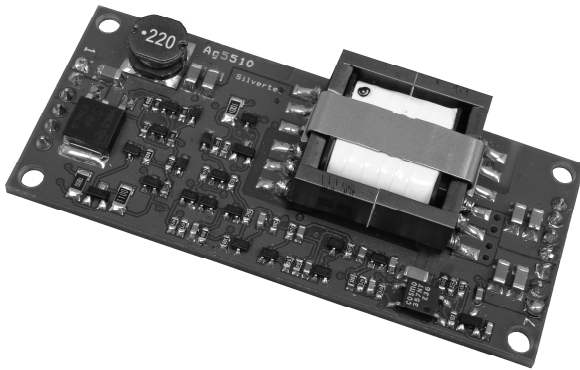




# Ag5510

## PoE Ultra Module

### 1. Features



- 60 Watt Output Power
- Very small size
- High efficiency DC/DC converter
- Wide adjustable output voltage range
- 1500V isolation (input to output)
- Input voltage range 36V to 57V
- IEEE802.3at compliant
- Low output ripple and noise
- Minimal (low cost) external components required
- Overload, thermal and short-circuit protection
- Silvertel “design-in” assistance

### 2. Description

The Ag5510 is a High Power over Ethernet (PoE Ultra) module that can deliver up to 60 Watts of output power. Suitable for applications such as WiMAX access points, PTZ cameras, notebook computers and thin client terminals.

The Ag5510 has been designed to extract power from Power Sourcing Equipment (PSE) over an Ethernet cable. The module's input conforms to the IEEE 802.3at standard for signature recognition and class programming. It has been designed to work with existing high power PSE's from leading manufacturers.

The high efficiency DC/DC converter operates over a wide input voltage range and provides a regulated low ripple and low noise output. The DC/DC converter also has built-in overload, thermal and short-circuit output protection.

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### 3. Ag5510 Product Selector

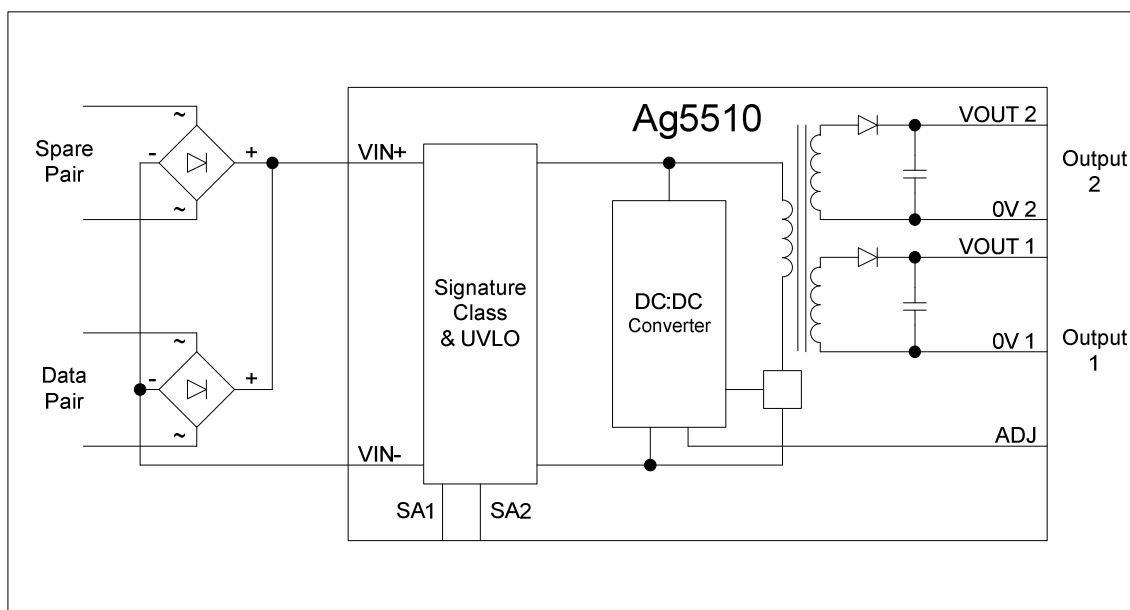
Part Number†	Nominal Output Voltage ‡	Maximum Output Power *
Ag5510	12V / 24V	60W

\*At 25°C must include adequate thermal management

† The Ag5510 fully meets the requirements of the RoHS directive 2002/95/EC on the restriction of hazardous substances in electronic equipment.

‡ Voltage depending on output configuration (Parallel or Series), see Section 5.7.

**Table 1: Ordering Information**



*Figure 1: Block Diagram*



*Figure 2: Ag5510 Package Format*

## 4. Pin Description

### Input Connector Pins

Pin #	Name	Description
1	VIN+	<b>Direct Input +.</b> This pin connects to the positive (+) output of the input bridge rectifier.
2	VIN-	<b>Direct Input -.</b> This pin connects to the negative (-) output of the input bridge rectifier.
3	CPA	<b>Class Programming.</b> The classification current can be changed by connecting an external resistor from this pin to VIN- (see section 5.4). With no resistor fitted this input will default to Class 4.
4	IC	<b>Internal Connection.</b> Do not connect to this pin.
5	SA1	Signature resistance adjustment (see section 5.2)
6	SA2	Signature resistance adjustment (see section 5.2)

### Output Connector Pins

Pin #	Name	Description
7 & 8	VOUT 1	<b>DC Output.</b> This pin provides the main regulated output from the DC/DC converter.
9	0V 1	<b>Ground.</b> The ground return for the VOUT 1 output.
10	VOUT 2	<b>DC Output.</b> This pin provides the secondary output from the DC/DC converter.
11 & 12	0V 2	<b>Ground.</b> The ground return for the VOUT 2 output.
13	ADJ	<b>Output Adjust.</b> The output voltage can be adjusted from its nominal value, by connecting an external resistor from this pin to either the VOUT 1 pin or the 0V 1 pin.

## 5. Functional Description

### 5.1 Inputs

The Ag5510 has a single input that can be connected to two external bridge rectifiers (see Figure 1: Block Diagram). This allows the Ag5510 to be compatible with equipment that uses the different power options. The Ag5510 was developed to be powered with the Silvertel Ag6110 PSE but can also be used with high Power PSE's from most leading manufactures such as Microsemi, Phihong, Cisco (uPOE).

