

PRODUCT OVERVIEW

The PEM3200 is globally one of the smallest size, full power IEEE802.3at and IEEE802.3af compliant Power Over Ethernet (PoE) Powered Device (PD) extraction module delivering up to 30 watts peak power, when sourced from a competent power IEEE 802.3at Power Sourcing Equipment (PSE), using twisted pair CAT5 or higher Ethernet cable. It offers fixed POE Class 4 and provides Two Event Physical Layer (Layer 1) classification, as per IEEE802.3at and supports layer 2 classification via an “AT Detect” pin. The module also supports Type 1 and Type 2 PD operation of the IEEE 802.3bt.

The PEM3200 output ripple is controlled within IEEE specifications. For improved EMI performance, the PEM3200 is featured with in-built frequency dithering and a dedicated pin for adjusting the switching frequency for additional tuning for targeted EMI filtration. PEM3200 supports external Auxiliary DC power, and enables Remote Shut Down to keep POE supply on standby mode.

The PEM3200 is a low cost solution with a high efficiency DC-DC converter with 1500V safety isolation, in-built under-voltage, over-voltage, output over-load and short-circuit protection. The PEM3200 series require minimal external components and provide a quick, easy, and cost effective method for Ethernet equipment manufacturers to “PoE enable” their equipment.

PEM3200 is ideal for POE application for IP & PTZ cameras, gaming instruments, audio & video interfaces, security and access control devices, door monitoring, sensors, environment control devices, routers, and network access points.

PRODUCT FEATURES

- Full power IEEE802.3at (POE) solution, Class4
- 30W peak and 24W continuous output power¹
- 12V, 19V and 24V DC output voltage models
- Frequency Dithering
- “AT Detect” pin for layer 2 classification
- Continuous output short-circuit and overload protection³
- Adjustable output voltage
- Compact package and minimum PCB footprint
- IEEE 802.3af, 802.3bt (Type 1 and 2)
- Highly efficient 1500V isolated DC-DC converter
- Low output ripple and noise
- Adjustable operating frequency²
- Supports Auxiliary power supply
- Minimal external component required (470uF x 1 ECAP on output side)
- RoHS compliant
- Low-cost, quick and easy POE solution

¹ 30watt peak for maximum 30sec. at duty cycle of 10%. Please see *section 17* Thermal profile on operating temperature.

² Please see *section 16*. Frequency Adjustment

³ If maximum power is exceeded, the PEM3200 will operate in an over current mode and will auto recover when the overload condition is removed.

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1. PRODUCT SELECTOR⁴

Part Number	Marking	Output Voltage ⁵	Efficiency ⁶	IEEE Power Classification	Output Power (Maximum) ⁷
		(Volts DC)	(%)		(Watts)
PEM3212	12	12	88	Fixed Class 4	24 watts continuous / 30 watts peak
PEM3219	19	19	89	Fixed Class 4	24 watts continuous / 30 watts peak
PEM3224	24	24	89	Fixed Class 4	24 watts continuous / 30 watts peak

2. INPUT CHARACTERISTICS

Parameter	Symbol	Units	Min.	Typ	Max.
Input Voltage (DC) ⁸	V _{IN}	V	36	51	57
Under Voltage Lockout (DC)	V _{UVLO}	V	30		36
Input Current (DC) ⁹	I _{IN}	mA	100 ^{8,10}		600
Maximum Inrush Current ¹⁰	I _{PK}	mA			650
Operating Temperature ⁶	T _{OP}	°C	-20	25	70
IEEE 802.3at/af Power Classification ¹¹	Fixed Class 4				

3. DC OUTPUT CHARACTERISTICS

Parameter	Symbol	Units	Min	Typ	Max.
Line Regulation ⁹	V _{LNRG}			0.2%	
Load Regulation ⁹	V _{LDRG}			0.5%	
Output Ripple and Noise ^{4,9,12}	V _{RIP}	mVp-p		50	150
Isolation Voltage (DC)	V _{ISOL}	V			1500
Temperature Coefficient (Slope)	TC	ppm/ °C		100	300
Output Short Circuit Duration (at ambient 25 deg C)		Sec			∞

4. ABSOLUTE MAXIMUM RATINGS,¹³

Supply Voltage (V _{CC})	0V ~ 57V DC
Storage Temperature (T _S)	-25 °C ~ +100 °C
Output Voltage (V _{OUT})	0V to controlled output voltage (operating or non-operating)

⁴ Electrical specifications and measurements in this data sheet are considered to be at the respective input and output pins, wherever applicable.

All readings in this data sheet are considered to be at 25 deg C ambient, unless otherwise specified.

⁵ Output voltage typical $\pm 3\%$ at T_A for 25°C with a nominal input voltage and rated output current.

⁶ Typical at nominal V_{IN} at 67% load at T_A 25°C.

⁷ 30watt peak for maximum 30sec. at duty cycle of 10%. Please see *section 17 – Thermal profile on operating temperature.*

⁸ Ensure minimum output load of 1 Watt or 100mA input current whichever is higher.

⁹ Please refer to IEEE802.3at/af standards document. Maximum input current is dependent on power class, and input voltage. Input current (DC or RMS) at V_{PORT} = 37VDC is 600mA, at V_{PORT} = 57vDC is 450mA. Peak inrush current is 650mA for 50mS max at duty cycle of 5% max.

