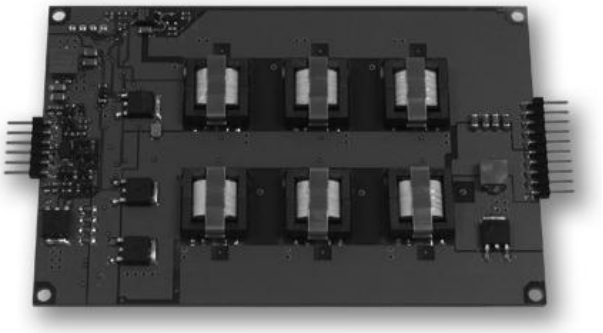
Silvertel

Ag5700

200W Powered Device Module



1. Features

- Maximum 200 Watt Output Power
- Low Profile – only 8mm thick
- High efficiency DC/DC converter
- 1500V isolation (input to output)
- Low output ripple and noise
- Minimal (low cost) external components required
- Comprehensive overload, thermal and short-circuit protection
- Silvertel “design-in” assistance

2. Description

The Ag5700 is a Powered Device (PD) module capable of supplying up to 200W to the user equipment, over standard Cat5e / 6 Ethernet cable.

It is designed to work exclusively with the Ag6700 Power Sourcing Equipment (PSE) module to provide a complete Power over Ethernet (PoE) solution for very high power applications such as TV’s, displays, computer monitors and laptops.

It incorporates a wide range of micro-processor controlled monitoring and protection features to ensure it operates safely within the target equipment.

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3. Ag5700 Product Selector

Part Number†	Nominal Output Voltage	Maximum Output Power * Peak / Continuous
Ag5700	24V	200W / 180W

*At 25°C must include adequate thermal management
† The Ag5700 fully meets the requirements of the RoHS directive 2002/95/EC on the restriction of hazardous substances in electronic equipment.

