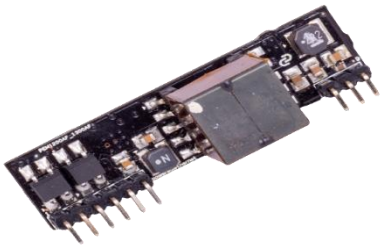
PEM1300AF SERIES

by INFOMART

IEEE802.3af Class Programmable PoE PD Module



RoHS COMPLIANT

PRODUCT FEATURES

- Low-Cost IEEE802.3af 12.95W PoE PD Module
- Frequency Dithering (AFD model) for improved EMI
- 3.3V, 5V, 12V and 24V DC output voltage models
- Overload and short circuit protection [1]
- Minimal external components required
- Infomart “design-in” assistance
- Programmable PoE Class 0, 1, 2, 3
- High Efficiency 1500V isolated DC-DC converter
- Input Polarity Protection
- Adjustable output voltage
- Low output ripple and noise

PRODUCT OVERVIEW

The PEM1300AF is a compact IEEE802.3af compliant Power over Ethernet (PoE) Powered Device (PD) extraction module, delivering up to 12.95W of power when sourced from an IEEE802.3af compliant Power Sourcing Equipment (PSE) using twisted-pair CAT5e or higher Ethernet cable. The module also supports Type 1 PD operation under the IEEE802.3at and IEEE802.3bt standards.

The module is cost-effective and features a high-efficiency DC-DC converter with 1500V safety isolation, in-built under-voltage, output over-load, and short-circuit protection, along with a well-regulated, low-noise, low-ripple output.

The PEM1300AF series requires minimal external components, providing a quick, easy, and low-cost solution for Ethernet equipment manufacturers to “PoE enable” their devices.

The module supports programmable power classification according to IEEE802.3af. Output ripple is controlled within IEEE specifications, and for improved EMI performance, the PEM1300AFD variant features frequency dithering.

APPLICATION AREAS

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

[1] If the maximum power is exceeded, the PEM1300AF will operate in overcurrent mode and will auto recover once the overload condition is removed. Continuous operation under this condition for more than 15 seconds may cause damage to the module.

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PRODUCT SELECTOR

Part Number	Marking		Nom. Input Voltage	Output Voltage[2]	Efficiency[3]	Power (Maximum)[5,6]
	Till Batch 2516	From Batch 2518	(Volts DC)	(Volts DC)	(%)	(Watts)
PEM1303AF	03F	03R	48	3.3	80	12.95
PEM1305AF	05F	05R	48	5	83	12.95
PEM1312AF	12F	12R	48	12	85	12.95
PEM1324AF	24F	24R	48	24	86	12.95
PEM1303AFD	03D	03T	48	3.3	80	12.95
PEM1305AFD	05D	05T	48	5	83	12.95
PEM1312AFD	12D	12T	48	12	85	12.95
PEM1324AFD	24D	24T	48	24	86	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[4]	V_{IN}	36	48	57	Volts
Under Voltage Lockout	V_{UVLO}	30		36	Volts
Input Current[5,9]	I_{IN}		350	400	mA
Operating Temperature[6]	T_{OP}	-20	25	70	°C
IEEE802.3af Power Classification[7]		Programmable Class 0, 1, 2, or 3			

DC OUTPUT CHARACTERISTICS

Parameter	Symbol	Min.	Typ[3].	Max.	Units
Line Regulation[8]	V_{LNRG}		0.2%		
Load Regulation[8]	V_{LDRG}		0.5%		
Output Ripple and Noise[4,7]	V_{RIP}		80		mV
Isolation Voltage	V_{ISOL}			1500	V DC
Temperature Coefficient (Slope)	TC		100	300	ppm/°C

ABSOLUTE MAXIMUM RATINGS[8,9]

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)

[2] Output voltage is typical ± 3% at a T_A of 25°C with nominal input voltage and rated output current.
[3] Typical values are measured at nominal V_{IN} with 67% load at a T_A of 25°C.
[4] With minimum load 100mA
[5] Please refer to IEEE802.3af standards document
[6] Refer to the *THERMAL MANAGEMENT* section for operating temperature details.
[7] Refer to the *POWERED DEVICE (PD) SIGNATURE and POWER CLASSIFICATION* Section for more information.
[8] All specifications are typical at a T_A of 25°C with nominal input voltage and rated output current, unless otherwise noted. These values are intended as a design aid only and are indicative, not guaranteed.
[9] Exceeding the absolute maximum ratings may cause permanent damage to the product. Functional operation under these conditions is not implied. These ratings assume free airflow.