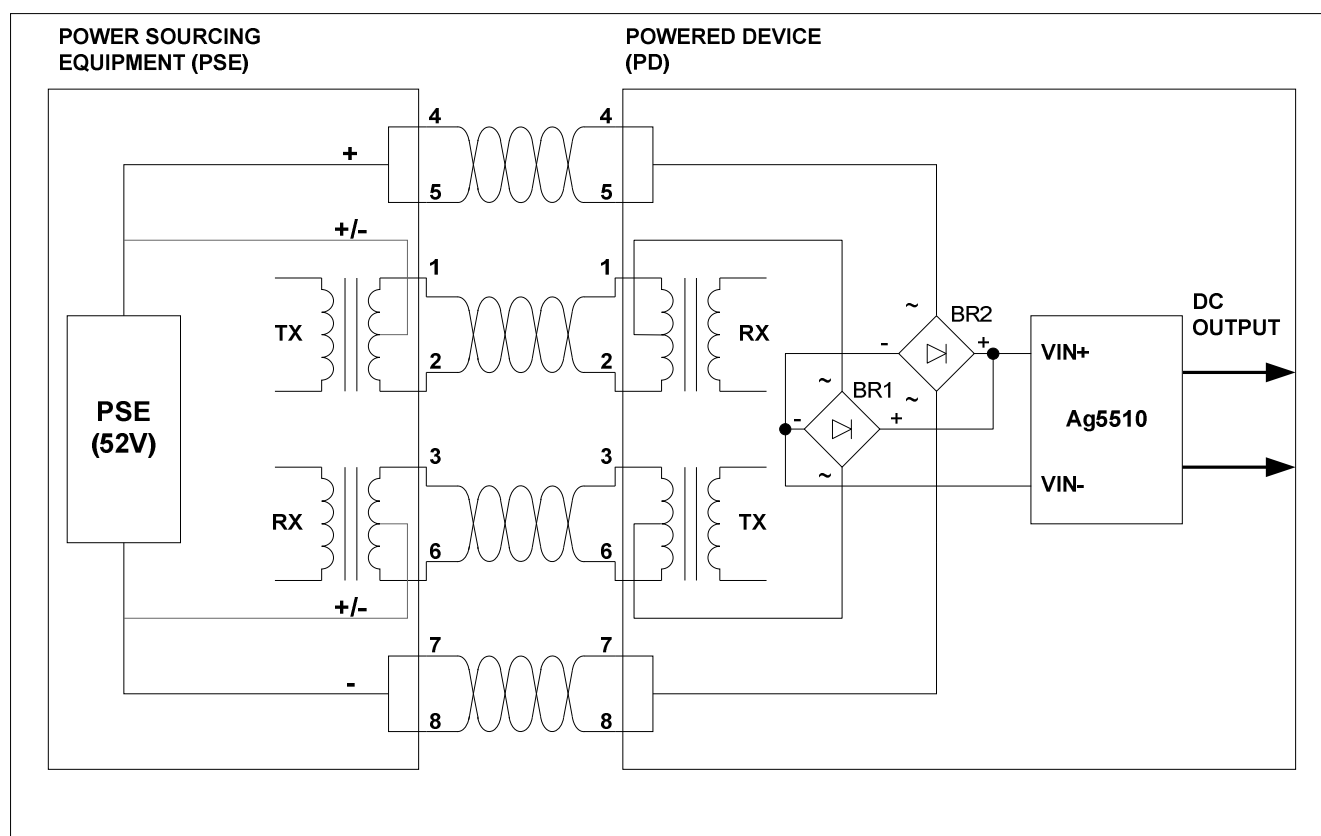


Figure 3: Typical System Diagram

### 5.2 PD Signature

The Ag5510 input complies with the IEEE802.3at specification. When the inputs are connected to a Power Sourcing Equipment (PSE), they will automatically present a Powered Device (PD) signature to the PSE (when requested). The equipment will then recognise that a PD is connected to that line and supply power.

Note: The SA1 and SA2 pins must be connected together when used with a Phihong POE80U or POE60U PSE.

## 5.3 Isolation

To meet the isolation requirements of IEEE802.3at section 33.4.1 a Powered Device (PD) must pass the electrical strength test of IEC 60950 sub clause 6.2. This calls for either a) 1500VAC test or b) 1500V impulse test. The Ag5510 has been designed to meet b) 1500V impulse test. When mounting the module to the heat sink, you must ensure a clearance of 1.5mm minimum between the pins of the connectors and the heat sink or use some form of isolation such as at least two layers of 3M#56 insulating tape.

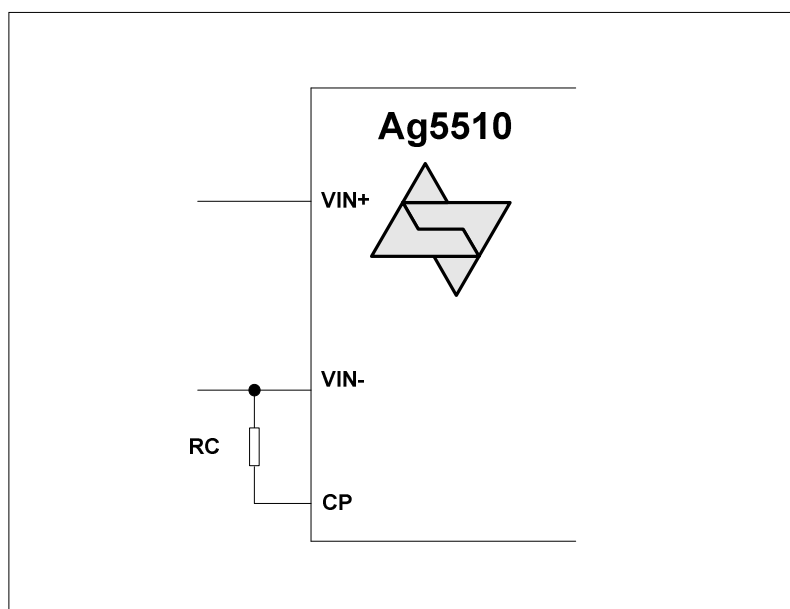
## 5.4 Power Classification

The Ag5510 classification is fixed at Class 4, this means that an IEEE802.3at Type 1 or an IEEE802.3af PSE will default to Class 0. However an IEEE802.3at PSE will recognise the Class 4 as a Type 2 PD. The Ag5510 allows the class current to be externally programmed to Class 5 by connecting a 360Ohm resistor (RC) between the CP and VIN- pins, see below.

CLASS	Programming Resistance (Ohms)	PSE Power (W)
4	Open circuit	up to 60W
5	360 $\pm$ 1%	up to 60W

**Table 2: Class Programming**

Note: The Ag6110 will supply 60W when it sees Class 4 or Class 5.



*Figure 4: Class Programming Option*

## 5.5 High Power Applications

Figures 5a and 5b show typical application diagrams for the Ag5510 connected to the Ag6110 PSE.

