



## PRODUCT OVERVIEW

The PEM1400 is a compact sized power extraction module, with complete IEEE 802.3af Power-Over-Ethernet (PoE) standard compliance. They are designed to extract power from CAT5 or higher Ethernet cable when sourced from an IEEE 802.3af compliant Power Sourcing Equipment (PSE).

Its high efficiency DC-DC converter provides a well regulated low noise and low ripple output with in-built overload and output short-circuit protection

The PEM1400 series provides a quick, easy, and low cost method for Ethernet equipment manufacturers to "PoE enable" their equipment.

**With size of 35mm x 14mm, and a footprint of 409 mm<sup>2</sup>, the PEM1400 is the world's smallest POE Module.**

## PRODUCT FEATURES

- Fully IEEE 802.3af compliant
- 12.95 watt output load<sup>1</sup>
- Wide input voltage (36V to 57V DC)
- Full Power start up even from 36V input
- 3.3V, 5V, 12V DC output voltage models
- All models capable of 12.95W output
- Stable efficiency even at high ambient
- On board PI filter for output ripple control
- Overload and short circuit protection<sup>2</sup>
- Minimal external components required
- 1500 Volt DC isolation (Input to Output)
- Compact dimension of 35 x 14
- Adjustable output voltage
- RoHS compliant
- Low output ripple and noise
- Low cost



<sup>1</sup> In 5V and 12V model

<sup>2</sup> If maximum power is exceeded, the PEM1400 will operate in over current mode and will auto recover when the over load condition is removed.

## PRODUCT SELECTOR

Part Number	Marking	Nominal Input Voltage	Output Voltage <sup>3</sup>	Efficiency <sup>4</sup>	Power (Maximum) <sup>6,7</sup>
		(Volts DC)	(Volts DC)	(%)	(Watts)
PEM1403	3	48	3.3	84	12
PEM1405	5	48	5	86	12.95
PEM1412	12	48	12	90	12.95

## ABSOLUTE MAXIMUM RATINGS<sup>5,6</sup>

Supply Voltage (V <sub>CC</sub> )	0V – 57V DC
Storage Temperature (T <sub>s</sub> )	-25 °C – 100 °C
Output Voltage (V <sub>OUT</sub> )	0V to controlled output voltage (operating or non-operating)

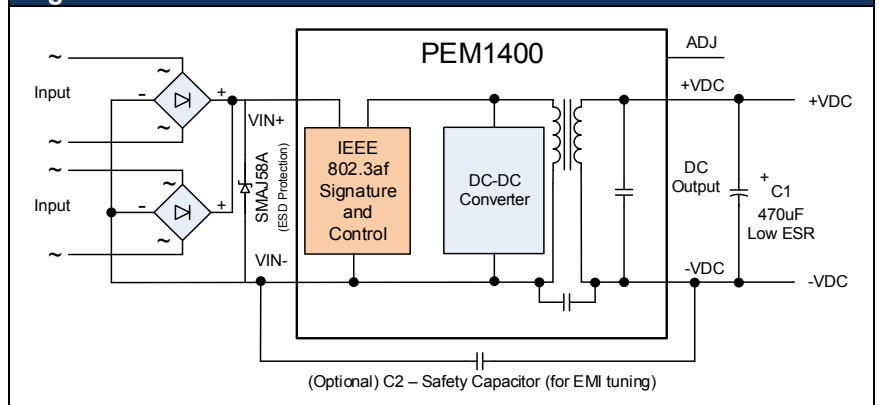
## INPUT CHARACTERISTICS

Parameter	Symbol	Min.	Typ <sup>4</sup> .	Max.	Units
Input Voltage <sup>7</sup>	V <sub>IN</sub>	36	48	57	Volts
Under Voltage Lockout	V <sub>UVLO</sub>	30		36	Volts
Input Current <sup>8,10</sup>	I <sub>IN</sub>		350	400	mA
Operating Temperature <sup>9</sup>	T <sub>OP</sub>	-20	25	70	°C
IEEE 802.3af Power Classification <sup>10</sup>		Class 0			

