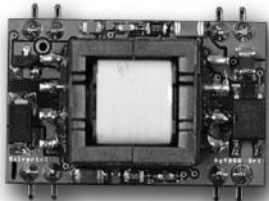# Silvertel

Ag9800M

Miniature PoE Module

1. Features

➢ Small SMT package

➢ IEEE802.3af compliant

➢ Low cost

➢ Input voltage range 36V to 57V

➢ Minimal external components required

➢ Short-circuit protection

➢ Adjustable Output

➢ 1500V isolation (input to output)

➢ Silvertel "design-in" assistance

2. Description

The Ag9800M Power-over-Ethernet (PoE) modules are designed to extract power from a conventional twisted pair Category 5 Ethernet cable, conforming to the IEEE 802.3af PoE standard.

The Ag9800M signature and control circuit provides the PoE compatibility signature required by the Power Sourcing Equipment (PSE) before applying up to 15W power to the port. The Ag9800M provides a Class 0 signature.

The DC/DC converter operates over a wide input voltage range and provides a regulated output. The DC/DC converter also has built-in short-circuit output protection.

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3. Ag9800M Product Selector

Standard			
Part Number†	Nominal Output Voltage	Maximum Output Power *	Date code‡ and Voltage Marking
Ag9803M	3.3V	6 Watts	WWYY 3
Ag9805M	5.0V	9 Watts	WWYY 5
Ag9812M	12.0V	12 Watts	WWYY 12
with Thermal Protection			
Part Number†	Nominal Output Voltage	Maximum Output Power *	Date code‡ and Voltage Marking
Ag9803MT	3.3V	6 Watts	WWYYT 3
Ag9805MT	5.0V	9 Watts	WWYYT 5
Ag9812MT	12.0V	12 Watts	WWYYT 12

*At 25°C with V_{IN} = 48V
† The Ag9800M fully meets the requirements of the RoHS directive 2011/65/EC on the restriction of hazardous substances in electronic equipment.
‡ Date code format: "WW" = Week Number, "YY" = Year; if the Ag9800M has thermal protection this will be followed by the letter "T".

Table 1: Ordering Information
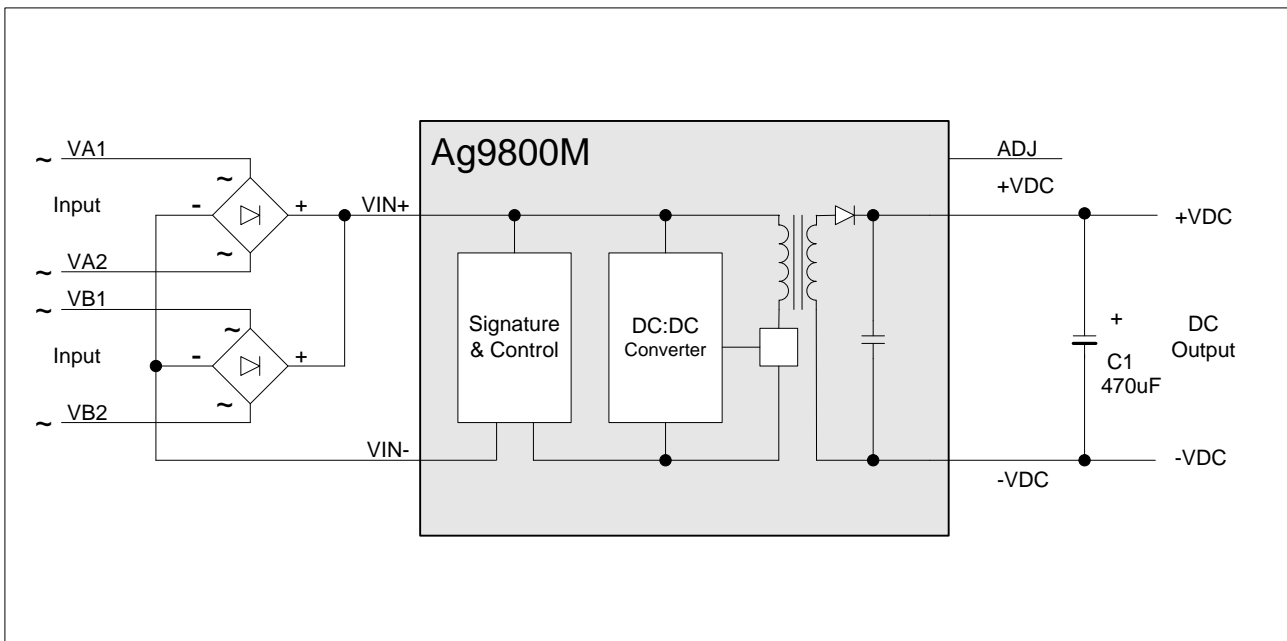
Figure 1: Block Diagram

