Converter ON Converter OFF Enable Pin Current Source/Sink	All voltages are WRT – Vin. Converter has internal pull-up of approx. 5V		 -0.7 2.4 2.4 -0.7	 0.25	 0.8 15 20 1.2 1	 VDC VDC VDC VDC mA
Output Voltage Overshoot @ startup				0	2	%Vo
Auto-Restart Period	With all protection features			100		ms
Efficiency Full Load		AA5S5-6 AA22S3.3-9 AA22S5-8 AA22S12-3.3 AA45S5-8 AA45S12-3.3		88 88 89 88 88 88		%
Load Change 50%-75% or 25% to 50% of Iout Max. di/dt = 0.1 A/us	Co = 1 µF ceramic + 22 µF ceramic	All		80	120	mV
Settling Time to 1% of Vout		All		5 0		µs
Load Change 50%-75% or 25% to 50% of Iout Max, di/dt = 2.0 A/µs	Co = 1 µF ceramic + 1000 µF Oscon	All		80	120	mV
Settling Time to 1% of Vout		All		5		µs
Isolation Capacitance				1000		pF
Isolation Resistance			10			MΩ
Isolation Voltage– Input to Output	Open Frame		2250			V_D
Isolation Voltage– Input to Output	Encapsulated		1600			V
Isolation Voltage –Output to baseplate	Only needed for encapsulated units		1000			V
RELIABILITY Per Telcordia SR-332, Issue 2: Method I, Case 3 (Io =80% of Io_max, T_A=40 °C, Airflow = 200lfm, 90% Confidence	MTBF	AA5S5-6 AA22S3.3-9 AA22S5-8 AA22S12-3.3 AA45S5-8 AA45S12-3.3		3,000,420 3,000,410 3,363,122 2,964,202 3,380,145 2,646,603		Hours
	FITs (failures in 10^9 hours)	AA5S5-6 AA22S3.3-9 AA22S5-8 AA22S12-3.3 AA45S5-8 AA45S12-3.3		333 332 297 337 296 378		/10^9 HOURS

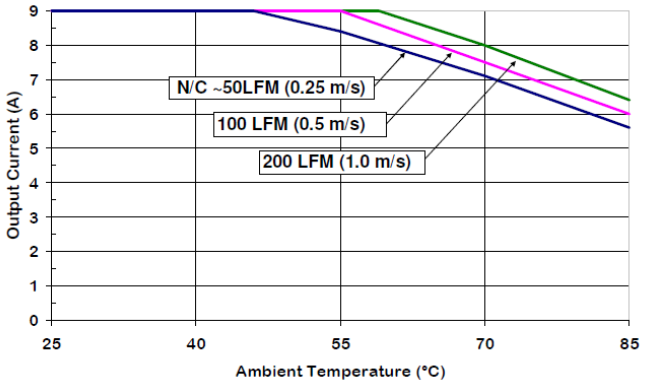
Efficiency vs. Load and Other Characteristic Curves:



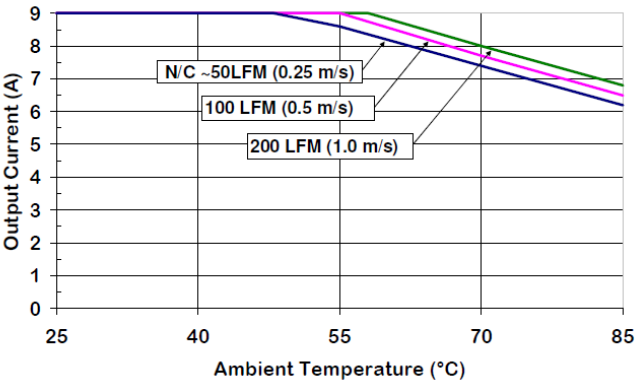
AA22S3.3-9 Efficiency vs Output Current, 300lfm airflow, 25°C ambient.



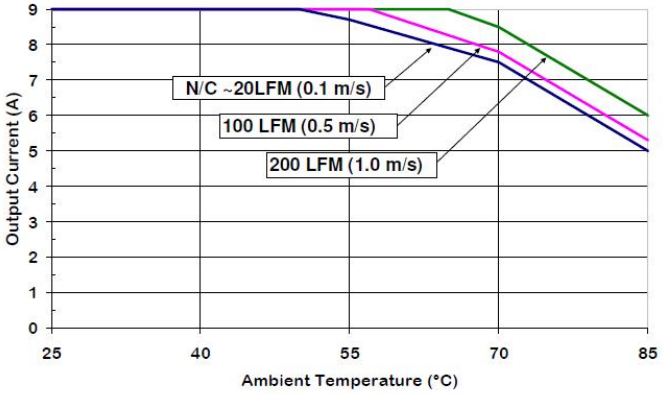
AA22S3.3-9 Power Dissipation vs. Load Current, 300lfm airflow, 25°C ambient.



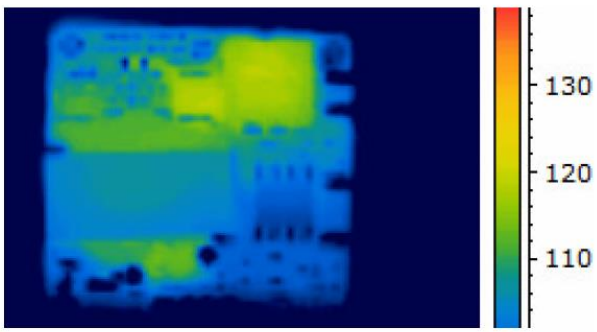
AA22S3.3-9 Output Current Derating vs Ambient Temperature & Airflow (Open Frame module) Vin = 24 V



AA22S3.3-9 Output Current Derating vs Ambient Temperature & Airflow (Open Frame module) Vin = 12 V

