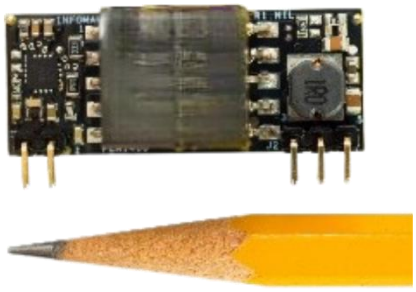
PEM1400 SERIES

by INFOSMART

World's Smallest Full Power PoE PD Module



PRODUCT FEATURES

- Low-Cost IEEE802.3af 12.95W PoE PD Module
- Ultra Compact Size (35mm x 14mm)
- Low EMI
- On board PI filter for output ripple control
- Adjustable output voltage
- Low output ripple and noise
- High Efficiency 1500V isolated DC-DC converter
- 3.3V, 5V, and 12V DC output voltage models
- IEEE802.3af, Type 1 802.3at and 802.3bt
- Overload and short circuit protection[1]
- Minimal external components required
- Infomart "design-in" assistance

PRODUCT OVERVIEW

The PEM1400 is the world's smallest full-power IEEE802.3af compliant Power over Ethernet (PoE) Powered Device (PD) module, delivering up to 12.95W of power across all voltage variants: 3.3V (PEM1403), 5V (PEM1405), and 12V (PEM1412). Its low-cost design requires only input diodes and an output capacitor to rapidly enable a PoE solution.

With an ultra-compact size of 35 mm × 14 mm (1.38 in × 0.55 in), the module occupies just 490 mm² (0.759 sq. inches) of PCB area, making it ideal for compact, next-generation devices such as IoT modules, IP phones, IP cameras, security and access-control systems, sensors, routers, and network access points. The PEM1400 features an isolated, high-efficiency DC-DC converter with built-in frequency dithering to reduce EMI and noise.

With an on-board PI filter, the output ripple is controlled within IEEE specifications.

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 PEM1400 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	Nominal Input Voltage (V_{IN})	Output Voltage[2]	Efficiency[3]	Power (Maximum)[7,10]
		(Volts DC)	(Volts DC)	(%)	(Watts)
PEM1403	03	48	3.3	80	12.95
PEM1405	05	48	5	85	12.95
PEM1412	12	48	12	87	12.95

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]	I_{IN}		350	400	mA
Operating Temperature[6]	T_{OP}	-20	25	70	°C
IEEE802.3af Power Classification[7]	Class 0				

DC OUTPUT CHARACTERISTICS

Parameter		Symbol	Min.	Typ[3].	Max.	Units
Line Regulation[8]		V_{LNRG}		0.2%		
Load Regulation[8]	PEM1405 and PEM1412	V_{LDRG}		0.5%		
	PEM1403			0.8%		
Output Ripple and Noise[8]		V_{RIP}		80		mV p-p
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 full load at a T_A 25°C.
[4] With minimum load 1Watt or 100mA, whichever is higher.
[5] Please refer to IEEE802.3af standards document.
[6] Refer to the *THERMAL MANAGEMENT* for operating temperature details.
[7] Refer to the *POWERED DEVICE (PD) SIGNATURE* Section.
[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

