

PRODUCT FEATURES

- Low-Cost IEEE802.3af PoE PD Module
- 3.3V, 5V, 12V and 24V DC output voltage models
- Overload and short circuit protection¹
- Adjustable output voltage
- Low output ripple and noise
- Miniature size SMD (22mm x 14mm)
- IEEE802.3af, Type 1 of 802.3at and 802.3bt
- High Efficiency 1500V isolated DC-DC converter
- Minimal external components required
- Infomart “design-in” assistance

PRODUCT OVERVIEW

The PEM1900 is a compact IEEE 802.3af compliant Power over Ethernet (PoE) Powered Device (PD) module delivering up to 12.95W². Its low-cost design requires only input bridge diodes and an output capacitor to implement a complete PoE solution.

With an ultra-compact size of 22 mm × 14 mm (0.87 in × 0.55 in), the module occupies just 308 mm² (0.478 sq. in) of PCB area, making it ideal for compact, next-generation devices such as IoT products, IP phones, IP cameras, security and access-control systems, sensors, routers, and network access points.

The PEM1900 includes an isolated, high efficiency DC-DC converter with in-built frequency dithering to reduce EMI (electromagnetic interference) and noise.

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 PEM1900 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.

² Please refer to *THERMAL MANAGEMENT* section for Output power.

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PRODUCT SELECTOR

Part Number	Marking	Nominal Input Voltage (V_{IN})	Output Voltage ³	Efficiency ⁴	Power (Maximum) ⁷
		(Volts DC)	(Volts DC)	(%)	(Watts)
PEM1905	05	48	5	82	12.95
PEM1912	12	48	12	86	12.95
PEM1924*	Under Development				

INPUT CHARACTERISTICS

Parameter	Symbol	Min.	Typ.	Max.	Units
Input Voltage ⁵	V_{IN}	36	48	57	Volts
Under Voltage Lockout	V_{UVLO}	30		36	Volts
Input Current ⁶	I_{IN}		350	400	mA
Operating Temperature ⁷	T_{OP}	-20	25	70	°C
IEEE802.3af Power Classification ⁸	Class 0				

DC OUTPUT CHARACTERISTICS

Parameter	Symbol	Min.	Typ ⁴ .	Max.	Units
Line Regulation ⁹	V_{LNRG}		0.2		%
Load Regulation ⁹	V_{LDRG}		0.5		%
Output Ripple and Noise ⁹	V_{RIP}		80		mV p-p
Isolation Voltage	V_{ISOL}			1500	V DC
Temperature Coefficient (Slope)	TC		100	300	ppm/°C

ABSOLUTE MAXIMUM RATINGS^{9,10}

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)

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

⁴ Typical values are measured at nominal V_{IN} with 67% load at a T_A 25°C.

⁵ With minimum load 1Watt or 100mA, whichever is higher.

⁶ Please refer to IEEE802.3af standards document.

⁷ Refer to the *THERMAL MANAGEMENT* for operating temperature details.

⁸ Refer to the *POWERED DEVICE (PD) SIGNATURE* Section.

⁹ 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.

