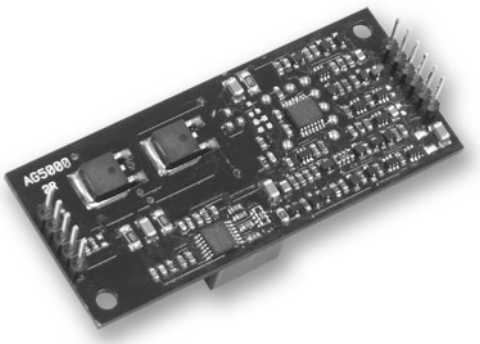
Silver TELECOM

# Ag5000

## Power-Over-Ethernet Module



## 1. Features

- 30 Watt Output Power
- Dynamic input power sharing
- High efficiency DC/DC converter
- Adjustable output voltage from 7.3V to 29V
- 1500V isolation (input to output)
- Input voltage range 36V to 57V
- IEEE802.3af compliant inputs
- Low output ripple and noise
- Minimal (low cost) external components required
- Overload, thermal and short-circuit protection
- Silver Telecom “design-in” assistance

## 2. Description

The Ag5000 is a High Power over Ethernet (PoE+) module that can deliver up to 30 Watts of output power. Suitable for applications such as IP Telephones, WiMAX access points, PTZ cameras and thin clients.

The Ag5000 has been designed to extract power from Power Sourcing Equipment (PSE) over a conventional twisted pair Category 5 Ethernet cable. The modules dual inputs both conform to the IEEE 802.3af standard for signature recognition and class programming.

The Ag5000’s dynamic input power sharing, automatically detects if the input power is being supplied from the data pair, the spare pair or both pairs. The module can also detect voltage mismatches and adjust accordingly.

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. Ag5000 Product Selector

| Part Number† | Nominal Output Voltage ‡ | Maximum Output Power * |
|---|---|---|
| Ag5000 | 12V / 24V | 30 Watts |

*At 25°C
† The Ag5000 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**

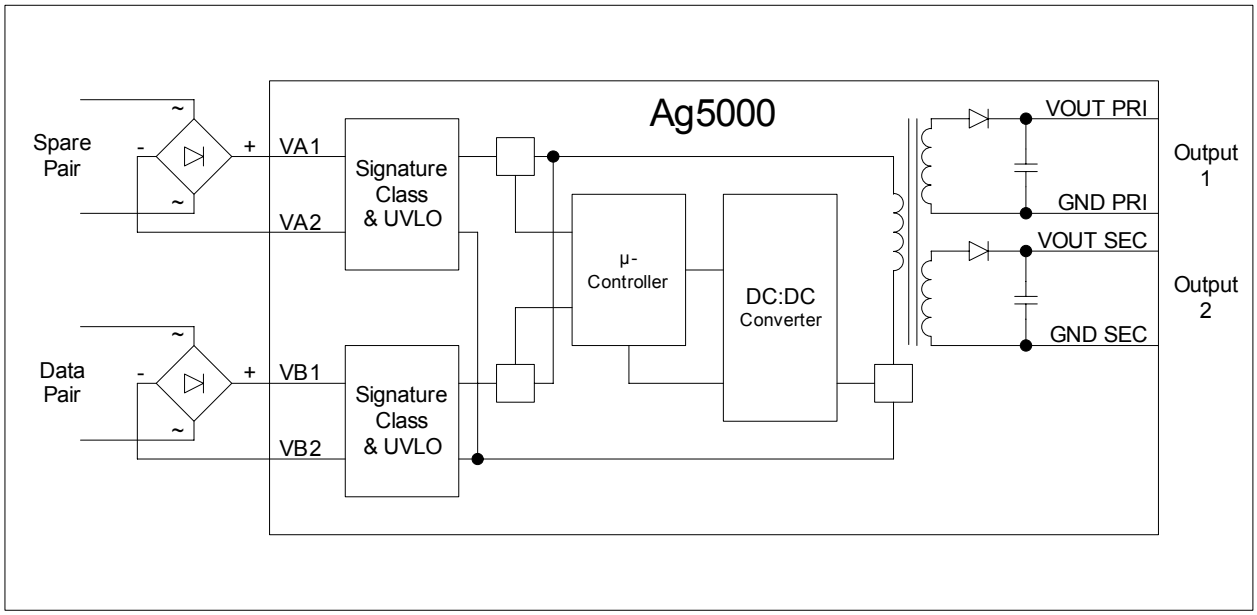


**Figure 1: Block Diagram**


**Figure 2: Ag5000 DIL Package Format**

## 4. Pin Description

| Pin # | Name | Description |
|---|---|---|
| TBD | VA1 | **Direct Input +**. This pin connects to the positive (+) output of the input bridge rectifier. |
| TBD | VA2 | **Direct Input -**. This pin connects to the negative (-) output of the input bridge rectifier. |
| TBD | CPA | **Class Programming.** Connecting an external resistor from this pin to VA2 will change the current class of this input. With no resistor fitted this input will default to Class 0. |
| TBD | VB1 | **Direct Input +**. This pin connects to the positive (+) output of the input bridge rectifier. |
| TBD | VB2 | **Direct Input -**. This pin connects to the negative (-) output of the input bridge rectifier. |
| TBD | CPB | **Class Programming.** Connecting an external resistor from this pin to VB2 will change the current class of this input. With no resistor fitted this input will default to Class 0. |
| TBD | VOUT PRI | **DC Output.** This pin provides the primary regulated output from the DC/DC converter. |
| TBD | GND PRI | **Ground.** The ground return for the VOUT PRI output. |
| TBD | ADJ | **Output Adjust.** The output voltage can be adjusted from is nominal value, by connecting an external resistor from this pin to either the VOUT PRI pin or the GND PRI pin. |
| TBD | VOUT SEC | **DC Output.** This pin provides the secondary output from the DC/DC converter. |
| TBD | GND SEC | **Ground.** The ground return for the VOUT SEC output. |

