

AFD = With Optional Frequency Dithering  
AF = Without Optional Frequency Dithering

## PRODUCT FEATURES

- Low-Cost IEEE 802.3af PD Module
- Optional Frequency Dithering for improved EMI
- 3.3V, 5V, 12V, 24V DC output voltage models
- 12.95W output load
- Overload and short circuit protection<sup>1</sup>
- Highly efficient 1500V isolated DC-DC converter
- Low output Ripple and Noise
- RoHS compliant
- High Efficiency
- Programmable POE Class 0,1,2,3
- Compact size
- Wide input voltage (36V to 57V DC)
- Adjustable output voltage
- Minimal external components required
- Low-cost, quick and easy POE solution

## PRODUCT OVERVIEW

The PEM1200AF is a compact size IEEE802.3af compliant Power Over Ethernet (PoE) Powered Device (PD) extraction module delivering up to 12.95W of power, when sourced from an IEEE 802.3af compliant Power Sourcing Equipment (PSE) using twisted pair CAT5 or higher Ethernet cable. The module also supports Type 1 PD operation of the IEEE 802.3at and IEEE 802.3bt.

The module is low cost and features a high-efficiency DC-DC converter with 1500V safety isolation, in-built under-voltage, output over-load, and short-circuit protection, a well-regulated low noise and low ripple output. The PEM1200AF series requires minimal external components and provide a quick, easy, and low-cost method for Ethernet equipment manufacturers to “PoE enable” their equipment.

The PEM1200AF provides programmable power classification of IEEE802.3af.

POE applications of PEM1200AF include IP phones, IP cameras, security and access control devices, sensors, environment control devices, routers, and network access points.

The output ripple is controlled within IEEE specifications. For improved EMI performance, the PEM1200AFD is featured with Frequency dithering.

## 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

<sup>1</sup> If maximum power is exceeded, the PEM1200AF will operate in over current mode and will auto recover when the overload condition is removed. This condition exceeding continuous 15 seconds may cause damage to the module.

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## PRODUCT SELECTOR

Part Number	Marking	Nominal Input Voltage ( $V_{IN}$ )	Output Voltage <sup>2</sup>	Efficiency <sup>3</sup>	Power (Maximum) <sup>5,6</sup>
		(Volts DC)	(Volts DC)	(%)	(Watts)
PEM1203AF	3F	48	3.3	83	12.95
PEM1205AF	5F	48	5	86	12.95
PEM1212AF	12F	48	12	88	12.95
PEM1224AF	24F	48	24	89	12.95
PEM1203AFD	3D	48	3.3	83	12.95
PEM1205AFD	5D	48	5	86	12.95
PEM1212AFD	12D	48	12	88	12.95
PEM1224AFD	24D	48	24	89	12.95

AFD = On board Optional Frequency Dithering Circuit for improved EMI.  
AF= Without Optional Frequency Dithering Circuit.

## INPUT CHARACTERISTICS

Parameter	Symbol	Min.	Typ.	Max.	Units
Input Voltage <sup>4,9</sup>	$V_{IN}$	36	48	57	Volts
Under Voltage Lockout	$V_{UVLO}$	30		36	Volts
Input Current <sup>5,9</sup>	$I_{IN}$		350	400	mA
Operating Temperature <sup>6</sup>	$T_{OP}$	-20	25	70	°C
IEEE 802.3af Power Classification <sup>7</sup>		Programmable Class 0, 1, 2, or 3			

## DC OUTPUT CHARACTERISTICS

Parameter	Symbol	Min.	Typ <sup>3</sup> .	Max.	Units
Line Regulation <sup>8</sup>	$V_{LNRG}$		0.2%		
Load Regulation <sup>8</sup>	$V_{LDRG}$		0.5%		
Output Ripple and Noise <sup>4,8</sup>	$V_{RIP}$		80	150	mV
Isolation Voltage	$V_{ISOL}$			1500	V DC
Temperature Coefficient (Slope)	TC		100	300	ppm/°C

## ABSOLUTE MAXIMUM RATINGS<sup>8,9</sup>

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)

<sup>2</sup> Output voltage typical  $\pm 3\%$  at  $T_A$  of 25°C with a nominal input voltage and rated output current.

<sup>3</sup> At nominal  $V_{IN}$  at 67% load.

<sup>4</sup> With minimum load 100mA.