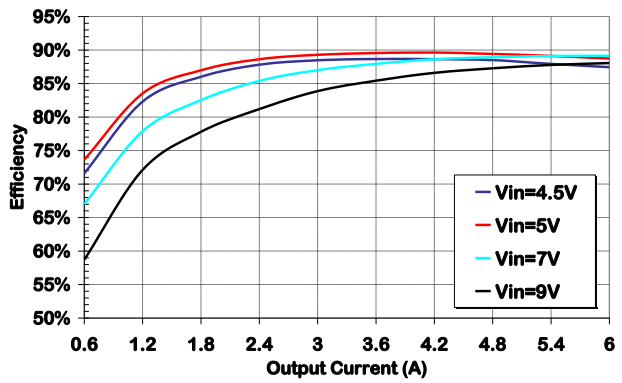


AA22S3.3-9 Output Current Derating vs Ambient Temperature & Airflow (Encapsulated module) Vin = 12V,24V

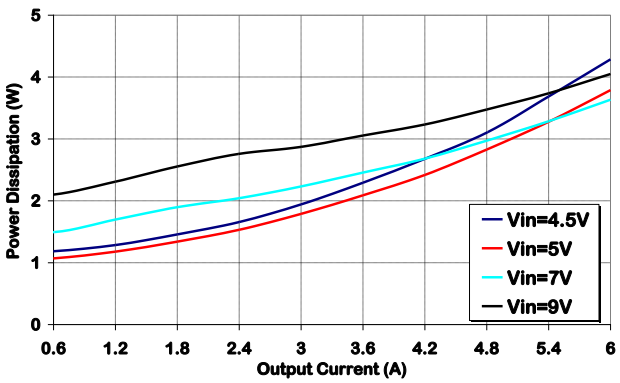


Thermal Image of **AA22S3.3-9** 9A output, 55°C Ambient, 200lfm airflow, Vin = 24V, T_{max} = 118°C

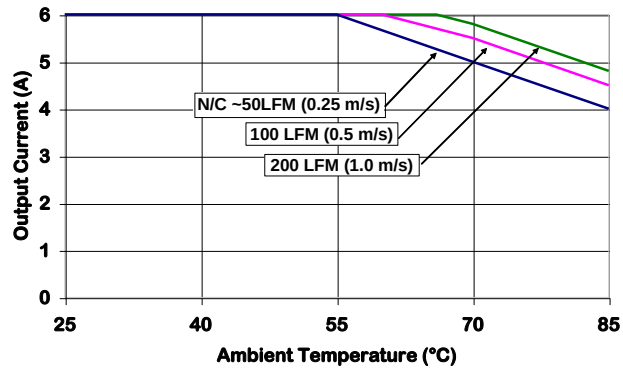
Efficiency vs. Load and Other Characteristic Curves



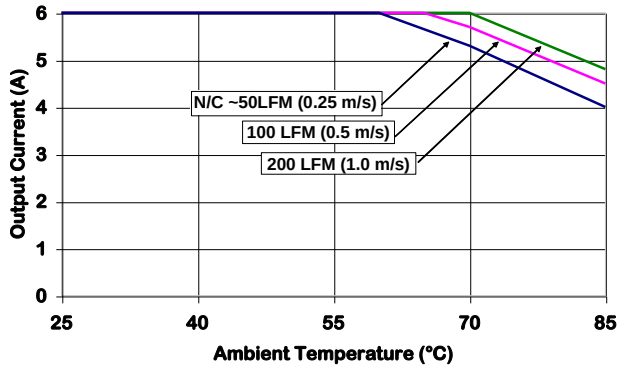
AA5S5-6 Efficiency vs Output Current, 300lfm airflow, 25°C ambient. (Estimated)



AA5S5-6 Power Dissipation vs. Load Current, 300lfm airflow, 25°C ambient. (Estimated)

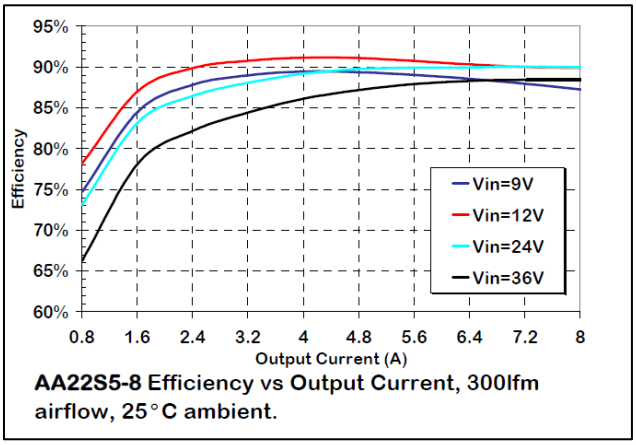


AA5S5-6 Output Current Derating vs Ambient Temperature & Airflow (converter mounted vertically with air flowing from Vin to Vout, Vin = 5 V.)

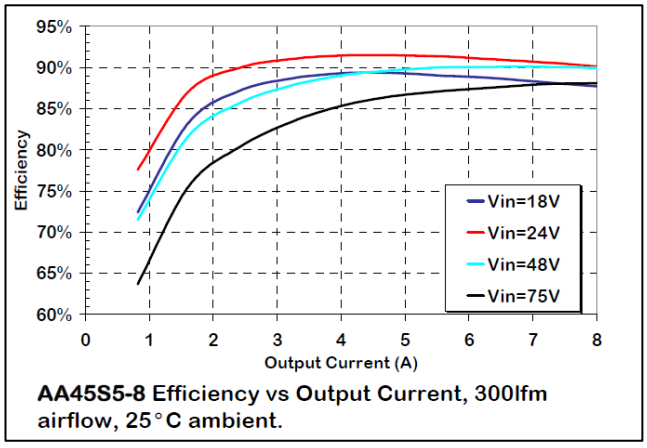


AA5S5-6 Output Current Derating vs Ambient Temperature & Airflow (Encapsulated module) Vin = 5 V (Estimated)