# 5. Functional Description

## 5.1. Inputs

The Ag5000 has two input pairs VA (1 & 2) and VB (1 & 2) as shown in Figure 3: Typical System Diagram, the on-board µ-controller automatically detects and monitors both of these inputs.

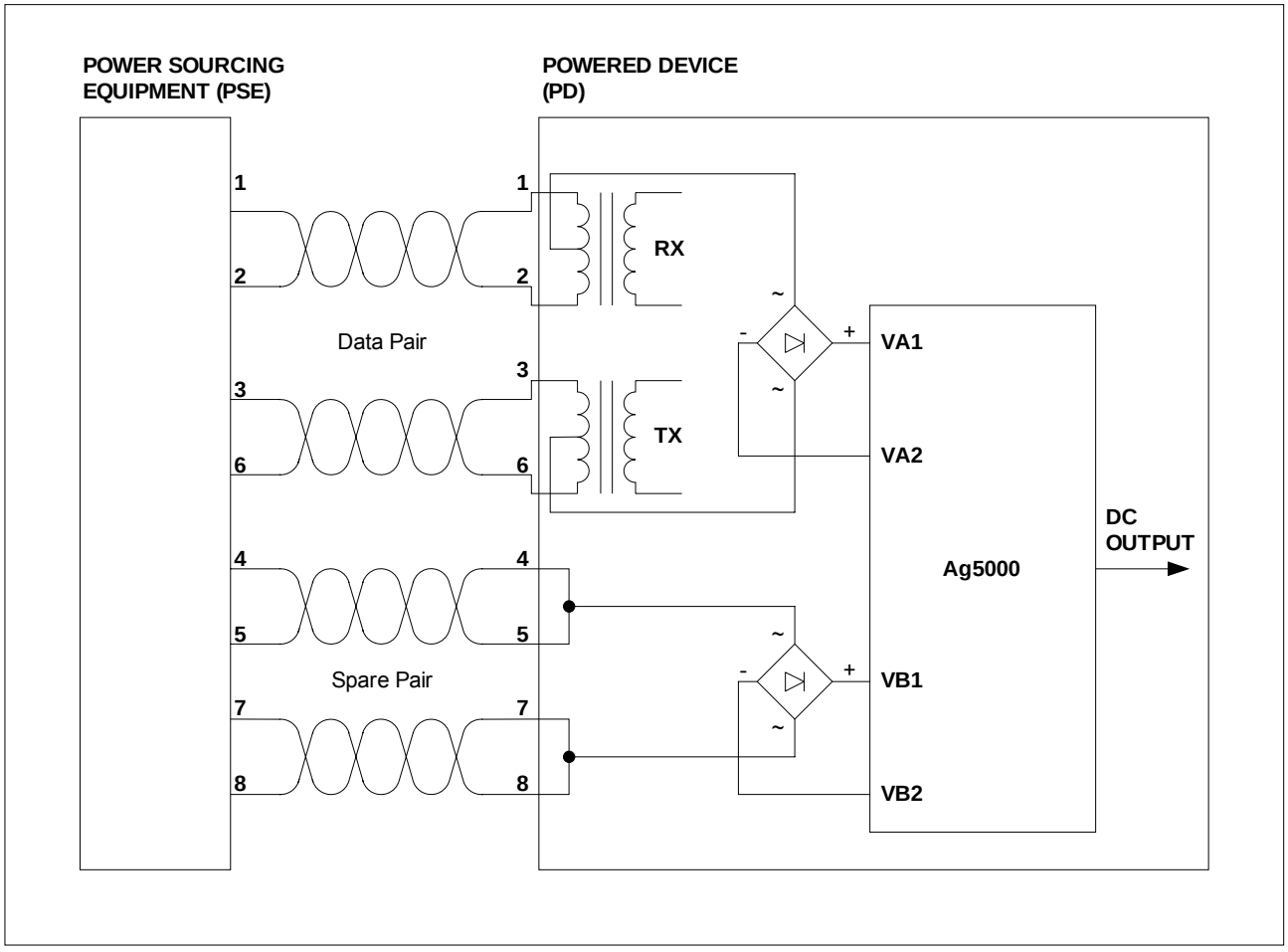


**Figure 3: Typical System Diagram**

## 5.2. PD Signature

Both inputs comply with the IEEE802.3af specification. When the inputs are connected to a Power Sourcing Equipment (PSE) via a Cat 5e cable, 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.