¹⁰ Minimum current required to maintain power signature as per IEEE802.3af / at standards.

¹¹ Please see *section 11 - IEEE POE Power Classification Method*, for more details.

¹² Output Ripple measured along with and across the Out Put ECAP (Typical Connections)

¹³ 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.

5. BLOCK DIAGRAM and TYPICAL CONNECTIONS

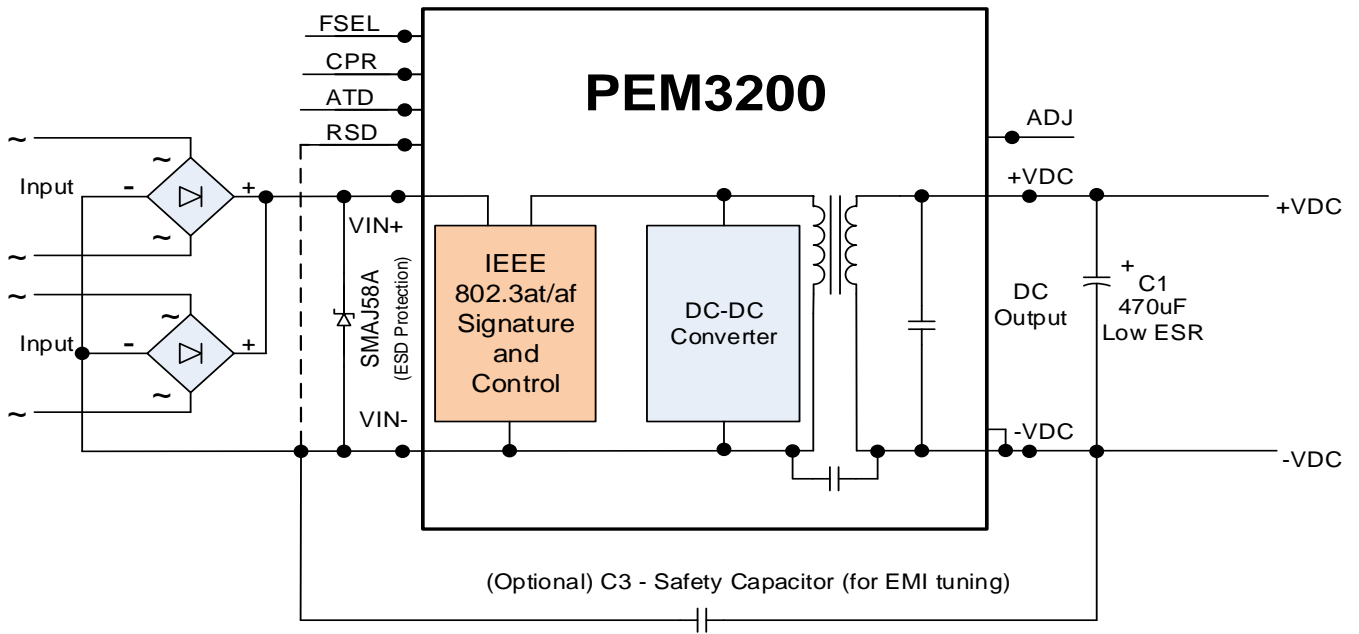


Figure 1 – Typical Connections

6. PIN CONNECTIONS

INPUT PINS		OUTPUT PINS	
1	VIN+. This pin connects to the positive (+) output of the input bridge rectifiers	7	-VDC. The ground return for the +VDC output. (Internally connected to pin 10).
2	VIN-. This pin connects to the negative (-) output of the input bridge rectifiers	8	+VDC. This pin provides the regulated output from the DC/DC converter.
3	ATD. AT Detect Pin. Please see <i>section 12. AT Detection</i>	9	OADJ. The output voltage can be adjusted from its nominal value. Please see <i>section 14. Output Voltage Adjustment</i> .
4	RSD. This pin can be used for remotely shutting down the module from the target device. Please see <i>section 13. Remote Shutdown</i> .	10	-VDC. The ground return for the +VDC output. (Internally connected to pin 7).
5	CPR. This pin used for Remote Shut down. Please see <i>section 13. Remote Shutdown</i> .	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.	
6	FSEL. This pin can be used for adjusting the switching frequency. Please see <i>section 16. Frequency Adjustment</i> .		

7. INPUTS

The PEM3200 series is compatible with all IEEE 802.3af / at 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*. (Refer to IEEE802.3at and IEEE802.3af standards for more information).

PEM3200 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 wants to use only one PEM3200 module to save costs. Another advantage is that this allows the system designer to control the type and costs of the input rectification diodes.

8. 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. In 4 pair injection both Signal and Spare Pairs carries power simultaneously. PEM3200 supports only Mode A and Mode B.

