



PRODUCT OVERVIEW

The PEM3200 series of Power Over Ethernet Powered Device (PD) power extraction modules, have complete compliance with the high power IEEE 802.3at Power-Over-Ethernet Plus (PoE+) standard, and are designed to extract power from CAT5 Ethernet cable when sourced by both IEEE 802.3at(PoE+) and IEEE 802.3af (POE) compliant Power Sourcing Equipments (PSE).

The PEM3200 series modules provide full two event PoE+ and single event POE signature for layer 1 classification and supports layer 2 classification via an “AT Detect” pin. Its high efficiency DC-DC converter provides up to 30 watts of power in a well-regulated, low noise and low ripple output with in-built in-rush current, overload and output short-circuit protection.

The PEM3200 is a compact size, one of the smallest PD modules for IEEE802.3at power. With the inbuilt frequency dithering function it helps in reducing electromagnetic interference and harmonics. PEM3200 also provides the option for tuning the operating frequency¹.

The PEM3200 series provides a quick, easy, and cost effective method for manufacturers of Ethernet equipment like PTZ cameras, WiMAX@tower and access points, Wireless N, RFID readers, POS terminals, thin client terminals, and IP telephones to “PoE enable” their equipment

PRODUCT FEATURES

- Fully IEEE® 802.3at and 802.3af compliant
- Up to 30Watt output load²
- IEEE Power class 4
- High Efficiency
- Compact package and minimum PCB footprint
- Minimal external components required
- “AT Detect” pin for layer 2 classification
- Frequency Dithering
- Adjustable operating frequency¹
- 1500 Volt DC isolation (Input to Output)
- Overload protection³
- Continuous short circuit protection
- Low output ripple and noise
- 12V, 19V and 24V DC output voltage models
- Adjustable output voltage
- Support for external aux. power supply
- Cost effective
- RoHS compliant

¹ For 19V and 24V. Change of frequency is not permitted for 12V model. Please see section 16. Frequency Adjustment

² 30watt peak for maximum 30sec. at duty cycle of 10%. Please see section 17 Thermal profile on operating temperature.

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		100	150
Isolation Voltage (DC)	V _{ISOL}	V			1500
Temperature Coefficient (Slope)	TC	ppm/°C		100	300
Output Short Circuit Duration		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.