¹⁰ 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

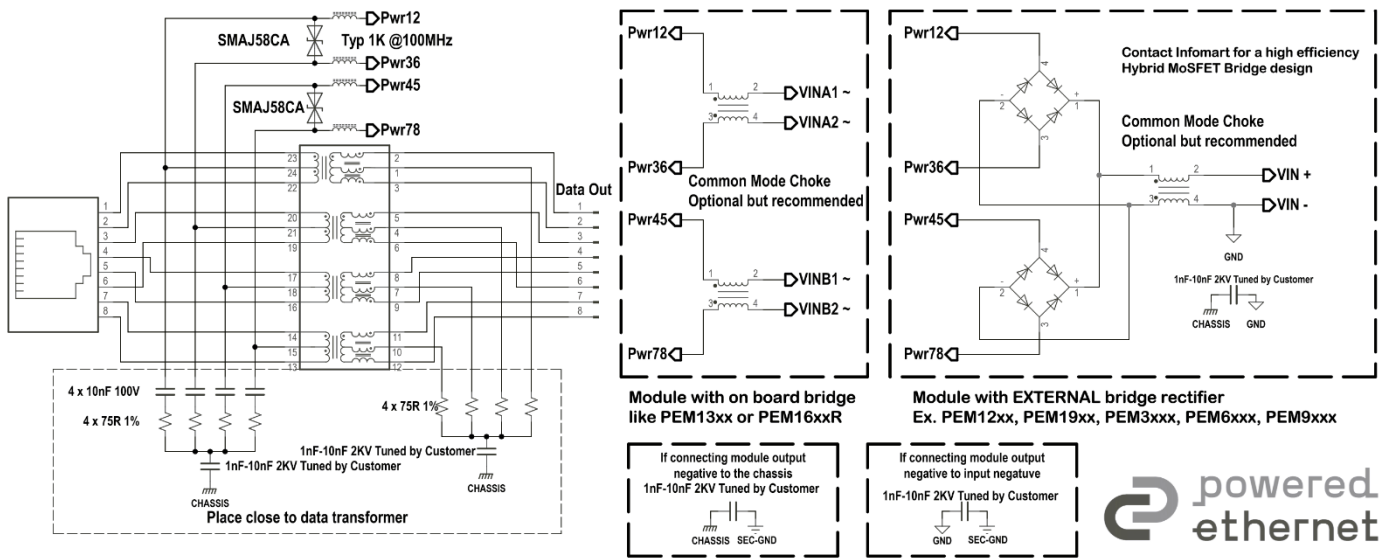
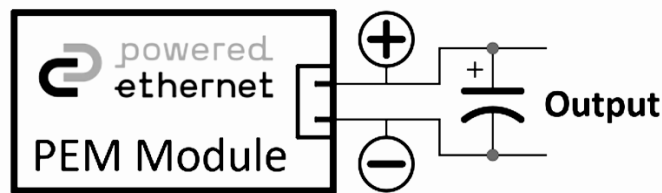