Table 1: Ordering Information

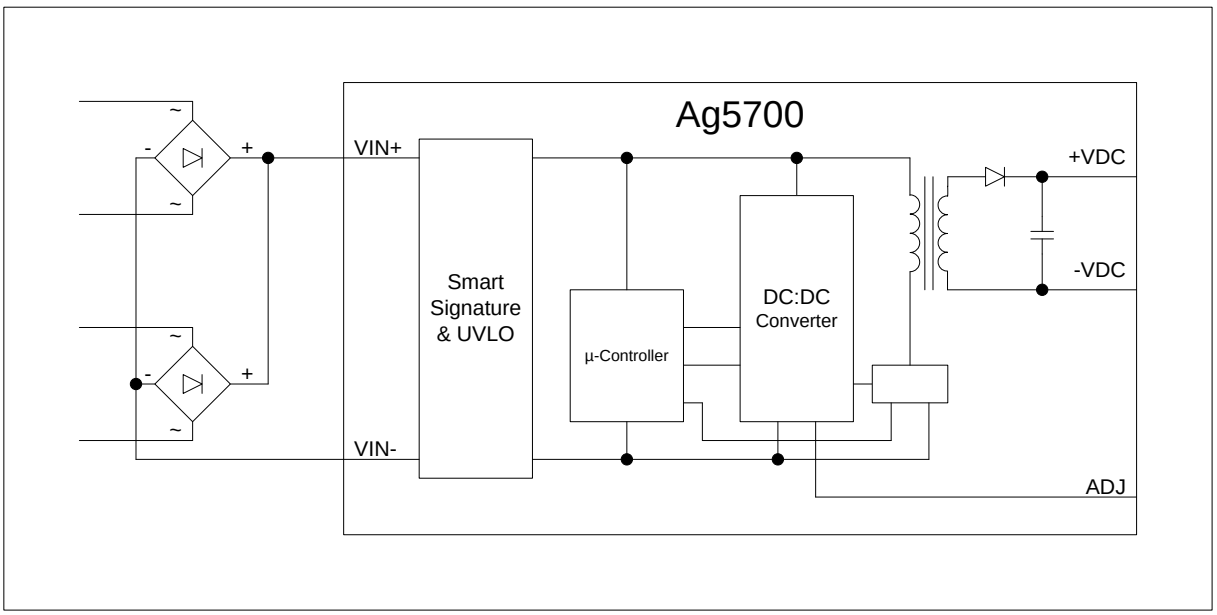

Figure 1: Block Diagram

Figure 2: Ag5700 Package Format

4. Pin Description

Input Connector pins J1

Pin #	Name	Description
1,2,3	VIN+	**Direct Input +**. These pins connect to the positive (+) output of the input bridge rectifier.
4,5,6	VIN-	**Direct Input -**. These pins connect to the negative (-) output of the input bridge rectifier.

Output Connector pins J2

Pin #	Name	Description
7 - 10	+VDC	**DC Output.** These pins provide the main regulated output from the DC/DC converter.
11	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.
12 - 16	-VDC	**Return.** These pins provide the return path for the +VDC output.

5. Functional Description

5.1 Inputs

The Ag5700 has a single input that is connected to two external bridge rectifiers (see Figures 1 and 3). It is essential that the voltage drop across the external bridge rectifiers is as small as possible, to maximise efficiency and reduce heat dissipation.