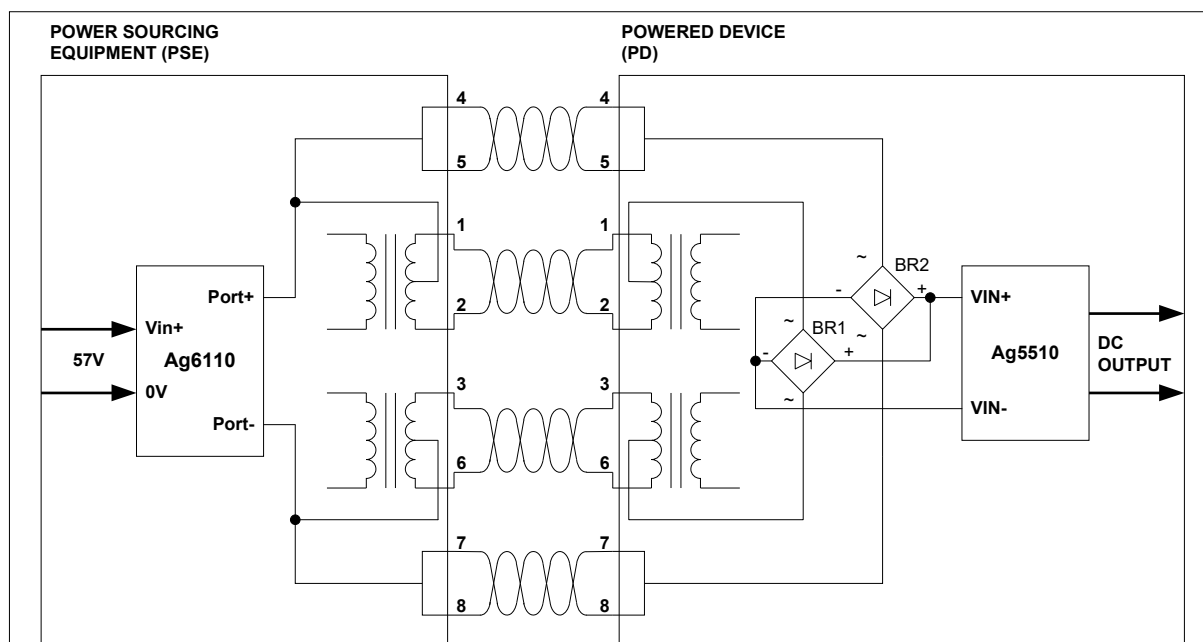


Figure 5a – Typical Application Diagram for Ag6110 using 10/100BASE-T

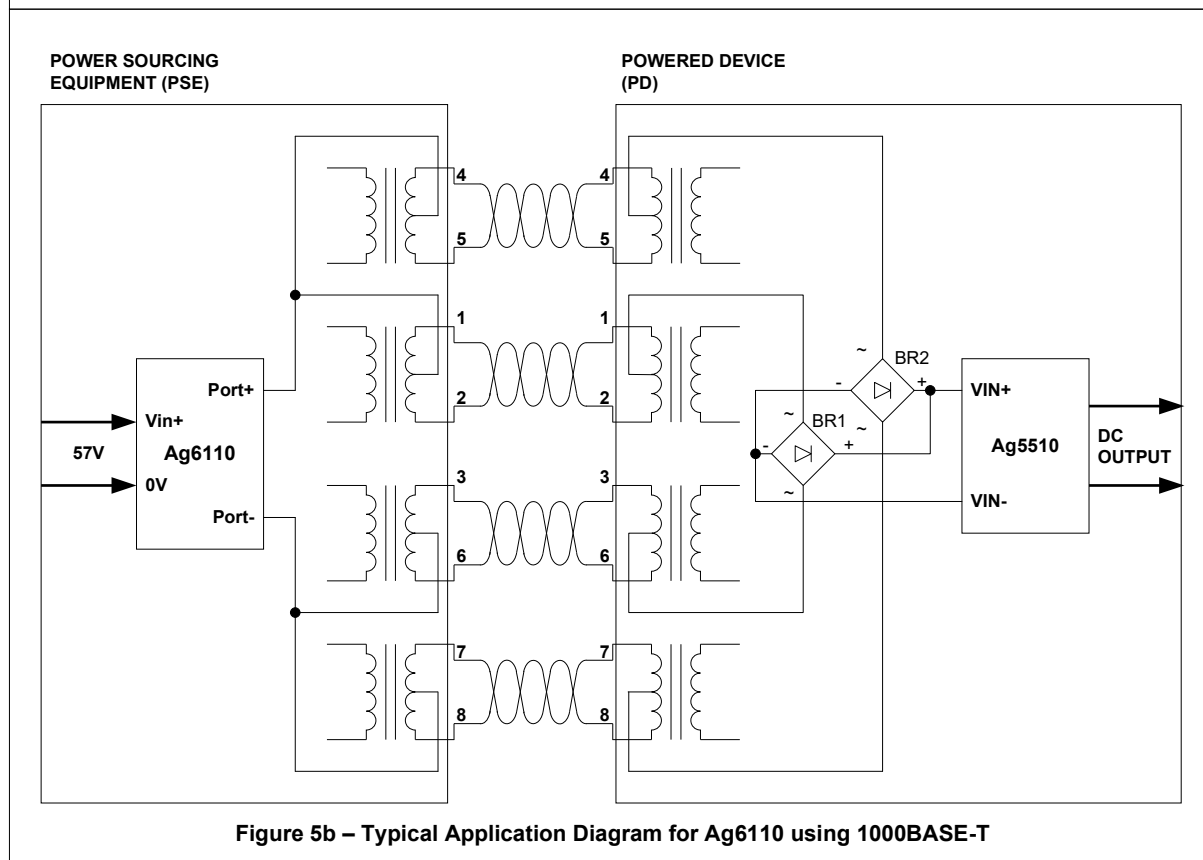


Figure 5b – Typical Application Diagram for Ag6110 using 1000BASE-T

Figure 5: High Power configuration

## 5.6 DC/DC Converter

The Ag5510's DC/DC converter provides a regulated low ripple and low noise output that has built-in output over-load and short-circuit protection.

## 5.7 Output Configuration

The Ag5510 has two outputs which must be connected either in parallel to provide 12V or in series to provide 24V, as shown in Figure 6: Output Configurations.

Output 2 voltage (VOUT 2) tracks the output 1 voltage (VOUT 1). The use of the two outputs separately is not recommended due to voltage regulation issues.

It is important that C1, C3 and C2, C4 are both used and connected as close to the output pins of the Ag5510 as possible (for both configurations).

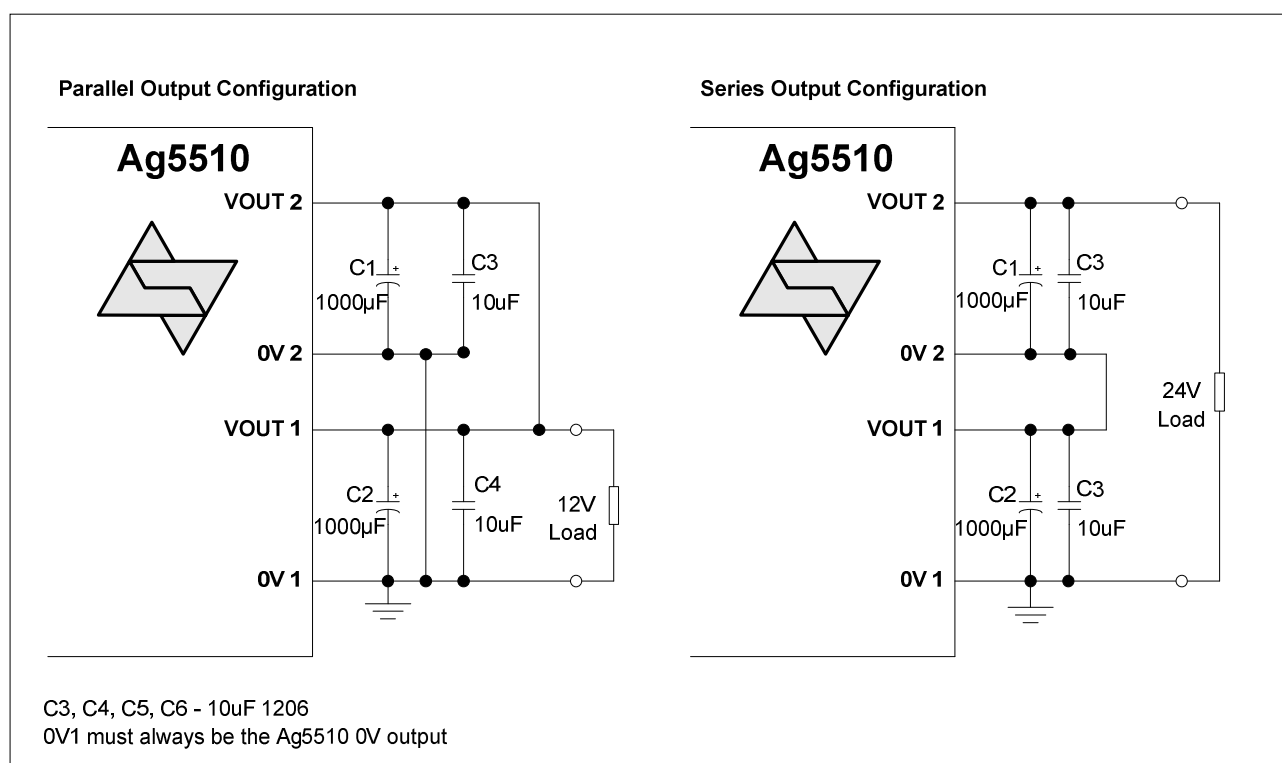


Figure 6: Output Configurations

## 5.8 Output Adjustment

The Ag5510 has an ADJ pin, which allows the output voltage to be increased or decreased from its nominal value.