TYPICAL INPUT CONNECTIONS

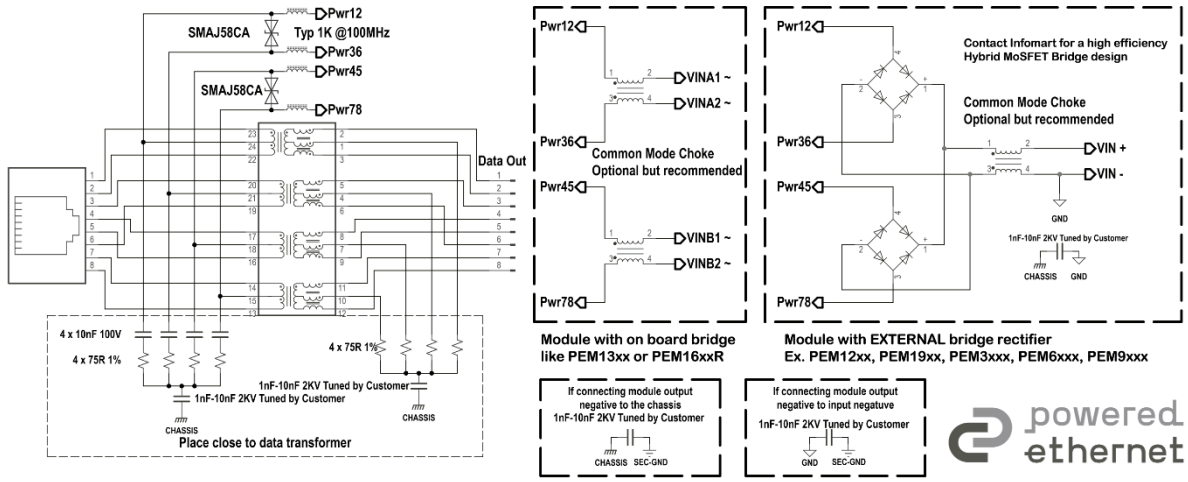

Figure 1- Typical Input Connections

OUTPUT CONNECTIONS

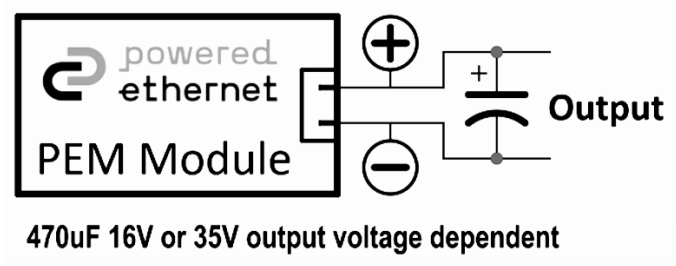

Figure 2- Output Connections

BLOCK DIAGRAM

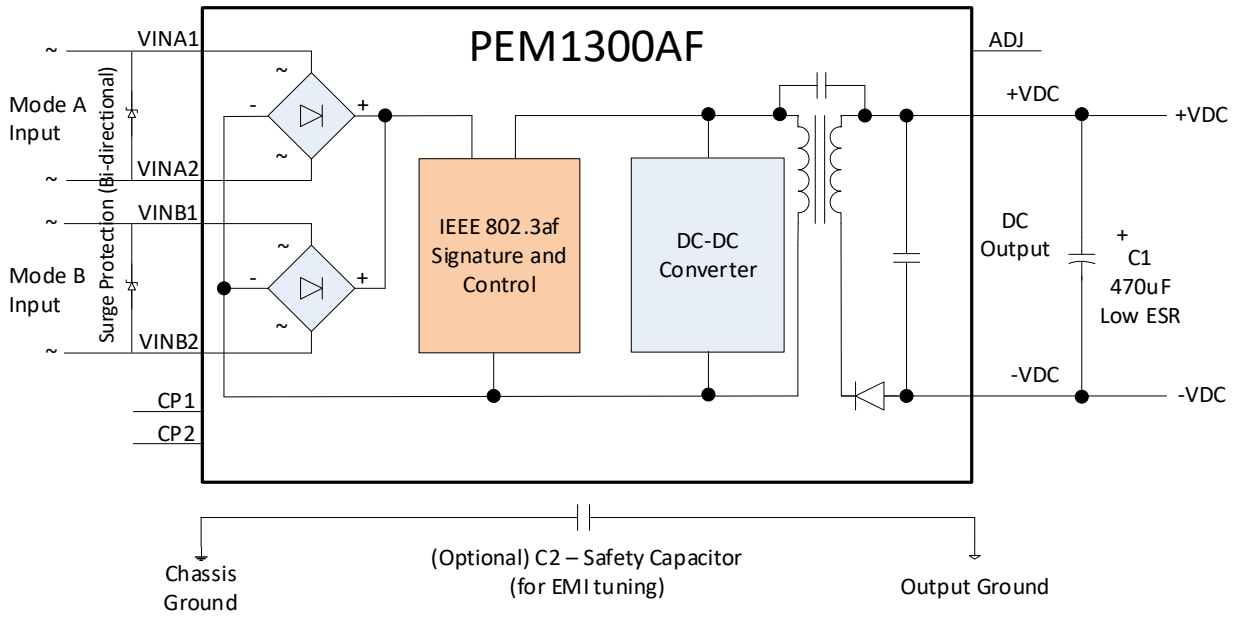

Figure 3- Block Diagram

PIN CONNECTIONS

INPUT PINS	
1	**VINA1.** This pin connects to the output of the data transformer center-tap (for Mode A PoE injection). Not polarity sensitive.
2	**VINA2.** This pin connects to the output of the data transformer center-tap (for Mode A PoE injection). Not polarity sensitive.
3	**VINB1.** This pin connects to Ethernet cable spare pair (for Mode B PoE injection). Not polarity sensitive.
4	**VINB2.** This pin connects to Ethernet cable spare pair (for Mode B PoE injection). Not polarity sensitive.
5	**CP1.** Connect this pin only as per the instructions in *Table 1.*
6	**CP2.** Connect this pin only as per the instructions in *Table 1.*
OUTPUT PINS	
7	**-VDC.** The ground return for the +VDC output. Max. Current 3A per pin[10].
8	**+VDC.** This pin provides the regulated output from the DC-DC converter. Max. Current 3A per pin[10].
9	**OADJ.** The output voltage can be adjusted from its nominal value, by connecting an external resistor from this pin to either the +VDC pin or -VDC pin. For more details, refer to the *OUTPUT VOLTAGE ADJUSTMENT* section
To maintain isolation integrity, always connect respective input and output poles only via X or Y safety capacitors. Maintain the isolation barrier on the motherboard PCB as specified in the *PHYSICAL PACKAGE* .	

INPUTS

The PEM1300AF is compatible with IEEE802.3af compliant Power Sourcing Equipment (PSE) and supports different power injection options: data/signal pairs (Mode A) or spare pairs (Mode B). As specified in IEEE802.3af, the PSE does not apply power to both outputs simultaneously, i.e., four-pair injection is not supported (refer to the IEEE802.3af standard for more information).

The PEM1300AF features onboard input bridge rectifiers for improved system integration and minimal external components.

POWERED DEVICE (PD) SIGNATURE and POWER CLASSIFICATION

When the PEM1300AF is connected to a CAT5e or higher Ethernet cable from an IEEE802.3af compliant Power Sourcing Equipment (PSE), endspan or midspan, it automatically presents a Powered Device (PD) signature to the PSE when requested. The PSE then recognizes that a PD is connected and supplies power.