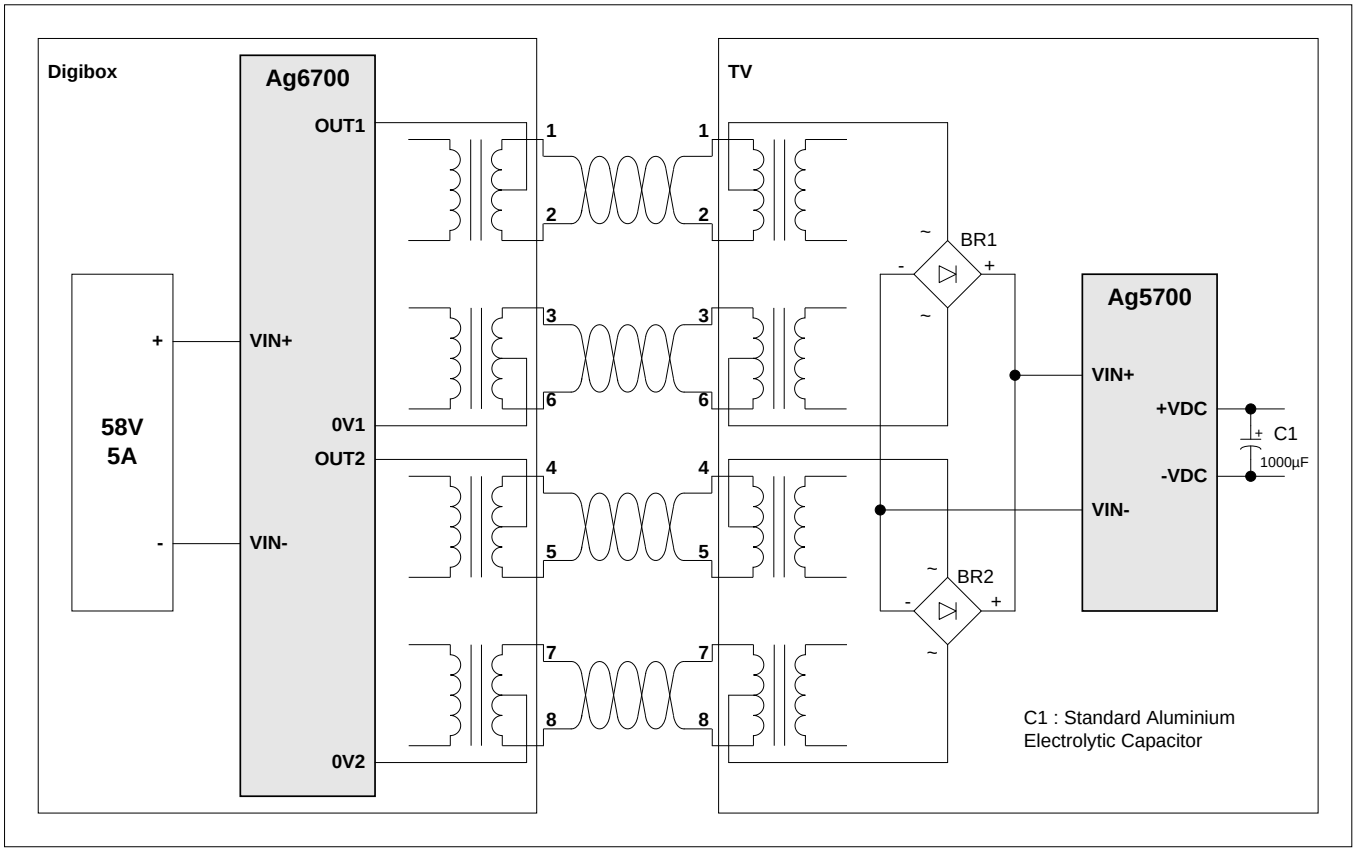

Figure 3: Typical System Diagram

Because of the high input current, standard bridge rectifiers cannot be used. Schottky bridge rectifiers are available or can be made by using discrete diodes. Even with Schottky diodes at maximum power, the voltage drop across each bridge can be >1V and at ~2A the bridges will have to dissipate > 2W each. To minimise the voltage drop and losses incurred (even with Schottky diodes) using MOSFET bridge rectifiers can reduce the voltage drop to <0.4V and the power dissipation to < 0.8W each.

Figure 4 shows a typical MOSFET bridge rectifier circuit. VA1 & VA2 connect to the input centre taps of the data transformer supplying power from one of the Ag6700's outputs and VB1 & VB2 connect to the other Ag6700's output.