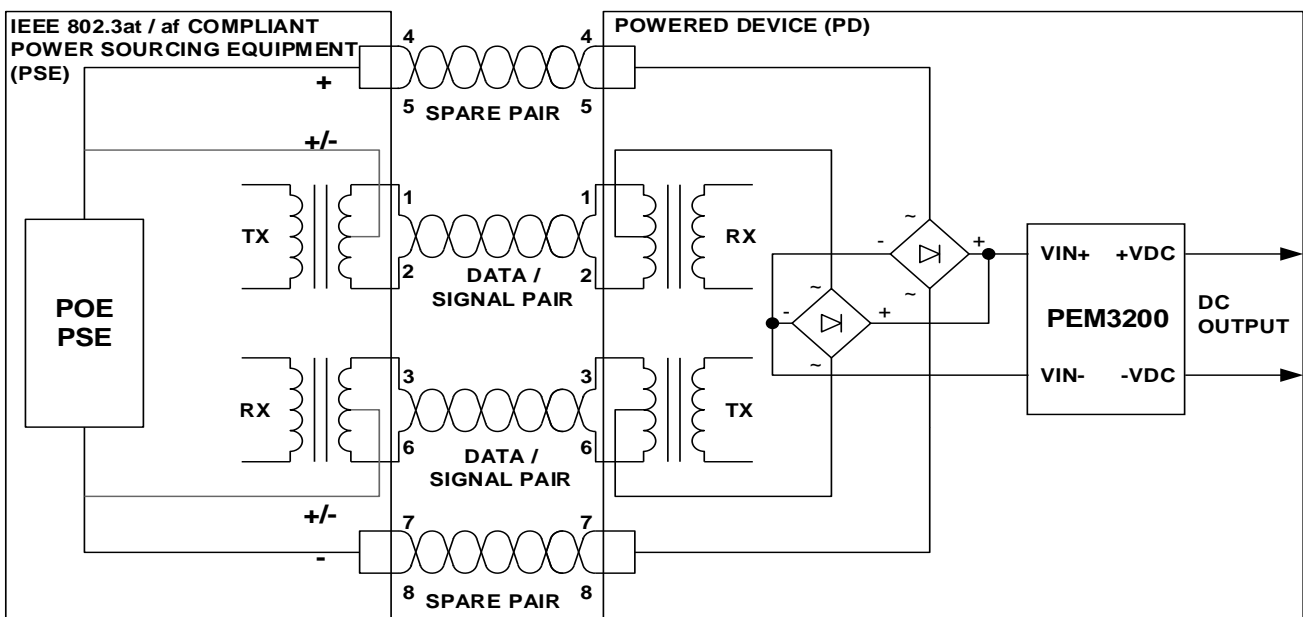


Figure 2 – Typical System configuration

9. POWERED DEVICE (PD) SIGNATURE

When PEM3200 is connected to a Cat 5e or greater Ethernet cable from an IEEE 802.3af /at 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.

POE Power-on start-up waveform

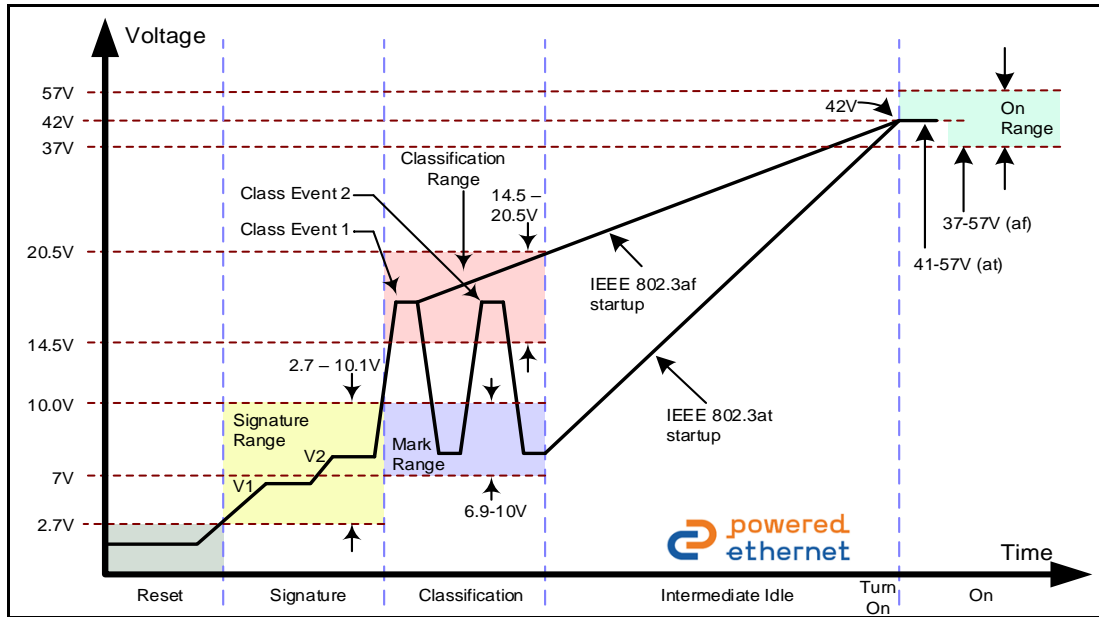


Figure 3 - Two Event Physical Layer (Layer 1) classification

10. ISOLATION

IEEE 802.3af / at 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™ PEM3200 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’.

11. IEEE POE POWER CLASSIFICATION METHOD

The PEM3200 classification is fixed to present the POE PD Class 4. If it connected to a Type 1 (IEEE802.3af) PSE, the PSE will default to Class 0. If it is connected to a Type 2 (IEEE802.3at) PSE, the PSE will recognise the PEM3200 as a Class 4 POE PD.