<sup>5</sup> Please refer to IEEE802.3af standards document.

<sup>6</sup> Please see *THERMAL MANAGEMENT* Section for operating temperature.

<sup>7</sup> Please see *POWERED DEVICE (PD) SIGNATURE and POWER CLASS PROGRAMMING* Section for more details.

<sup>8</sup> All specifications typical are at  $T_A$  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>9</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.

TYPICAL INPUT CONNECTIONS

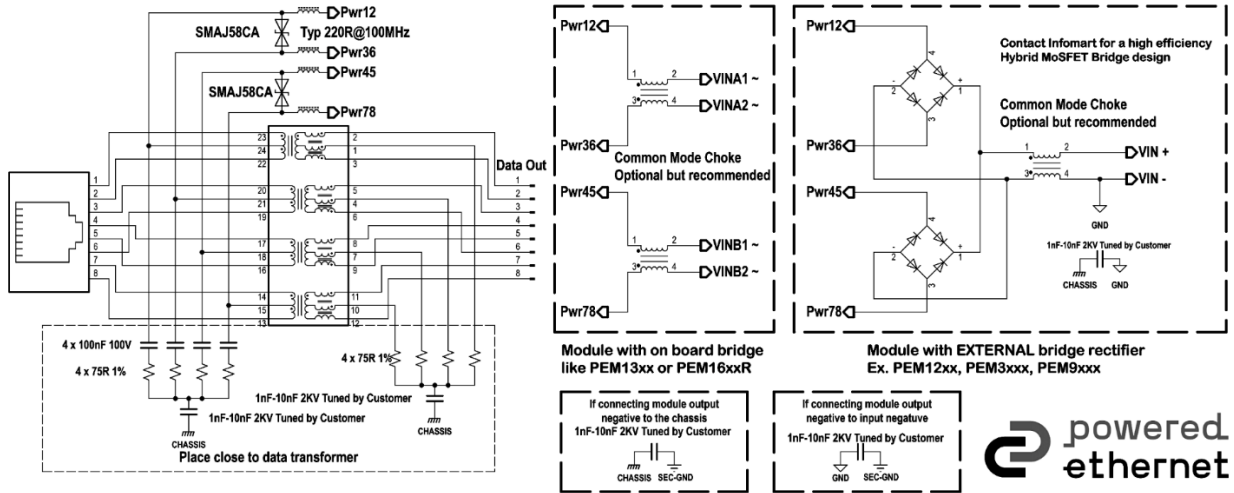
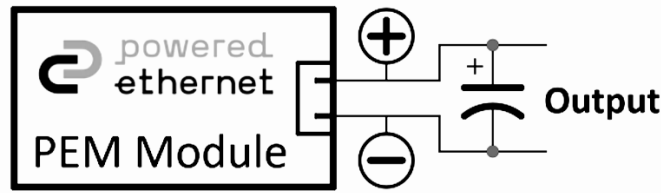