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

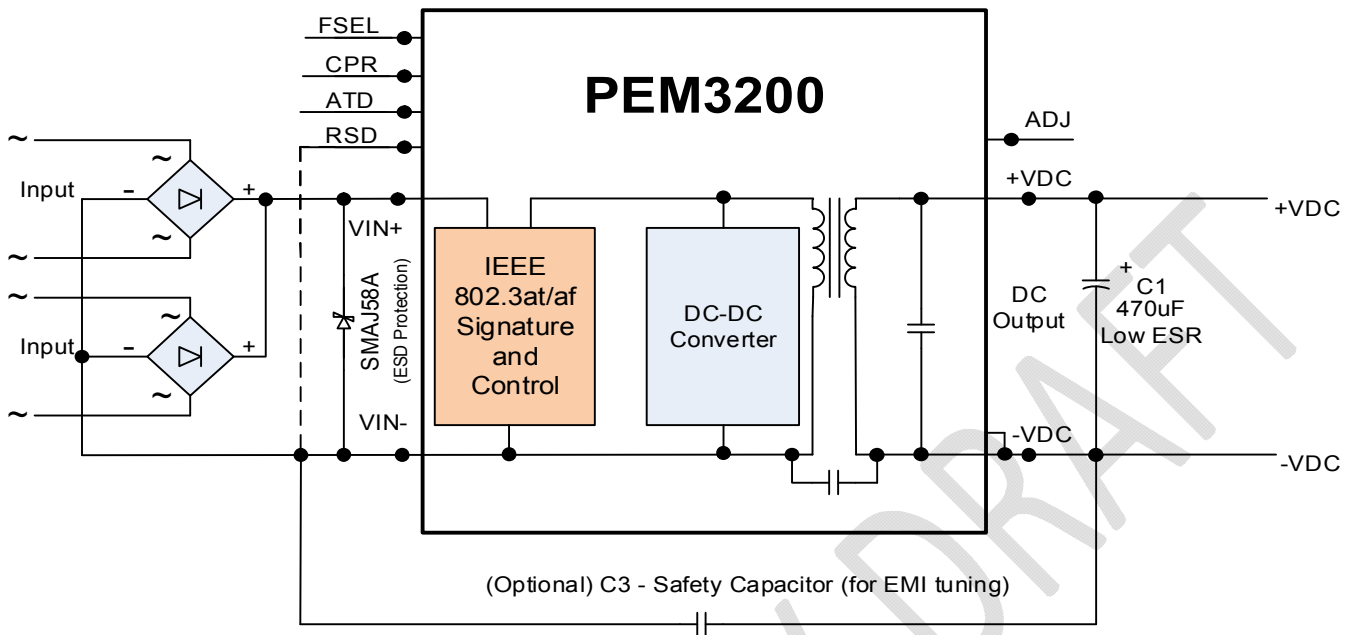


Figure 1

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 section 12. <i>AT Detection</i>	9	OADJ . The output voltage can be adjusted from its nominal value. Please see section 14. <i>Output Voltage Adjustment</i> .