The PEM3200 supports Two Event Physical Layer (Layer 1) classification, as per IEEE802.3at, as shown in *Figure 3*, above. For Data Link Layer (Layer 2) (Data Link layer) please see *section 12. AT Detection* below.

12. AT DETECTION (ATD Pin)

If the PEM3200 detects a Type 2 PSE via the Two Event Physical Layer method, it asserts the ATD pin high (+5V), indicating connection to a Type 2 PSE. If the PD controller detects only a single event classification, it identifies the PSE to be Type 1 and the ATD pin is asserted Low.

As per the IEEE 802.3at standards, to extract more than 15.4W power from the PSE the host board controller has to inform the PSE through the Layer 2 (data link layer) that it is a Type-2 POE PD. Full details are available in the IEEE 802.3at standards document.

The PEM3200 ATD pin can be connected to the host board through an opto-coupler as shown in *Figure 4*.

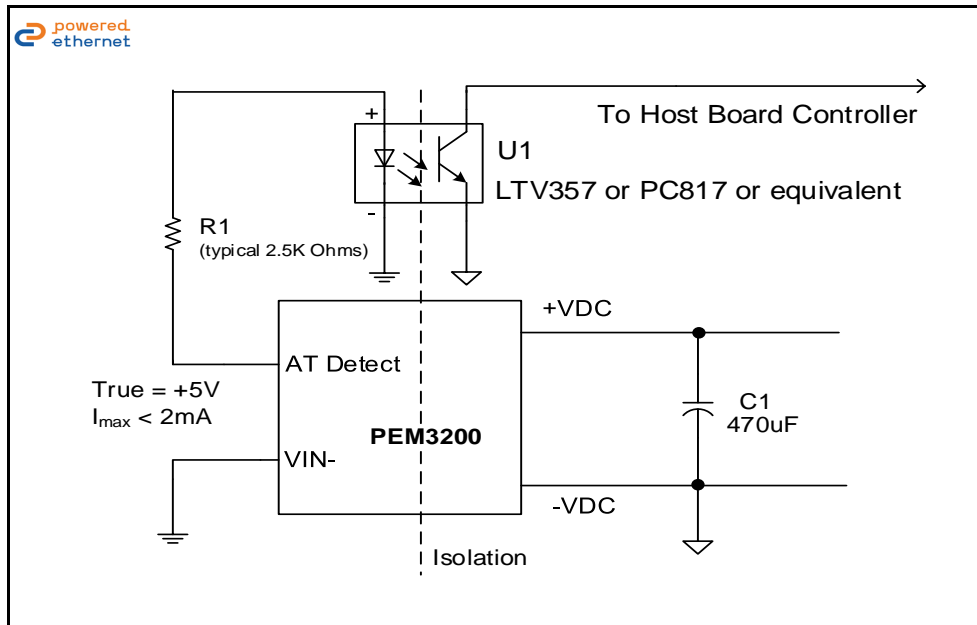


Figure 4 – AT Detect Pin Connection

The value of R1 resistor should be selected to ensure the **maximum current remains below 2mA at all times**. The collector pin of U1 should be connected to the host board controller, via a pull-up resistor. When connected to a Type 2 PSE the +5V on the ATD pin turns on the opto-coupler U1, and its output goes low (Logical Zero). Using this, the host board controller can sense that the PSE can deliver more than 15.4W and confirm to the PSE via Data Link Layer it is a Type 2 PD.

If the PEM3200 does not detect a Two Event Physical Layer classification, the ATD pin will remain low, thus U1 remains OFF and its output collector remains high via the pull-up resistor.

In case the Physical Layer classification is not supported by the PSE, then U1 remains OFF.

13.REMOTE SHUTDOWN (RSD)

The PEM3200 series is featured with Remote Shut Down option, which can be used in case the host board need to shut down PEM3200. This feature is helpful with host boards having auxiliary power supply.

Using the remote shut down feature the designer can decide the priority of POE power or auxiliary power. For example, when the auxiliary power supply is live, the host board can shut down the PEM3200 output. Similarly, the RSD feature can be used to initiate a hardware reset by the host board based on SNMP.

The RSD pin can be connected to host board through an opto-coupler as shown in the below *Figure 5*. The opto-coupler is required in order to maintain the 1500V isolation barrier.

To shut down the PEM3200 the host board needs to pull the RSD pin from Zero to High. When the RSD pin is activated, the output of the PEM3200 will switch off. RSD is a current-mode pin, the ratings are as per Table 1 below.

If the remote shut down feature is not used, connect RSD to Vin-.