Figure 1- Typical Input Connections

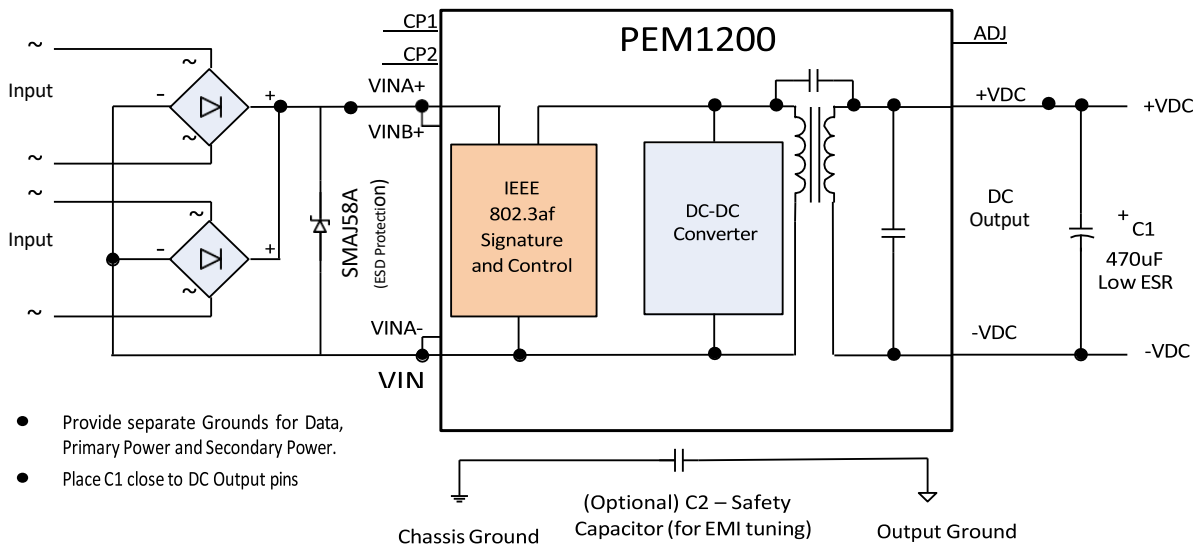
OUTPUT CONNECTION



470uF 16V or 35V output voltage dependent

Figure 2- Output Connection

BLOCK DIAGRAM



- Provide separate Grounds for Data, Primary Power and Secondary Power.
- Place C1 close to DC Output pins

Figure 3- Block Diagram

## PIN CONNECTIONS

INPUT PINS	
1	<b>VINA+</b> . This pin connects to the positive (+) output of the input bridge rectifiers (internally connected to pin 3). Polarity Sensitive.
2	<b>VINA-</b> . This pin connects to the negative (-) output of the input bridge rectifiers (internally connected to pin 4). Polarity Sensitive.
3	<b>VINA+</b> . This pin connects to the positive (+) output of the input bridge rectifiers (internally connected to pin 1). Polarity Sensitive.
4	<b>VINA-</b> . This pin connects to the negative (-) output of the input bridge rectifiers (internally connected to pin 2). Polarity Sensitive.
5	<b>CP1</b> . Connect this pin only as per the instructions in <i>Table 1</i> .
6	<b>CP2</b> . Connect this pin only as per the instructions in <i>Table 1</i> .
OUTPUT PINS	
7	<b>-VDC</b> . The ground return for the +VDC output. Max. Current 3A per pin <sup>10</sup> .
8	<b>+VDC</b> . This pin provides the regulated output from the DC/DC converter. Max. Current 3A per pin <sup>10</sup> .
9	<b>OADJ</b> . The output voltage can be adjusted from its nominal value, by connecting an external resistor from this pin to either the +VDC pin or the -VDC pin. For more details, see <i>OUTPUT VOLTAGE ADJUSTMENT</i> section.
<b>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.</b>	

## INPUTS

The PEM1200AF is compatible with 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). As per IEEE 802.3af, it is specified that the PSE does not apply power to both of its outputs at the same time i.e. 4 pair injection. (Refer to IEEE802.3af standards for more information).

The PEM1200 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 additional or alternate RJ45 inputs, both of which are PoE enabled, but use only one PEM1200 module to save costs. Another advantage is that this allows the system designer to control the type and costs of the input rectification diodes.

## POWERED DEVICE (PD) SIGNATURE and POWER CLASS PROGRAMMING

When the PEM1200AF 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 recognize that a PD is connected to that line and supply power. With the growing emphasis on “Green Power”, in the latest standard, IEEE has stressed for PDs to implement the IEEE 802.3af Power Classification system to ensure the correct provisioning of power from the PSE.

<sup>10</sup> Max. Current 4A per pin for PEM1203AF

To help in proper power level provisioning and improved power management, the IEEE 802.3af standard provides for PDs to inform the PSE their required power levels via a Class system. The classes are defined as per *Table 1* below.

System designers can program the power class using 1/16W or greater 1% tolerance resistors as in *Table 1*.

PoE Power Class	Required PD Power	1/16W or greater and 1% tolerance resistor between		
		Pin 2 (VINA -) and Pin 6(CP2) (For Mode A PoE injection)	Pin 4 (VINB -) and Pin 6 (CP2) (For Mode B PoE injection)	Pin 5 (CP1) and Pin 6 (CP2)
0	0.44W ~ 12.95W	Do not connect	Do not connect	Any value 10KΩ to 100 KΩ
1	0.44W ~ 3.84W	461KΩ	461KΩ	Do not connect
2	3.84W ~ 6.49W	235KΩ	235KΩ	Do not connect
3	6.49W ~ 12.95W	150KΩ	150KΩ	Do not connect
4	Reserved for 802.3at	Reserved	Reserved	Reserved

**Note:**

- Do not connect Pin 2 to Pin 5, or Pin 4 to Pin 5 at any time.
- Do not connect Pin 4 and Pin 5 and Pin 6 together at any time.
- Connect Pin 5 only to Pin 6 and only as per *Table 1*.