4	RSD . This pin can be used for remotely shutting down the module from the target device. Please see section 13. <i>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 section 13. <i>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 section 16. <i>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.

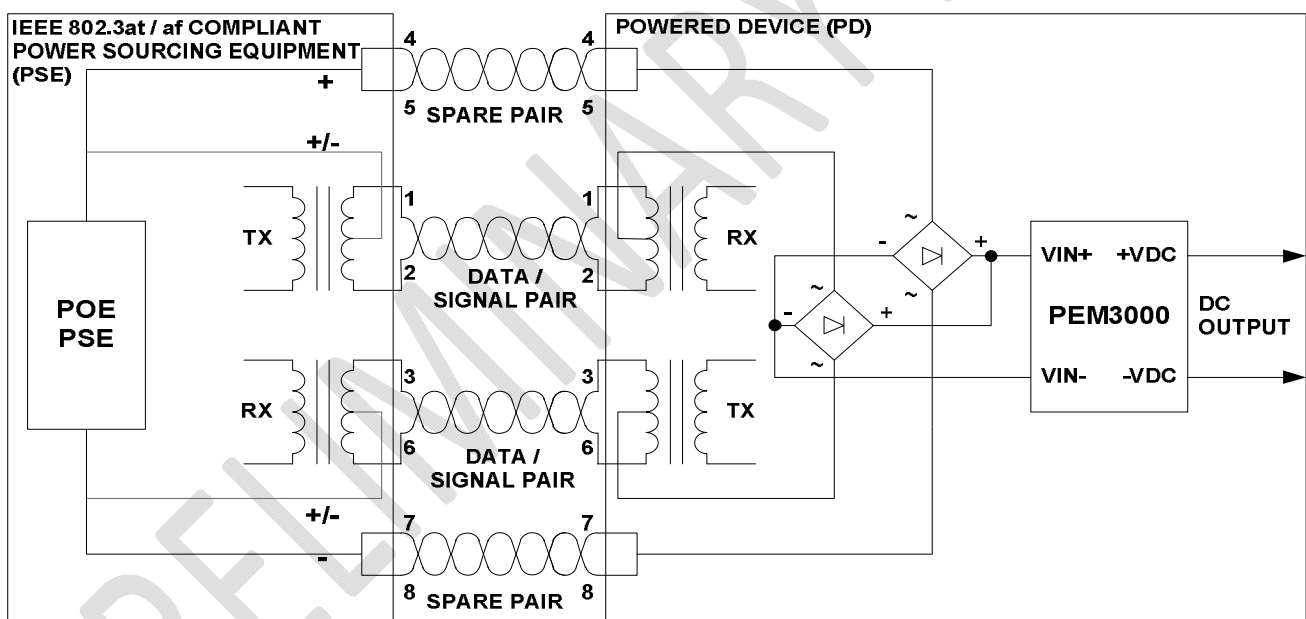
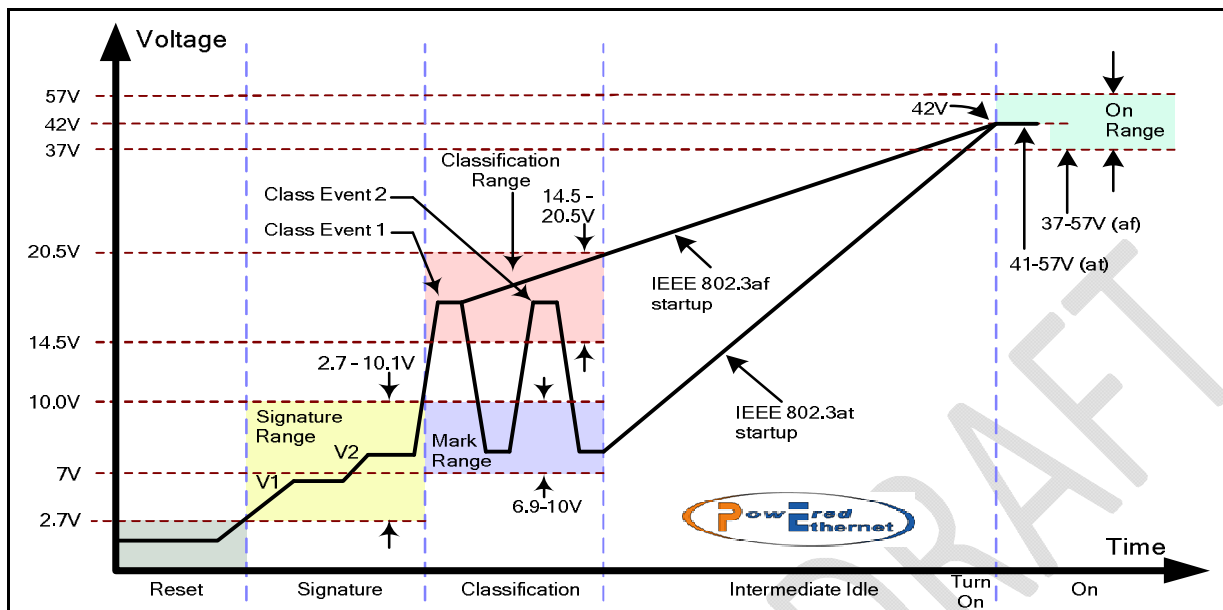