The adjustment range allows the Ag5510 to provide an output voltage from 10.55V up to 30.4V. Voltage must not be adjusted to less than 10.5V or permanent damage may be caused. Contact Silvertel for further details.



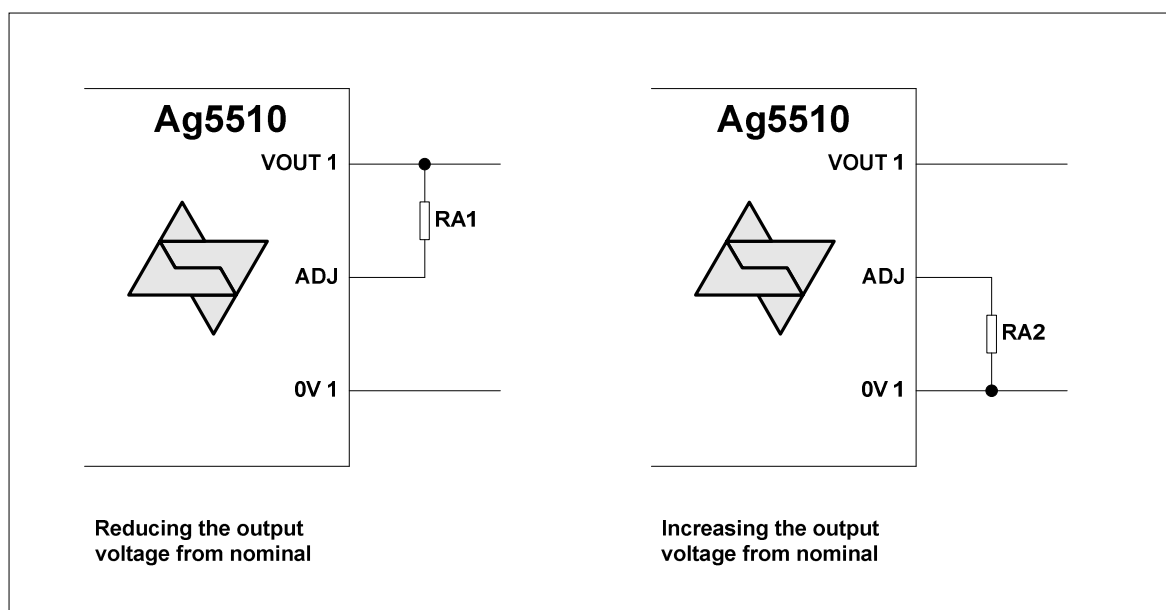


Figure 7: Output Adjustment

Reducing the output voltage, connect R between ADJ and VOUT 1		
Value of RA1	VOUT Parallel	VOUT Series
Open Circuit	12V	24V
91K *	10.55V	21.1V
Increasing the output voltage, connect R between ADJ and 0V 1		
Value of RA2	VOUT Parallel	VOUT Series
Open Circuit	12V	24V
8K2	15V	30.2V

Table 3: Output Adjustment Resistor (R) Value

\* RA1 must not be less than 91K. Adjusting Vout to less than 10.5V may cause permanent damage

## 5.9 Output Power

The maximum output power of the Ag5510 is 60W\*; however this is limited by the available input power to the module.

When calculating the output power, the following factors must be taken into account: -

1. Ag5510 efficiency
2. PSE output power
3. Cable and connector losses
4. Input bridge rectifier losses

\* When the output voltage is adjusted to its maximum the power must be limited to 60W. e.g. with Vout set to 30V the output current must be reduced to 2A.

## 5.10 Typical Connections

As shown in Figure 8: Typical Connection Diagram, a minimum of  $1000\mu\text{F}$  must be connected across each output, positioned as close to the output pins as possible. These capacitors are needed for output filtering and step load change performance and can be a standard low cost electrolytic; they do not need to be a low ESR type.

The Class programming and the Output Adjust inputs are optional and are provided to give greater flexibility to the Ag5510. Further information on using these inputs can be found in sections 5.4 Power Classification and 5.8 Output Adjustment.