Table 1: Remote Shut Down				
Description	Unit	Min	Typ	Max
RSD pin threshold low	uA			20
RSD pin threshold high	uA	100		
Input voltage RSD pin	V			6

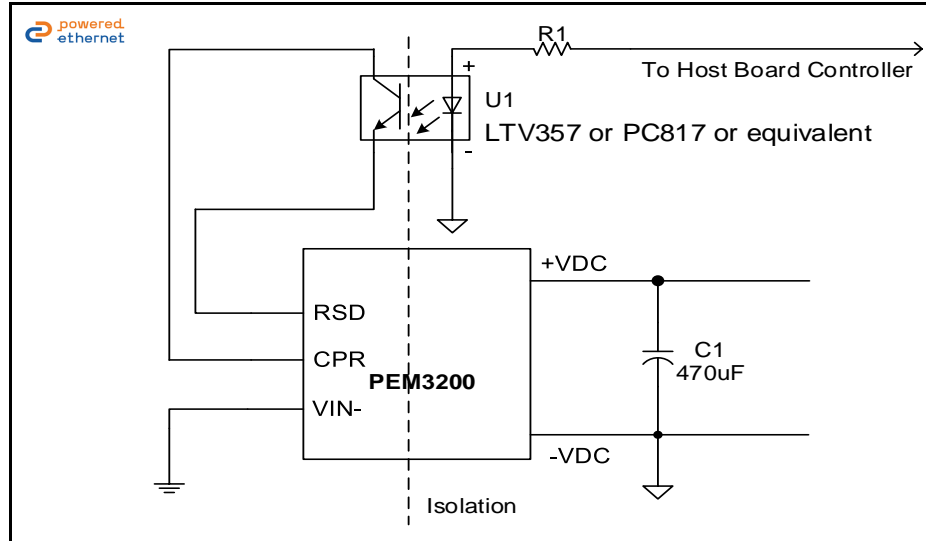


Figure 5 - Remote Shut down Connection

If RSD is asserted, the ATDET pin is forced high, irrespective of the PD mode. See *Table 2* below for ATDET output definitions under various powering modes. Please [contact Infomart technical support](#) for more details.

Table 2: ATDET Truth Table		
ATDET signal status	PSE	
	Type 1	Type 2
RSD = Low	Low	High
RSD = High	High	High

14. OUTPUT VOLTAGE ADJUSTMENT

The PEM3200 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. The resistor to be connected between the OADJ pin and either the +VDC or -VDC pin as per *Figures 6~8* shown below. Only one connection i.e. between OADJ and +VDC or between OADJ and -VDC is permitted at a time. Do not adjust output voltage by more than $\pm 10\%$ or $\pm 1.5V$, whichever is lower, from nominal voltage. Maximum output voltage on PEM3224 is 24.5V. The voltages are to be measured at the output pins of the module. Please [contact Infomart technical support](#) for more any further clarifications.

An estimate of resistance value for voltage adjustment is provided below. The most appropriate resistance value to be tuned by customers.