Figure 2

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
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

With the growing emphasis on **"Green Power"**, in the latest standard, IEEE has stressed for Powered Devices (PDs) to implement the IEEE **Power Classification** system to ensure correct provisioning of power from the PSE.

To help in proper power level provisioning and improved power management, the IEEE 802.3af and 802.3at standards provide for PDs to inform the PSE their required power levels via a Class system. Each class represents a power allocation range for a PD to inform and therefore assist the PSE in managing power distribution.

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

The PEM3200 identifies the PSE as either Type 1 (15.4W) or Type 2 (33.6W). If the 2-Event method is detected by the PD controller during the classification stage, it asserts the ATD pin High, indicating connection to a Type 2 PSE. If the PD controller detects only single-event classification, it identifies the PSE to be Type 1 and the ATD pin is asserted Low.

To prevent false positives due to noise or transient ringing on the Ethernet line during the classification phase, the PEM3200 integrates a proprietary digital filter for ensuring reliable AT detection.

12. AT DETECTION (ATD Pin)

In case of Layer 2 (link layer) classification, in order to extract more than 15.4W power from the PSE the host board controller has to confirm back to the PSE through the data link layer (Layer 2) that it is a Type-2 PD. Full details are available in the IEEE 802.3at standards document.

ATD Pin can be connected to host board through an opto-coupler as shown in Figure 4.

The opto-coupler (U1) is connected across the isolation barrier. When a Type-2 PSE is connected to the PEM3200, the ATD pin goes High and turns on the opto-coupler. The collector pin of U1 to be connected to the host board controller, using a pull-up resistor. When the ATD pin goes High, U1 output goes Low. Then the host board controller can understand that the PSE can deliver more than 15.4W and confirm back that this is a Type-2 PD.

If the PEM3200 detects a 1 – Event Physical Layer classification, U1 remains OFF and the output collector remains high (via pull-up resistor). The host board then understands that the PSE is not Type-2.