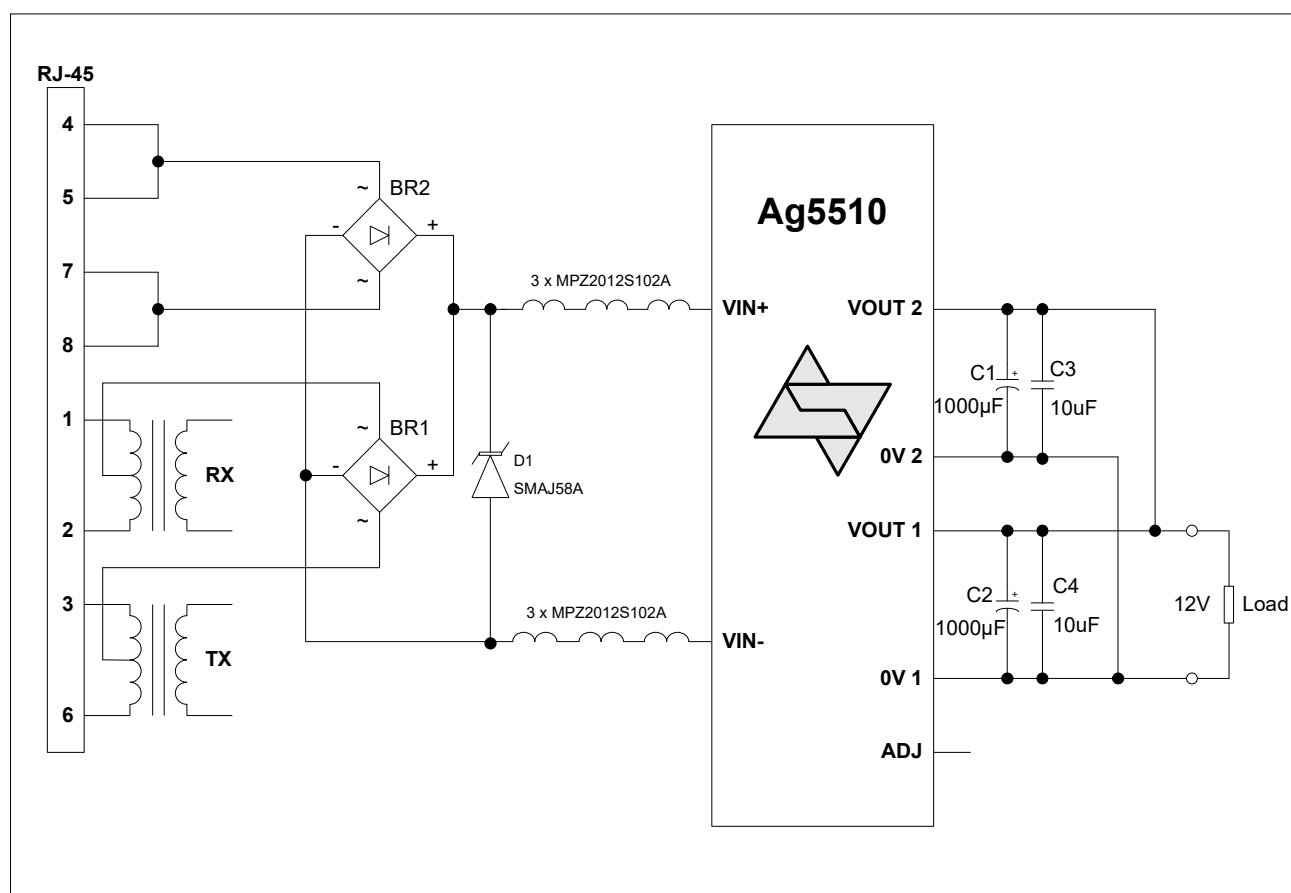
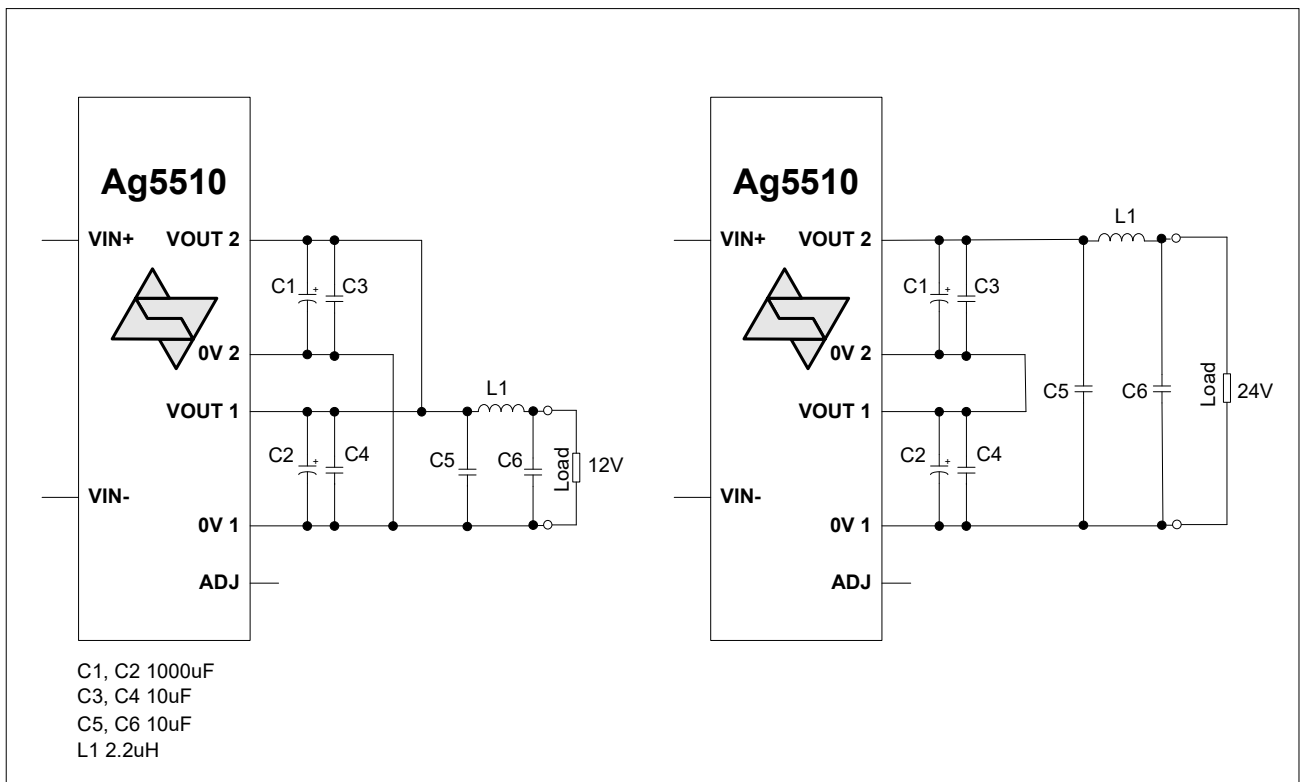


Figure 8: Typical Connection Diagram

## 5.11 Additional Output Filtering

The Ag5510 output ripple and noise can be reduced by adding an additional output filter. Figure 9 shows a cost effective method which can reduce the output ripple from  $294\text{mVp-p}$  down to  $15.6\text{mVp-p}$  when configured in parallel. When configured in series the output ripple can be reduced from  $600\text{mVp-p}$  down to  $40\text{mVp-p}$ .



*Figure 9: Additional Output Filtering*

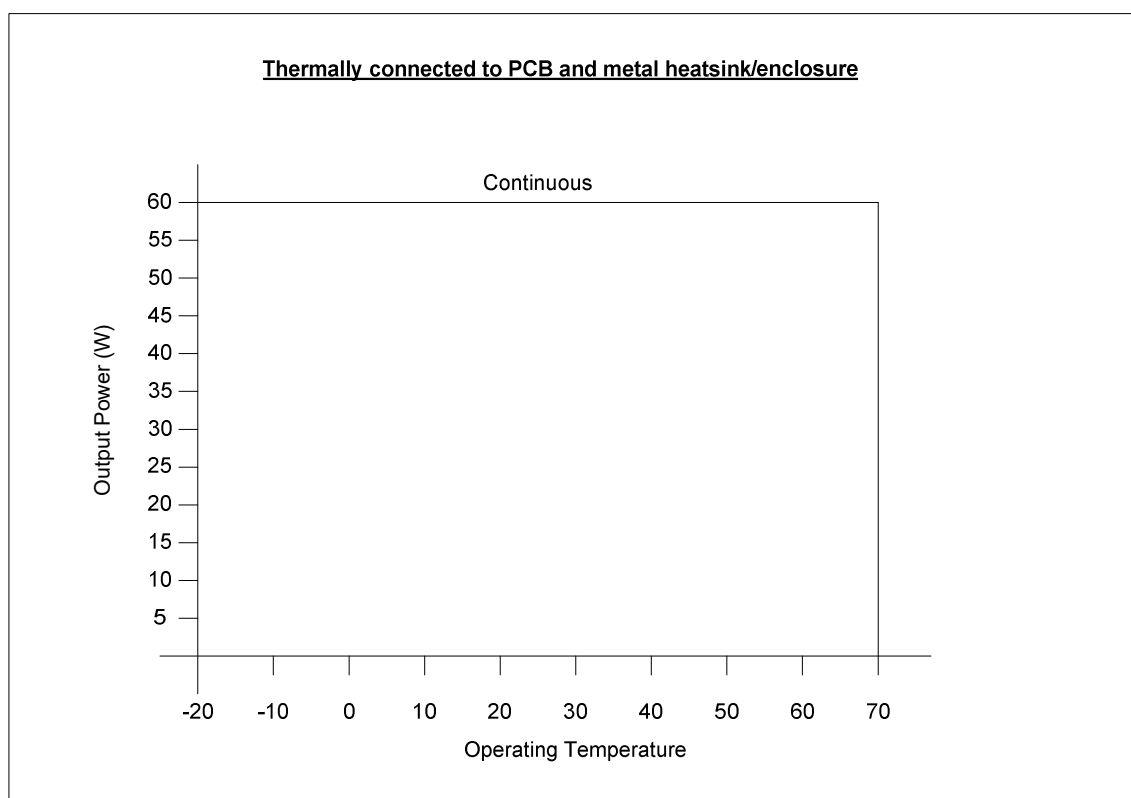
## 6. Operating Temperature Range

It is important to remember that Ag5510 is a power supply, and as such careful consideration should be taken over the mechanical design of the host product, with provision for heat sinking and/or forced air cooling.