## 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 Ag5000 has been designed to meet b) 1500V impulse test.

## 5.4. Power Classification

Both inputs offer IEEE802.3af “Class Programming” this is optional from the PSE and is used for power management. The Ag5000 allows the current class to be externally programmed by connecting a resistor between the CPA and VA2 (or CPB and VB2) pins, see Figure 4: Class Programming Option. If no resistor is fitted the Ag5000 will default to Class 0 which is recommended for high power applications, a full list of programming resistor values are shown in Table 2: Class Programming. For 30W operation, ensure that Class 0 is set (no resistor fitted).

| CLASS | Programming Resistance (Ohms) | Min Power (W) | Max Power (W) |
|---|---|---|---|
| 0 | Do not fit | 0.44 | 12.95 |
| 1 | 698 | 0.44 | 3.84 |
| 2 | 383 | 3.84 | 6.49 |
| 3 | 243 | 6.49 | 12.95 |
| 4 | TBD | Reserved | Reserved |

**Table 2: Class Programming**

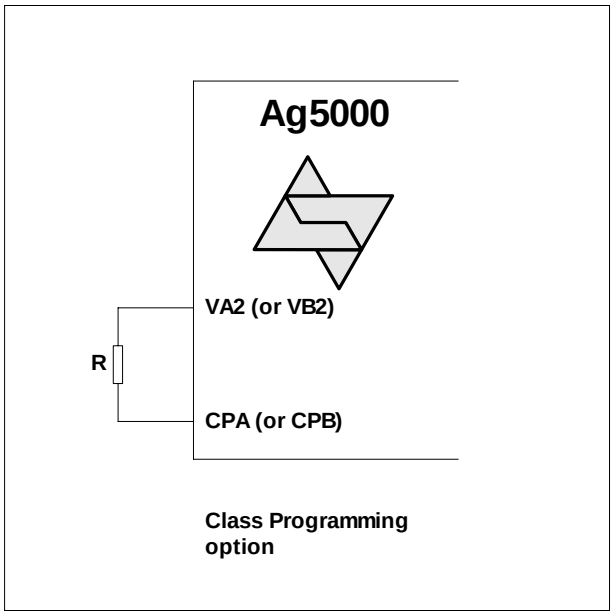


**Figure 4: Class Programming Option**

## 5.5. Dynamic Input Power Sharing

The Ag5000's dynamic input power sharing, automatically detects when power is available on either of its inputs, thus making it compatible with all the input configurations shown in Figure 5: Input Power Options.