With the growing emphasis on green power, the latest IEEE standards emphasize that PDs should implement the IEEE802.3af power classification system to ensure correct power provisioning from the PSE. To support proper power allocation and improved power management, the IEEE802.3af standard allows PDs to inform the PSE of their required power levels through a classification system. The power classes are defined in *Table 1* below. System designers can program the required power class using 1/16 W resistors with ±1% tolerance or better, as shown in *Table 1*.

Due to the input polarity neutrality of the PEM1300AF, system designers must use four general-purpose diodes rated 75V or higher, such as 1N4148, as shown in *Figure 4*. Populate either RCP1 or RCP2, but do not populate both at the same time.

[10] Max. Current 4A per pin for PEM1303AF

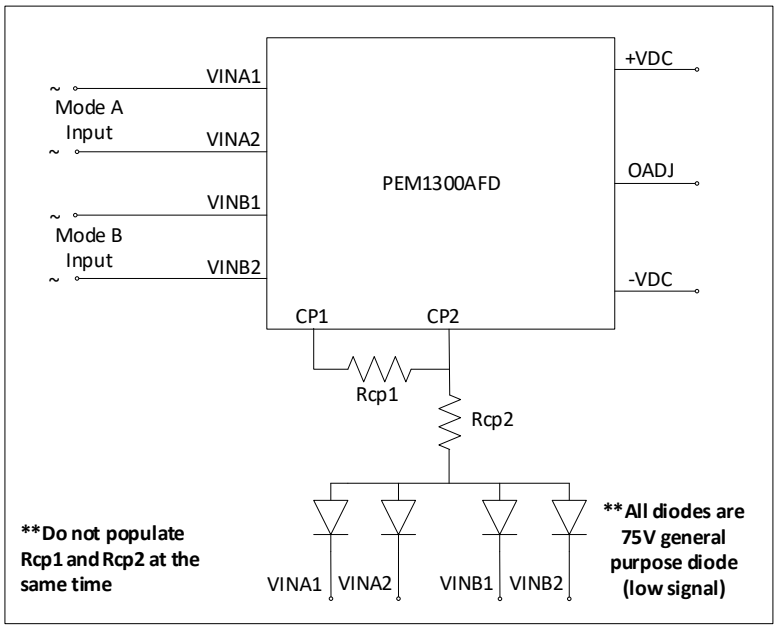

Figure 4- Class Programming

PoE Power Class	Required PD Power	1/16W or greater and 1% tolerance resistor at location	
		Rcp1	Rcp2
0	0.44W ~ 12.95W	Any value 10KΩ to 100 KΩ	Do not connect
1	0.44W ~ 3.84W	Do not connect	461KΩ
2	3.84W ~ 6.49W	Do not connect	235KΩ
3	6.49W ~ 12.95W	Do not connect	150KΩ
4	Reserved for 802.3at	Reserved	Reserved
Note: • **Do not populate Rcp1 and Rcp2 at the same time** • **Use 4 x 1N4148 or similar 75V or greater general-purpose diodes as in *Figure 4***			

Table 1- Power Classification programming

ISOLATION

The IEEE802.3af standard requires that a Powered Device (PD) meet safety isolation requirements by passing the electrical strength test specified in IEC 60950, sub-clause 6.2. The PEM1300AF module complies with these requirements by meeting or exceeding the 1500V impulse test, commonly referred to as the “Hi-Pot Test” or “Isolation Test Voltage”.

The “keep-out area” shown in *Figure 7- Mechanical Dimensions* indicates the location and size of the electrical isolation barrier. This area must be kept clear of PCB tracks (traces) or planes on the base PCB on which the PEM1300AF is mounted to ensure compliance with the isolation requirements.

FREQUENCY DITHERING

The PEM1300AFD series is built with a frequency dithering circuit to help better control EMI (electromagnetic interference) emissions. The nominal switching frequency of the PEM1300AFD series is 300 kHz, with a dithering range of ±10%.