Figure 1- Typical Input Connections

OUTPUT CONNECTION



470uF 16V or 35V output voltage dependent

Figure 2- Output Connection

BLOCK DIAGRAM

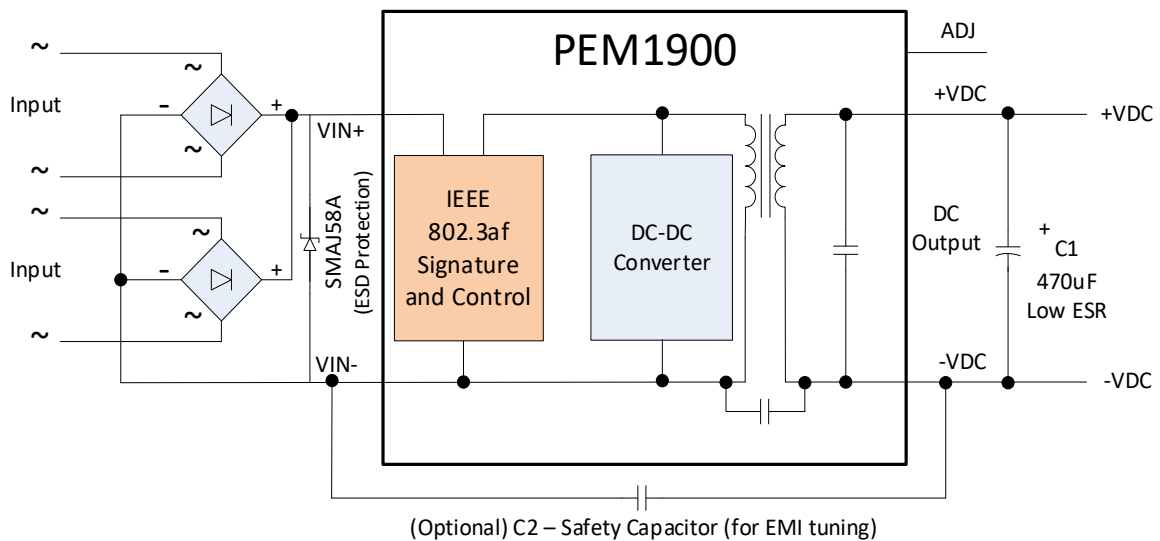


Figure 3- Block Diagram

PIN CONNECTIONS

PINS	
1	+VDC. This pin provides the regulated output from the DC/DC converter.
2	-VDC. The ground return for +VDC output.
3	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 <i>OUTPUT VOLTAGE ADJUSTMENT</i> Section.
4	VIN+. This pin connects to the positive (+) output of the input bridge rectifiers.
5	VIN-. This pin connects to the negative (-) output of the input bridge rectifiers.

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 *Figure 6*.

INPUTS

The PEM1900 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) see *Figure 4*. As specified in IEEE802.3af, the PSE does not apply power to both outputs simultaneously, i.e., 4 pair injection is not supported (refer to the IEEE802.3af standard for more information).

The PEM1900 supports the use of external input bridge rectifiers, providing improved system design flexibility and better distribution of heat generation. For example, a system designer who wishes to provide additional or alternate PoE-enabled RJ45 inputs can use a single PEM1900 module, resulting in cost savings. Another advantage is that this approach allows the system designer to select and optimize the type and cost of the input rectification diodes.

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.