At full power the Ag5510 will generate heat. The device has been designed to be used with a heatsink which thermally connects to the Ag5510 through the use of thermal pad such as Bergquist .01" Ultra soft gap pad, thermally mounted to the chassis of the host equipment, or cooled with forced air.

Because each application is different it is impossible to give fixed and absolute thermal recommendations. However to obtain maximum power it is important that any enclosure used has sufficient ventilation and airflow over the Ag5510.

Figure 10 shows the maximum ambient temperature under continuous load conditions. The Ag5510 is capable of handling 60W up to 70°C only when mounted to a heatsink, which a suggested mounting method is shown in Figure 13.



*Figure 10: Operating Temperature*

If the Ag5510 is thermally connected to the PCB only without an additional heatsink, then 60W can only be obtained up to 50°C. Suggested layout and dimensions of the thermal relief pads can be found in Figure 14 and Figure 15 respectively.

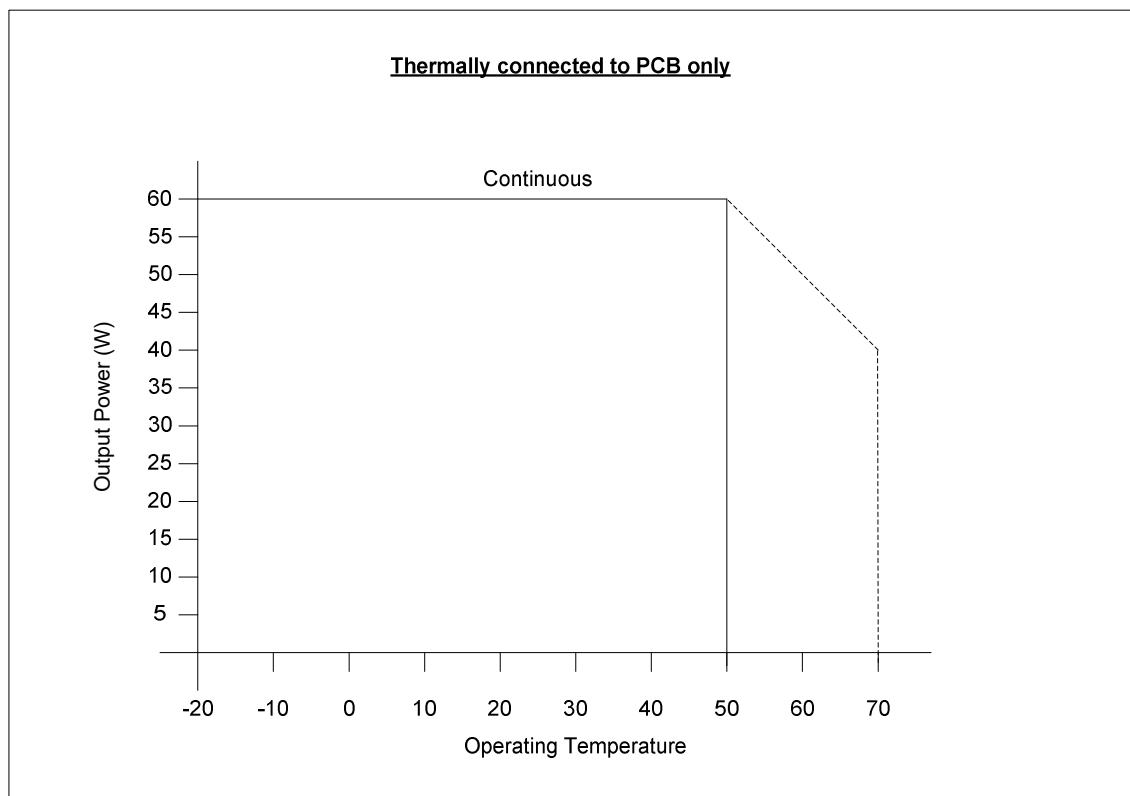


Figure 11: Operating Temperature (Thermally connected to PCB)

When intended for use in ambient temperatures below 0°C we would recommend a low ESR electrolytic capacitor be used on the DC output. Capacitors rated for -55°C operation should be used below 0°C.

## 7. Protection

The Ag5510 must be protected from over-voltages exceeding the 80V maximum rated surge input voltage. An inexpensive but effective solution can be achieved by connecting a Tranzorb diode across the input; see Apps Note “ANX-POE-Protection”.

## 8. EMC

The Ag5510 has been designed to pass EN55022 Class B, however the Ag5510 will only be one component within a system so we would always advise that provisions are put in place in case further noise reductions are needed. From our extensive experience we would recommend an inexpensive but effective solution to reduce emissions shown in Figure 12.



### 9.1 Absolute Maximum Ratings<sup>1</sup>

Note 1: Exceeding the above ratings may cause permanent damage to the product. Functional operation under these conditions is not implied. Maximum ratings assume free airflow.

## 9.2 Recommended Operating Conditions

	Parameter	Symbol	Min	Typ	Max	Units
1	Input Supply Voltage <sup>1</sup> 60W Output Minimum Load -12Vout	V <sub>IN</sub>	52 36		57 57	V V
2	Under Voltage Lockout	V <sub>LOCK</sub>	30		36	V
3	Operating Temperature <sup>2</sup>	T <sub>OP</sub>	-20	25	70	Ta / °C

Note 1: Output power limited by PSE current limit

Note 2: See Section operating temperature range

## 9.3 DC Electrical Characteristics

	DC Characteristic	Sym	Min	Typ <sup>1</sup>	Max	Units	Test Comments
1	Nominal Output Voltage	+VDC	11.4 22.8	12 24	12.6 25.2	V V	Parallel O/P Series O/P
2	Voltage Adjust Range	V <sub>ADJ</sub>	10.55		30.2	V	See 5.8 Output Adjustment
3	Continuous Output Current <sup>2</sup> V <sub>IN</sub> = 52V Min, Vout = 24V max	I <sub>CONT</sub>			5.0 2.5	A A	Parallel O/P Series O/P
4	Line Regulation	V <sub>LINE</sub>		0.1		%	@ 60W Load
5	Load Regulation	V <sub>LOAD</sub>		0.1		%	@ V <sub>IN</sub> =52V
6	Output Ripple and Noise Parallel O/P (12v) Series O/P (24v)	V <sub>RN</sub>		15.6 40		mVp-p mVp-p	@ Max load <sup>3</sup>
7	Minimum Load <sup>4</sup>	I <sub>MIN</sub>	0			mA	
8	Short-Circuit Duration	T <sub>SC</sub>			∞	sec	
9	Efficiency	Eff		89		%	Vin = 52V @ 1.8A Load
10	Isolation Voltage (I/O)	V <sub>ISO</sub>			1500	V <sub>PK</sub>	Impulse Test