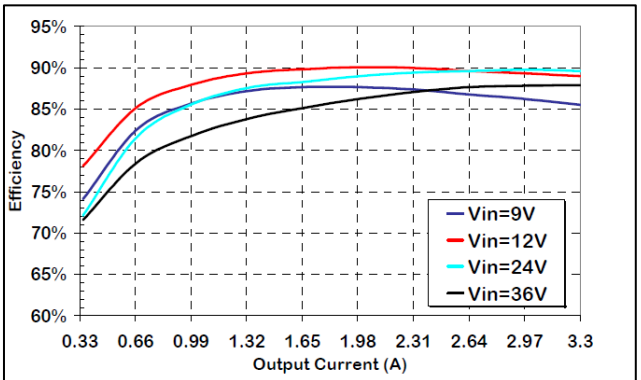
Efficiency vs. Load and Other Characteristic Curves



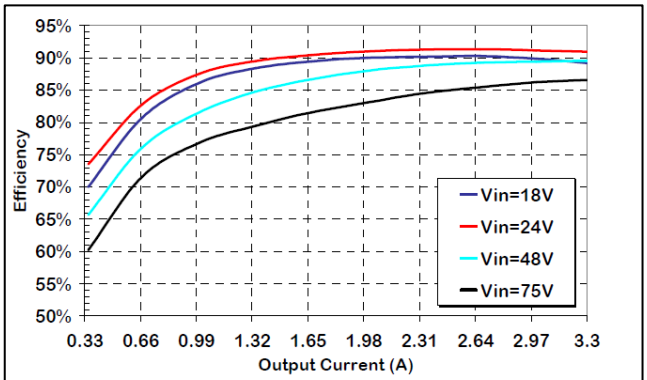
AA22S5-8 Efficiency vs Output Current, 300lfm airflow, 25°C ambient.



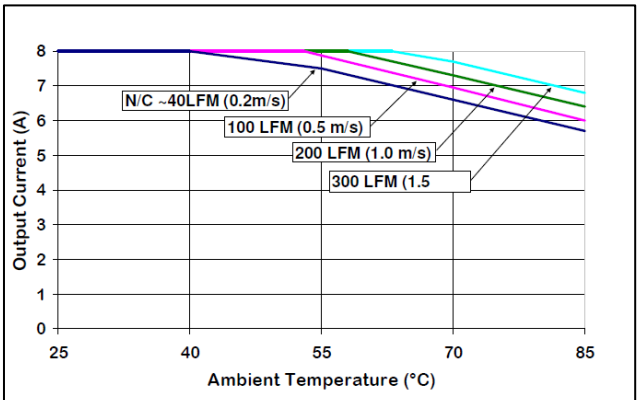
AA45S5-8 Efficiency vs Output Current, 300lfm airflow, 25°C ambient.



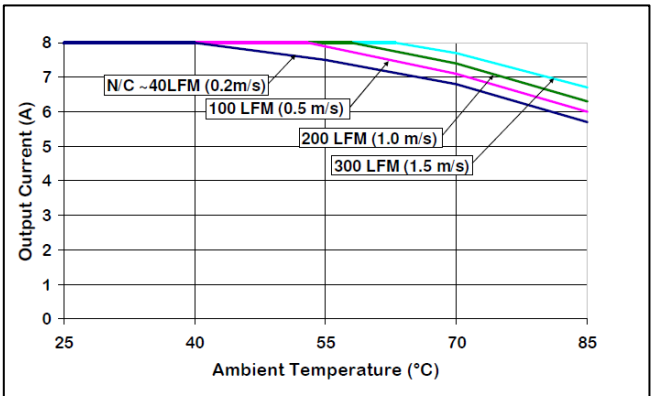
AA22S12-3.3 Efficiency vs Output Current, 300lfm airflow, 25°C ambient.



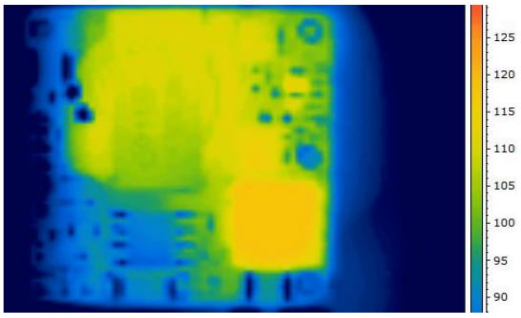
AA45S12-3.3 Efficiency vs Output Current, 300lfm airflow, 25°C ambient.



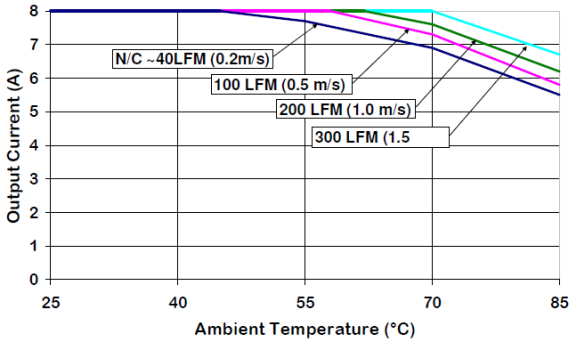
AA22S5-8 Output Current Derating vs Ambient Temperature & Airflow (Open Frame module) Vin = 24 V (airflow from pin 1 to pin 2)



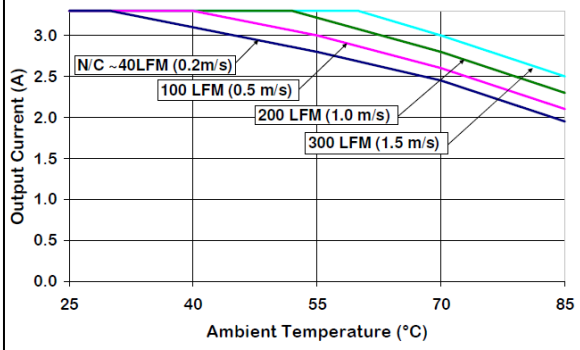
AA22S5-8 Output Current Derating vs Ambient Temperature & Airflow (Open Frame module) Vin = 12 V (airflow from pin 1 to pin 2)