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

ATD Pin Connection

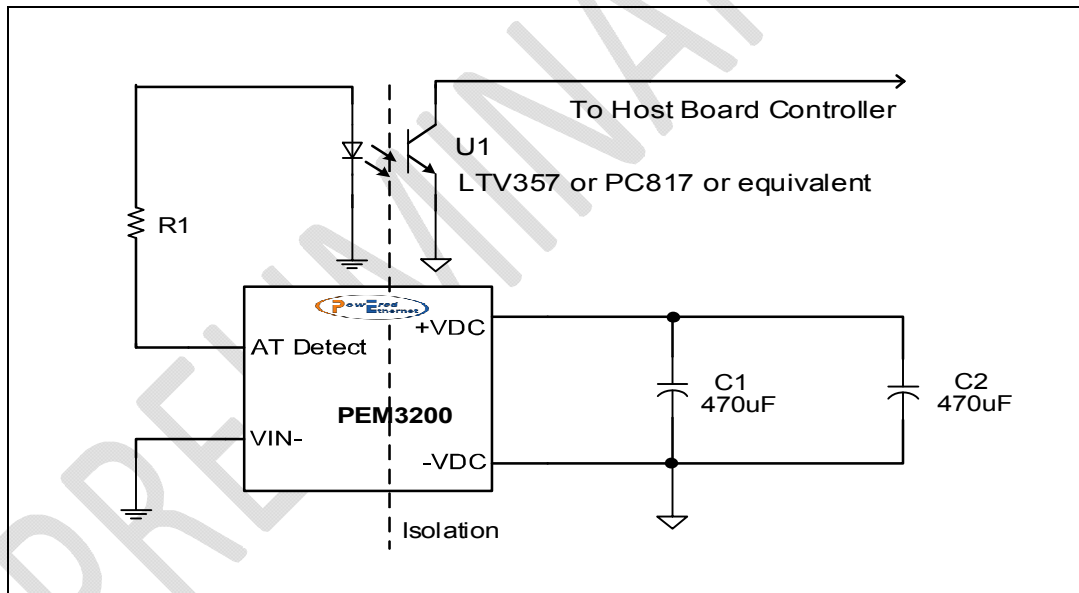


Figure 4

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 2 below.

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

Table 2: 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

Remote Shut down Connection

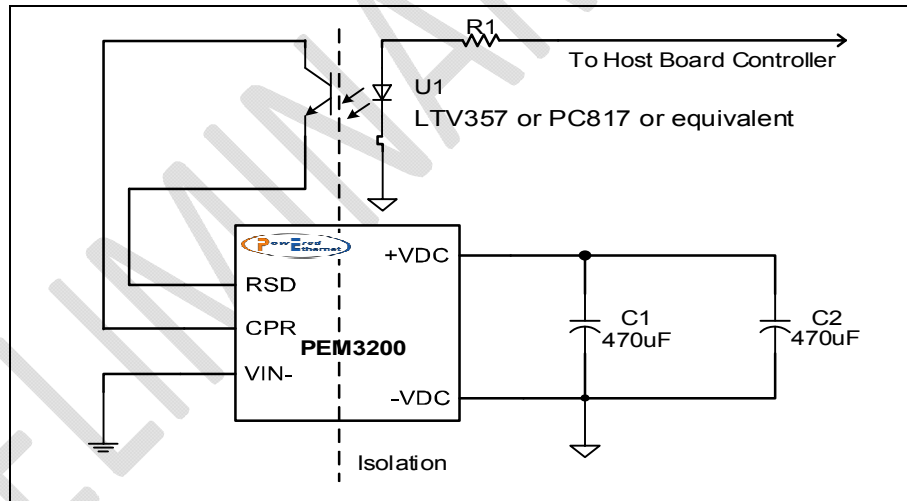


Figure 5

If RSD is asserted, the ATDET pin is forced high, irrespective of the PD mode. Please see Table 3 below for ATDET output definitions under various powering modes.

Table 3: ATDET Truth Table		
ATDET signal status	PSE	
	Type 1	Type 2
RSD = Low	Low	High
RSD = High	High	High

Please [contact Infomart technical support](#) for more details.

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. A change of more than $\pm 10\%$ or $\pm 1.5V$ whichever is lower from nominal voltage is not permitted. (PEM3224, 24.5V max). The voltages are considered 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.