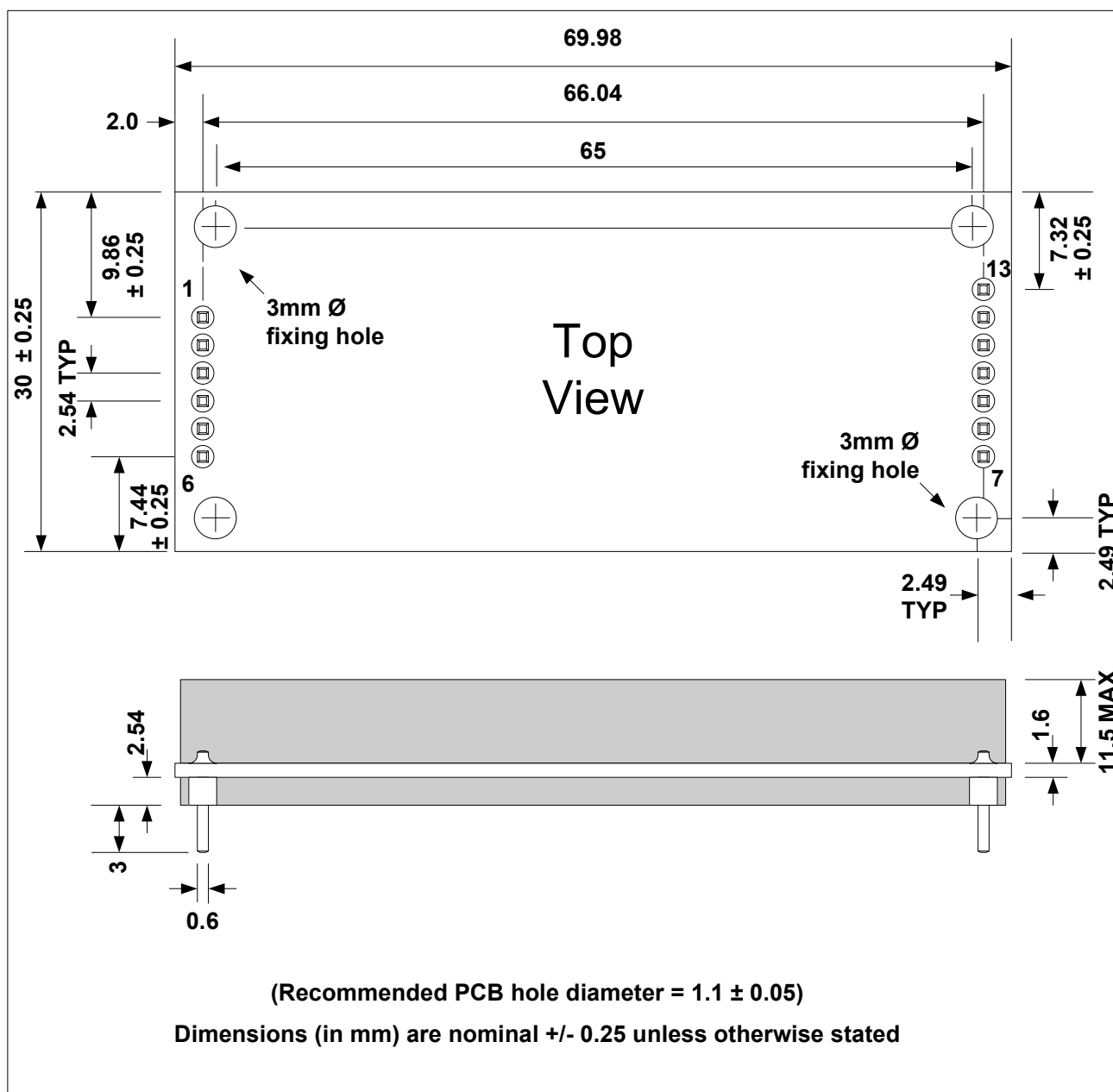
Note 1: Typical figures are at 25°C with a nominal 56V supply, parallel output configuration (unless otherwise stated) and are for design aid only. Not Guaranteed

2: The output must not exceed 60W or 5.0A Parallel / 2.5A Series.

3: The output ripple and noise was measured using the Pi Filter shown in figure 9.

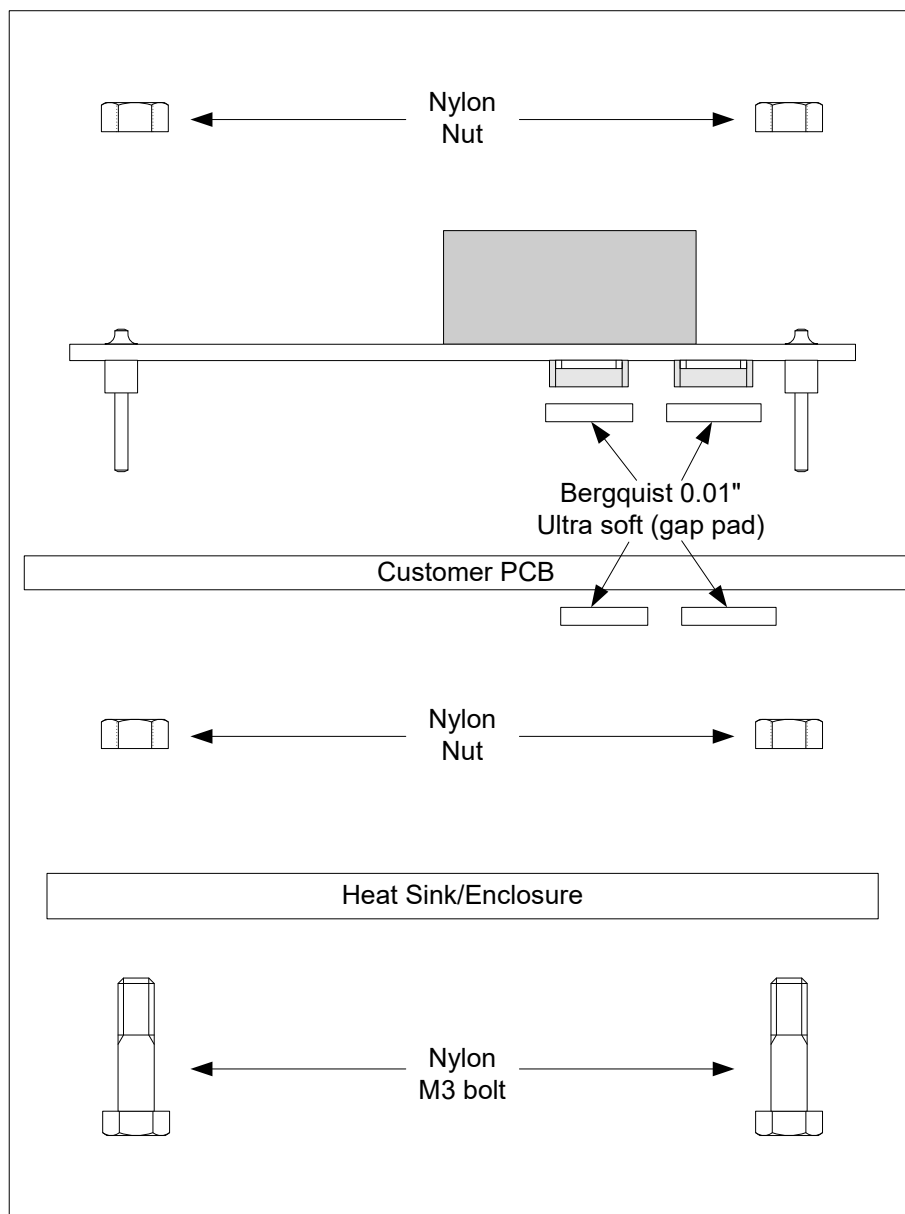
4: The Ag5510 has been designed to work normally when no load is connected.