## DC OUTPUT CHARACTERISTICS

Parameter	Symbol	Min.	Typ <sup>4</sup> .	Max.	Units
Line Regulation <sup>8</sup>	V <sub>LNRG</sub>		0.2%		
Load Regulation <sup>8</sup>	V <sub>LDRG</sub>		0.5%		
Output Ripple and Noise <sup>5,8</sup>	V <sub>RIP</sub>		80		mV p-p
Isolation Voltage	V <sub>ISOL</sub>			1500	V DC
Temperature Coefficient (Slope)	TC		100	300	ppm °C

## Figure 1 - BLOCK DIAGRAM and TYPICAL CONNECTIONS



<sup>3</sup> Output voltage typical  $\pm 3\%$  at T<sub>A</sub> of 25°C with a nominal input voltage and rated output current.

<sup>4</sup> At nominal V<sub>IN</sub> at 67% load.

<sup>5</sup> All specifications typical are at T<sub>A</sub> of 25°C with a nominal input voltage and rated output current unless otherwise noted. These are meant as a design aid only and are indicative, and not guaranteed.

<sup>6</sup> Exceeding the absolute maximum ratings may cause permanent damage to the product. We do not imply functional operation under these conditions. These ratings assume free air flow.

<sup>7</sup> With minimum load current 100mA.

<sup>8</sup> Please refer to IEEE802.3af standards document. Maximum input current is dependent on power class, and input voltage. Input current (DC or RMS) at V<sub>PORT</sub> =37VDC is 350mA, at V<sub>PORT</sub> =57VDC is 230mA. Peak inrush current is 400mA for 50mS max at duty cycle of 5% max.