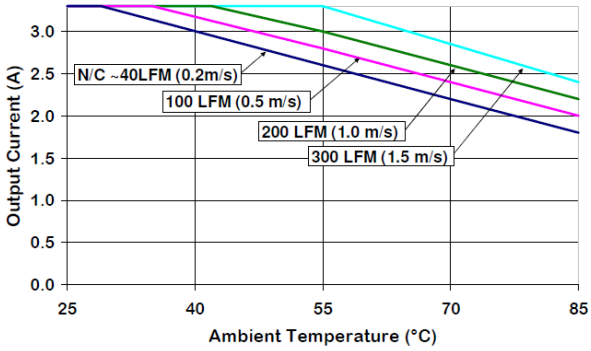
AA22S5-8. Thermal Image 55C
Ambient, 200lfm airflow
Vin = 24V, Tmax = 121°C



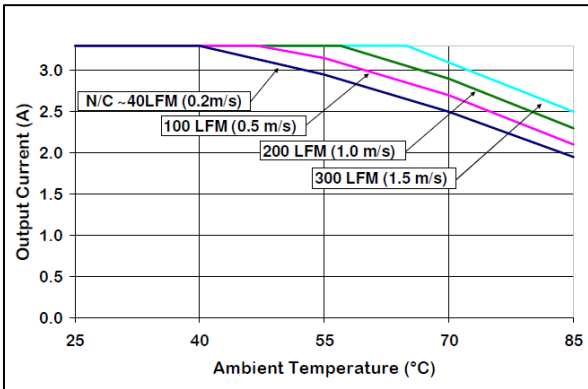
AA22S5-8E Output Current Derating vs Ambient Temperature & Airflow (Encapsulated module)
Vin = 12V,24V



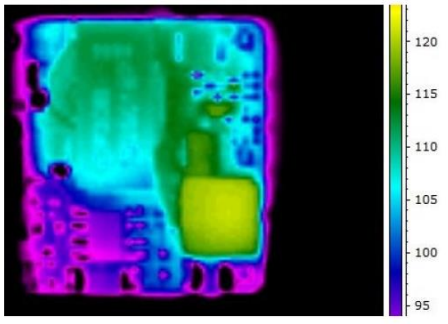
AA22S12-3.3 Output Current Derating vs Ambient Temperature & Airflow (Open Frame module)
Vin = 24 V (airflow from pin 1 to pin 2)



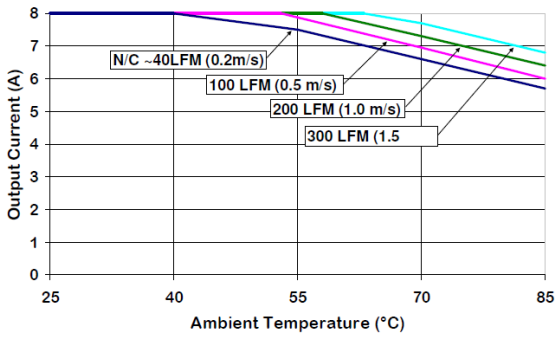
AA22S12-3.3 Output Current Derating vs Ambient Temperature & Airflow (Open Frame **module)**
Vin = 12 V (airflow from pin 1 to pin 2)



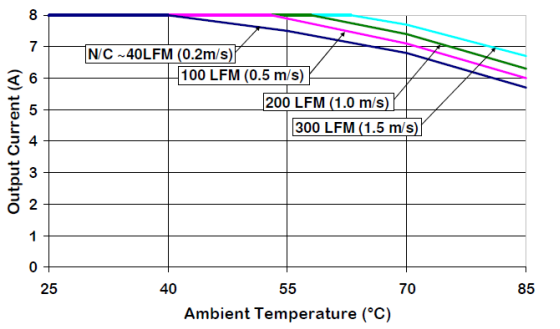
AA22S12-3.3 Output Current Derating vs Ambient Temperature & Airflow (Encapsulated module)
Vin = 12V,24V



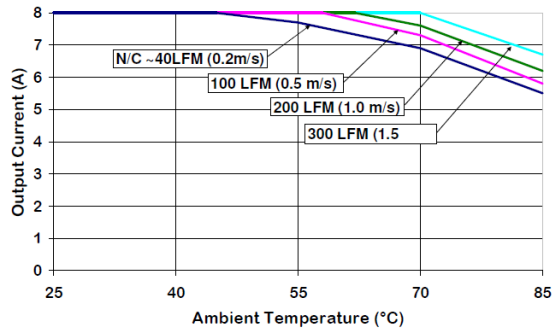
AA22S12-3.3 Thermal Image output,
55C Ambient, 200lfm airflow,
Vin = 24V, T_{max} = 125°C



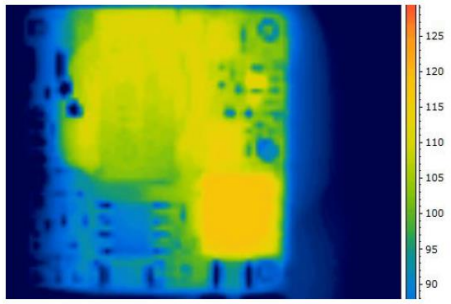
AA45S5-8 Output Current Derating vs Ambient Temperature & Airflow (Open Frame module)
Vin = 48 V (airflow from pin 1 to pin 2)



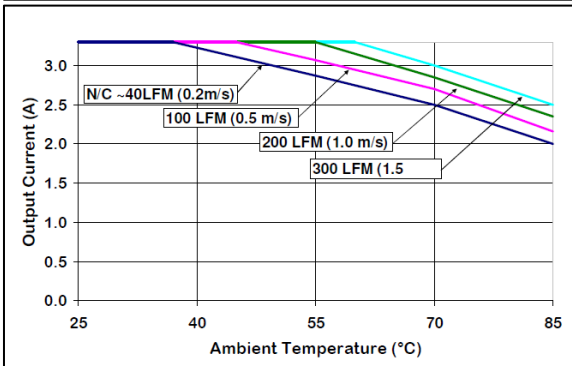
AA45S5-8 Output Current Derating vs Ambient Temperature & Airflow (Open Frame module)
Vin = 24 V (airflow from pin 1 to pin 2)