4. Pin Description
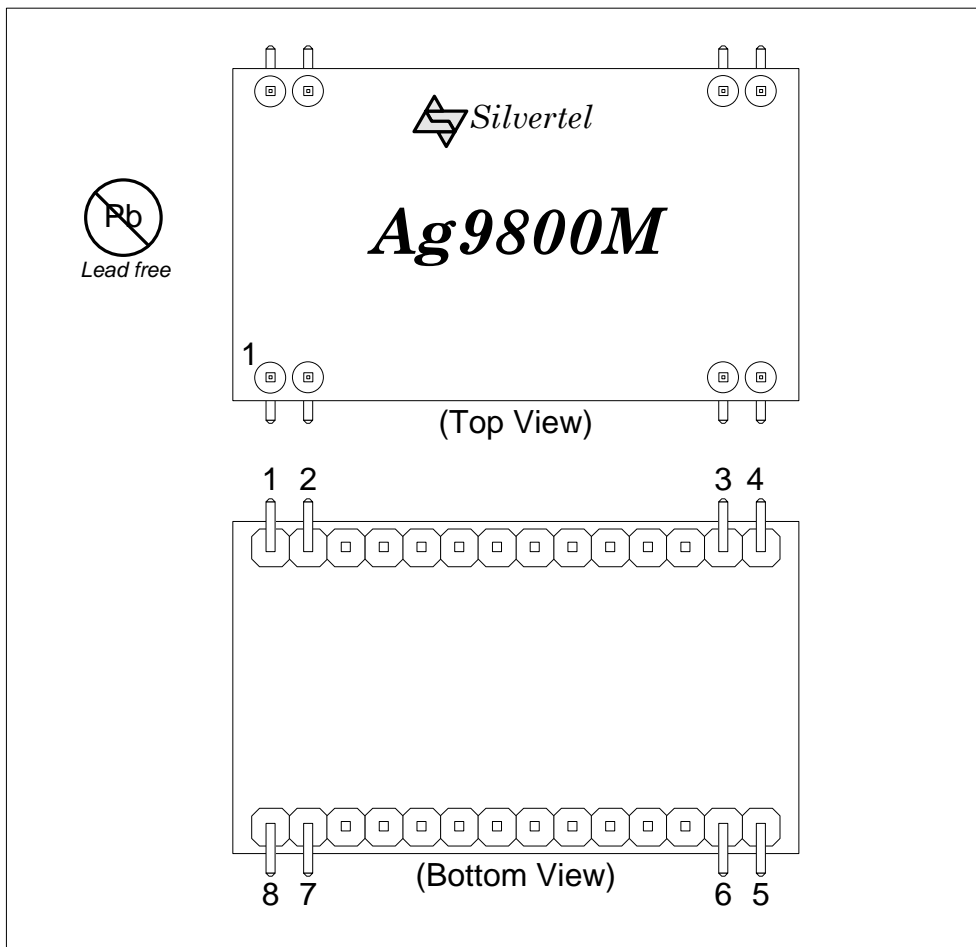
Figure 2: Ag9800M SMT Package Format

4.1 Ag9800M

Pin #	Name	Description
1	+VDC	**DC Output.** This pin provides the regulated output from the DC/DC converter.
2		
3	-VDC	**DC Return.** This pin is the return path for the +VDC output.
4	ADJ	**Output Adjust.** The output voltage can be adjusted from is nominal value, by connecting an external resistor from this pin to either the +VDC pin or the -VDC pin.
5	VIN+	**Direct Input +**. This pin connects to the positive (+) output of the input bridge rectifiers.
6		
7	VIN-	**Direct Input -**. This pin connects to the negative (-) output of the input bridge rectifiers.
8		

Table 2: Pin Description

5. Functional Description

5.1 Inputs

The Ag9800M is compatible with equipment that uses Alternative A (power on data pair) or Alternative B (power on spare pair) options, see Figure 3. It is specified that the PSE does not apply power to both outputs at the same time (Refer to IEEE802.3af for more information).

To prevent the module from being damaged, it is recommended that the module be powered by an IEEE 802.3af compliant PSE.

However the Ag9800M may be powered by a user designed power supply. But this equipment should include thermal and over current protection. It is also important that this equipment is current limited to 400mA.
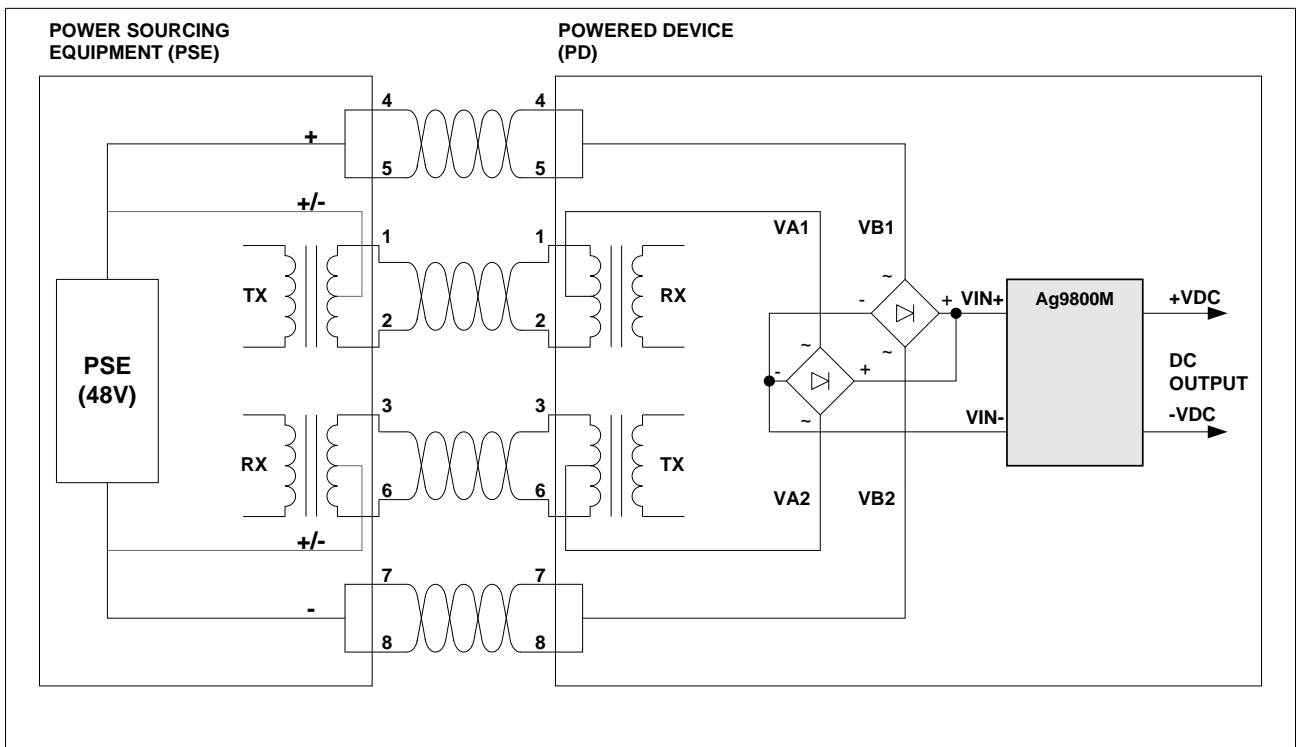
Figure 3: Typical System Diagram

5.2 PD Signature

When the Ag9800M is connected to the Cat5e cable, it will automatically present a Powered Device (PD) signature to the Power Sourcing Equipment (PSE) or Midspan Equipment, when requested. The equipment will then recognise that a powered device is connected to that line and supply power.