<sup>9</sup> Please see section F.6. – Thermal profile on operating temperature

<sup>10</sup> Please see section F.2 – Powered Device Signature

## FUNCTIONAL DESCRIPTION

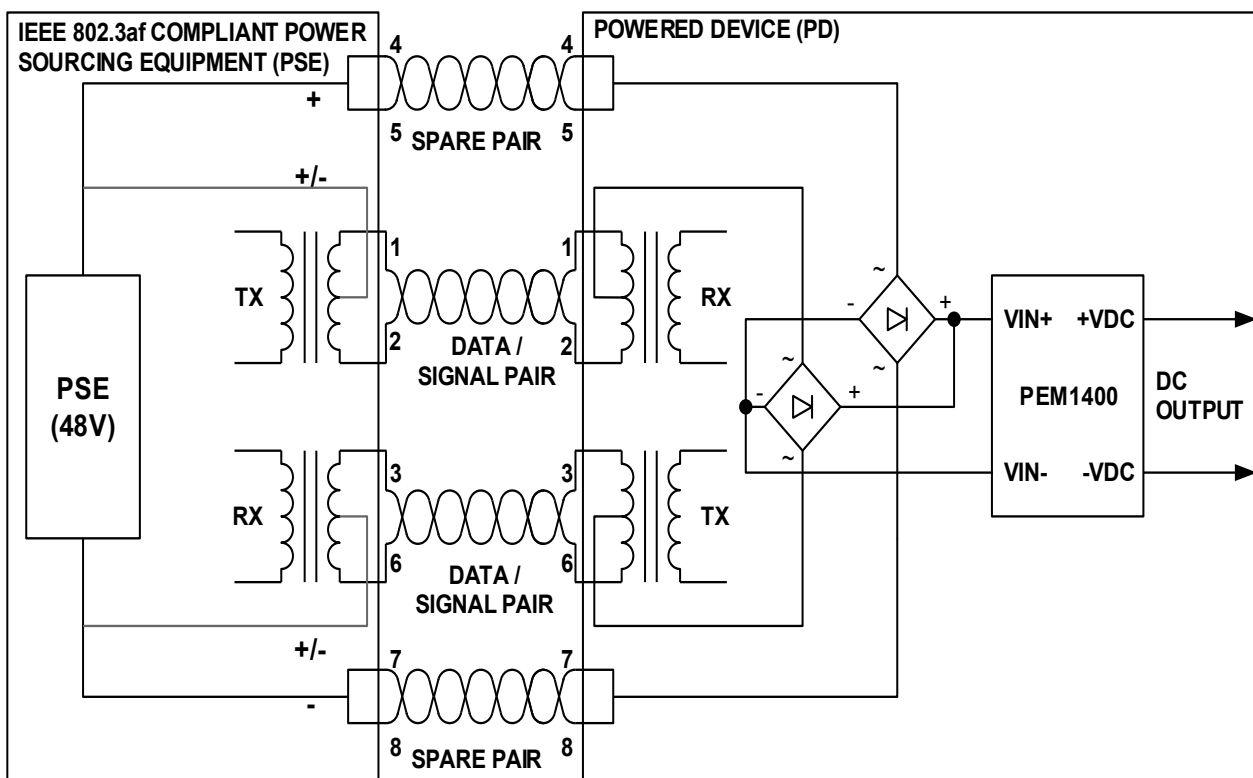
### F.1. Inputs

The PEM1400 is compatible with all IEEE 802.3af compliant Power Sourcing Equipment (PSE) and supports the different power injection options of Data/Signal pair (Mode A) or Spare Pair (Mode B). See Figure 2 – Typical System Configuration. As per IEEE 802.3af, it is specified that the PSE does not apply power to the both outputs at the same time i.e. 4 pair injection. (Refer to IEEE802.3af standards for more information).

The PEM1400 provides for external input bridge rectifiers for improved system design flexibility, and distribution of heat generation. As an example, a system designer wanting to provide two RJ45 inputs, both of which are PoE enabled, but use only one PEM1400 module to save costs. Another advantage is that this allows the system designer to control the type and costs of the input rectification diodes.

### Figure 2 – Typical System Configuration

In Mode A – Signal Pair injection, the signal lines carry both data and power. In Mode B – Spare Pair injection, the Signal pair carries only data, and the spare pair carries power.



### F.2. Powered Device (PD) Signature

When the PEM1400 is connected to a Cat 5e or greater Ethernet cable from an IEEE 802.3af compliant Power Sourcing Equipment (PSE), Endspan or Midspan, it will automatically present a Powered Device (PD) signature to the PSE, as and when requested. The PSE will then recognise that a PD is connected to that line and supply power.

The PEM1400 presents class 0 detection to the PSE.

### F.3. Isolation

IEEE802.3af section 33.4.1 calls for a Powered Device (PD) to meet safety isolation requirement by meeting the electrical strength test of IEC 60950 sub clause 6.2. Infomart's® PoweredEthernet™ PEM1400 modules meet or exceed 1500V impulse test. This is also referred to as 'Hi Pot Test', 'Flash Tested', 'Withstand Voltage', 'Proof Voltage', 'Dielectric Withstand Voltage' & 'Isolation Test Voltage'.

### F.4. Output Voltage Adjustment

The PEM1400 series has an OADJ pin, which allows the output voltage to be increased or decreased from its nominal value using a 1/16W power rating or greater and 1% tolerance resistor connected between the OADJ pin and either the +VDC or -VDC pin as per figures below. Only one connection i.e. between OADJ and +VDC or between OADJ and -VDC is permitted at a time. A change of more than  $\pm 10\%$  from nominal is not permitted. Please [contact Infomart technical support](#) for more details or specific resistor values.