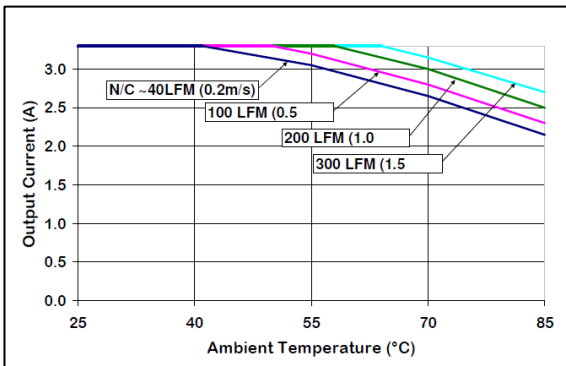
AA45S5-8E Output Current Derating vs Ambient Temperature & Airflow (Encapsulated module)
Vin = 24V,48V



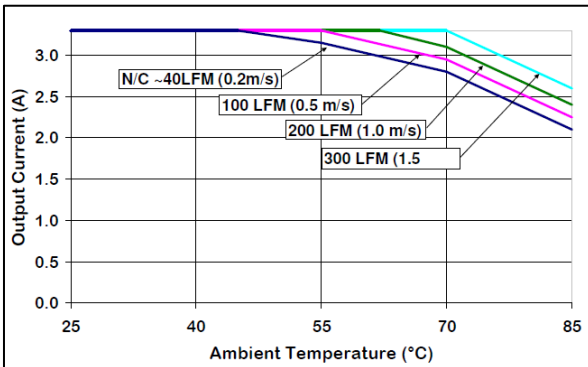
AA45S5-8 Thermal Image, 55C Ambient,
200lfm airflow, Vin = 48V, T_{max} = 121°C



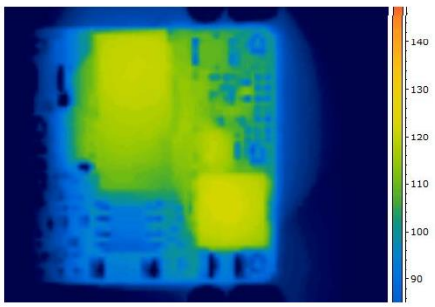
AA45S12-3.3 Output Current Derating vs Ambient Temperature & Airflow (Open Frame module)
Vin = 48 V (airflow from pin 1 to pin 2)



AA45S12-3.3 Output Current Derating vs Ambient Temperature & Airflow (Open Frame module)
Vin = 24 V (airflow from pin 1 to pin 2)

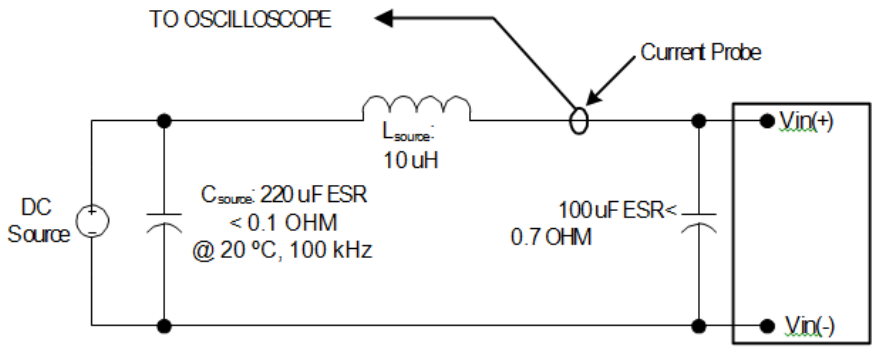


AA45S12-3.3 Output Current Derating vs Ambient Temperature & Airflow (Encapsulated module)
Vin = 24V,48V



AA45S12-3.3 Thermal Image, 55C Ambient,
200lfm airflow,
Vin = 48V, T_{max} = 122°C

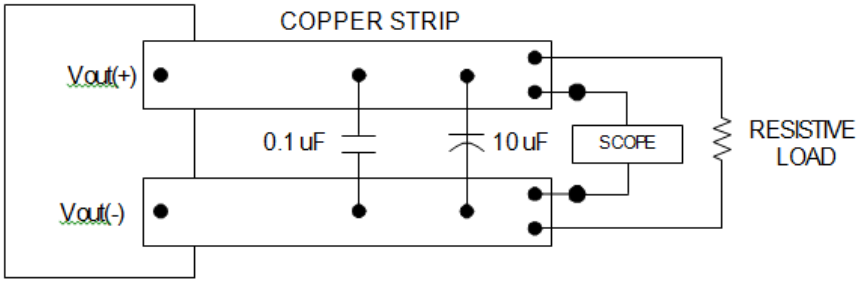
INPUT REFLECTED RIPPLE TEST SETUP:



Note: Measure the input reflected-ripple current with a simulated source inductance (Ltest) of 10 uH and Capacitor CS offsets possible source impedance.

Input Reflected-ripple Current Test Setup.

OUTPUT RIPPLE TEST SETUP:



Note: Use a 0.1µF X7R ceramic capacitor and a 12µF @ 16V X7R capacitor. Scope measurement should be made using a BNC socket. Also, place the load 3 in. [76mm] from module.

Peak-to-Peak Output Noise Measurement Test Setup.

OUTPUT VOLTAGE TRIM

Output voltage adjustment is accomplished by connecting an external resistor between the Trim Pin and either the +Vout or –Vout Pins.