5.3 Isolation

To meet the safety isolation requirements of IEEE802.3af 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 Ag9800M is specified to meet the 1500Vdc impulse test. It is also important that the tracks on either side of the isolation barrier have at least a 3mm clearance, see Figure 8 and Section 7 for more information.

5.4 Power Classification

To minimise cost, the Ag9800M is fixed for Class 0 (0.44 Watts to 12.95 Watts) operation.

5.5 DC/DC Converter

The Ag9800M's DC/DC converter provides a regulated output that has built-in short-circuit output protection – refer Table 1: Ordering information for voltage and power ratings.

5.6 Output Adjustment

The Ag9800M has an ADJ pin, which allows the output voltage to be increased or decreased from its nominal value. Figure 4: Output Adjustment shows how the ADJ pin is connected.
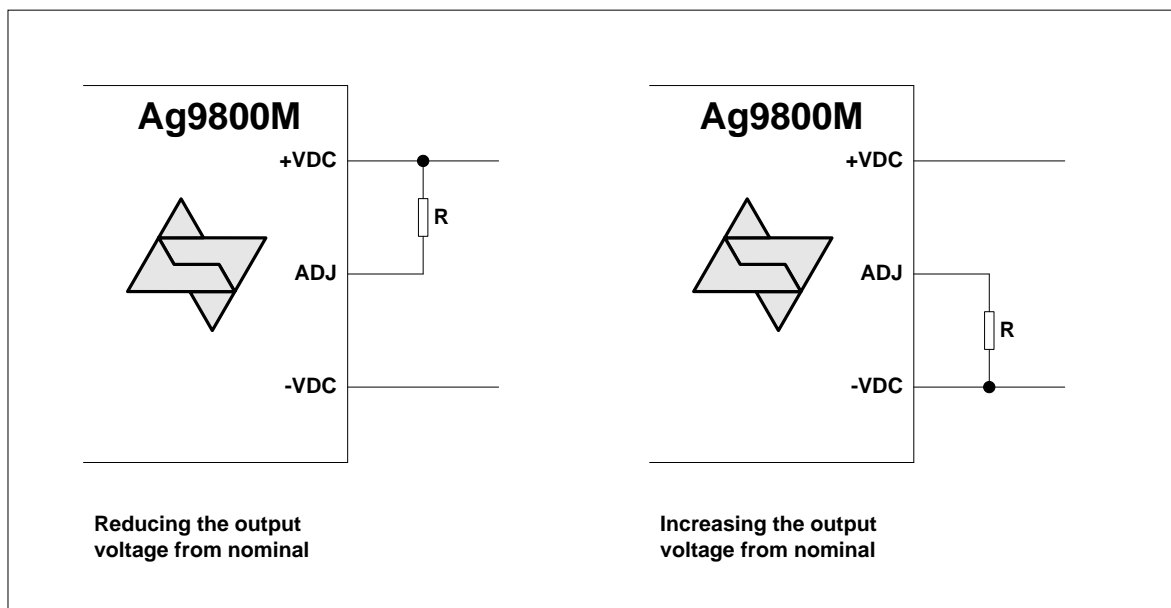

Figure 4: Output Adjustment

Reducing the output voltage, connect R between ADJ and +VDC			
Value of R	Ag9803M output	Ag9805M output	Ag9812M Output
Open Circuit	3.30V	5.00V	12.00V
0 Ohms	3.20V	4.45V	10.0V
Increasing the output voltage, connect R between ADJ and -VDC			
Value of R	Ag9803M output	Ag9805M output	Ag9812M output
Open Circuit	3.30V	5.00V	12.00V
0 Ohms	3.78V	5.62V	12.63V

Table 3: Output Adjustment Resistor (R) Value
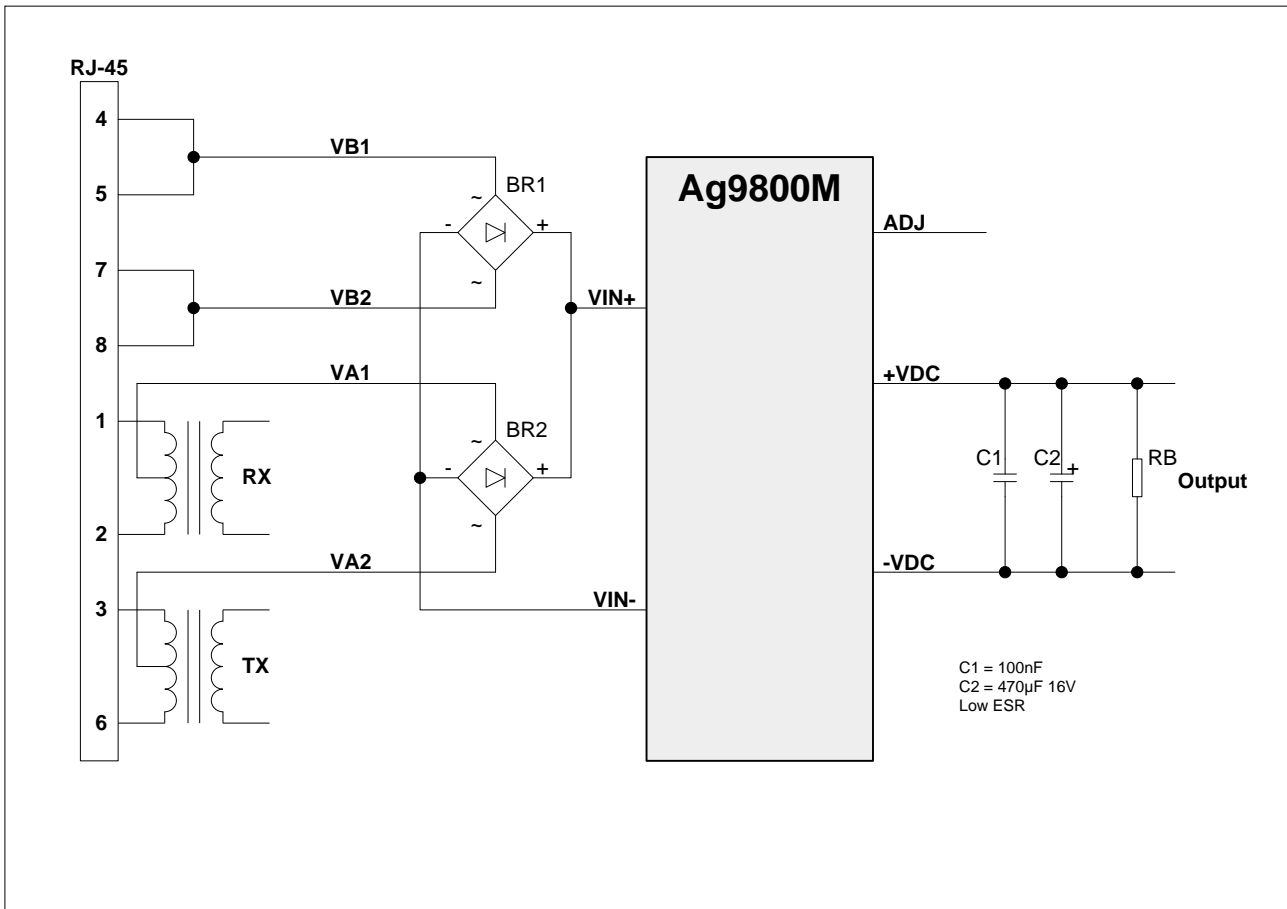
5.7 Typical Connections