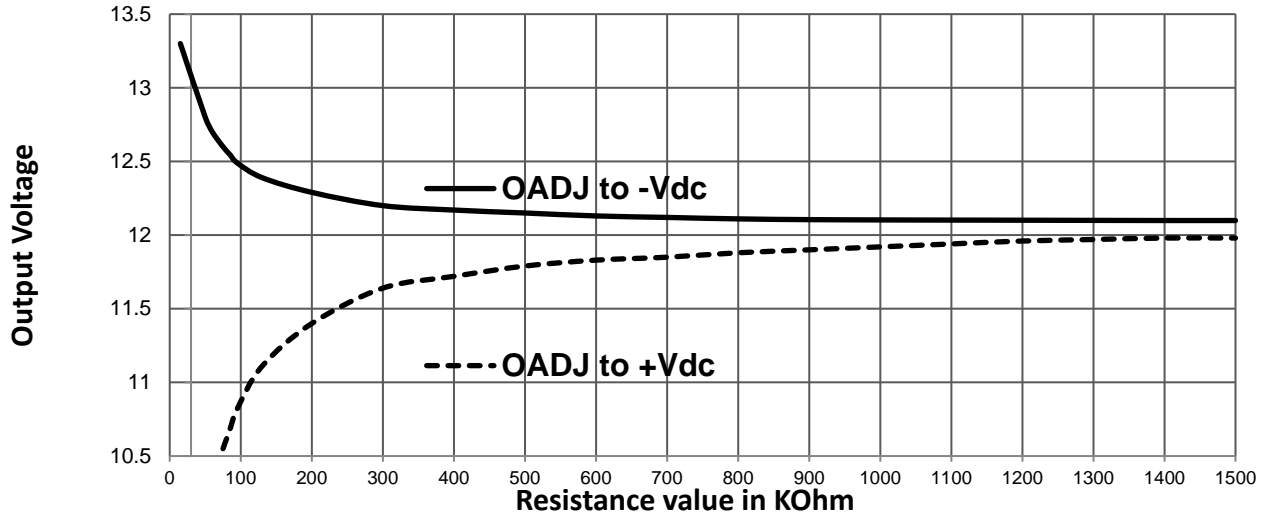


Figure 6 - PEM3212 Output Voltage Adjustment

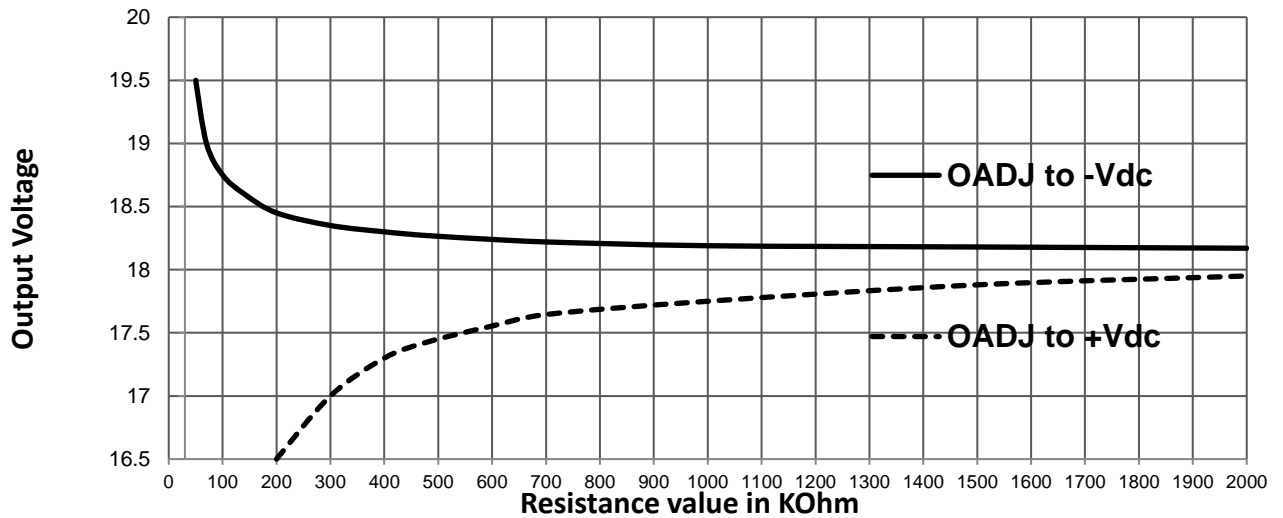


Figure 7 - PEM3219 Output Voltage Adjustment

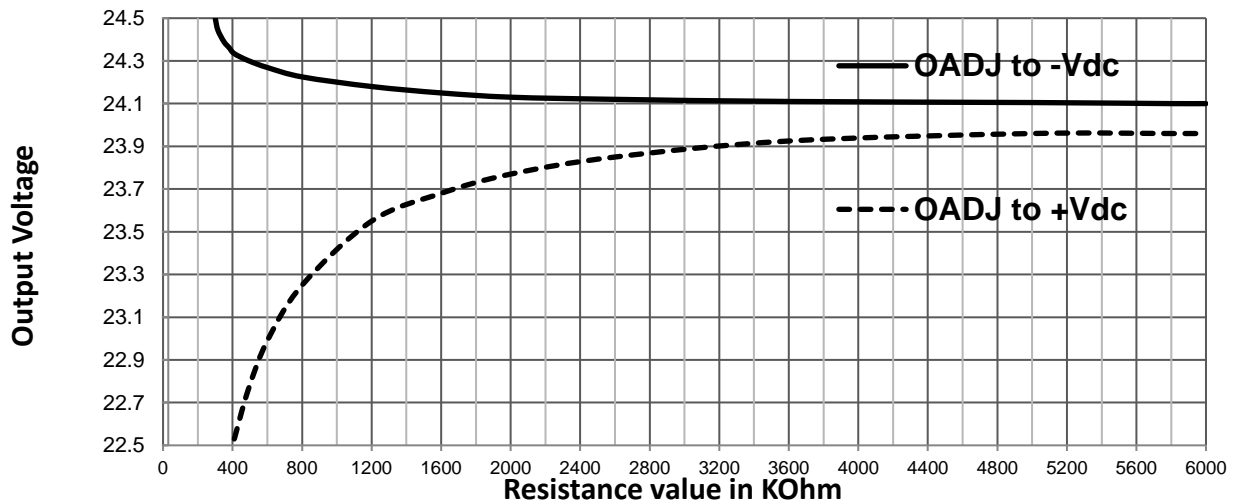


Figure 8 - PEM3224 Output Voltage Adjustment

15.FREQUENCY DITHERING

The PEM3200 series is built with Switching Frequency Dithering to help better controlling of EMI emissions and harmonics. The nominal switching frequency of PEM3200 is 300KHz, with a frequency dithering range of $\pm 10\%$.

16.FREQUENCY ADJUSTMENT

To provide greater flexibility in EMI control, the PEM3200 allows designers to increase the switching frequency, via the FSEL pin. This feature must be used with great care and in consultation with Infomart technical support. Always use a resistor of maximum 1% tolerance and minimum 1/16W power rating which should be connected between the FSEL pin and -VDC pin. As an example, about 900 KOhms resistance will produce a 10% increase in frequency.

17.THERMAL MANAGEMENT

As with any power component, the PEM3200 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 PEM3200 will depend on the output load it is required to drive. The maximum ambient operating temperature is 70°C. *Figure 9* below, shows the thermal performance of the PEM3200 with a nominal 51VDC input.