OUTPUT VOLTAGE ADJUSTMENT

The PEM1300AF series features an OADJ pin that allows the output voltage to be increased or decreased from its nominal value by using a 1/16W (or higher) power-rated resistor with ±1% tolerance, connected between the OADJ pin and either the +VDC or −VDC pin, as shown in the table below. Only one connection either between OADJ and +VDC or OADJ and −VDC is permitted at a time. An output voltage adjustment of more than ±10% from the nominal value is not allowed. An estimated resistance value for voltage adjustment is provided below. Customers should fine-tune the most appropriate resistance value as required.

Please contact Infomart technical support for more details or specific resistor values.

PEM1303AF			**PEM1305AF**		
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
PEM1312AF			**PEM1324AF**		
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 PEM1300AF modules generate heat. It is important to ensure adequate ventilation and airflow during the design stage. The amount of heat generated by the PEM1300AF depends on the output load it is required to drive. The maximum ambient operating temperature is 70°C. *Figure 5* shows the thermal performance of the PEM1300AF with a nominal 48V DC input. Thermal performance can be improved by applying forced airflow over the module and by using a heat sink (a) glued to the output diodes using thermal adhesive, or (b) implemented as a power-plane heat sink, as described in *Figure 6*. These two methods can also be combined for improved thermal management.

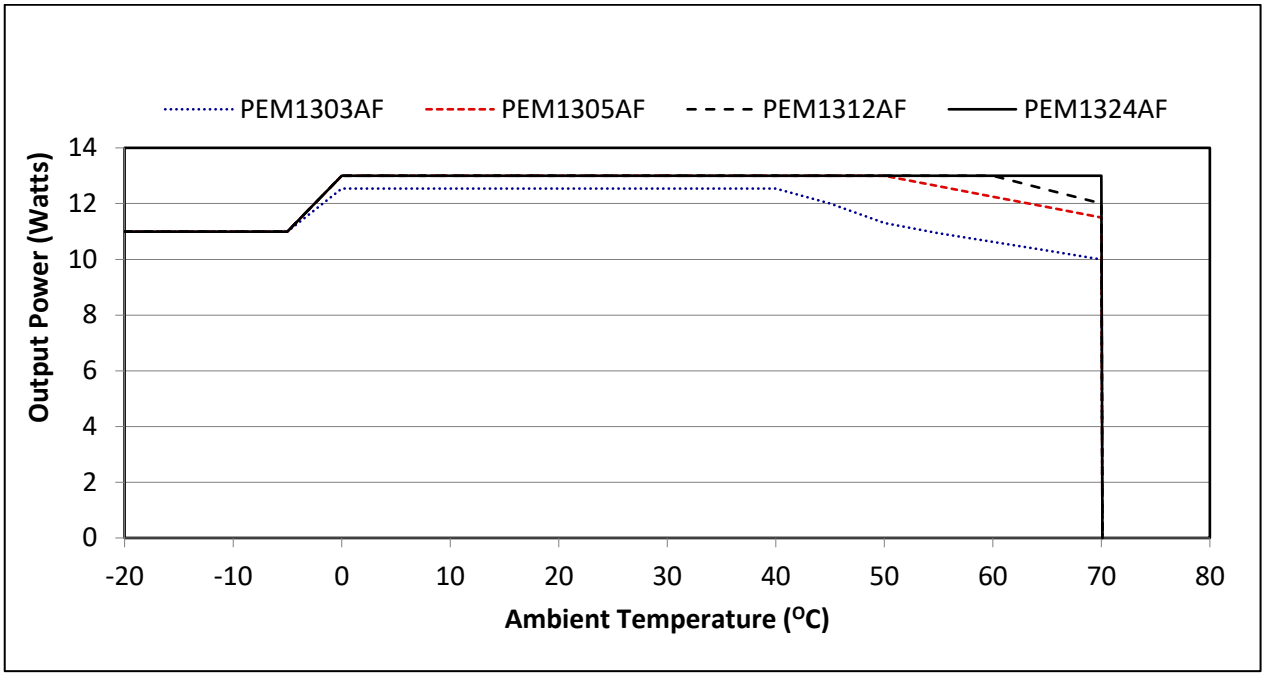

Figure 5- Thermal Performance profile at nominal Vin

POWER PLANE HEAT SINK

A power-plane heat sink on the motherboard is a relatively simple method to draw heat away from the PEM1300AF 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 the OADJ pin and the +VDC and −VDC pins to ensure proper output voltage regulation.**

These power-plane heat sinks must be implemented on the outer layers of the PCB, and the PEM1300AF must not be socketed. This method can be combined with forced airflow cooling and with a heat sink glued to the two output diodes using thermal glue for improved thermal performance.