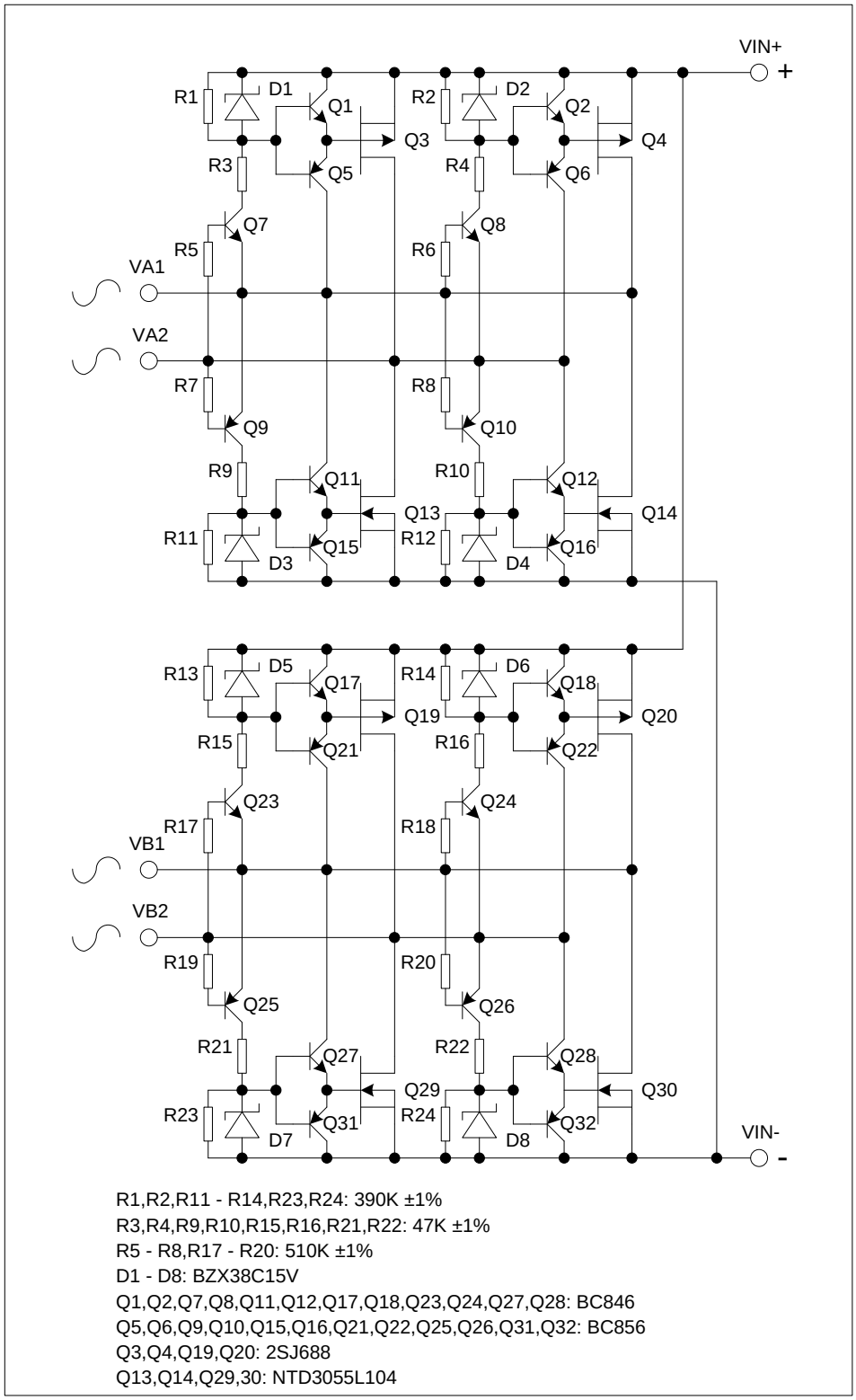

Figure 4: Optional MOSFET Bridge Rectifier

The minimum input voltage needed by the Ag5700 depends on the output load it is required to drive. If the voltage is too low the current will be higher and the module could be damaged.

For example: 42V is the minimum needed for a load of less than 120W. 48V is the minimum needed for a load of 120-150W load and 52V is the minimum needed for a load of 150W-200W.

Note: This is the voltage at the input to the Ag5700 and should be calculated by taking into account the voltage from the PSE and the volts drop in the Ethernet cable, connectors, magnetics and rectifier bridges.

5.2 PD Signature

The Ag5700 input automatically presents the Ag6700 PSE with a valid smart signature; no external programming components are required. The PSE will not provide power until it recognises a valid smart signature.

5.3 Isolation

The Ag5700 has been designed to pass the IEEE802.3 1500V impulse test. When mounting the module to the heat sink, you must ensure a clearance of 1.5mm minimum between components and pins on either side of the isolation barrier. This can be overcome by placing an isolative film on the heat sink.

5.4 DC/DC Converter

The Ag5700's DC/DC converter provides a regulated low ripple and low noise output that has built-in output over-load and short-circuit protection. Special design features have been used to reduce EMI to a very low level.

5.5 Output Voltage and Adjustment

The Ag5700 has a nominal output voltage of 24V. This can be adjusted higher by connecting a resistor between the ADJ pin and the –VDC pin; or adjusted lower by connecting a resistor between the ADJ pin and the +VDC pin.