The Ag9800M requires minimal external components as shown in Figure 5: Typical Connection Diagram.

C1 is required to reduce the dc/dc converter switching noise. C2 must be fitted for output stability and should be a minimum of 470µF. Both of these capacitors should be positioned as close to the output pins as possible.

C2 is also required to handle load step changes and to reduce the output ripple. It may need to be increased in value, for applications where the output needs to cope with high load step changes. We recommend using a low ESR electrolytic as this reduces the output ripple. Also a low ESR capacitor is essential for operation below 0°C.

BR1 and BR2 can be inexpensive bridge rectifiers, for example MB4S or MB6S.

Figure 5: Typical Connection Diagram

The output adjust input (ADJ) is optional, it is provided to give greater flexibility to the Ag9800M product range. Further information on using these inputs can be found in Section 5.6.

RB may be required to maintain a minimum load, see Section 5.9 for more details.

5.8 Additional Output Filtering

The Ag9800M configuration shown in Figure 5, offers basic output filtering for ripple and noise. On the 12V option, at maximum load this is ~160mVp-p; although on the 5V and 3.3V options the ripple and noise is much lower (see Section 11.3). Figure 6 shows two cost effective methods for reducing the ripple and noise, if required.
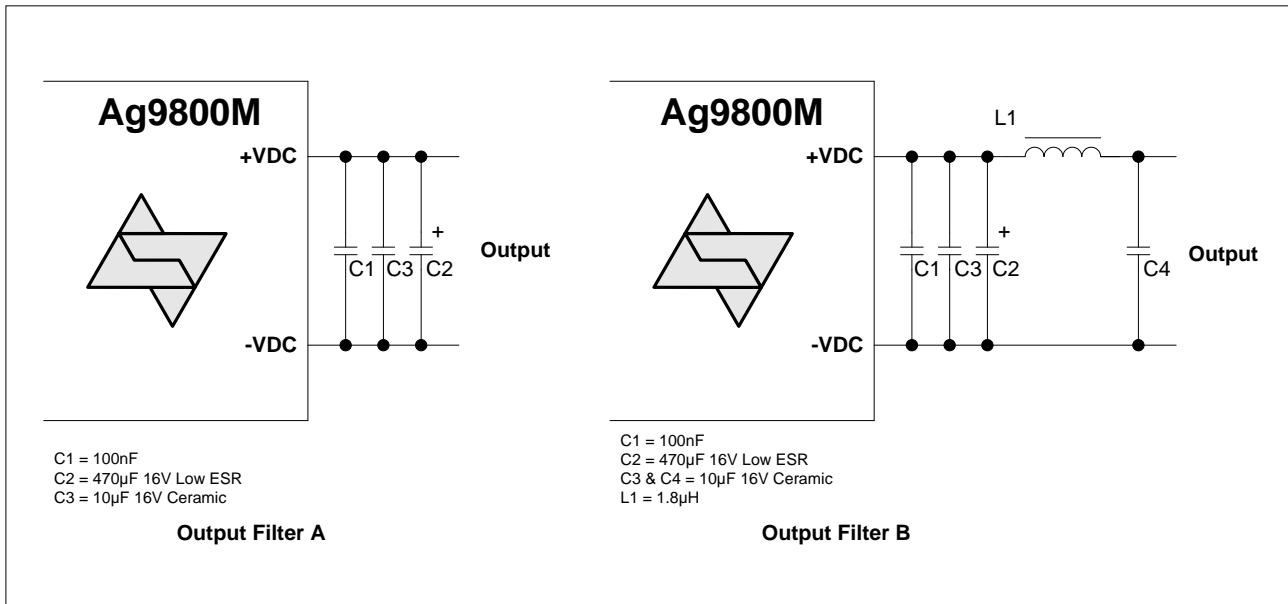
Figure 6: Output Filtering

The simplest and cheapest solution is shown in Figure 6 - Output Filter A. This will reduce the ripple and noise to ~43mVp-p (12V option). Adding a PI filter, as shown in Figure 6 – Output Filter B, will take the ripple and noise level down to ~16mVp-p (12V option). A low ESR electrolytic is essential for operation below 0°C.

5.9 Minimum Load

The Ag9800M must always supply a minimum current, see Table 11.3.

When operated below this current, the Ag9800M can emit a low level audible noise and may cause some PSEs to fail the Maintain Power Signature (MPS) and switch its output off.

The reason that the module emits this noise is due to the dc/dc converter running in discontinuous mode.

If this audible noise is not an issue, then the Ag9800M can work safely with a much smaller load. But to ensure that the PSE has a sufficient load to meet the PSEs MPS, it would be advisable not to operate the Ag9800M below the specified minimum load.

5.10 Start-up Voltage

It is important that during start-up the Ag9800M input voltage is ≥42V, this will ensure that the module powers up correctly. Once the dc/dc converter is up and running the module will work normally even if the input voltage is reduced to its minimum level of 36V.

When using an IEEE802.3af compliant PSE this will not be an issue, as the minimum output voltage of the PSE must be ≥44V.