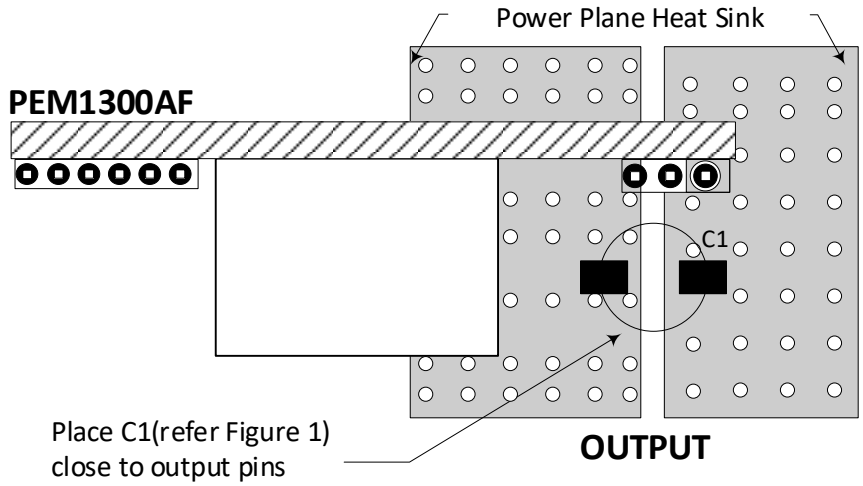

Figure 6- Power Plane Heat Sink

PHYSICAL PACKAGE

All dimensions in mm and nominal unless stated otherwise

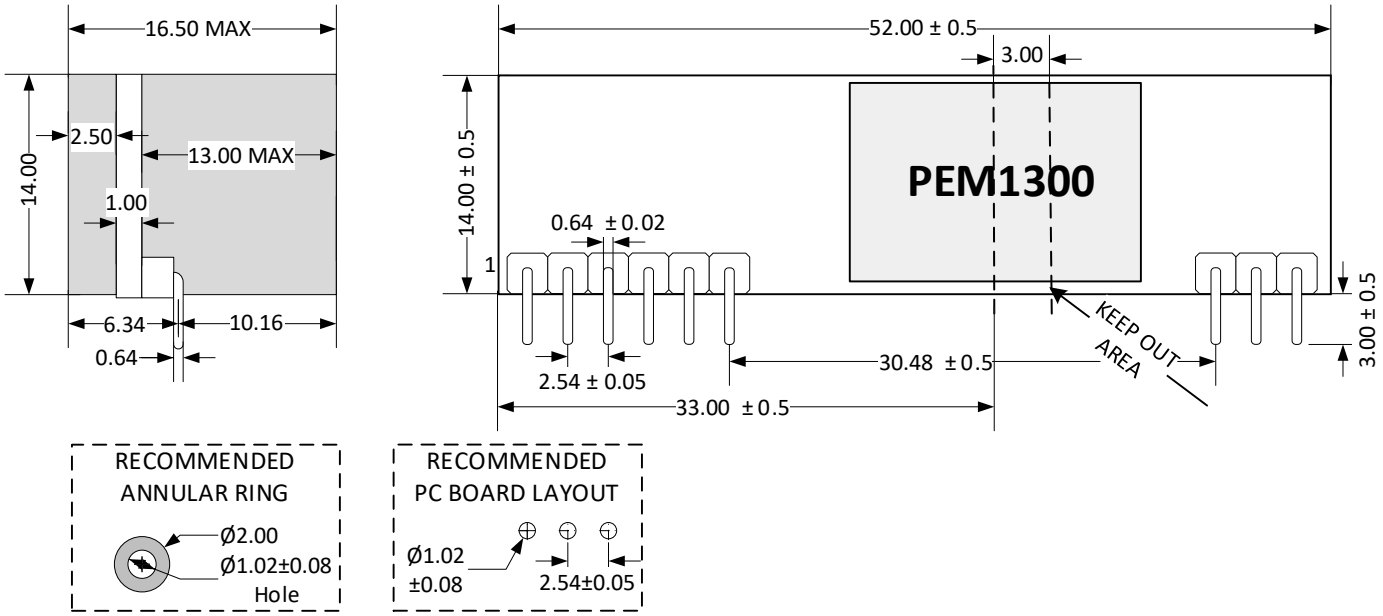

Figure 7- Mechanical Dimensions

IMPROVEMENTS

- The updated version improves the component supply chain.
- The module size has been reduced with no change in performance.
- An AFD model has been added with operating frequency dithering for improved EMI performance.

APPLICATION NOTES

Power over Ethernet (PoE) is a technology for wired Ethernet, the most widely deployed local area network technology in use today. PoE allows the electrical power required for the operation of each end device to be carried over data cables along with the data, rather than through separate power cords. This minimizes the number of wires needed to install a network, resulting in lower cost, reduced downtime, easier maintenance, and greater installation flexibility.

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

The PEM1300AF series offers a modular solution incorporating full IEEE802.3af compliant PD signature to the PSE and an isolated on-board DC-DC converter. These modules serve as ideal building blocks for manufacturers of Ethernet equipment to “PoE enable” their products with minimal effort and cost. The PEM1300AF series enables simpler and faster product development while maximizing return on investment.

The PEM1300AF can also be powered using a user-designed power supply that provides adequate thermal and overcurrent protection. However, it is strongly recommended to use only IEEE802.3af compliant power sourcing equipment to prevent damage to the module, as the output stage does not include thermal protection.

ESD AND SURGE PROTECTION