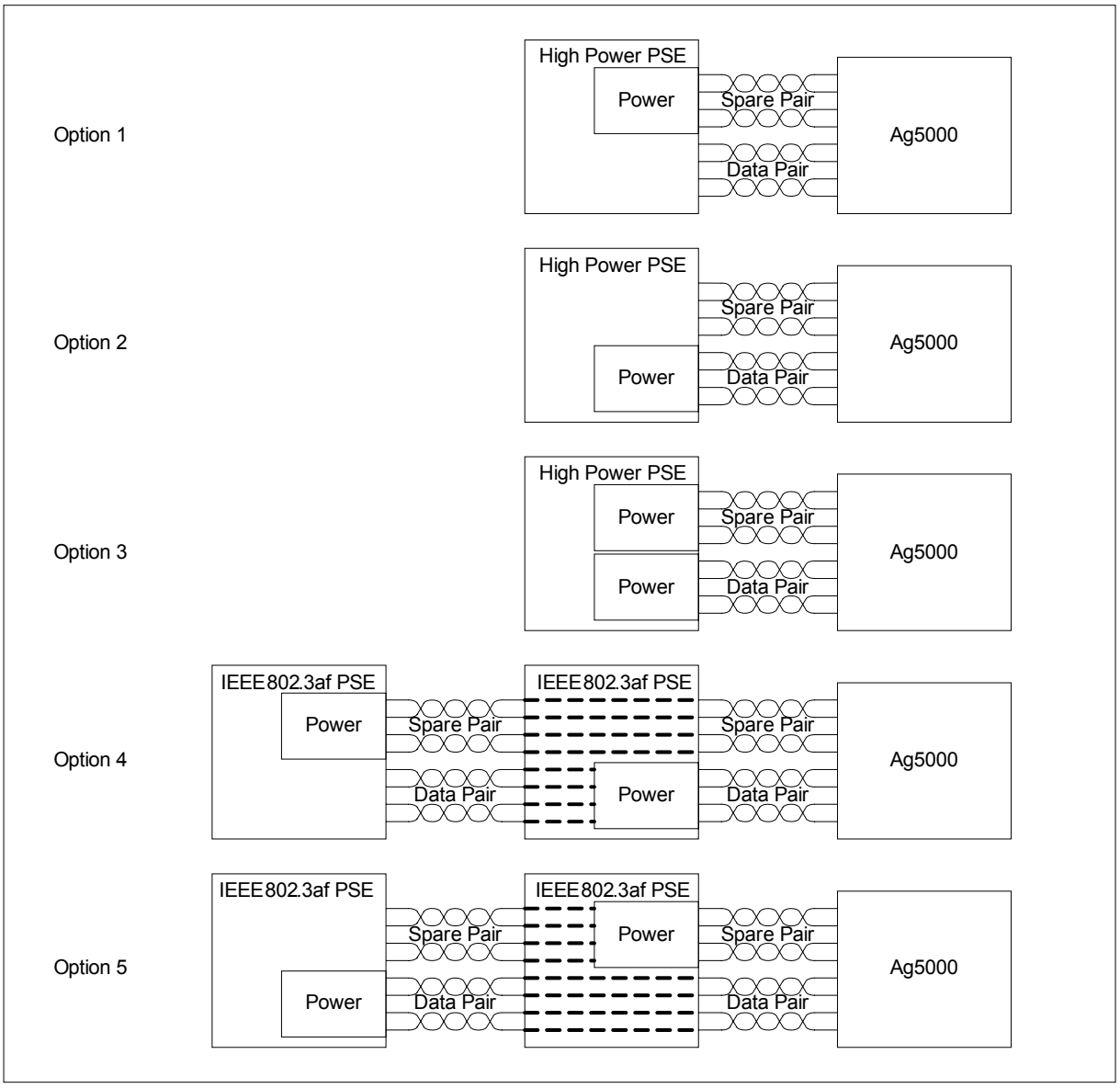


**Figure 5: Input Power Options**

In addition to automatically detecting the input power, when both inputs are used (Options 3, 4 and 5) the on-board µ–controller monitors the input voltage and will automatically compensate the input power sharing if the input voltages are different. This can occur if one of the pairs has a higher cable (or connector) resistance than the other; or with Options 4 and 5 the PSE output voltages may be different.

## 5.6. DC/DC Converter

The Ag5000's DC/DC converter provides a regulated low ripple and low noise output that has built-in over-load and short-circuit output protection.

## 5.7. Output Configuration

The Ag5000 has two outputs which must be connected in parallel to provide 12V or in series to provide 24V, as shown in Figure 6: Output Configurations.

The secondary output voltage tracks the primary output voltage.

It is important that C1 and C2 are both used and connected as close to the output pins of the Ag5000 as possible (for both configurations).

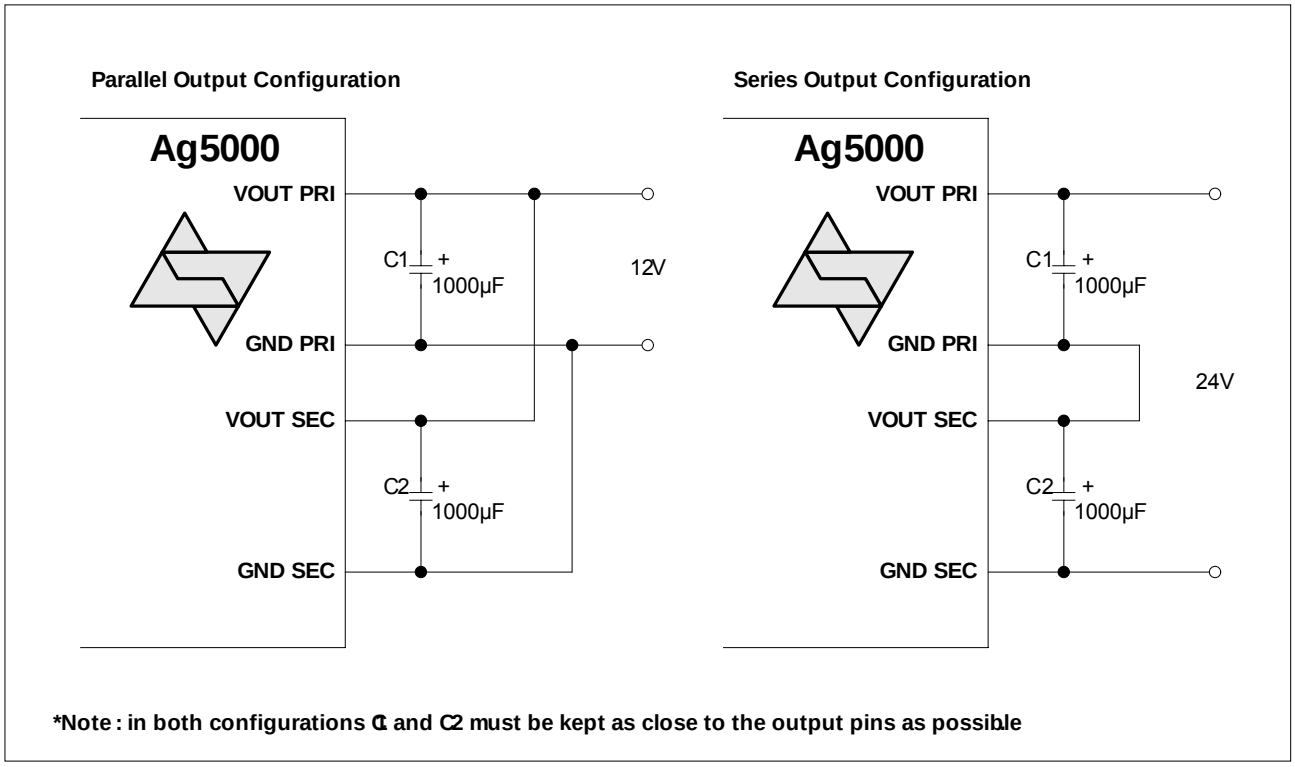


**Figure 6: Output Configurations**

## 5.8. Output Adjustment

The Ag5000 primary output has an ADJ pin, which allows the output voltage to be increased or decreased from its nominal value. The secondary output voltage will track the adjusted primary output voltage.
Figure 7: Output Adjustment shows how the ADJ pin is connected: -