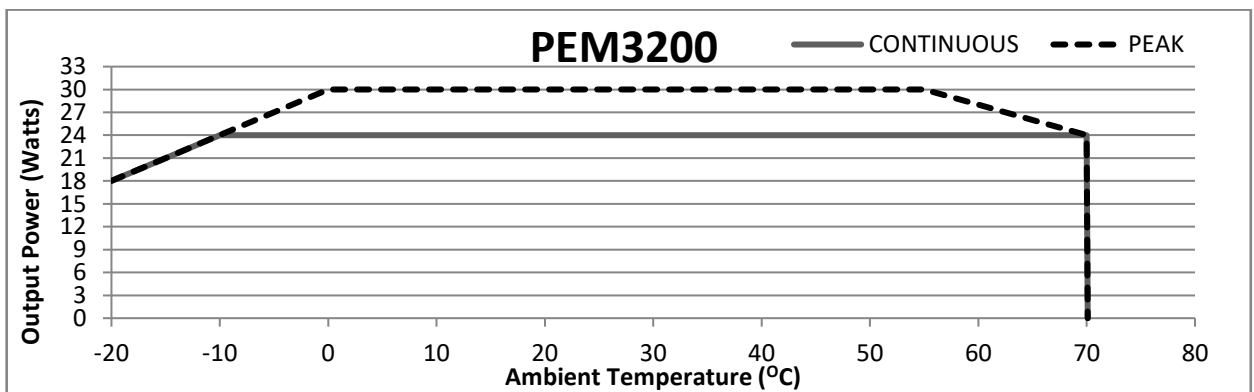
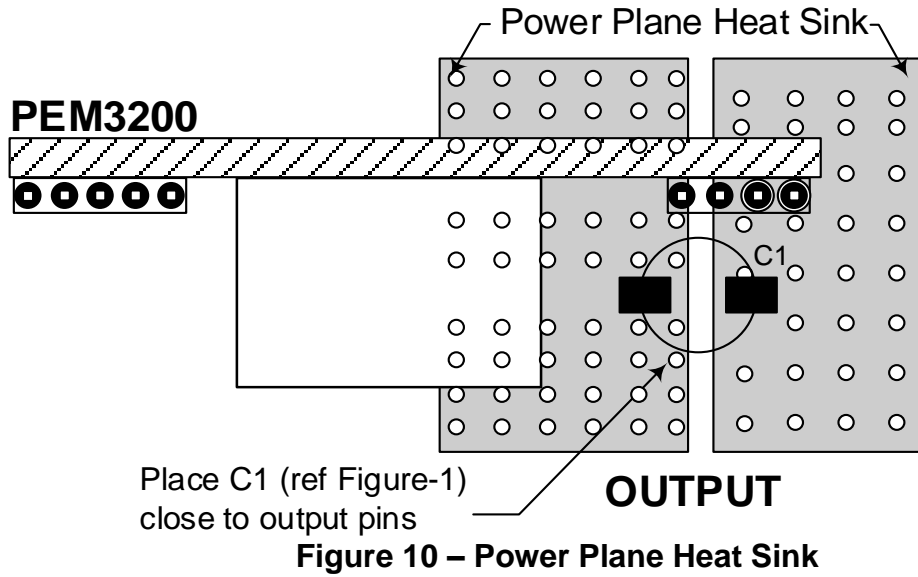


Figure 9 - Thermal Performance profile at nominal Vin

Power Plane Heat Sink

The PEM3200 thermal performance can be improved by forced airflow cooling over the module and by using (a) a heat sink glued on to the diodes using thermal glue or (b) a power plane heat sink described in *Figure 10* below. The two methods can be combined.

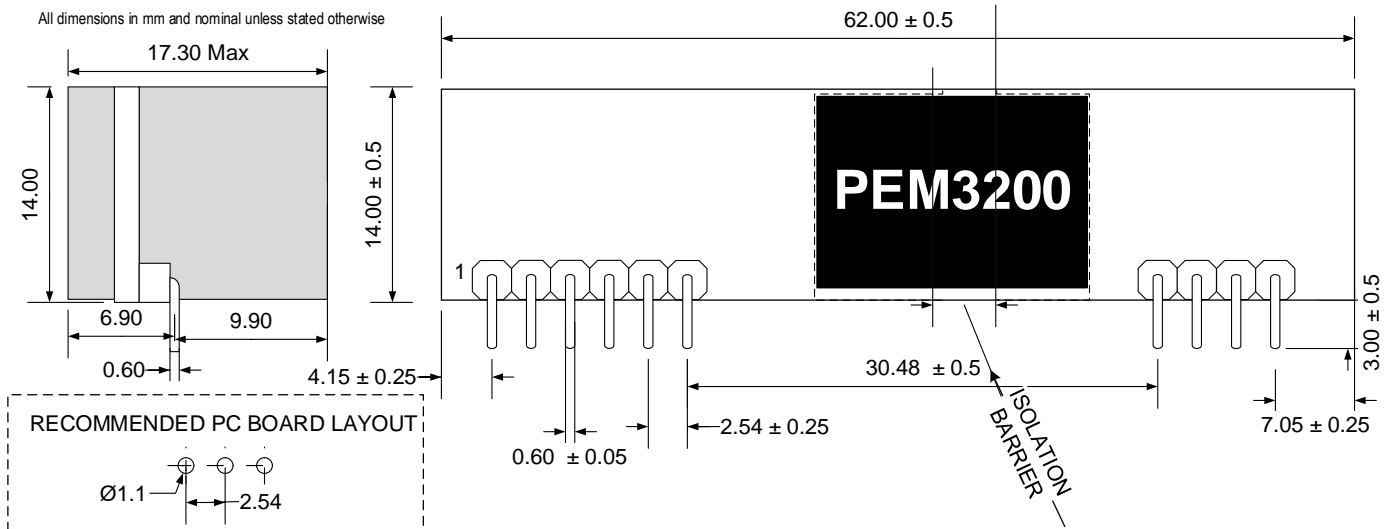
A power plane heat sink on the motherboard is a relatively simple method to draw some heat away from the PEM3200 using the output pins (-VDC and +VDC) which are connected to a PCB heat sink on the motherboard. **It is important to maintain electrical isolation mutually between the OADJ pin, the EMO pin, the +VDC pin, and the -VDC pin in order to ensure proper output voltages.**