6. Typical Application

The Ag9800M can be used in numerous applications. In the example shown in Figure 7, the data outputs from the switch are connected to the inputs of a midspan. The midspan will then add power (to the data) on each output that supports Power over Ethernet (PoE).

In this example port 1 is connected to an Ethernet camera and port 2 is connected to a wireless access point, both of these devices have a built-in Ag9800M. When the midspan is switched on (or when the device is connected), the midspan will check each output for a PoE signature. On ports 1 and 2 the Ag9800M will identify themselves as PoE enabled devices and the midspan will supply both data and power to these peripherals.

The other ports (shown in this example) will not have a PoE signature and the midspan will only pass the data through to these peripherals. The midspan will continuously monitor each output to see if a PoE enabled device has been added or removed.
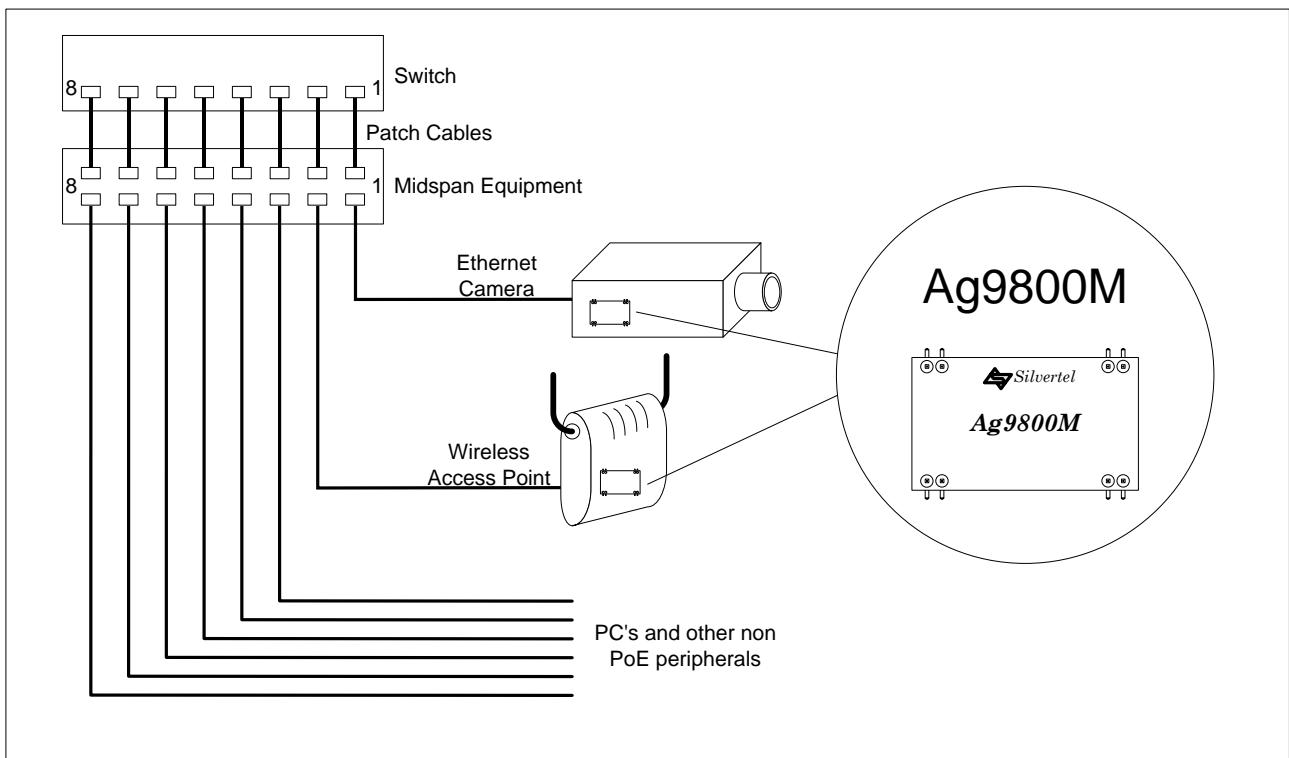
Figure 7: Typical Application

7. Layout Consideration

Figure 8 shows our suggested board layout for the Ag9800M, with reference to the basic output configuration shown in Figure 5.
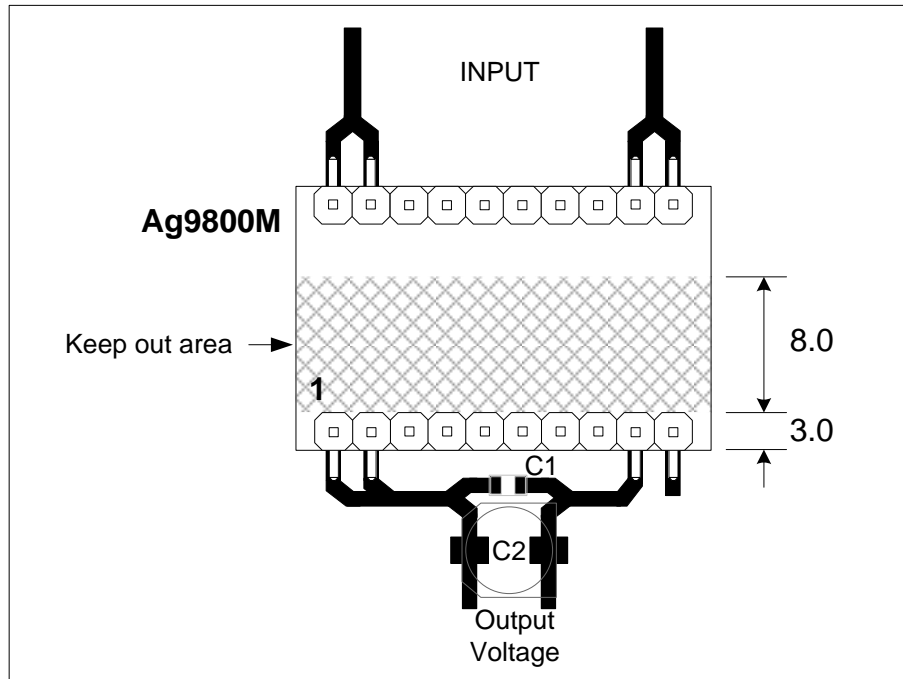
Figure 8: Layout Consideration

8. Operating Temperature Range

Because the Ag9800M is a power component, it will generate heat, so it is important that this be taken into consideration at the design stage.