PEM3212 Output Voltage Adjustment

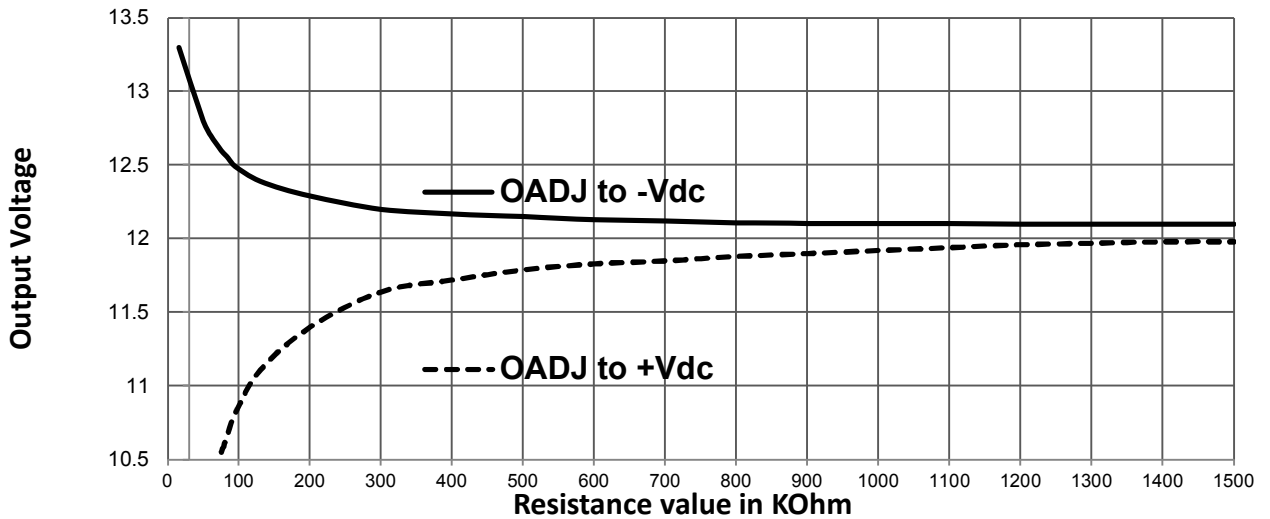


Figure 6

PEM3219 Output Voltage Adjustment

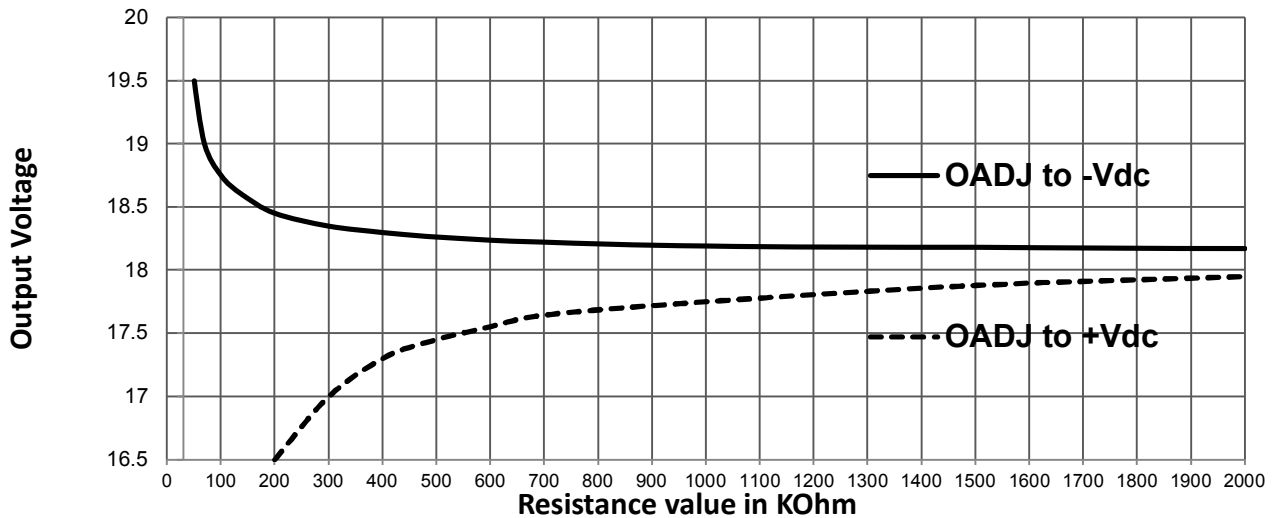


Figure 7

PEM3224 Output Voltage Adjustment

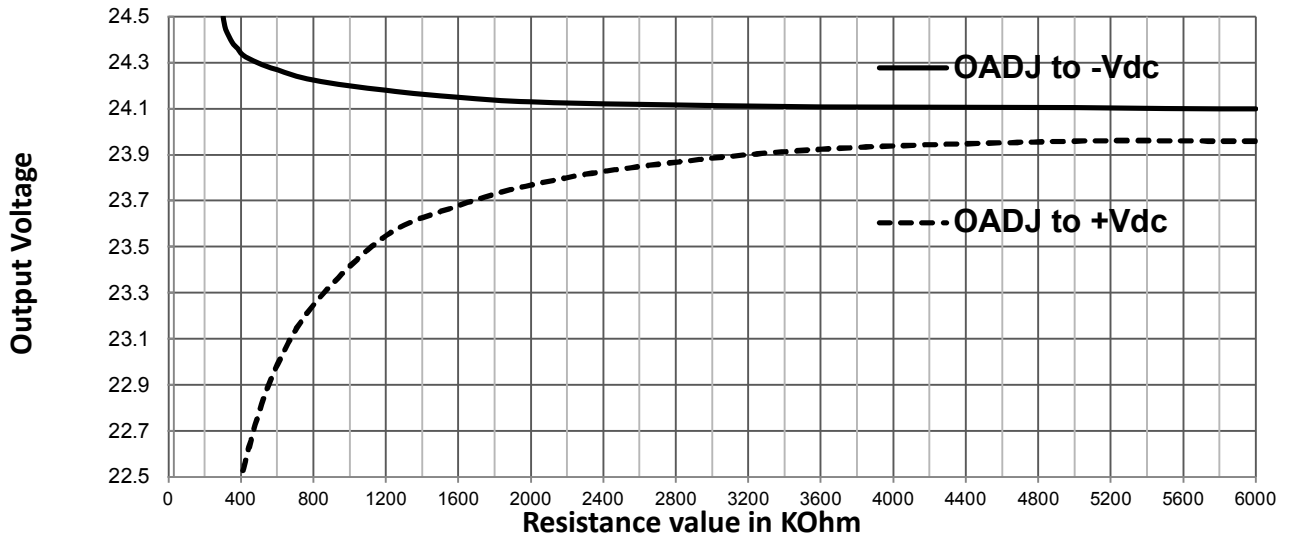


Figure 8

15. FREQUENCY DITHERING

The PEM3200 series is built with Switching Frequency Dithering to help better controlling of EMI (electromagnetic-interference) emissions and harmonics. The nominal switching frequency of PEM3219 and PEM3224 is 300KHz, and that of PEM3212 is 375KHz, with a dithering range of +/- 10%.

16. FREQUENCY ADJUSTMENT

For better controlling of EMI (electromagnetic-interference) emissions and harmonics, in case the designers want to increase the switching frequency, there is provision to do so with the FSEL pin. **This pin can be used only with PEM3219 and PEM3224. Do not use with PEM3212.** The nominal switching frequency of PEM3219 and PEM3224 is 300KHz, with a +/- 10% dithering range. A change of more than 10% nominal frequency is not permitted. A resistor of 1% tolerance and 1/16W or greater power rating can be connected between the FSEL pin and -VDC pin. About 920 KOhms resistance value should give 10% increase of 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.