The system designer is required to provide ESD and surge protection, such as a TVS diode (e.g., SMAJ58A for unidirectional or SMAJ58CA for bidirectional), at the PEM1300AF input to prevent damage from over-voltage surges and to ensure system EMC/ESD compliance.

ROHS REACH and CONFLICT MINERALS COMPLIANCE

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

REVISION HISTORY

REVISION NUMBER	DESCRIPTION
21LR1-6	▪ NRND clause added ▪ Image of the Product changed ▪ PRODUCT OVERVIEW and PRODUCT FEATURES updated ▪ Clerical and aesthetic changes ▪ Revision History added to this document
23LR1-1	▪ AF series revision modules introduced. PRODUCT OVERVIEW and PRODUCT FEATURES updated ▪ Image of the Product changed ▪ FREQUENCY DITHERING is added
24GR1	▪ Thermal performance updated ▪ Output voltage adjustment resistor values are updated
24JR1	▪ Updated OUTPUT CONNECTION diagram. Updated Figure 4 Class programming
24LR1	▪ Updated IEEE802.3 POWER LEVELS AND CLASSES
25AR6	▪ Updated Dimension of keep out area
25CR7	▪ Update in PHYSICAL PACKAGE
25DR8	▪ Update in TYPICAL INPUT CONNECTIONS
25ER9	▪ Update in PRODUCT SELECTOR- Marking
25GR10	▪ Update in BLOCK DIAGRAM
25LR11	▪ Update in ISOLATION

IEEE802.3 POWER LEVELS AND CLASSES for PoE Powered Devices

IEEE Standard	Common Name	PD Class	PD/PSE Type	Max num. Of events	PD Power[1]	PSE Power[2]	Wire pairs energised
802.3af	PoE	0	1	-	12.95W	15.4W	2
802.3af	PoE	1	1	1	3.84W	4W	2
802.3af	PoE	2	1	1	6.49W	7W	2
802.3af	PoE	3	1	1	12.95W	15.4W	2

[1] Min. power delivered to PD / Module input. Max. PD / Module output depends on operating conditions.

[2] Power delivered from the Power Sourcing Equipment (PSE) (switch or injector) at its output port.

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