The heart of the Ag9800M is a DC/DC converter, which like any other power supply will generate heat. The amount of heat generated by the module will depend on the load it is required to drive and the input voltage supplied by the PSE. The information shown within this section of datasheet is referenced to a nominal 48Vdc input voltage supplied by the PSE.

The Ag9800M has a maximum ambient operating temperature of 70°C see   Figures 9, 10 and 11. These results were performed in an environment chamber - Associated Environmental System SD-302, without any heat-sinking. The performance of the Ag9800M can be improved by forcing the airflow directly over the part or by using a heatsink (see Apps Note "ANX-POE-Thermal Consideration").

The output stage of the standard Ag9800M has no built-in thermal protection; so it is very important that the maximum operating temperature is never exceeded. If the module is intended for use in high ambient temperatures > 50°C; then we would recommend using the Ag9800MT, which has built-in thermal protection.
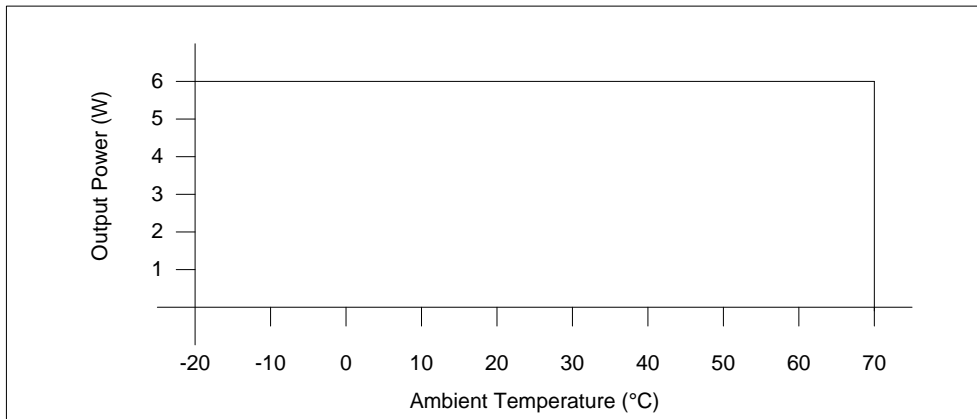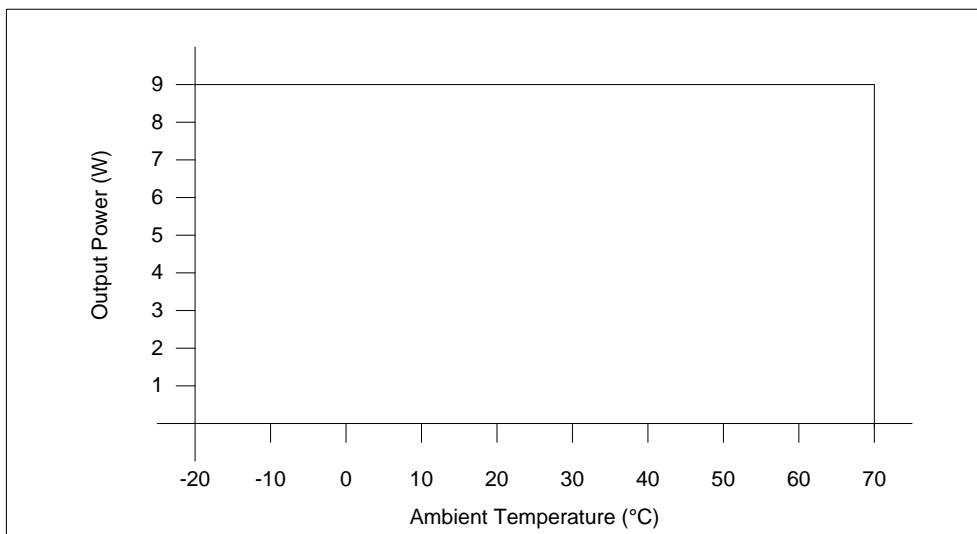
Figure 9: Ag9803M Operating Profile