Figure 3

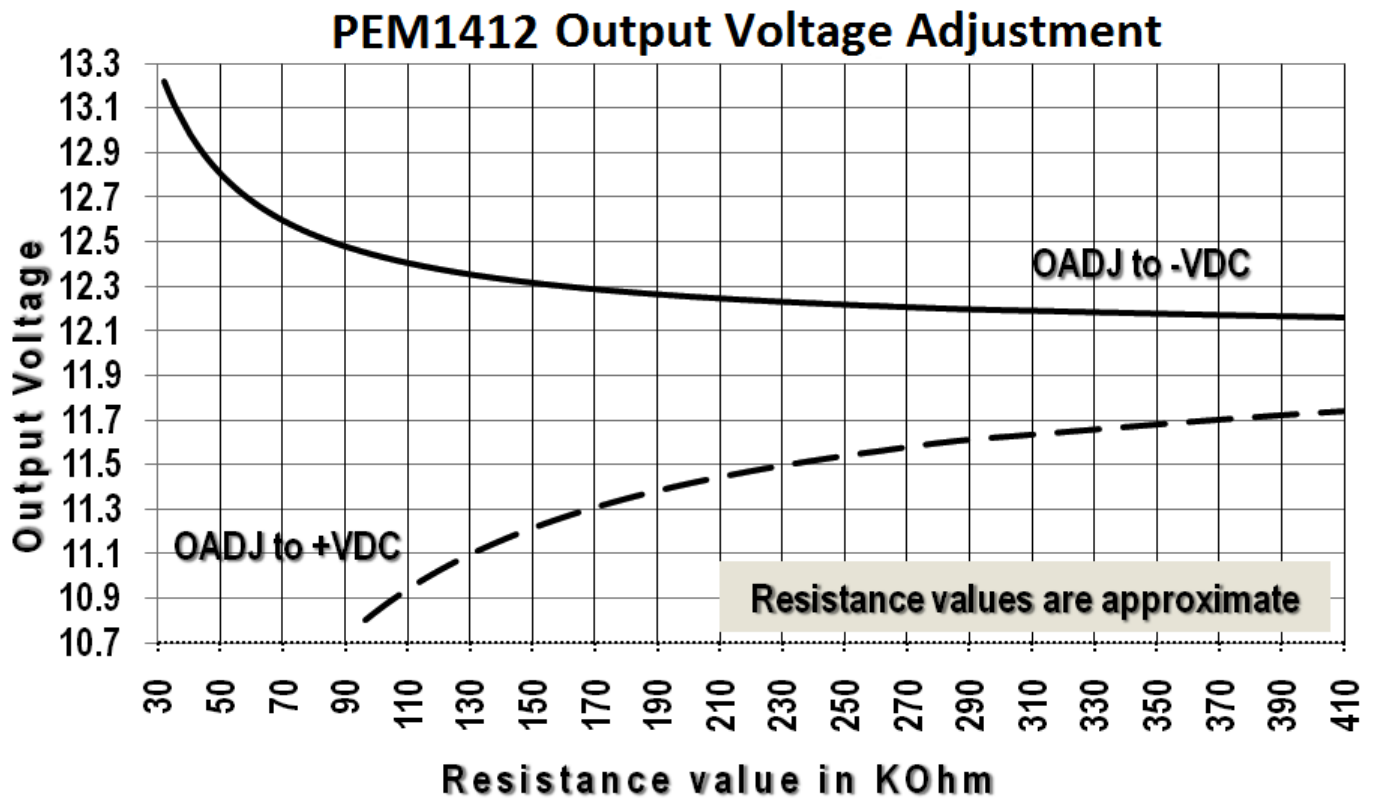


Figure 4

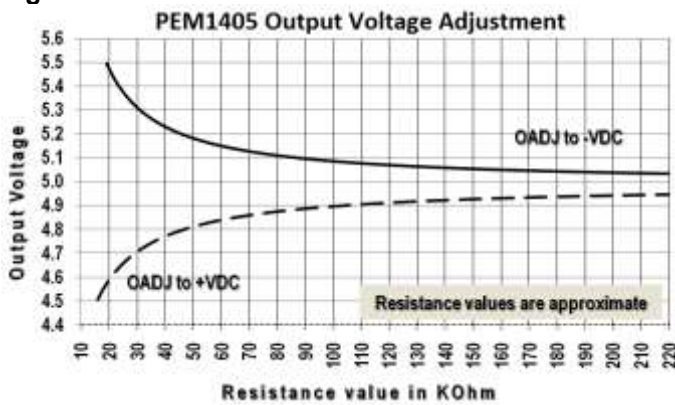
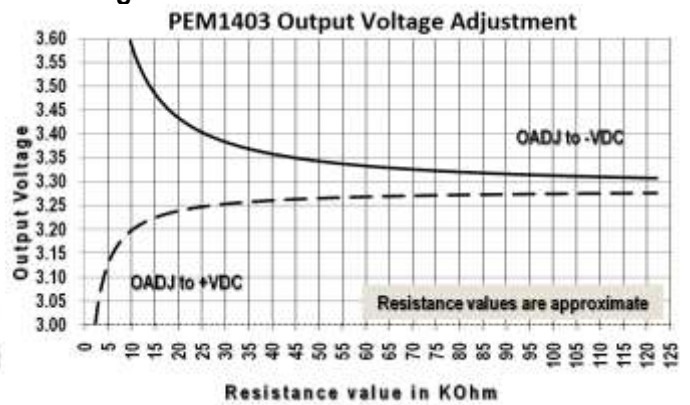