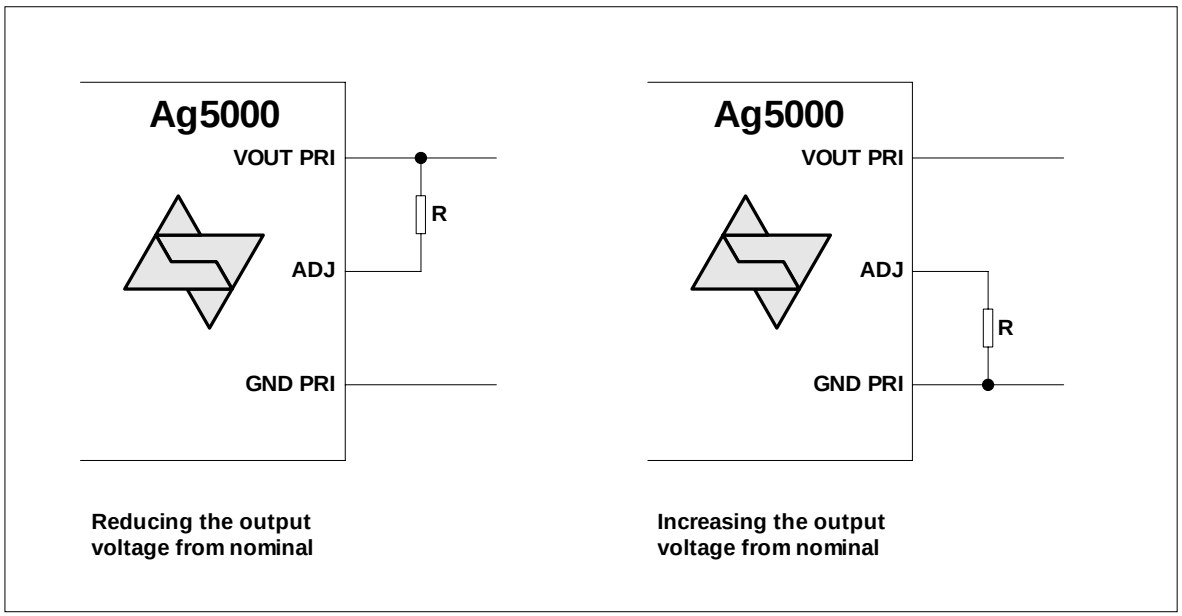


**Figure 7: Output Adjustment**

| **Reducing the output voltage, connect R between ADJ and VOUT PRI** | | |
|---|---|---|
| Value of R | VOUT PRI | VOUT SEC |
| Open Circuit | 12V | 12V |
| TBD | 9 | 9 |
| 0 Ohms | 7.3 | 7.3 |
| | | |
| **Increasing the output voltage, connect R between ADJ and GND PRI** | | |
| Value of R | VOUT PRI | VOUT SEC |
| Open Circuit | 12V | 12V |
| TBD | 12.5V | 12.5V |
| 0 Ohms | 14.5V | 14.5V |

**Table 3: Output Adjustment Resistor (R) Value**

The adjustment range allows the Ag5000 to provide any output voltage from 7.3V up to 29V, contact Silver Telecom for further details.

## 5.9. Typical Connections

Figure 8: Typical Connection Diagram, a minimum of 1000µF must be connected across each output, positioned as close to the output pins as possible. These capacitors can be a standard low cost electrolytic and do not need to be a low ESR type.

The Class programming and the Output Adjust inputs are optional and are provided to give great flexibility to the Ag5000. Further information on using these inputs can be found in sections 5.4. Power Classification and 5.8. Output Adjustment.