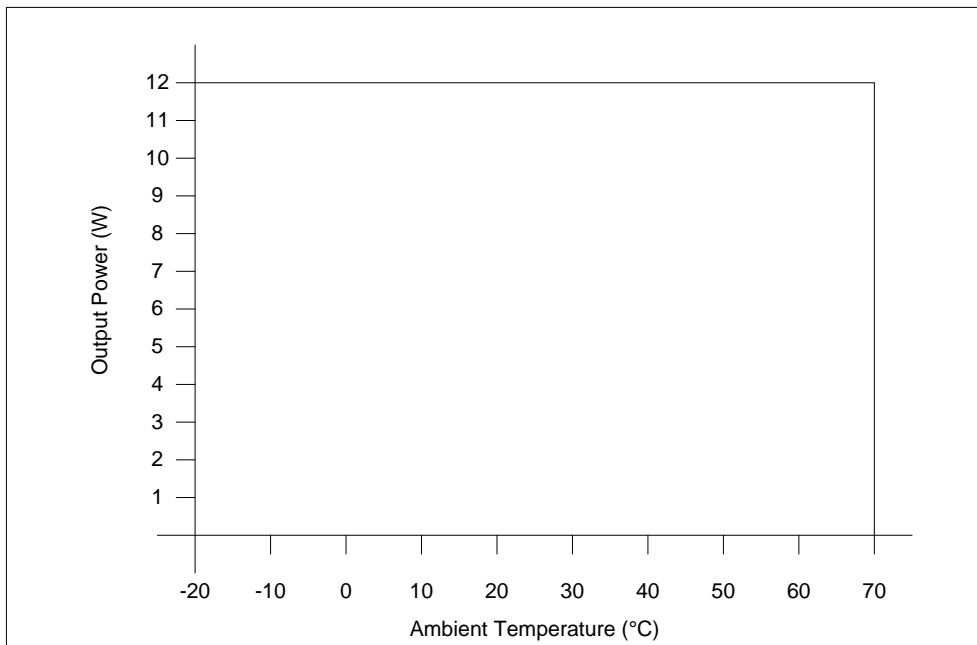Figure 10: Ag9805M Operating Profile

Figure 11: Ag9812M Operating Profile

One simple technique that can be used to draw heat away from the module is to add power planes to the input and output pins, see Figure 12 for an example of this.
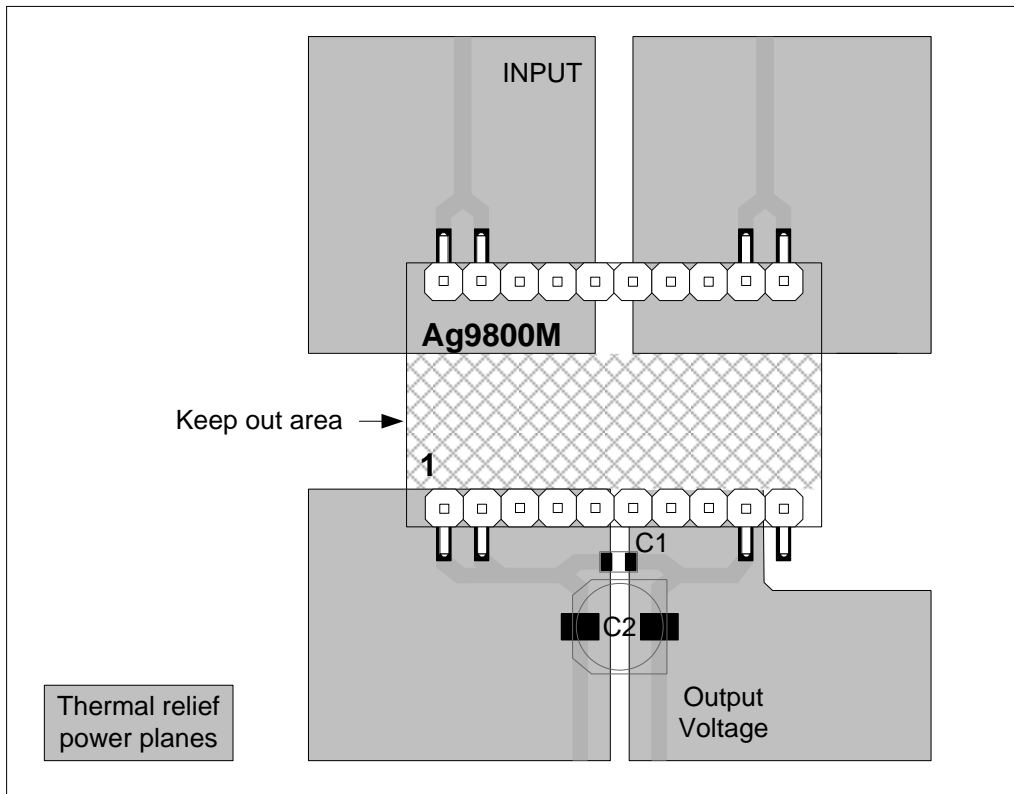

Figure 12: Ag9800M Thermal Relief Power Planes

Due to its small size, it is important that as much heat is drawn away from the module as possible. It is also important that any enclosure used has sufficient ventilation for the Ag9800M and a direct airflow if possible. But because each application is different, it is impossible to give fixed and absolute thermal recommendations.

9. Protection

9.1 Input Protection

The Ag9800M 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 Figure 13.
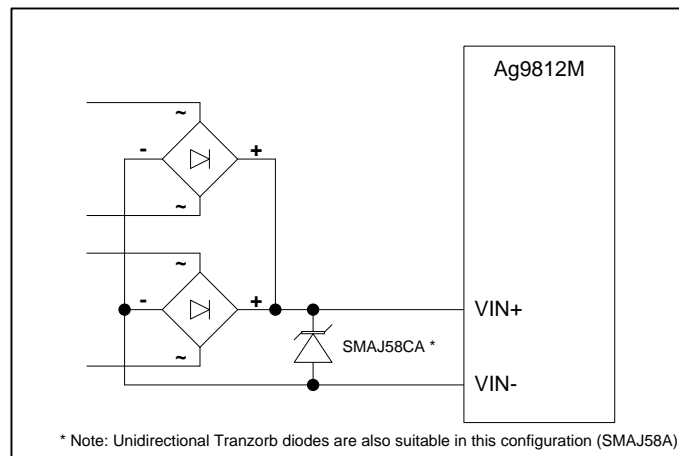

Figure 13: Ag9800M Input Protection

More information is available in Apps Note "ANX-POE-Protection".

9.2 Thermal Protection

The standard Ag9800M does not have built-in thermal protection. If this module is intended to be used in high ambient temperatures >50°C; then the Ag9800MT (with thermal protection) should be used.

The thermal protection reduces the output power, to ensure that the maximum component temperature is not exceeded. Full output power will be restored, when the ambient temperature drops back down into the safe operating range.

10. EMC

The Ag9800M is designed to meet EN55022 Class B (pre-compliance test results are available from Silvertel).

However, because the Ag9800M will only be one component within your system, it is impossible to say whether the final product will pass EMC testing, without the need for additional filtering. The Ag9800M uses a dc/dc converter with pulse frequency modulation, so care does need to be taken to minimise emissions.

To help with this an Apps Note "ANX-POE-EMI" has been written with tips and suggestions.

If the Ag9800M is to be used in HDBaseT application, then additional filtering may be required to minimize bit errors over long cable lengths. Another Apps Note "ANX-POE-HDBaseT" has been written specifically for this.

Note: The Silvertel website has the latest revisions of all the Apps Notes referred to in this document.

11. Electrical Characteristics

11.1 Absolute Maximum Ratings[1]

	Parameter	Symbol	Min	Max	Units
1	DC Supply Voltage	V_{CC}	-0.3	60	V
2	DC Supply Voltage Surge for 1ms	V_{SURGE}	-0.6	80	V
3	Storage Temperature	T_S	-40	+100	^{O}C

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.