**Table 1- Power Classification programming**

## FREQUENCY DITHERING

The PEM1200AFD series is built with Frequency Dithering Circuit to help better controlling of EMI (electromagnetic interference) emissions. The nominal switching frequency of PEM1200AFD series is 300KHz, with a dithering range of ±10%.

## OUTPUT VOLTAGE ADJUSTMENT

The PEM1200AF 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 the below table. Only one connection i.e. between OADJ and +VDC or between OADJ and -VDC is permitted at a time. A change of more than ± 10% from nominal is not permitted. Please contact Infomart technical support for more details or specific resistor values.

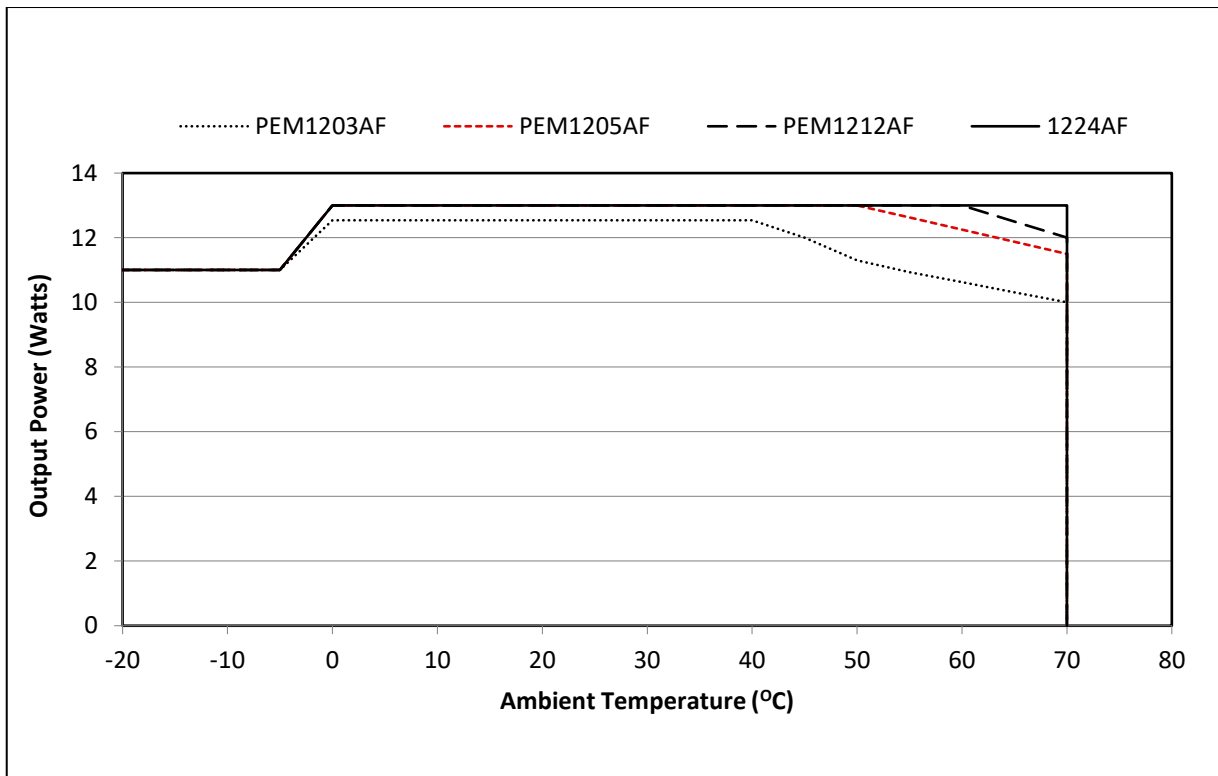
PEM1203AF			PEM1205AF		
Output Voltage	OADJ to +VDC	OADJ to -VDC	Output Voltage	OADJ to +VDC	OADJ to -VDC
3.1V	3.74KΩ		4.6V	20.52KΩ	
3.2V	8.66KΩ		4.8V	46.4KΩ	
3.3V	DNP	DNP	5V	DNP	DNP
3.4V		32.74KΩ	5.2V		45.3KΩ
3.5V		16.2KΩ	5.4V		23.2KΩ