## 10. Package





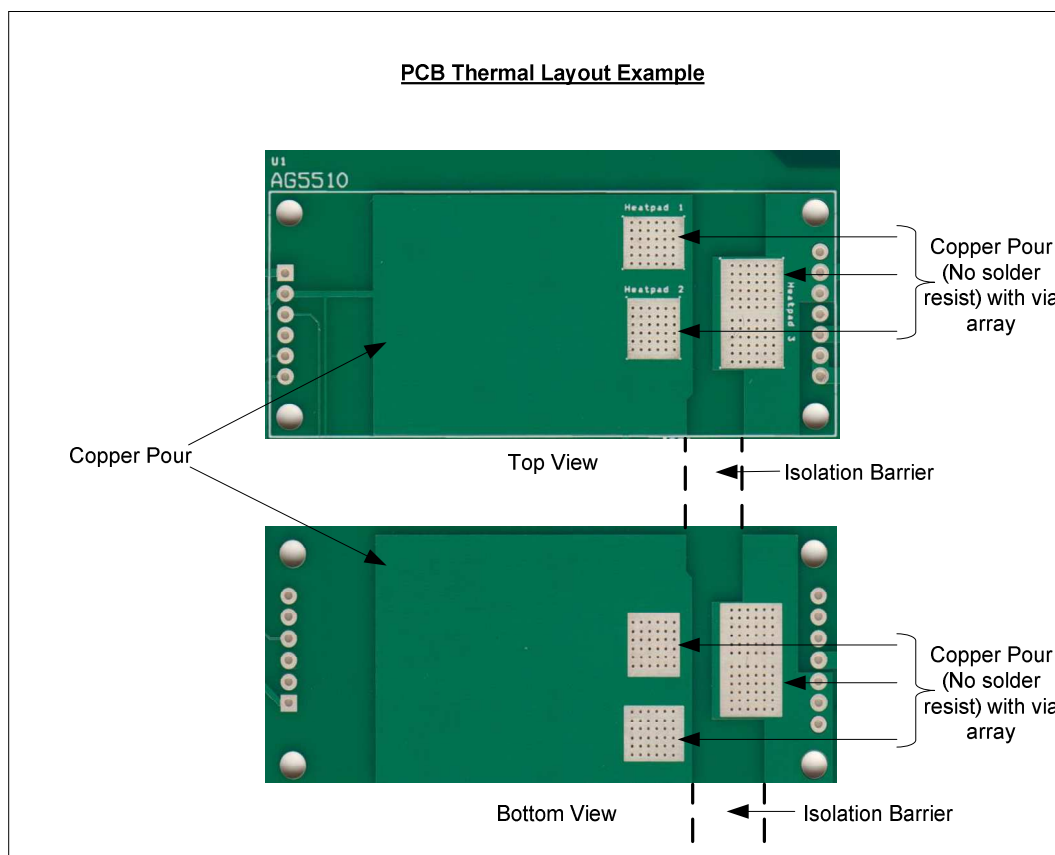
## 10.1 Heat Sink Assembly



*Figure 13: Suggested Heat Sink Assembly*

## 10.2 PCB Thermal Layout

To attain continuous operation at 60W the Ag5510 must be thermally connected to the customers PCB and their enclosure or heatsink. The thermal layout should have copper pads with a via array to help draw the heat through the PCB to the heatsink. An example of a thermal layout can be found below in Figure 14 with dimensions shown in Figure 15.



*Figure 14: Suggested PCB Thermal Layout*

## 10.3 Heatpad Footprint

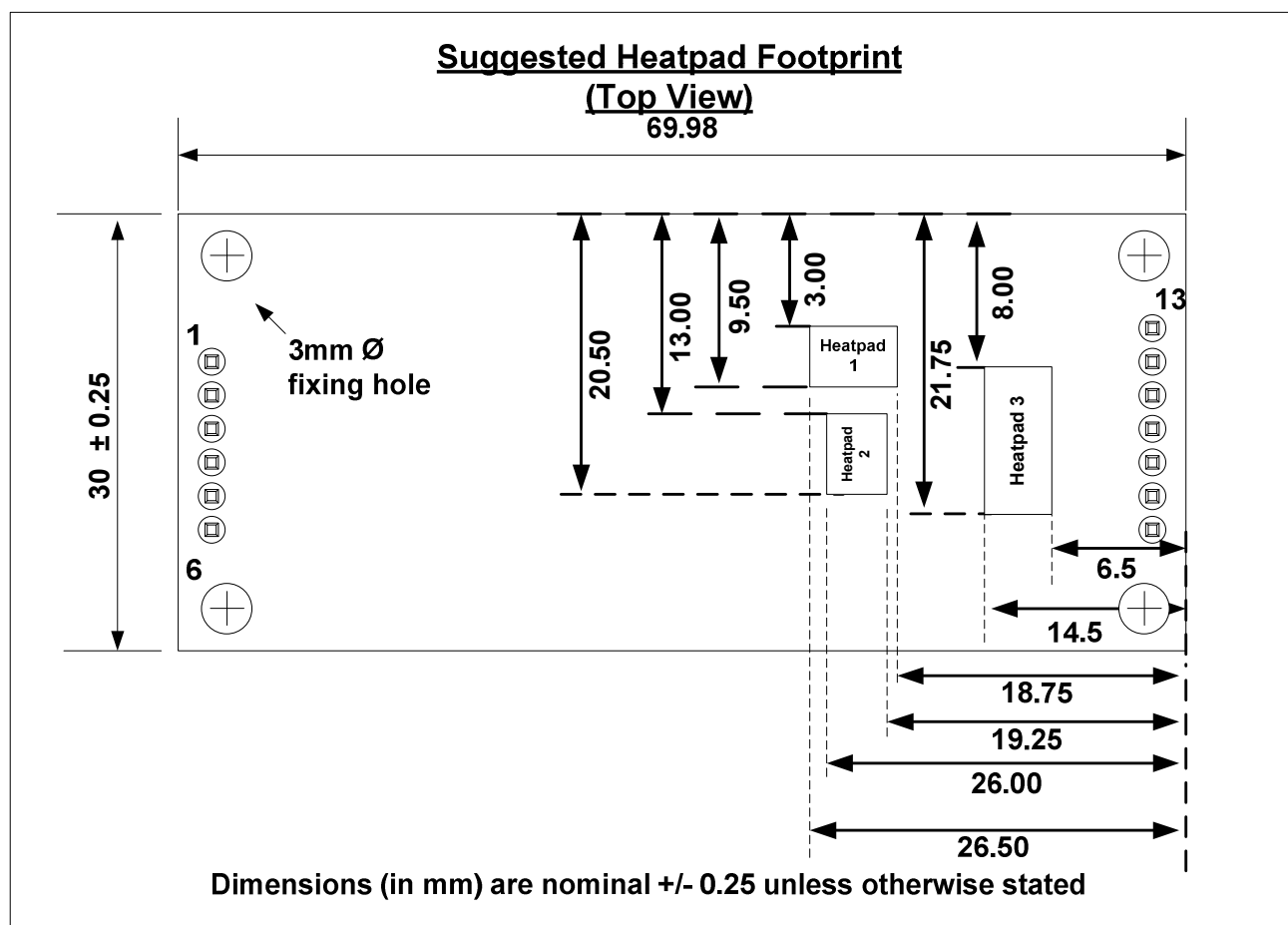


Figure 15: Suggested Heatpad Footprint

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