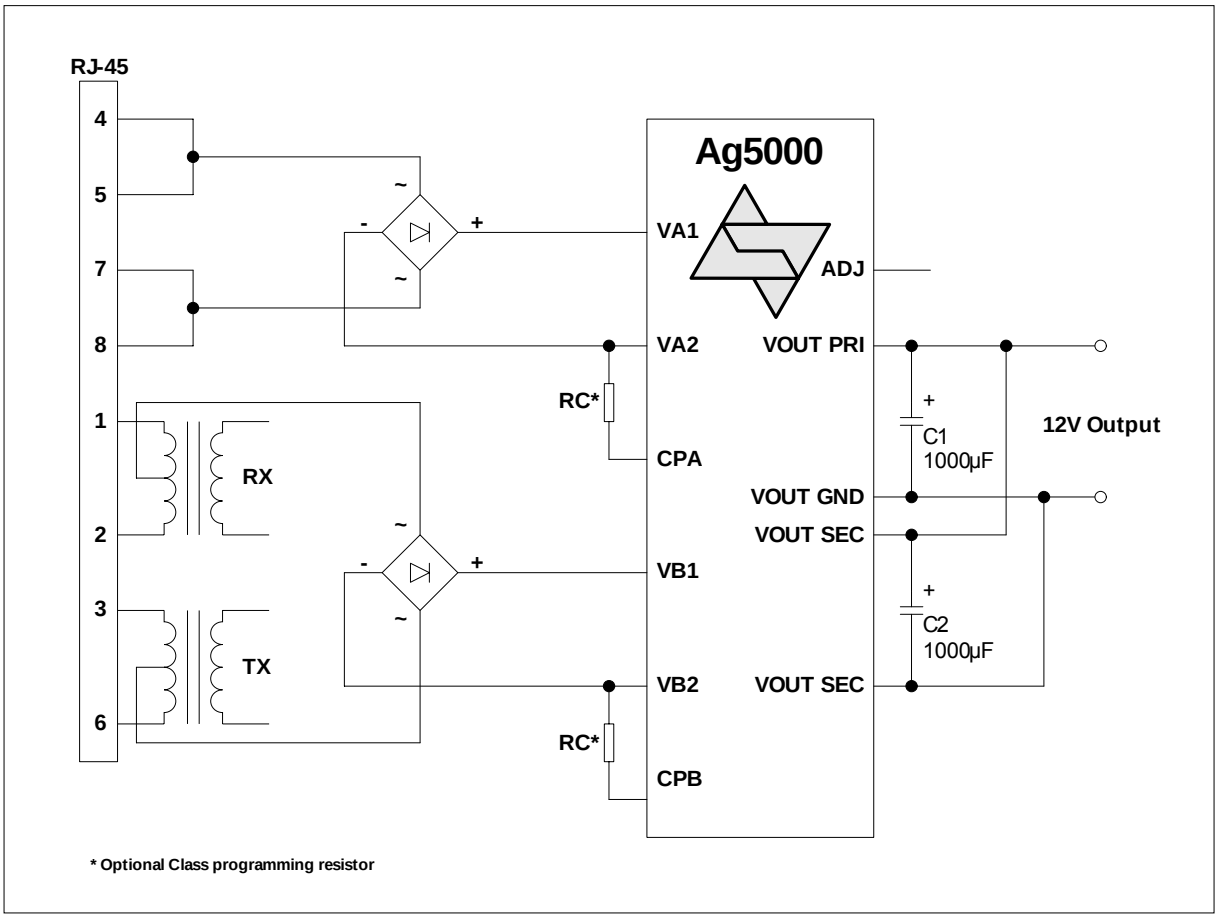


**Figure 8: Typical Connection Diagram**

# 6. Typical Application

The Ag5000 can be used in numerous applications, in the example shown in Figure 9: Typical Application, the data outputs from the Router are connected to the inputs of a Midspan. The Midspan will then add power (to the data from the Router) on each output that supports Power over Ethernet (PoE).

In this example port 1 is connected to an ethernet PTZ camera and port 2 is connected to a wireless access point, both of these devices have a built-in Ag5000. When the High Power 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 Ag5000 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.