Thermal Performance profile at nominal V_{in}

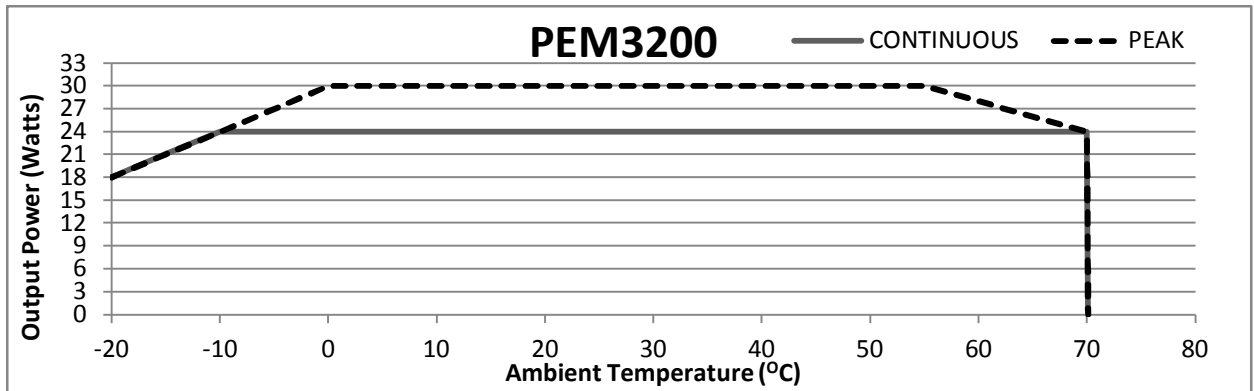
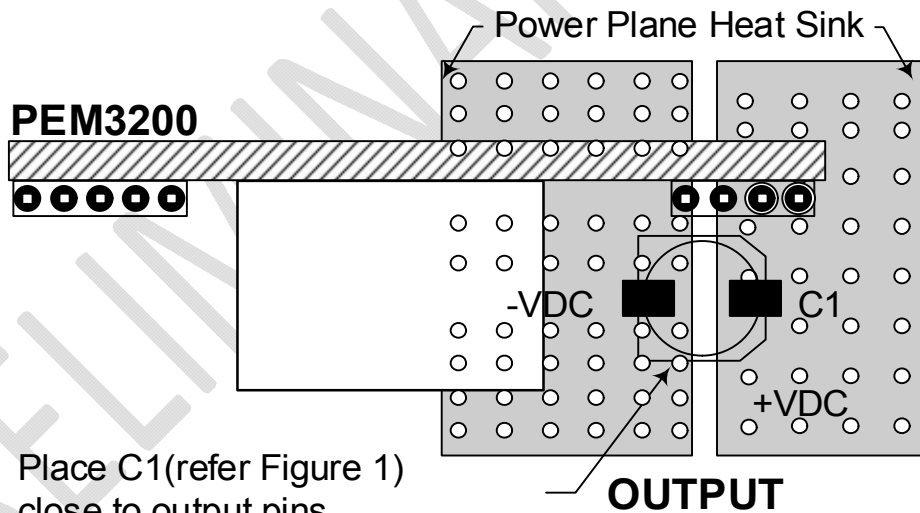