These power plane heat sinks must be on the outer layers of the PCB. For better heat dissipation always solder the PEM3200 on the power plane; don't use sockets. Sockets can also generate voltage spikes.

These methods can be combined with forced airflow cooling and for extreme cases with an additional heat sink glued on to the main transformer using thermal glue.

18. PHYSICAL PACKAGE



19. 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 IEEE802.3at and IEEE802.3af. Compliance with this standard ensures inter-operability between devices.

The PEM3200 series modules offering a modular solution, incorporating Layer-1 IEEE802.3at / af compatibility signature to the PSE and isolated on-board DC/DC converter. The PEM3200 series are ideal modular system blocks allowing manufacturers of Ethernet equipment to “PoE enable” their equipment with minimal effort and cost. The PEM3200 modules series offer simple and quicker product development, maximising return on investment.

PEM3200 can be powered using a user designed power supply which has adequate thermal and over-current protection. It is strongly recommended that only IEEE802.3at / af 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 PEM3200 input(s) to prevent damage from over-voltage surges and for system EMC compliance.

20. APPLICATION AREAS

- Security and alarm systems
- Voice over IP phones
- Access control systems
- IP Cameras
- Displays, Net Monitors
- IOT (Internet of Things)
- Wireless access points
- Environmental control
- Public address systems
- Remote environmental monitoring

21. SAMPLE PoE SYSTEM CONFIGURATION

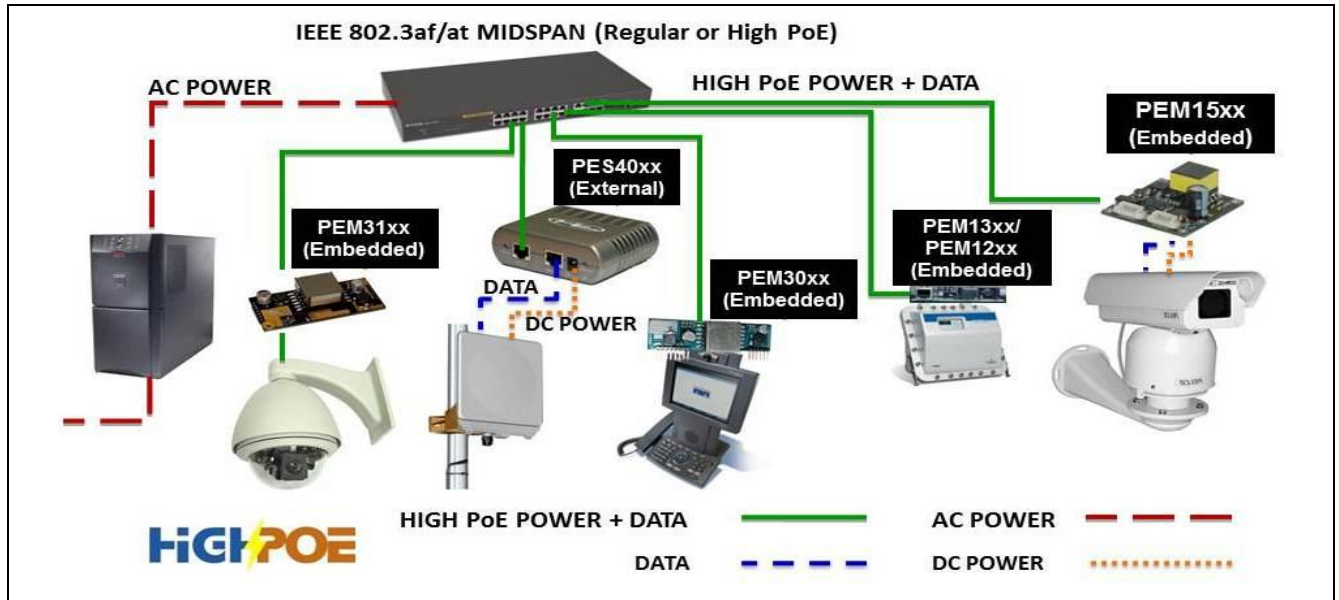


Figure 12 – Illustration of POE System Configuration

22. ROHS COMPLIANCE

ROHS compliance details on webpage: http://www.poweredethernet.com/rohs_compliance.html



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Revision History

REVISION NUMBER	DESCRIPTION
21GR0-3	<ul style="list-style-type: none">• Image of the Product changed• PRODUCT OVERVIEW updated• Clerical corrections• Section 11. IEEE POE POWER CLASSIFICATION METHOD updated• Section 12. AT DETECTION (ATD Pin) updated• Revision History added to this document

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