11.2 Recommended Operating Conditions

	Parameter	Symbol	Min	Typ	Max	Units
1	Input Supply Voltage[1]	V_{IN}	36	48	57	V
2	Under Voltage Lockout	V_{LOCK}	30		36	V
3	Minimum Start-up Voltage	V_{START}	42			V
4	Operating Temperature[2]	T_{OP}	-20	25	70	Ta / ^{O}C

Note 1: With minimum load.
   2: See Section 8.
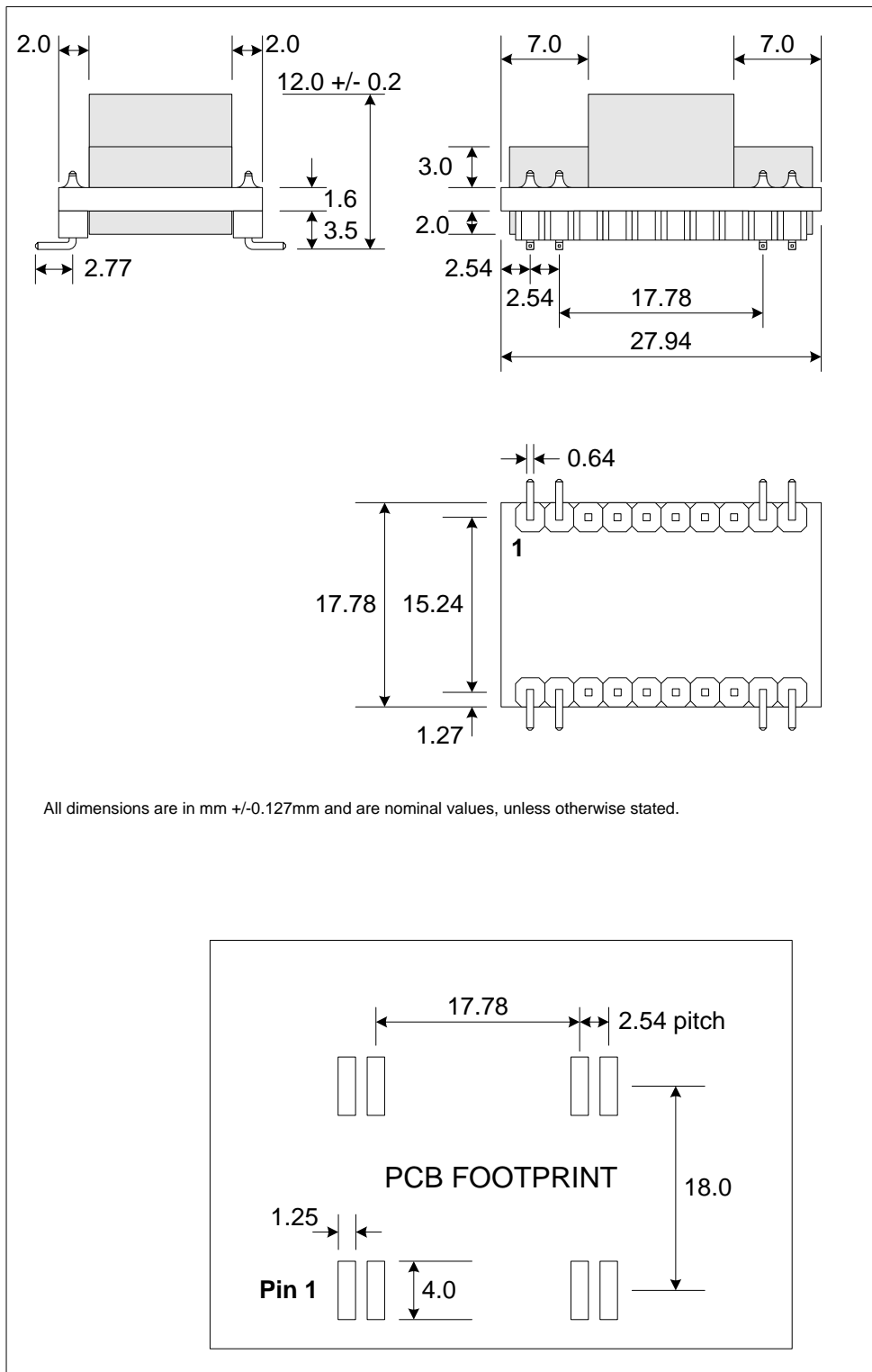
11.3 DC Electrical Characteristics

	DC Characteristic	Sym	Min	Typ[1]	Max	Units	Test Comments
1	Nominal Output Voltage	+VDC	3.1 4.75 11.5	3.3 5.0 12.0	3.5 5.25 12.5	V	Ag9803M Ag9805M Ag9812M
2	Output Current (V_{IN} = 48V)	PWR			1.8 1.8 1.0	A	Ag9803M Ag9805M Ag9812M
3	Line Regulation	V_{LINE}		0.3 0.06 0.06		%	Ag9803M Ag9805M Ag9812M
4	Load Regulation - Min to Max (V_{IN} = 48V)	V_{LOAD}		0.2 0.16 0.06		%	Ag9803M Ag9805M Ag9812M
5	Output Ripple and Noise[2] (Figure 5 @ maximum load)	V_{RN}		57 74 157		mVp-p	Ag9803M Ag9805M Ag9812M
6	Output Ripple and Noise[2] (Figure 6A @ maximum load)	V_{RNa}		52 54 43		mVp-p	Ag9803M Ag9805M Ag9812M
7	Output Ripple and Noise[2] (Figure 6B @ maximum load)	V_{RNb}		47 55 16		mVp-p	Ag9803M Ag9805M Ag9812M
8	Minimum Load[3]	I_{LOAD}	200 200 100			mA	Ag9803M Ag9805M Ag9812M
9	Short-Circuit Duration	T_{SC}			∞	sec	
10	Peak Efficiency	EFF		80.0 83.5 87.0		%	Ag9803M Ag9805M Ag9812M
11	Isolation Voltage (I/O)	V_{ISO}			1500	V_{PK}	Impulse Test

Note 1: Typical figures are at 25°C with a nominal 48V supply and are for design aid only. Not Guaranteed.
   2: Measurements made on a Grundig SO50 with a 200MHz (x10) probe (see Apps Note "ANX-EMI-Test-Probe – POE EMI Testing").
   3: The module can emit an audible noise if operated at less than the specified minimum I_{LOAD} and cause the PSE to fail its MPS. You must always ensure that the minimum load is never <10mA for prolonged periods of time, as this will damage the module.

12. Package

All dimensions are in mm +/-0.127mm and are nominal values, unless otherwise stated.

PCB FOOTPRINT