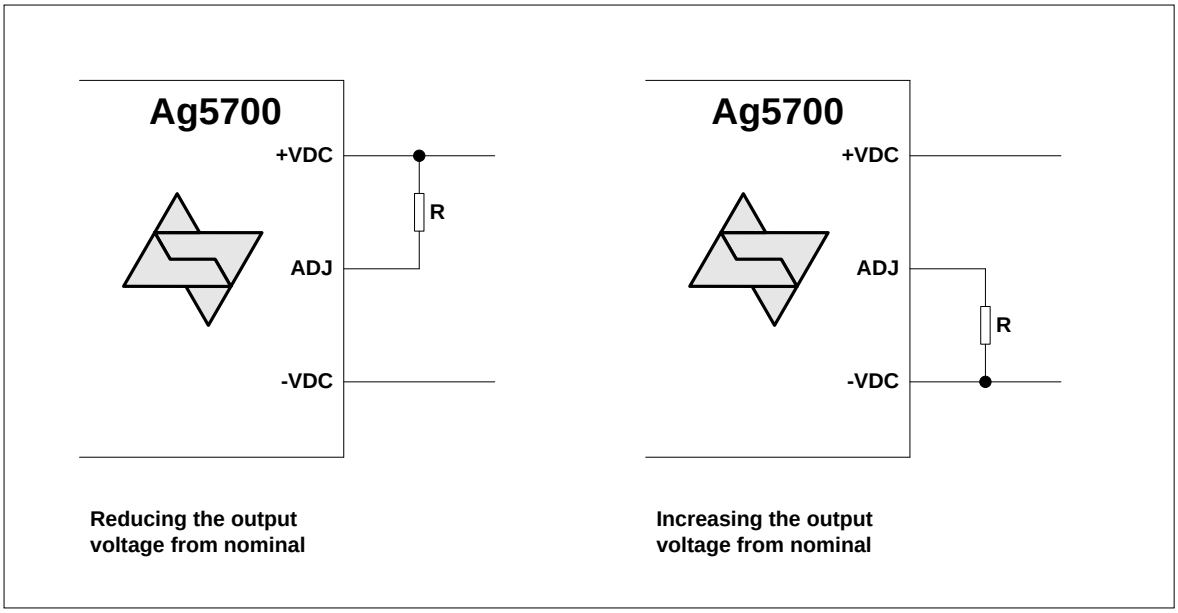

Figure 5: Output Adjustment

Reducing the output voltage, connect R between ADJ and VOUT 1	
Value of R	VOUT
Open Circuit	24V
56KOhms	19.5V
Increasing the output voltage, connect R between ADJ and 0V 1	
Value of R	VOUT
Open Circuit	24V
0KOhms	27V

Table 2: Output Adjustment Resistor (R) Value

5.6 µ-Controller

The on-board µ-controller monitors multiple parameters, including the input voltage, output current and output diode temperature. If any of these parameters go outside of the module's specification, the µ-controller will automatically shut the DC/DC output off within 10ms. It will monitor the status and normal operation will not resume until the parameter returns within specification.

5.7 Output Power

The maximum continuous output power of the Ag5700 is 180W; however this is limited by the available input power to the module (see Silvertel application notes for more details) and, most importantly, the module temperature (see Section 8).

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

1. Ag5700 efficiency
2. Ag6700 output power
3. Cable, connector and transformer losses
4. Input bridge rectifier losses

5.8 Typical Connections

As shown in Figure 6, a minimum of 1000µF must be connected directly across the output. It must be positioned as close to the output pins as possible, as it is required for output filtering and step load change performance. This capacitor can be made up by using smaller capacitors in parallel and can be a standard low cost electrolytic. The ESR of the capacitor is important but the use of a low ESR capacitor in not essential.