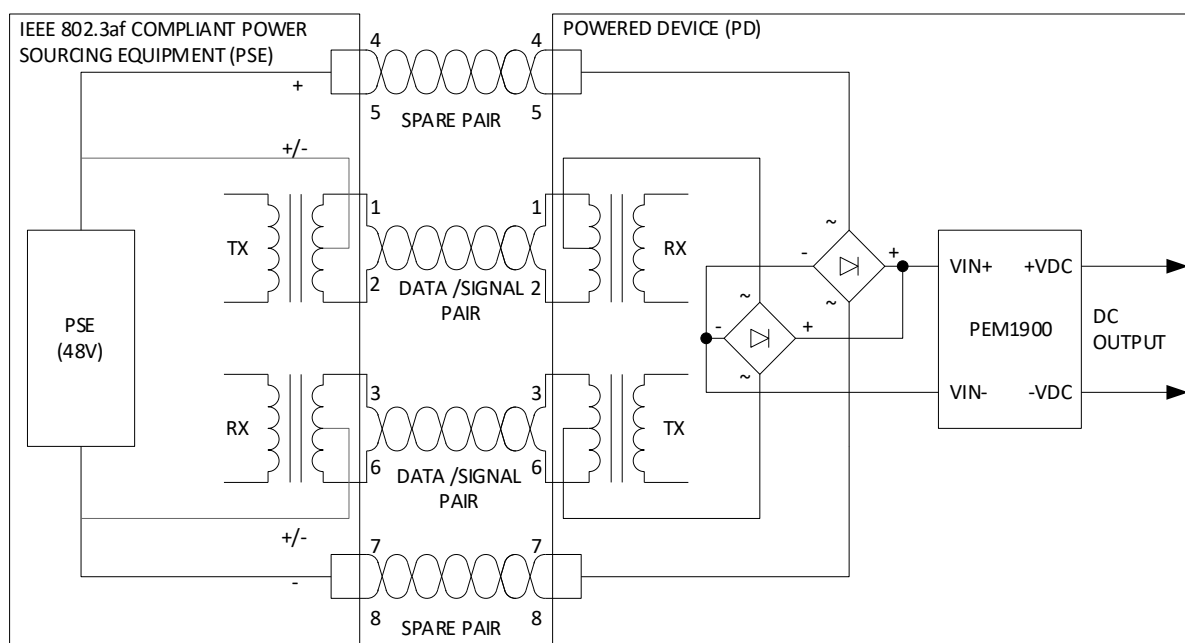


Figure 4- Typical System configuration

POWERED DEVICE (PD) SIGNATURE

When the PEM1900 is connected to a Cat 5e or higher Ethernet cable from an IEEE 802.3af compliant PSE, Endspan, or Midspan, it will automatically present a Powered Device (PD) signature to the PSE when requested. The PSE will then recognize that a PD is connected to the line and supply power.

The PEM1900 presents only class 0 detection to the PSE.

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 PEM1900 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 6- Power Plane Heat Sink* 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 PEM1900 is mounted to ensure compliance with the isolation requirements.

FREQUENCY DITHERING FOR IMPROVED EMI

The PEM1900 series is built with a frequency dithering circuit to help better control EMI (electromagnetic interference) emissions. The nominal switching frequency of the PEM1900 series is 300 kHz, with a dithering range of $\pm 10\%$.

OUTPUT VOLTAGE ADJUSTMENT

The PEM1900 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 $\pm 1\%$ 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 $\pm 10\%$ 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.

PEM1905			PEM1912		
Output Voltage	OADJ to +VDC	OADJ to -VDC	Output Voltage	OADJ to +VDC	OADJ to -VDC
4.6V	20.52K Ω		11V	121K Ω	
4.8V	46.4K Ω		11.5V	249K Ω	
5V	DNP	DNP	12V	DNP	DNP
5.2V		45.3K Ω	12.5V		82K Ω
5.4V		23.2K Ω	13V		39.2K Ω

Table 1- Output Voltage Adjustment

THERMAL MANAGEMENT

As with any power component, the PEM1900 modules generate heat. It is important to ensure adequate ventilation and airflow during the design stage. The amount of heat generated by the PEM1900 depends on the output load it is required to drive. The maximum ambient operating temperature is 70°C. Figure shows the thermal performance of the PEM1900 with a nominal 48 V 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 below. These two methods can also be combined for improved thermal management.