Figure 9

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.**



Place C1 (refer Figure 1) close to output pins

Figure 10

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

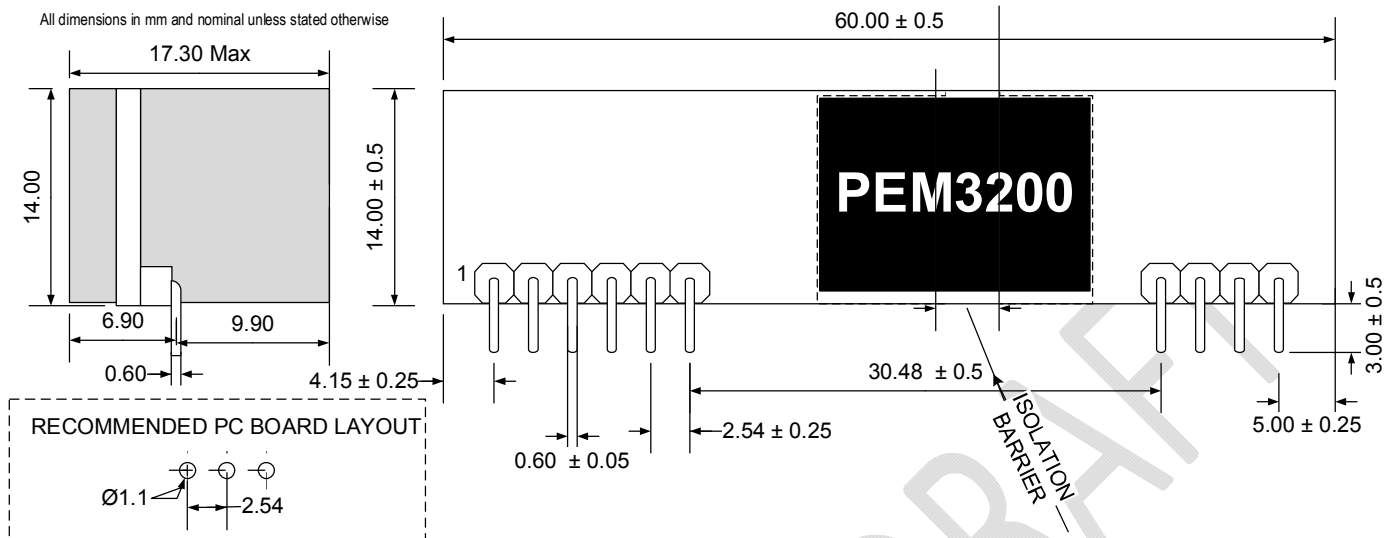


Figure 11

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

- | | |
|--|--|
| <ul style="list-style-type: none"> ▪ Security and alarm systems ▪ Voice over IP phones ▪ Access control systems ▪ IP Cameras ▪ Displays, Net Monitors | <ul style="list-style-type: none"> ▪ IOT (Internet of Things) ▪ Wireless access points ▪ Environmental control ▪ Public address systems ▪ Remote environmental monitoring |
|--|--|

21. SAMPLE PoE SYSTEM CONFIGURATION

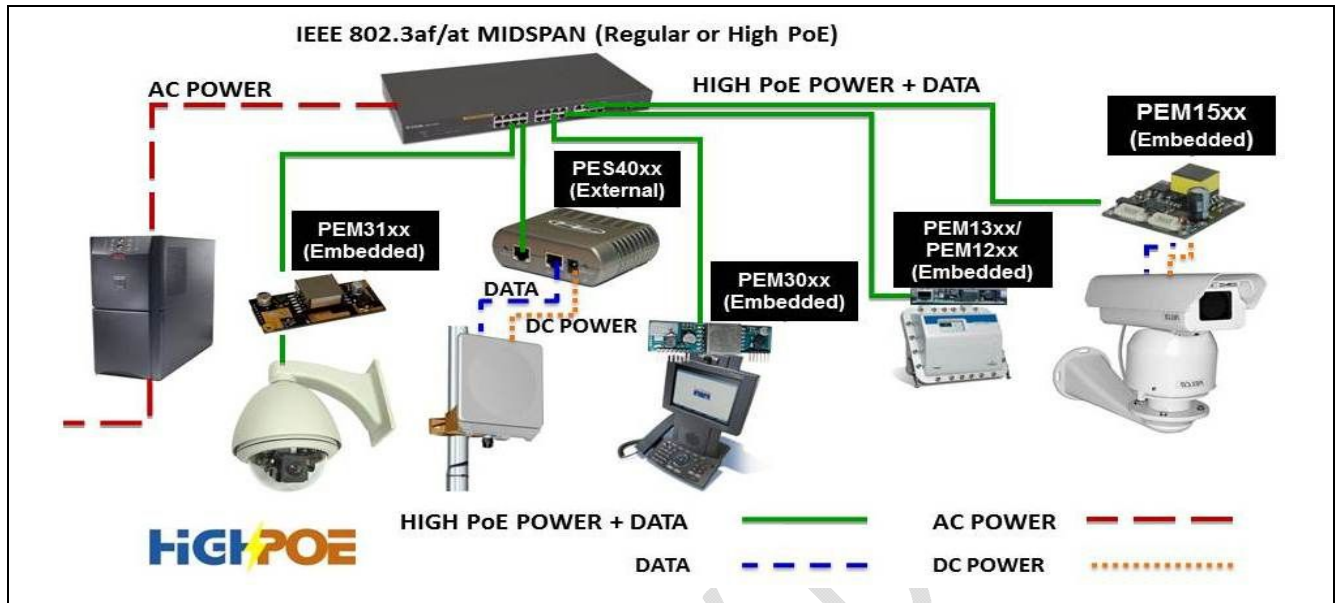


Figure 12

22. ROHS COMPLIANCE

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



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