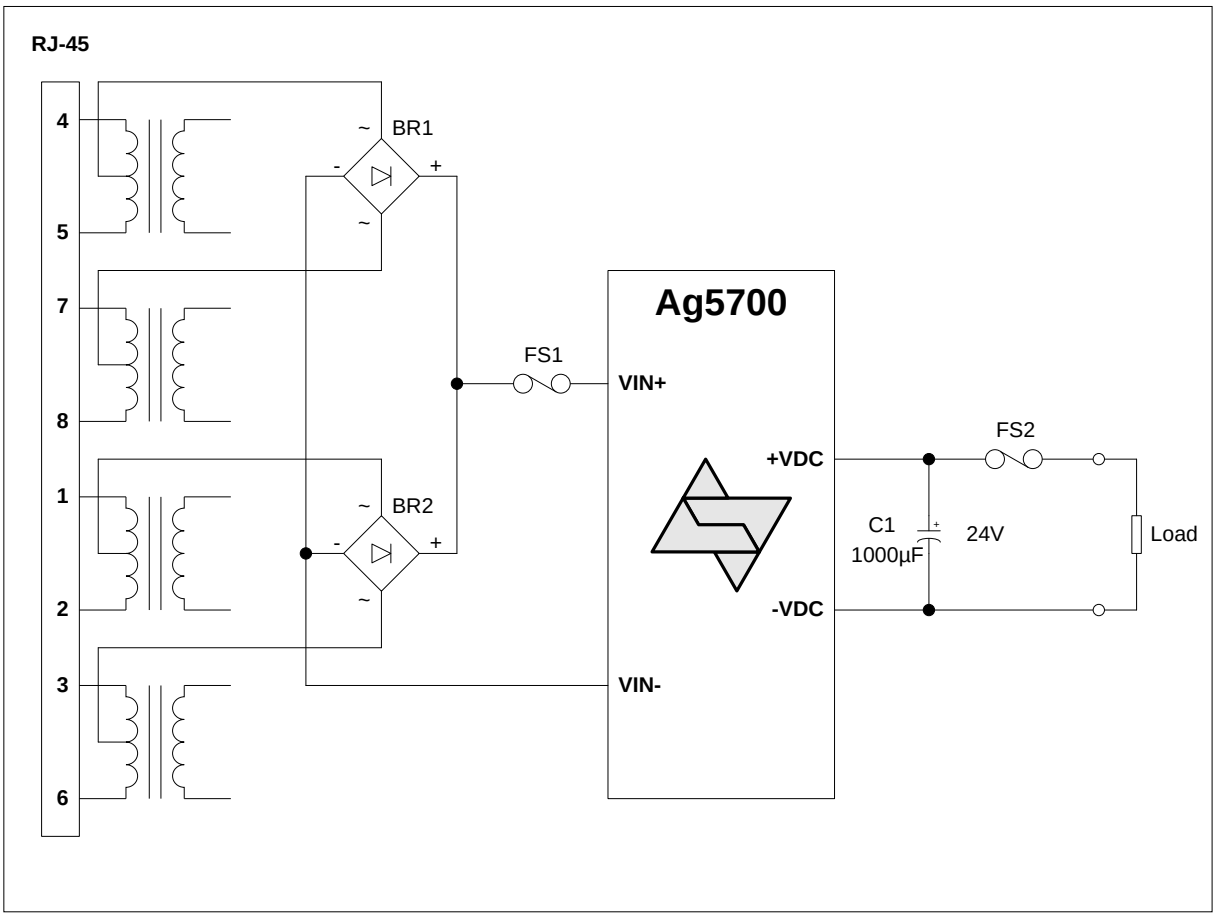

Figure 6: Typical Connection Diagram

5.9 EMC Performance

The Ag5700 is designed to meet EN55022 Class B. Test results are available by contacting Silvertel. For best signal / noise with low level data signals, e.g. due to long cables, an optional common mode inductor may be used in series with the V_{IN}+/- pins.

6. Protection

The Ag5700 is a very high power PoE module and as such safety has been a major factor in the design. But because of the very high power involved, external protection is also recommended.

6.1 Primary Internal Protection

The on-board µ-controller continually monitors the output current, UVLO voltage (36V) and module temperature. The output current limit has been set to 9A and the over temperature cut off has been set to 105°C measured at the output diode. The input voltage limit depends on the power drawn from the module; this is explained in Section 6.5. If these go outside the predefined limits the module will automatically shut down the DC/DC converter to protect itself. During the shut down time the µ-controller will periodically monitor its own status and will only resume normal operation when it returns within the predefined limits.