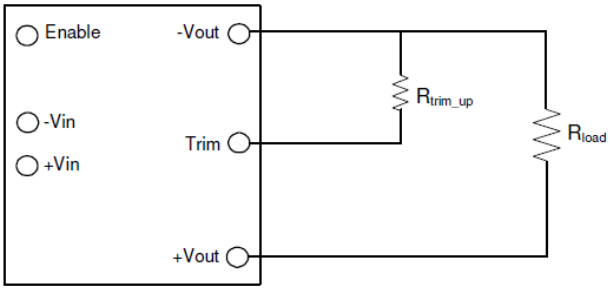
- **TRIM UP EQUATION**:

Where R_{TRIM_UP} is the resistance value in ohms and V_{DES} is the desired output voltage

$$R_{TRIM\_UP}(\Omega) = \frac{12750}{V_{DES} - 5} - 2050$$

R_{TRIM_UP} by 10% = $R_{TRIM\_UP} = \frac{12750}{5.5 - 5} - 2050 \cdot \Omega$

$$R_{TRIM\_UP} = 23.45\ kOhm$$

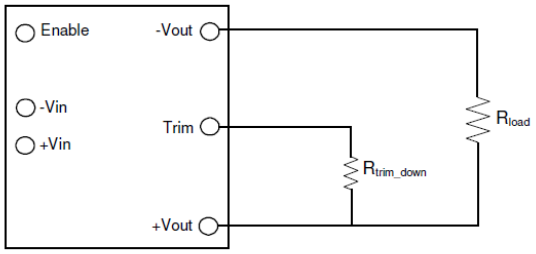


Trim UP circuit configuration

- **TRIM DOWN EQUATION:**

$$R_{TRIM\_DOWN}(\Omega) = \frac{10000 \cdot (V_{DES} - 2.5)}{12 - V_{DES}} - 5100$$

Where **Rtrim_down** is the resistance value in ohms and VDES is the desired output voltage.



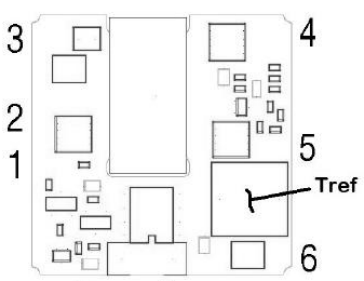
Trim DOWN circuit configuration

THERMAL DERATING

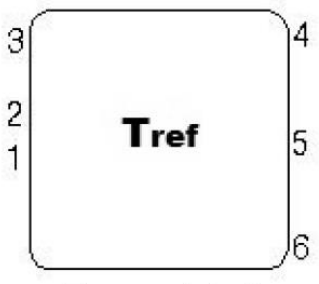
- It is preferable that the DC-DC module has an unobstructed flow of air across the unit for best thermal performance. Components taller than ~ 2mm in front of the module can deflect airflow and possibly create hotspots.

- Significant cooling is achieved through conductive flow from the modules I/O pins to the host PCB. Sufficiently large traces connecting the dc-dc converter to the source and load will help ensure thermal derating performance will meet or exceed the derating curves published in this datasheet. Thermal reliefs are not recommended on power pin connections.

- If the module is expected to be operated near the load limits defined in the derating curves, in-system verification of module derating performance should be performed to ensure long-term system reliability. Peak temperatures are to be measured using infrared thermography or by gluing a fine gauge (AWG #40) thermocouple at the TREF location(s) shown below. Temperature at the specified location(s) should be kept below 123°C for open frame units, 105°C for encapsulated modules in order to maintain optimum converter reliability.



Open Frame



Encapsulated

INPUT UNDERVOLTAGE LOCKOUT

- The converter is disabled until the input voltage has exceeded the UVLO turn-on threshold.
Once the input voltage exceeds this level (see Input Under-Voltage Lock-out in Electrical Specifications table) the module will commence soft-start. Hysteresis of 2-3 volts minimizes the likelihood of pulling the input voltage below the turn-off threshold during startup which could create an undesirable on/off cycling condition. Once started, the converter will continue to operate until the input voltage subsequently falls below the UVLO turn-off threshold.

ENABLE PIN FUNCTION

- The module has a remote enable function that allows it to be turned on or off remotely. The Enable pin is referenced to the negative input pin (-Vin) of the converter. Modules can be ordered with either negative or positive enable.

- With the negative enable option, the converter will not turn on unless the enable pin is connected to –Vin. The positive enable option allows the converter to turn on as soon as voltage sufficient to exceed the UVLO threshold of the converter has been applied to the input terminals. In this case the module is turned off by connecting the Enable pin to –Vin. On/off thresholds are shown in the Electrical Specifications table.

OUTPUT OVERVOLTAGE PROTECTION

- The module has an independent feedback loop that will disable the output of the converter if a voltage greater than about 125% of the nominal set point is detected. When this threshold is reached, the converter will shut down and remain off for the amount of time specified by the Auto-Restart Period. The converter will attempt a restart once this period of time has elapsed.

OUTPUT OVER-TEMPERATURE PROTECTION

- To provide protection under certain fault conditions, the unit is equipped with a thermal shutdown circuit. The unit will shut-down if the average PCB temperature exceeds approx. 135°C. Keep in mind that thermal shutdown is not intended as a guarantee that the unit will survive temperatures beyond its rating. The module will automatically restart once it has cooled below the shutdown temperature minus hysteresis (typically 20°C.)

SMT VERSION LAYOUT CONSIDERATIONS (IF APPLICABLE)

- Copper traces with sufficient cross-section must be provided for all output & input pins. SMT pads tied to internal power/ground planes must have multiple vias around each SMT pad to couple expected current loads from module pins into internal traces/planes. One 0.024" (0.6mm) diameter via for each 4A of expected source or load current must be provided as close to the termination as possible, preferably in the direction of current flow from SMT pad to load. Vias must be at least 0.024" (0.6 mm) away from the SMT pad to prevent solder from flowing into the vias.

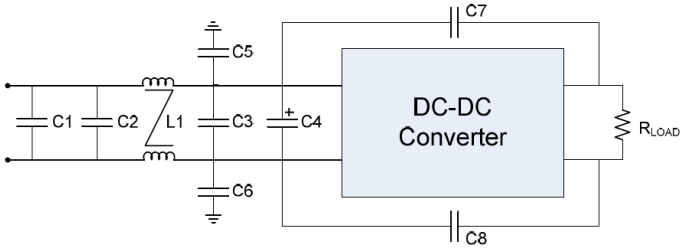
- SMT pads on the host card are to be 0.075" (1.9mm) diameter. Solder paste screen opening should be 0.70" diameter and the screen should be 0.006" (0.15 mm) thick (other thicknesses are possible; 0.006" provides a good compromise between solder volume and coplanarity compensation).