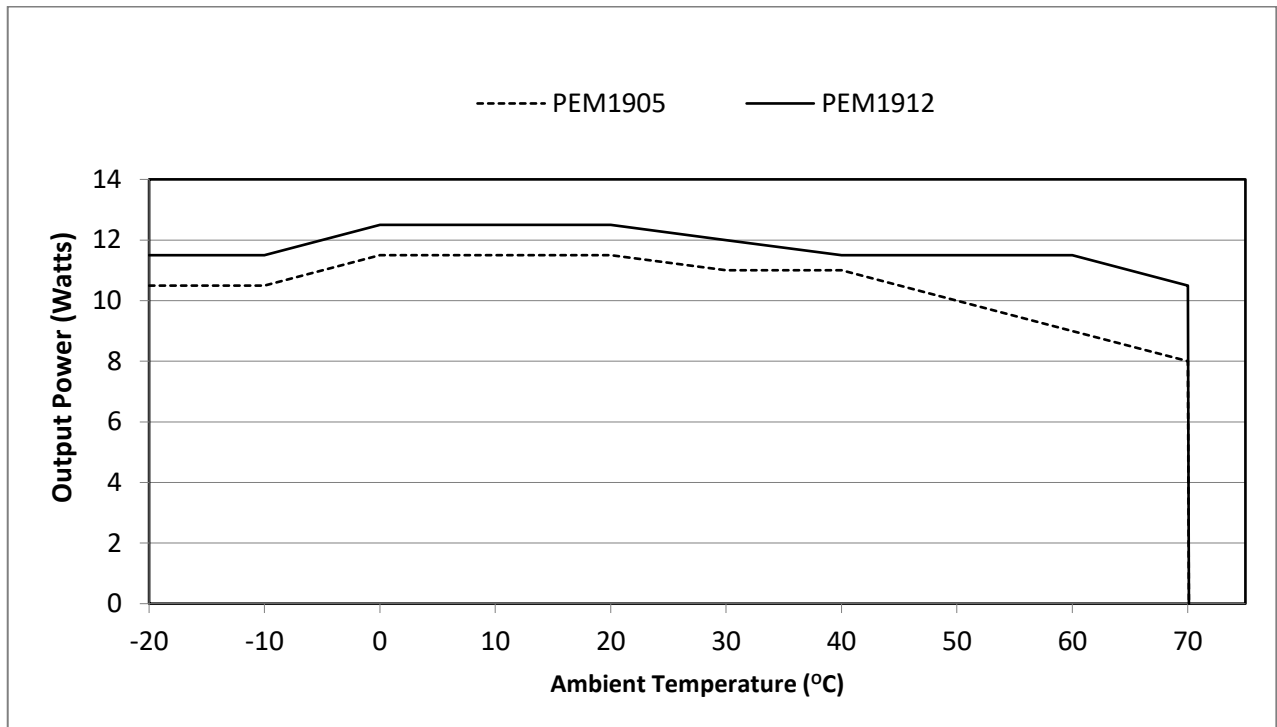


Figure 5- Thermal Performance profile at nominal V_{in}

POWER PLANE HEAT SINK

A power-plane heat sink on the motherboard is a relatively simple method to draw heat away from the PEM1900 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.**

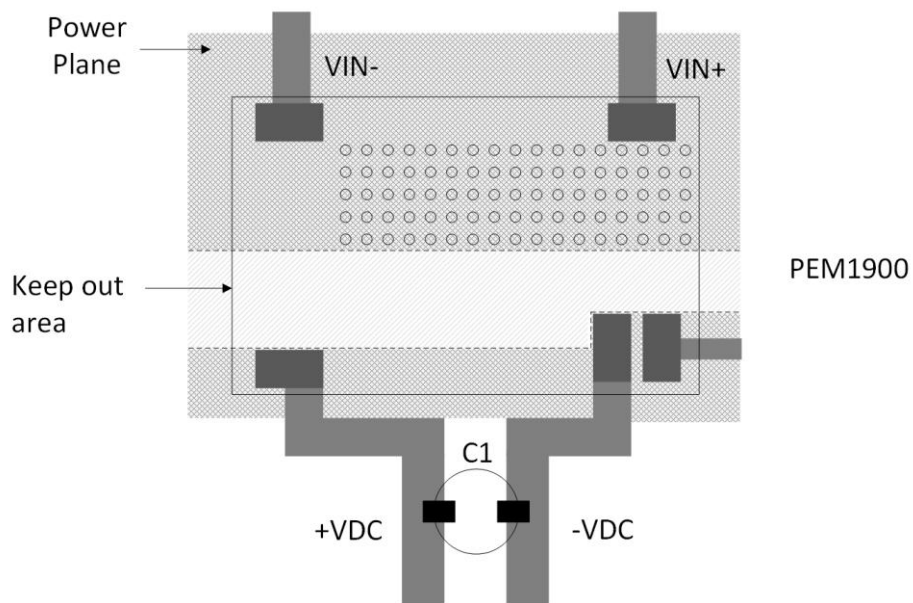


Figure 6- Power Plane Heat Sink

THERMAL PASTE REGION

A recommended method for dissipating heat when using the PEM1900 series is to place a thermal gap filler material placed underneath the PEM1900 PCB as shown below in *Figure 7*. The gap filler should fully encapsulate the components on the underside of the PCB and have suitable thermal conductivity to ensure effective heat transfer from the module to the application PCB.