PEM1212AF			PEM1224AF		
Output Voltage	OADJ to +VDC	OADJ to -VDC	Output Voltage	OADJ to +VDC	OADJ to -VDC
11V	121KΩ		22V	324KΩ	
11.5V	249KΩ		23V	681KΩ	
12V	DNP	DNP	24V	DNP	DNP
12.5V		82KΩ	25V		82KΩ
13V		39.2KΩ	26V		41.2KΩ

**Table 2- Output Voltage Adjustment**

**THERMAL MANAGEMENT**

As with any power component, the PEM1200AF 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 PEM1200AF will depend on the output load it is required to drive. The maximum ambient operating temperature is 70°C. Figure below, shows the thermal performance of the PEM1200AF with a nominal 48VDC input. The PEM1200AF 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 below. The two methods can be combined.



**Figure 4- Thermal Performance profile at nominal  $V_{in}$**

**POWER PLANE HEAT SINK**

A power plane heat sink on the motherboard is a relatively simple method to draw some heat away from the PEM1200AF 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 PEM1200AF must not be fitted into a socket. This method can be combined with forced airflow cooling, and with a heat sink glued onto the two output diodes using a thermal glue.

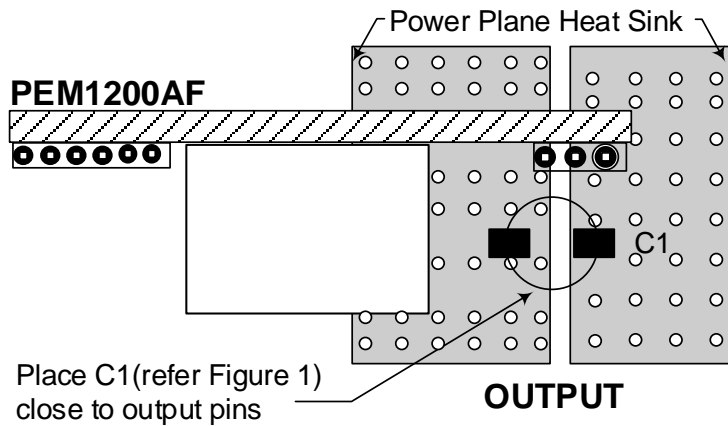


Figure 5- Power Plane Heat Sink

**PHYSICAL PACKAGE**

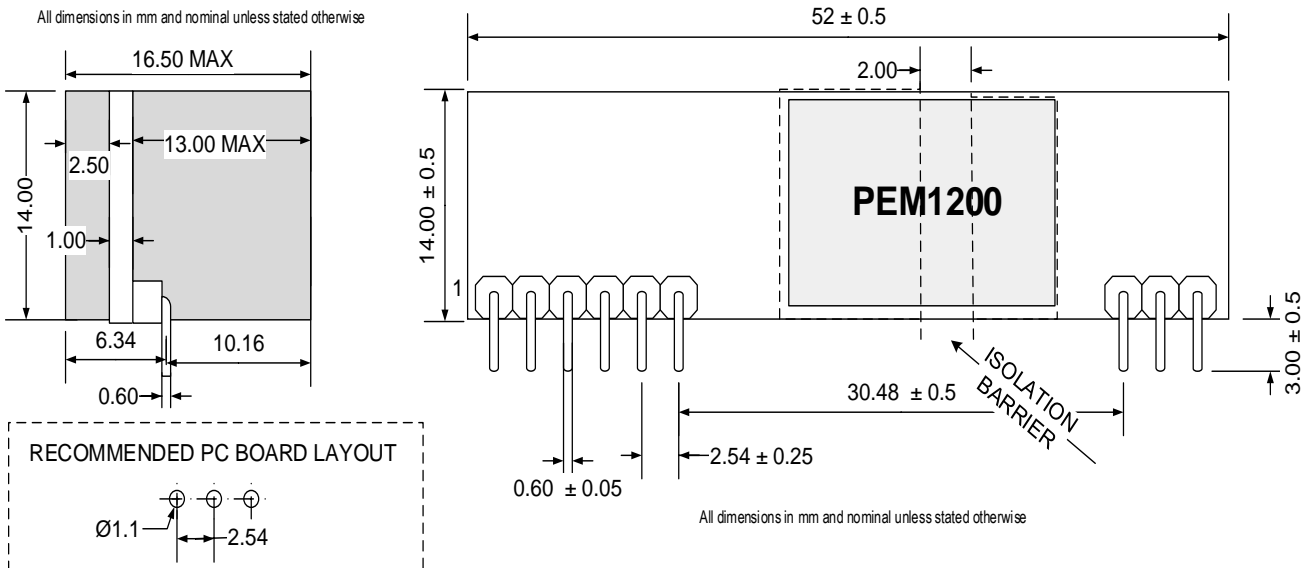


Figure 6- Mechanical Dimensions



## IMPROVEMENTS

- Updated version improved the supply chain of the components.
- Module size reduced with No Change in performance.
- Added AFD model with Operating Frequency Dithering for improved EMI.

## 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 PEM1200AFseries modules offering a modular solution, incorporating full IEEE802.3af compatibility signature to the PSE and isolated on-board DC/DC converter. The PEM1200AF series are ideal modular system blocks allowing manufacturers of Ethernet equipment to “PoE enable” their equipment with minimal effort and cost. PEM1200AF modules series offer simple and quicker product development, maximising return on investment.

PEM1200AF 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 AND SURGE PROTECTION