Figure 5



**F.5. Pin Connections**

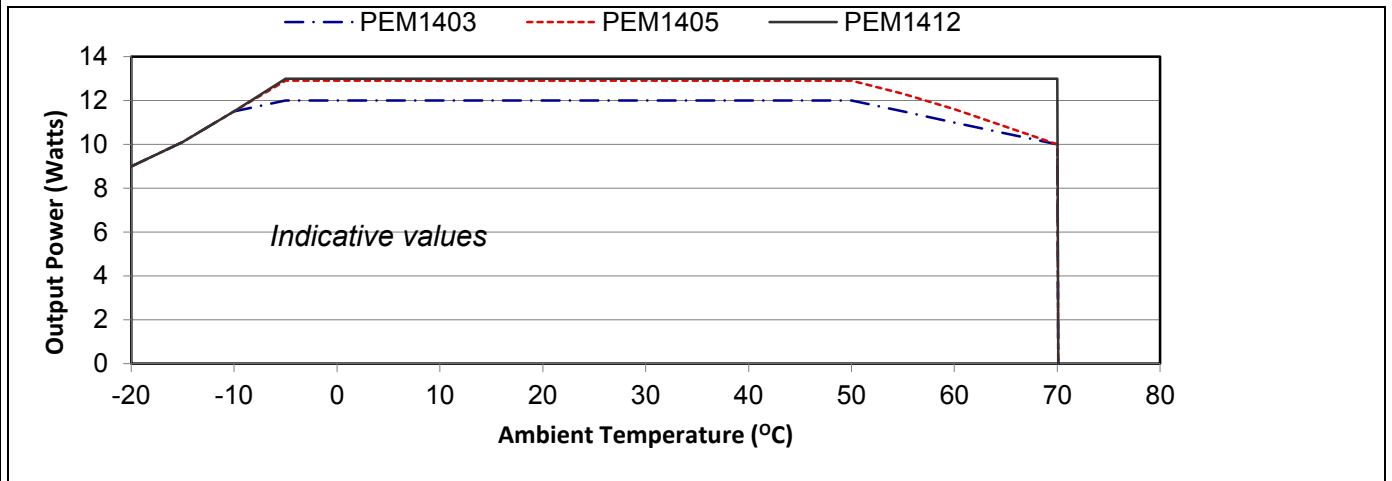
INPUT PINS		OUTPUT PINS	
1	<b>VIN+</b> . This pin connects to the positive (+) output of the input bridge rectifiers	3	<b>+VDC</b> . This pin provides the regulated output from the DC/DC converter. Max. Current 3A per pin.
2	<b>VIN-</b> . This pin connects to the negative (-) output of the input bridge rectifiers	4	<b>OADJ</b> . The output voltage can be adjusted from its nominal value, by connecting an external resistor from this pin to either +VDC pin or -VDC pin. For more details please see section F.4.
To maintain isolation integrity, always connect respective input and output poles only via X or Y safety capacitor. Maintain isolation barrier on motherboard PCB as per physical package.		5	<b>-VDC</b> . The ground return for +VDC output. Max. Current 3A per pin.

## THERMAL PROFILE

### F.6. Thermal Management

As with any power component, the PEM1400 modules generate heat. It is important that adequate ventilation and airflow be taken into consideration at the design stage. The quantum of heat generated by the PEM1400 will depend on the output load it is required to drive. The maximum ambient operating temperature is 70°C. *Figure 6* below, shows the thermal performance of the PEM1400 with a nominal 48VDC input. The PEM1400 thermal performance can be improved by forced airflow cooling over the module and by using a heat sink (a) glued on to the output diodes using a thermal glue, or (b) by a power plane heat sink described in *Figure 7* below. The two methods can be combined.