PARALLELING CONVERTERS

- Modules may be paralleled but it is recommended that the total power draw not exceed the output power rating of a single module. External sharing controllers are recommended for reliability and to ensure equal distribution of the load to the converters.

EMC COMPLIANCE:

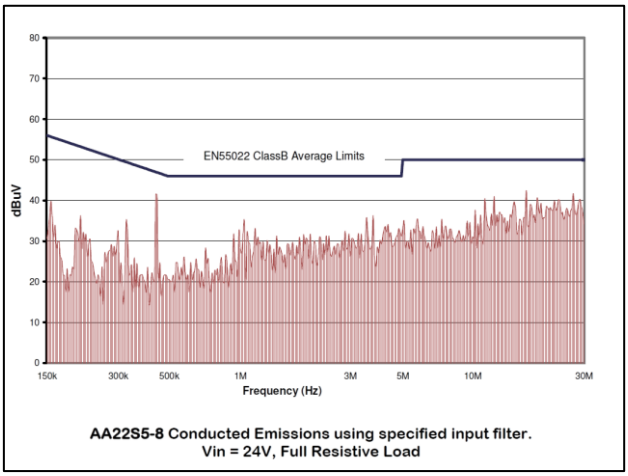
To meet Class B compliance for EN55022 (CISPR 22) or FCC part 15 sub part j, the following input filter is required:



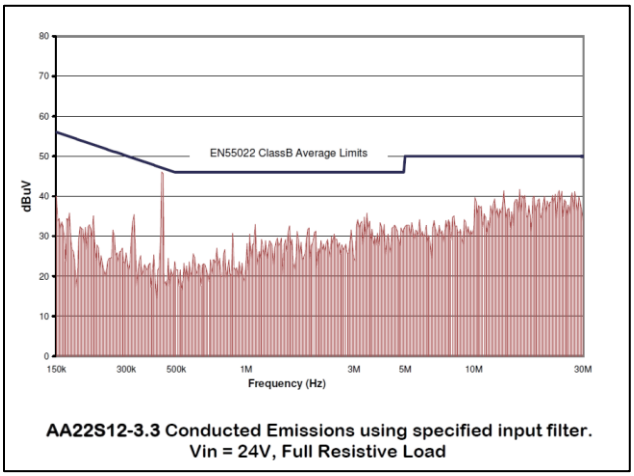
EMI Filter

Model No.	C1	C2, C3	C4	C5, C6	C7, C8	L1
AA5S5-6	1000µF Ceramic	Not Used	220µF Electrolytic	3300pF	Not Used	0.63mH
AA22S5-8	2.2µF Ceramic	2.2µF Ceramic	100µF Ceramic	10 nF	Not Used	0.77mH
AA22S5-8	2.2µF Ceramic	2.2µF Ceramic	220µF Ceramic	10 nF	Not Used	0.59mH
AA22S12-3.3	2.2µF Ceramic	2.2µF Ceramic	100µF Ceramic	10 nF	10 nF	0.77mH
AA45S5-8	2.2µF Ceramic	2.2µF Ceramic	220µF Ceramic	10 nF	Not Used	1.32mH
AA45S12-3.3	2.2µF Ceramic	2.2µF Ceramic	220µF Ceramic	10 nF	Not Used	1.32mH

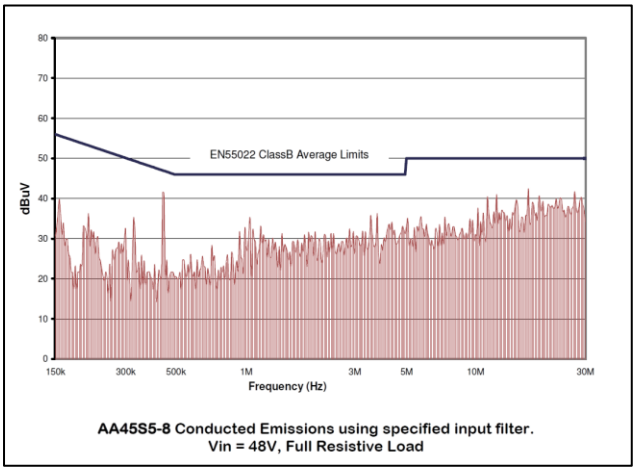
Conducted Emissions using the specified input filter



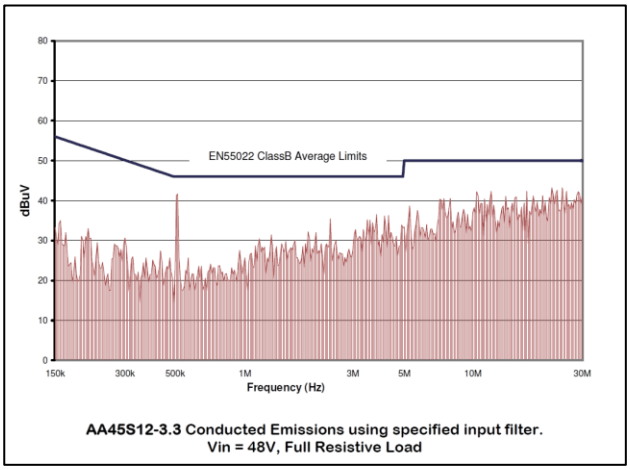
AA22S5-8 Conducted Emissions using specified input filter.
Vin = 24V, Full Resistive Load