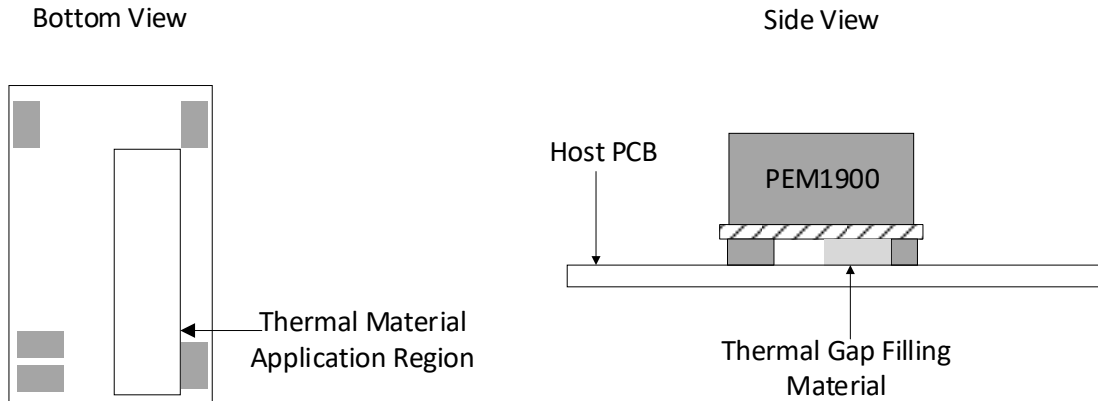


Figure 7- Thermal Paste Region

PHYSICAL PACKAGE

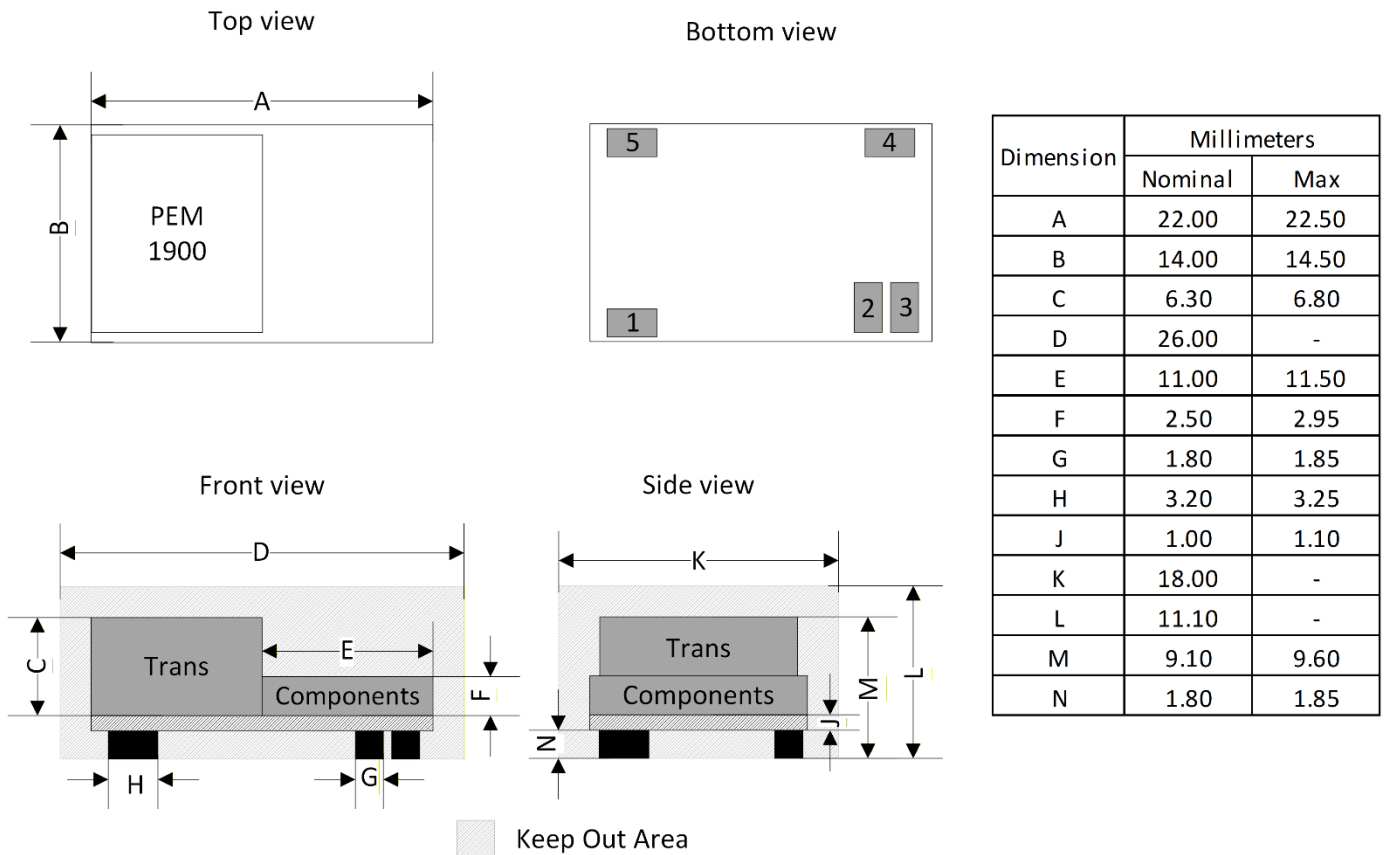


Figure 8- Mechanical Dimensions

REFLOW LAND PATTERNS

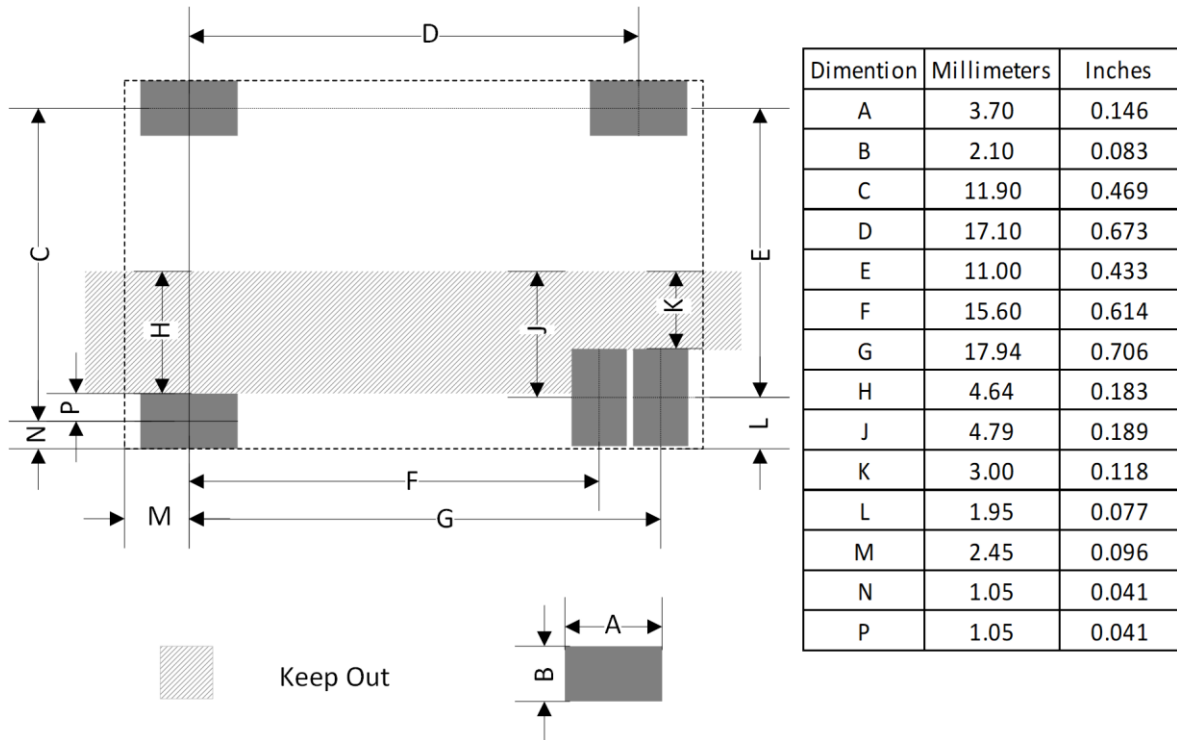


Figure 9- Reflow Land Pattern

HAND SOLDERING LAND PATTERNS

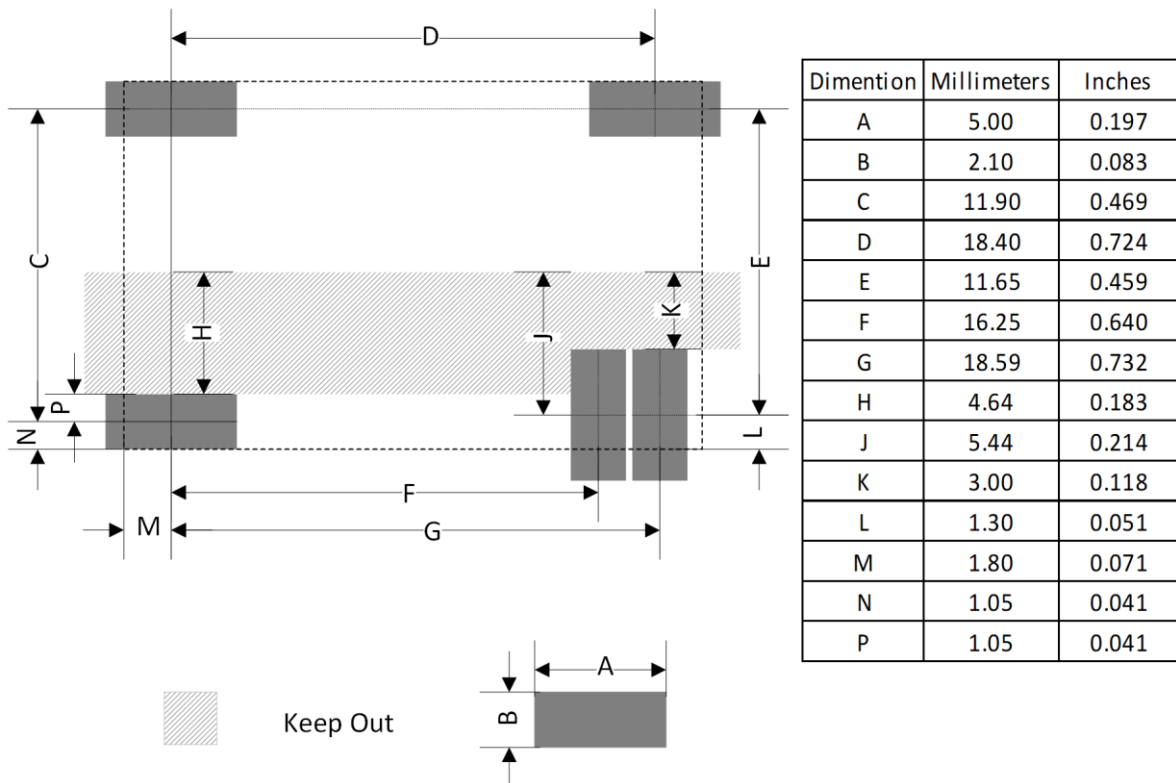


Figure 10- Hand Soldering Land Pattern

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 PEM1900 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 PEM1900 series enables simpler and faster product development while maximizing return on investment.

The PEM1900 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

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 PEM1900 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 www.poweredethernet.com.

REVISION HISTORY

REVISION NUMBER	DESCRIPTION
25GR1	▪ New release
25JR2	▪ 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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