**Figure 6 – Thermal Performance profile at nominal  $V_{in}$**



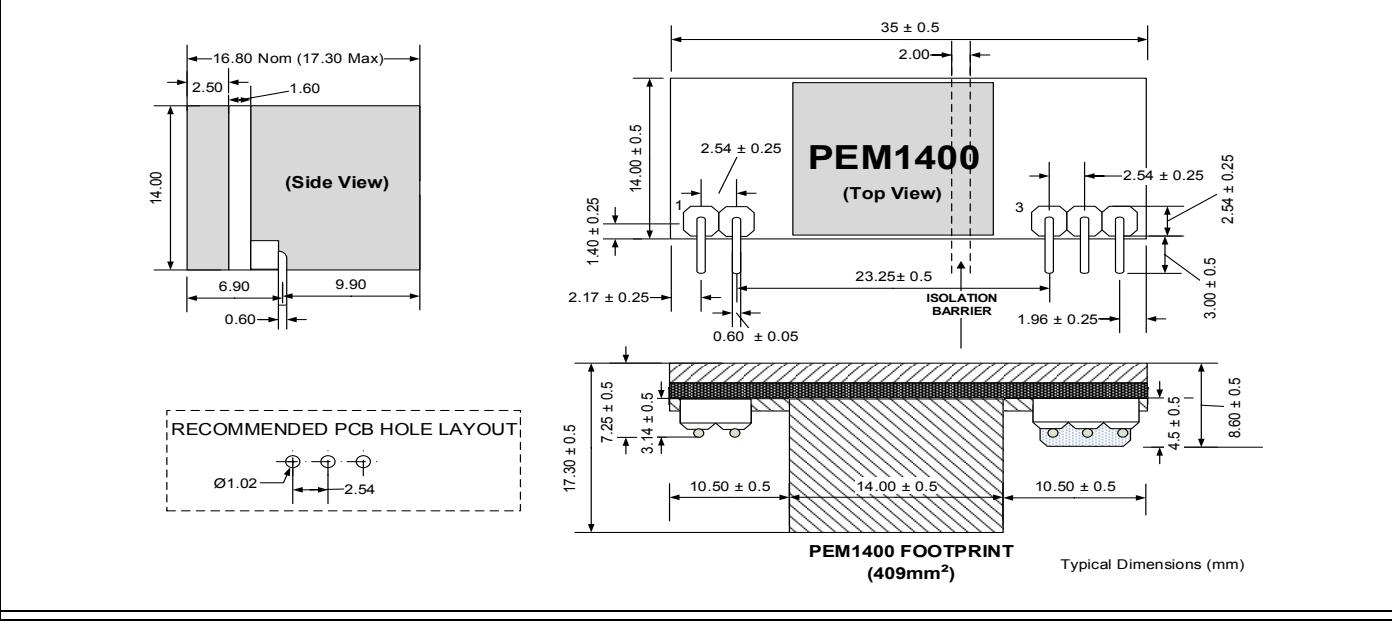
**Figure 7 – Power Plane Heat Sink**

A power plane heat sink on the motherboard is a relatively simple method to draw some heat away from the PEM1400 using the output pins (+VDC and -VDC) which are connected to a PCB heat sink on the motherboard. **It is important to maintain electrical isolation between OADJ pin and the +VDC and -VDC pins to ensure proper output voltages.**

These power plane heat sinks must be on the outer layers of the PCB and the PEM1400 must not be fitted into a socket.

This method can be combined with forced airflow cooling, and with a heat sink glued on to the two output diodes using a thermal glue.

**Figure 8 – PHYSICAL PACKAGE**



## APPLICATION NOTES

Power Over Ethernet (PoE) is a technology for wired Ethernet, the most widely installed local area network technology in use today. PoE allows the electrical power necessary for the operation of each end-device to be carried by data cables along with the data, rather than by separate power cords. Thus, it minimizes the number of wires used to install the network, resulting in lower cost, less downtime, easier maintenance and greater installation flexibility.

The IEEE standard governing PoE is IEEE802.3af. Compliance with this standard ensures inter-operability between devices.