6.2 Secondary Internal Protection

In addition to the µ-controller primary internal protection, the Ag5700 has extra hardware for secondary protection against over-temperature and output short circuit, provided by a PTC thermistor and hardware monitoring circuits (in the unlikely event of a µ-controller failure).

6.3 Input Protection

The Ag5700 has a built-in Tranzorb to protect against input voltage transients.

6.4 External Protection

Because the Ag5700 is a very high power device, it is strongly recommended that in-line over-current protection (e.g. fuse) is fitted, see Figure 6. Operation of the module without external protection is strongly discouraged and will not be supported by Silver Telecom.

7. Important Safety Considerations

7.1 Regulatory Safety Approval to IEC60950-1

The Ag5700 output of 200W exceeds the 100W limit for “Inherently limited power sources” as defined in IEC60950 Section 2.5. To meet the requirements of IEC60950 Section 3.5.4 “Data ports for additional equipment”, systems using the Ag5700 must be fitted with a “Fire Enclosure” meeting the requirements of IEC60950 Section 4.7. Enclosures are a normal part of products for both consumer and professional use. Meeting the requirements of Section 4.7 involves the use of materials with the correct flammability class and wall thickness in the design of these enclosures. The design must also use the correct spacing between components on the Ag5700 and the walls of the enclosure.

7.2 Normal Operating Power

Even though the Ag5700 has many built-in protection and safety features, it should be remembered that the module can still deliver 200W under normal operating conditions.

If the load connected to the Ag5700 has a fault condition, but the total power drawn is still <200W, the Ag5700 will not be able to detect the fault and will continue to operate normally. The load itself must be fitted with adequate protection to prevent damage under these conditions.

7.3 Cable and Connector Requirement

It is the user’s responsibility to ensure the cables, connectors and components connected to the Ag5700 are capable of handling the rated current.

For example if the Ag6700 is supplying output power of 232W at 58V to the Ag5700, this gives a total current of 4A. This means each conductor in the Ethernet cable and each contact in the RJ45 connector is carrying 4A / 4 = 1A. Therefore the cables and connectors used must be able to handle this current safely. Most standard RJ45 connectors are specified for operation at 1A per pin. Operation of Cat 5e / 6 cable at 1A per wire is within the IEEE specified 10°C temperature rise. But this will require the maximum number of cables per bundle be limited to no more than 3 or 4.

The user should also verify the cables between the PSE and PD meet the relevant safety regulations in the country where the product is being used. Nominally the PSE and PD are designed to be connected with a single CAT 5e/6 cable using RJ45 connectors. However in the USA, the National Electrical Code limits the power over a CAT5e/6 cable to 100W. Therefore to use these products in the USA at >100W would require a different type of cable. E.g. 2 x CAT5e/6 in parallel for upto 200W.

8. Operating Temperature Range

The Ag5700 is a power module and, as such, is going to run hot, so thermal management of the Ag5700 is NOT optional. Heat sinking and ventilation are essential.

The amount of power available from the Ag5700 is directly proportional to the efficiency of the heat removal from the module. The module has been designed so that thermal relief points are all on the bottom side and these can be connected to a metal heatsink or to the metal chassis of the host equipment using heat conducting 'gap-pad'. The heatsink should be positioned to encourage airflow over its surface. To achieve maximum power, forced air cooling using a fan or blower (minimum: 5.65 ft^3/min) is required, as shown in Figure 7 Power vs. Temperature.

For further recommendations on heat removal, please refer to Applications Notes on the Silvertel website.