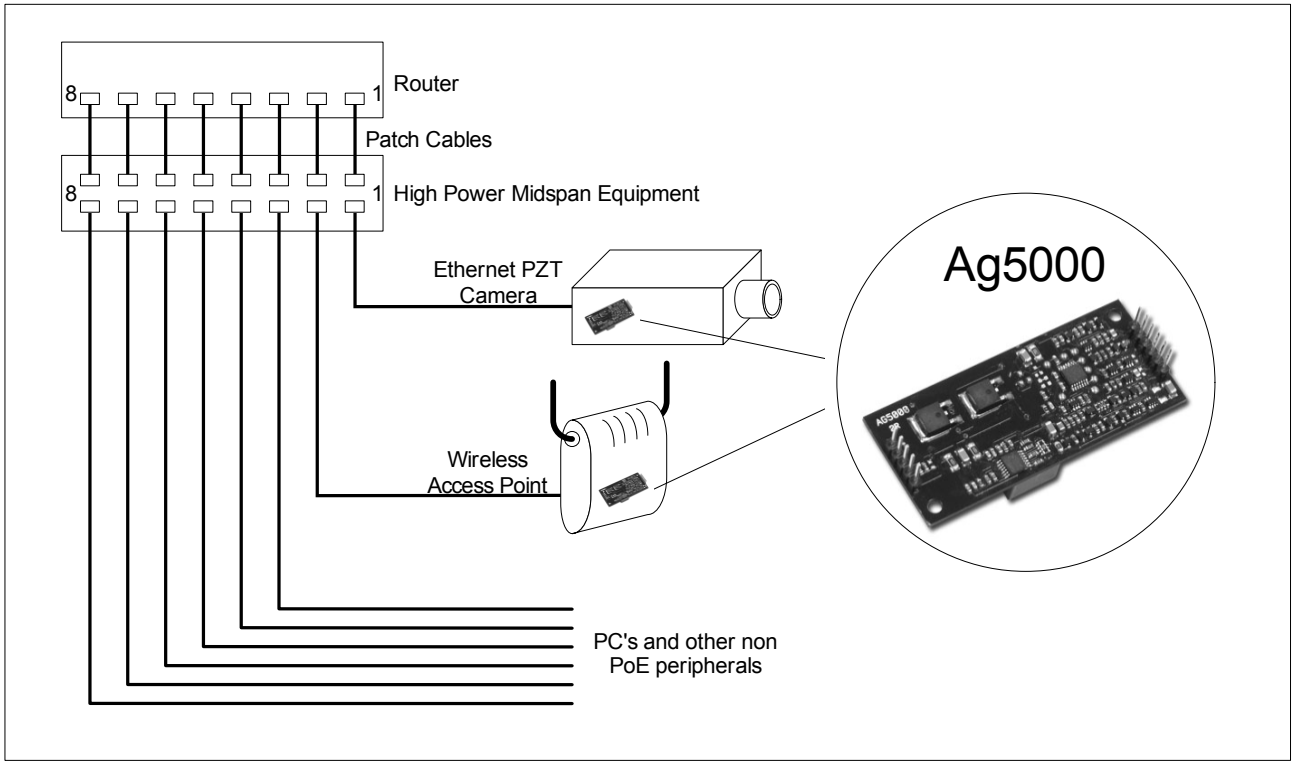


**Figure 9: Typical Application**

# 7. Typical Recommendations

Figure 10: Typical Layout gives an example of the tracking needed for the Ag5000. C1 and C2 must be positioned as close to the output pins as possible. The thermal performance of the Ag5000 can be improved by increasing the surface area of the output tracks. This is not applicable if the Ag5000 is in a socket.

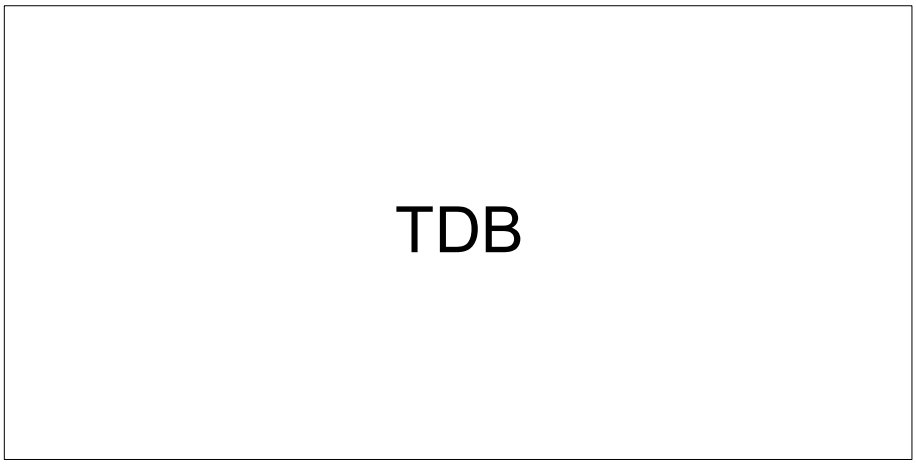


**Figure 10: Typical Layout**

# 8. Operating Temperature Range

Because the Ag5000 is a power component, it will generate heat, so it is important that this be taken into consideration at the design stage.

At the heart of the Ag5000 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 single nominal 48Vdc input voltage supplied by the PSE.

The Ag5000 has a maximum ambient operating temperature of TBD $^{O}$C see Figure 12. These results are in still air without any heatsinking, the performance of the Ag5000 can be improved by forcing the airflow over the part or by using a heatsink (the Ag5000 has two heatsink mounting locations).

The output stage of the Ag5000 has a built-in thermal protection circuit, to prevent the module from being damaged if operated beyond its power / temperature specification.

Because each application is different it is impossible to give fixed and absolute thermal recommendations. However it is important that any enclosure used has sufficient ventilation for the Ag5000 and a direct airflow if possible.

One simple method for drawing some of the heat away from the Ag5000 is shown in Figure 11. Power planes connected to the VOUT PRI, GND PRI, VOUT SEC and GND

SEC pins of the Ag5000 can be used to draw heat away from the DC/DC converter via the output pins.

These power planes must be on the outer layers of the PCB and the Ag5000 must not be fitted into a socket.