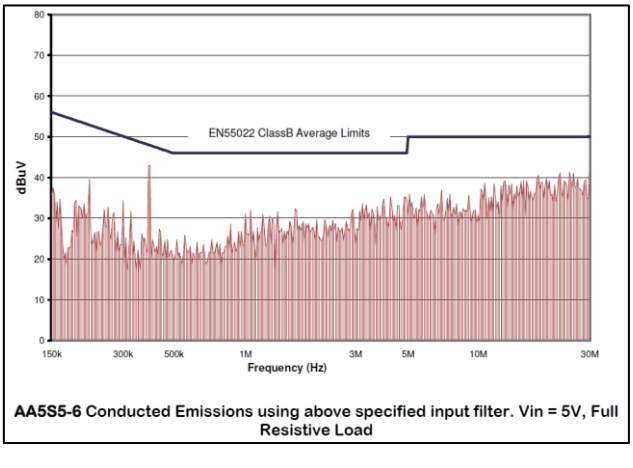
AA22S12-3.3 Conducted Emissions using specified input filter.
Vin = 24V, Full Resistive Load



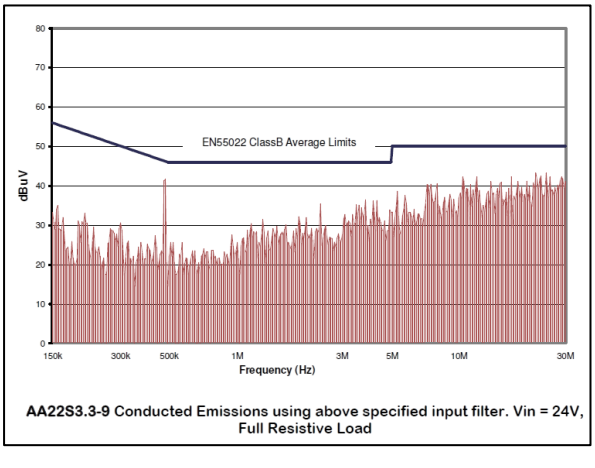
AA45S5-8 Conducted Emissions using specified input filter.
Vin = 48V, Full Resistive Load



AA45S12-3.3 Conducted Emissions using specified input filter.
Vin = 48V, Full Resistive Load

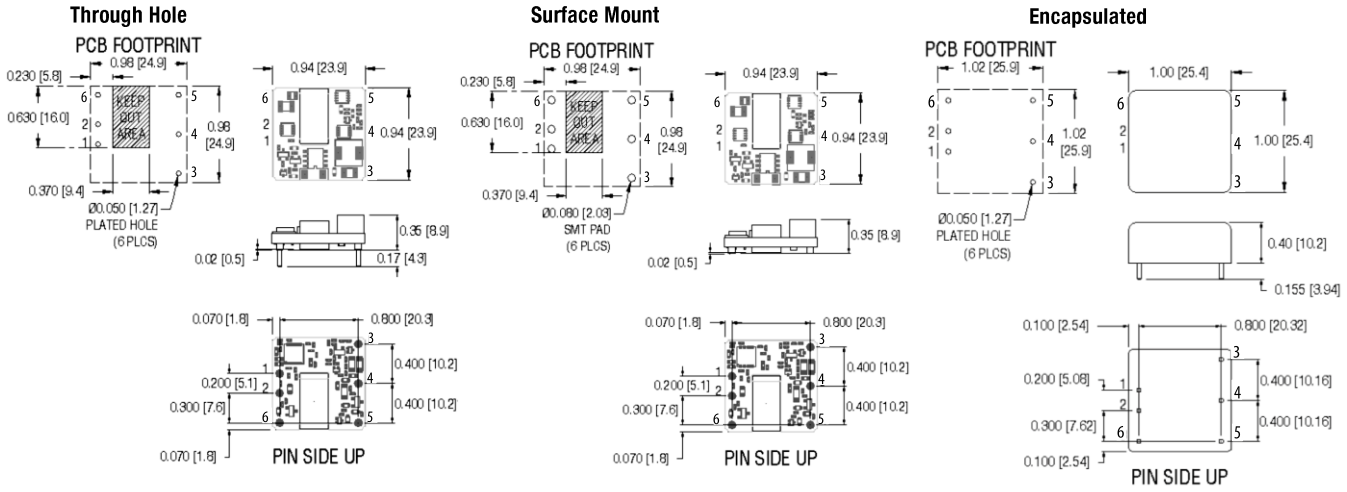


AA5S5-6 Conducted Emissions using above specified input filter. Vin = 5V, Full Resistive Load



AA22S3.3-9 Conducted Emissions using above specified input filter. Vin = 24V, Full Resistive Load

MECHANICAL SPECIFICATIONS



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 #	DESIGNATION
1	V_{IN} (+)
2	V_{IN} (-)
3	V_{OUT} (+)
4	Trim
5	V_{OUT} (-)
6	On/Off

NOTES

1) All dimensions in inches [mm]
Tolerances: .xx ± 0.02 [.x ± .5]
.xxx ± 0.010 [.xx ± .25]
2) Input, on/off control and sense/trim pins are Ø 0.040" [1.02] ± 0.002" [0.05] with Ø 0.070" [1.77] standoff shoulders.
3) Output pins 4 & 8 are Ø 0.062" [1.57] ± 0.003" [0.08] with Ø 0.093" [2.36] standoff shoulders
4) All pins are gold plated with nickel under plating.
5) Weight: 12.8 g (0.45 oz.)
6) Workmanship: Meets or exceeds IPC-A-610 Class II

PART NUMBER ORDERING INFORMATION

Family, Form Factor Package	Nominal Input Voltage	Number of Outputs	Voltage Output		Current Output (A)	Options
AA	22	S	5	—	8	E, I, N, P, S

Family, Form Factor Package	Nominal Input Voltage	Number of Outputs	Voltage Output	Current Output (A)	Options
	(4.5-9) 5 Volts (9-36) 22 Volts (36-75) 45 Volts	S- Single	3.3 Volts 5 Volts 12 Volts	3.3 Volts – 9A 5 Volts – 6A 5 Volts – 8A 12 Volts – 3.3A	None – Open Frame / Negative On/Off I – High Isolation P - Positive On/Off control E - Encapsulated S - SMT Construction

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