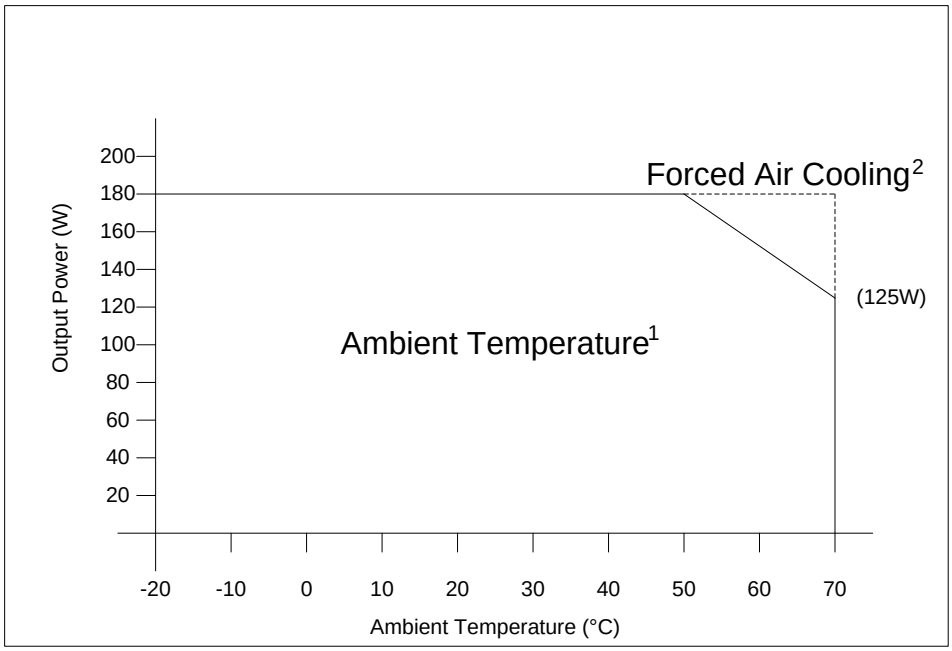

Figure 7: Power vs. Temperature

1 – Ambient Temperature - tested with stirred air in an environmental chamber
2 – Forced Air Cooling - tested in an environmental chamber with a blower moving air over the module at 9.6 m3/h (5.65 ft3/min)

The Ag5700 has multiple thermal protection mechanisms which will shutdown the DC/DC converter if tripped. These are fail safe circuits to protect the module and should not operate during normal operation.

9. Electrical Characteristics

9.1 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.

9.2 Recommended Operating Conditions

	Parameter	Symbol	Min	Typ	Max	Units
1	Input Supply Voltage – Output power 150W to 200W Output power 120W to 150W Output power < 120W	V_{IN}	 52 48 42		 58 58 58	 V V V
2	Under Voltage Lockout	V_{LOCK}	30		36	V
3	Operating Temperature [1]	T_{OP}	-20	25	70	Ta / ^{O}C

Note 1: See Section operating temperature range

9.3 DC Electrical Characteristics

	DC Characteristic	Sym	Min	Typ [1]	Max	Units	Test Comments
1	Nominal Output Voltage	$+V_{DC}$		24		V	
2	Output Voltage Adjustment Range [2]	V_{ADJ}	 19.35	24 24	27.5	V V	Minimum Maximum
3	Output Current Continuous[3] Peak[3] (30 secs max.)	 I_{CONT} I_{PK}		 7.5 8.33		 A	 V_{IN} = 52V min
4	Line Regulation (100W Load)	V_{LINE}		0.1		%	V_{IN} 42V to 58V
5	Load Regulation	V_{LOAD}		0.7		%	I_{LOAD} 0.1A to 7.5A
6	Output Ripple and Noise	V_{RN}		360		mVp-p	@ Max load
7	Minimum Load	R_{LOAD}		100		mA	
8	Short-Circuit Duration	T_{SC}			∞	sec	
9	Efficiency	EFF		90		%	Vin = 58V, Load = 6A
10	Isolation Voltage (I/O)	V_{ISO}			1500	V_{PK}	Impulse Test

Note 1: Typical figures are at 25°C with a nominal 58V supply and are for design aid only. Not Guaranteed
2: See Output Voltage and Adjustment Section 5.5.
3: With thermal management. May not be possible under all conditions. See Section 5.7 Output Power

10. Package