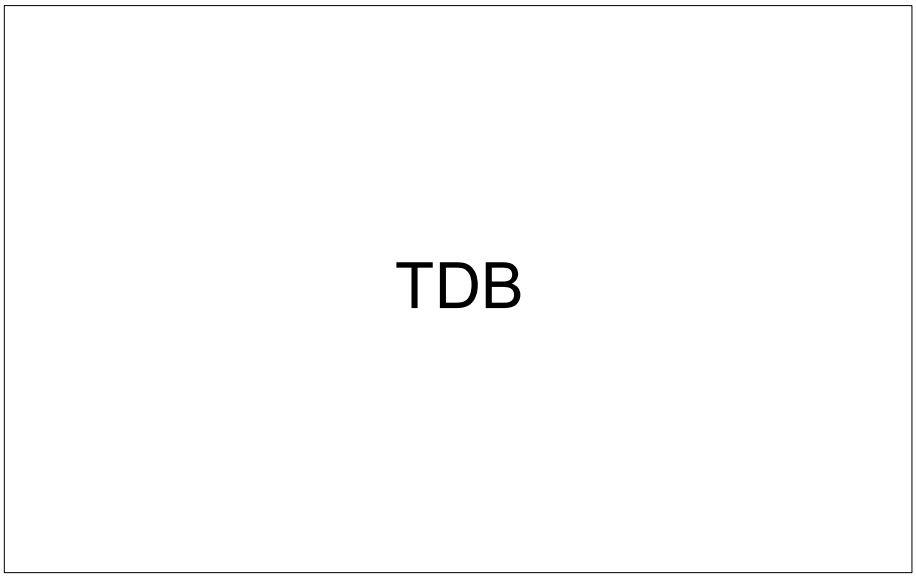


**Figure 11: Power Plane Heatsink for Ag5000**

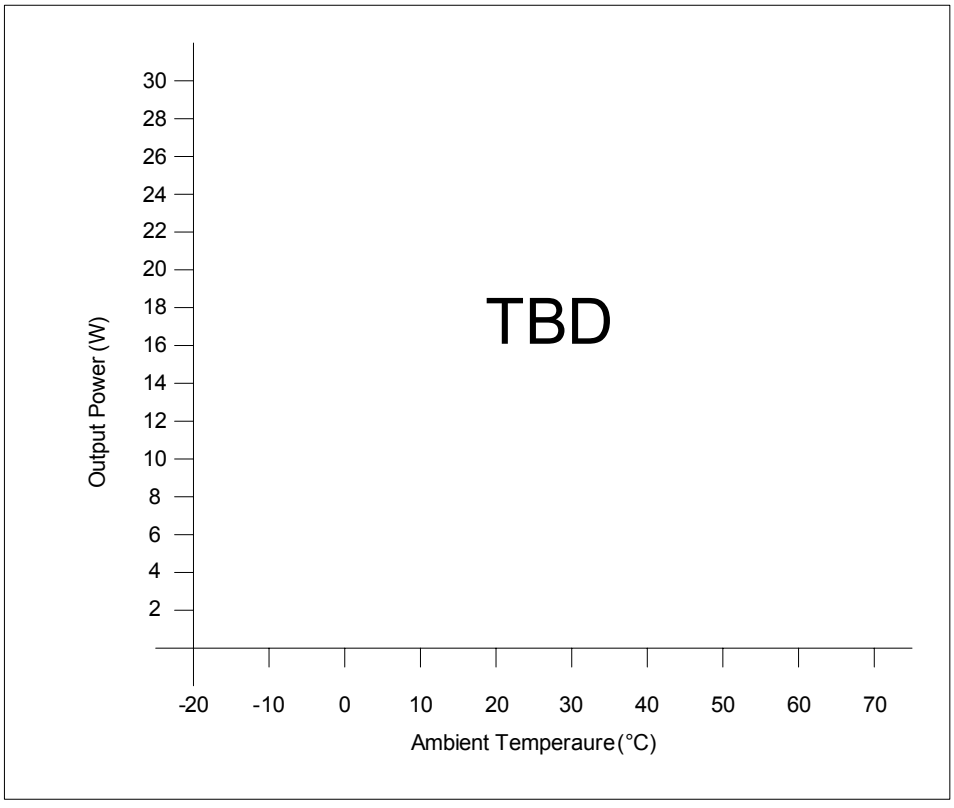


**Figure 12: Ag5000 Operating Profile**

# 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 [1] | $V_{IN}$ | 36 | 48 | 57 | V |
| 2 | Under Voltage Lockout | $V_{LOCK}$ | 30 | | 36 | V |
| 3 | Operating Temperature [2] | $T_{OP}$ | -20 | 25 | 70 | Ta / $^{O}C$ |

Note 1: With minimum load
2: See Section 8. Operating Temperature Range

## 9.3. DC Electrical Characteristics

| | DC Characteristic | Sym | Min | Typ [1] | Max | Units | Test Comments |
|---|---|---|---|---|---|---|---|
| 1 | Nominal Output Voltage | +VDC | 11.4<br>22.8 | 12<br>24 | 12.6<br>25.2 | V<br>V | Parallel O/P<br>Series O/P |
| 2 | Voltage Adjust Range | $V_{ADJ}$ | 7.3 | | 29 | V | See 5.8. Output Adjustment |
| 3 | Output Current [2] ($V_{IN}$ = 48V) | PWR | | | 2.5<br>1.25 | A<br>A | Parallel O/P<br>Series O/P |
| 4 | Line Regulation | $V_{LINE}$ | | TBD | | % | @ 50% Load |
| 5 | Load Regulation | $V_{LOAD}$ | | TBD | | % | @ $V_{IN}$=48V |
| 6 | Output Ripple and Noise | $V_{RN}$ | | TBD | | mVp-p | @ Max load [3] |
| 7 | Minimum Load | $R_{LOAD}$ | 150 | | | mA | |
| 8 | Short-Circuit Duration | $T_{SC}$ | | | ∞ | sec | |
| 9 | Efficiency | EFF | | 86 | | % | Vin = 48V<br>50% Load |
| 10 | Isolation Voltage (I/O) | $V_{ISO}$ | | | 1500 | $V_{DC}$ | |
| 11 | Temperature Coefficient | TC | | TBD | | % | Per $^{O}C$ |

Note 1: Typical figures are at 25°C with a nominal 48V supply and are for design aid only. Not Guaranteed
2: The output must not exceed 30W or 2.5A Parallel / 1.25A Series.
3: The output ripple and noise can be reduced with an external filter, see application note.

# 10. Package

## 10.1. Ag5000