The PEM1400 series modules offering a modular solution, incorporating full IEEE802.3af compatibility signature to the PSE and isolated on-board DC/DC converter. The PEM1400 series are ideal modular system blocks allowing manufacturers of Ethernet equipment to "PoE enable" their equipment with minimal effort and cost. The PEM1400 modules series offer simple and quicker product development, maximising return on investment.

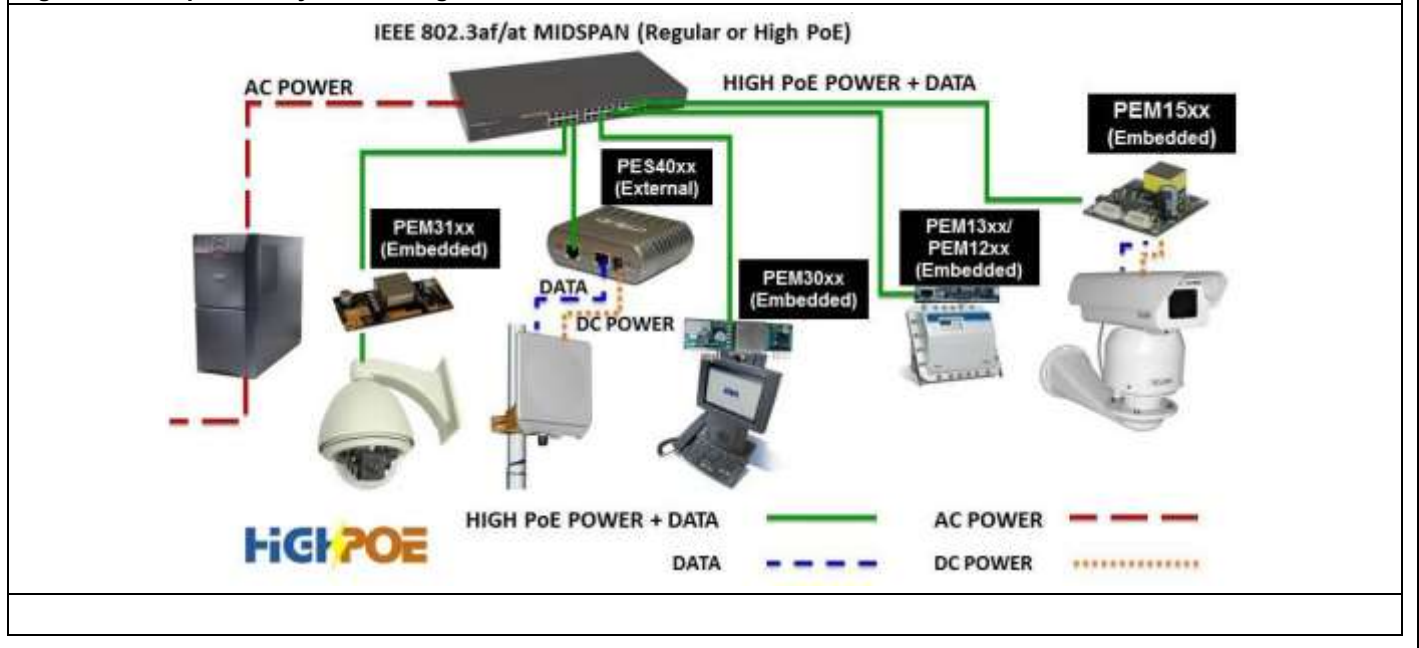
PEM1400 can be powered using a user designed power supply which has adequate thermal and over-current protection. It is strongly recommended that only IEEE802.3af compliant power supply equipment be used to prevent damage to the module, which lacks output stage thermal protection.

**ESD Protection:** It is required that the system designer must provide ESD protection such as an SMAJ58A (uni-directional) or SMAJ58CA (bi-directional) TVS diode at the PEM1400 input(s) to prevent damage from over-voltage surges and for system EMC compliance.

## APPLICATION AREAS

- Security and alarm systems
- Voice over IP phones
- Access control systems
- IP Cameras
- Displays, Net Monitors
- Public address systems
- Wireless access points
- Environmental control
- Telemetry
- Remote environmental monitoring

**Figure 9 – Sample PoE System Configuration**



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