It is required that the system designer must provide ESD and surge protection such as a TVS diode, like SMAJ58A (Uni-Directional) or SMAJ58CA (bi-directional), at the PEM1200AF input to prevent damage from over-voltage surges and for system EMC / ESD compliance.

## ROHS, REACH and CONFLICT MINERALS COMPLIANCE

ROHS, REACH, and Conflict Minerals compliance details are available on our website.

## REVISION HISTORY

REVISION NUMBER	DESCRIPTION
21LR1-6	<ul style="list-style-type: none"> <li>▪ NRND clause added</li> <li>▪ Image of the Product changed</li> <li>▪ PRODUCT OVERVIEW and PRODUCT FEATURES updated</li> <li>▪ Clerical and aesthetic changes</li> <li>▪ Revision History added to this document</li> </ul>
23LR1-1	<ul style="list-style-type: none"> <li>▪ AF series revision modules introduced. PRODUCT OVERVIEW and PRODUCT FEATURES updated</li> <li>▪ Image of the Product changed</li> <li>▪ FREQUENCY DITHERING is added</li> </ul>
24GR1	<ul style="list-style-type: none"> <li>▪ Thermal performance updated</li> <li>▪ Output voltage adjustment resistors values are updated</li> </ul>
24JR1	<ul style="list-style-type: none"> <li>▪ Updated OUTPUT CONNECTION diagram</li> </ul>
24LR1	<ul style="list-style-type: none"> <li>▪ Updated IEEE802.3 POWER LEVELS AND CLASSES</li> </ul>

## IEEE802.3 POWER LEVELS AND CLASSES

### IEEE 802.3 Power levels and Classifications for POE Powered Devices

IEEE Standard	Common Name	PD Class	PD / PSE Type	Max num. of events	PD Power <sup>1</sup>	PSE Power <sup>2</sup>	Wire pairs energised	AUC <sup>3</sup>
802.3af	POE	0	1	-	12.95W	15.4W	2	No Support
802.3af	POE	1	1	1	3.84W	4W	2	No Support
802.3af	POE	2	1	1	6.49W	7W	2	No Support
802.3af	POE	3	1	1	12.95W	15.4W	2	No Support
802.3at	POE+	4	2	2	25.5W	30W	2	No Support
802.3bt	POE++	5	3	4	38.25W	45W	4	Optional
802.3bt	POE++	6	3	4	51W	60W	4	Optional
802.3bt	POE+++	7	4	5	62W	75W	4	Optional
802.3bt	POE+++	8	4	5	71.3W	90W	4	Optional

<sup>1</sup> Min. power delivered to PD / Module input. Max. PD / module output depends on operating conditions

<sup>2</sup> Power delivered from the Power Sourcing Equipment (PSE) (switch or injector) at its output port

<sup>3</sup> Auto Class is supported. It is optional to enable or not.

[www.poweredethernet.com](http://www.poweredethernet.com). E.&O.E.

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