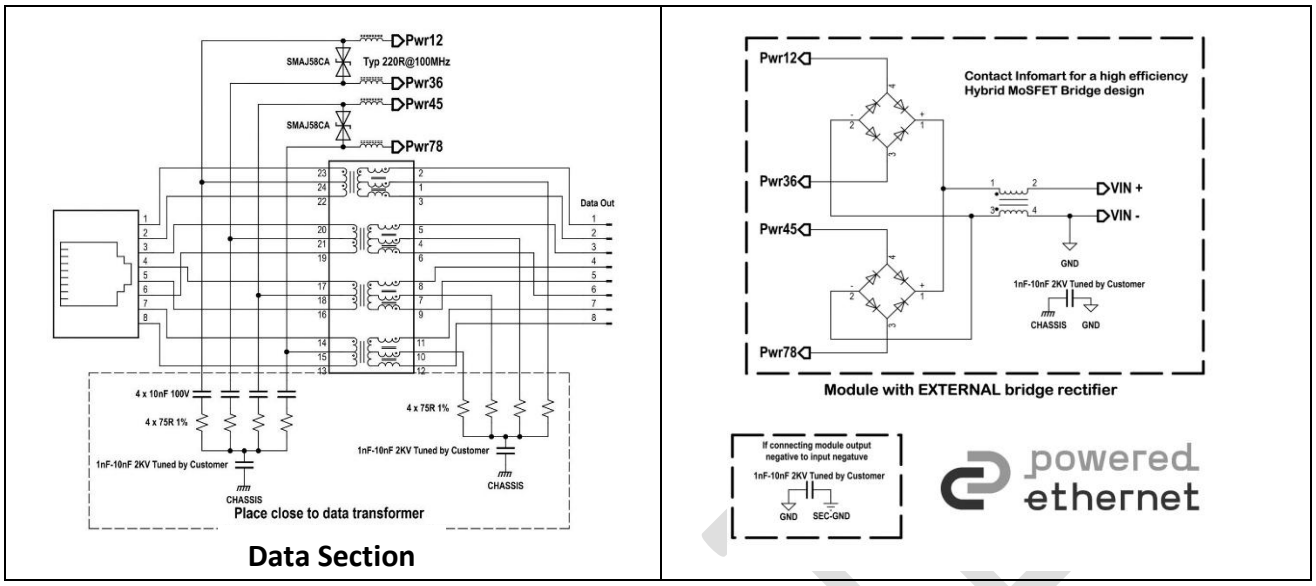

Figure 1- Typical Input Connections

OUTPUT CONNECTION

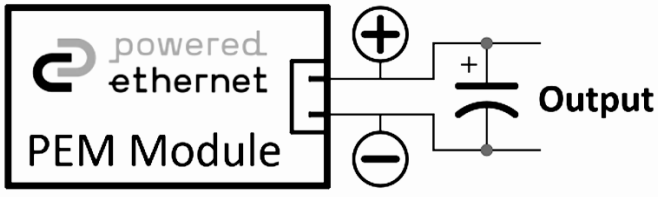

Figure 2- Output Connection

BLOCK DIAGRAM

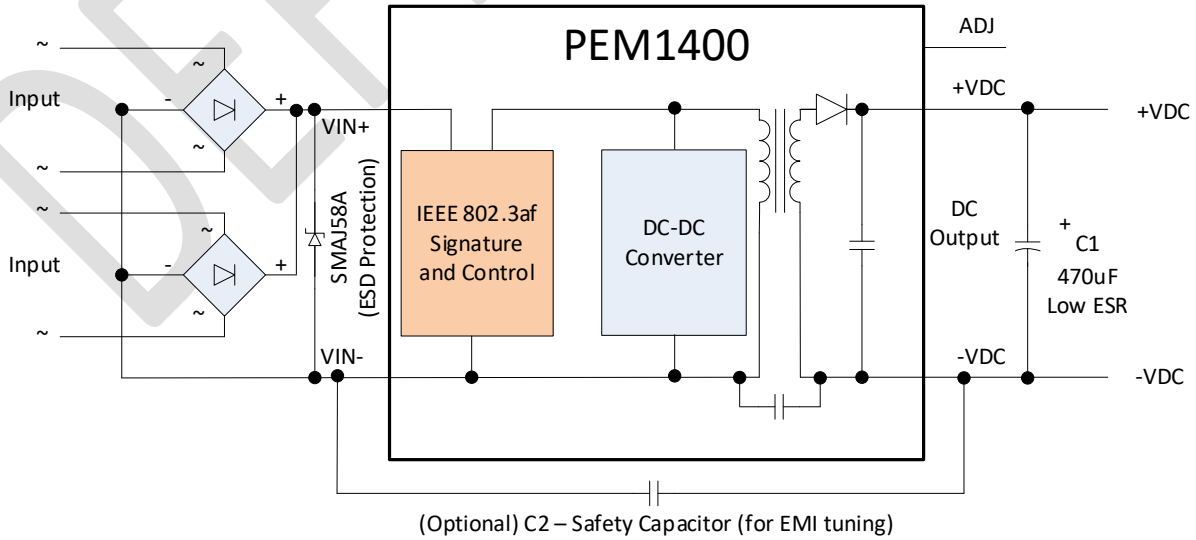

Figure 3- Block Diagram

PIN CONNECTIONS

INPUT PINS	
1	**VIN+.** This pin connects to the positive (+) output of the input bridge rectifiers.
2	**VIN-.** This pin connects to the negative (-) output of the input bridge rectifiers.
OUTPUT PINS	
3	**+VDC.** This pin provides the regulated output from the DC-DC converter. Max. Current 3A per pin[10].
4	**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.
5	**-VDC.** The ground return for the +VDC output. Max. Current 3A per pin[10].
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 PEM1400 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 PEM1400 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 PEM1400 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.

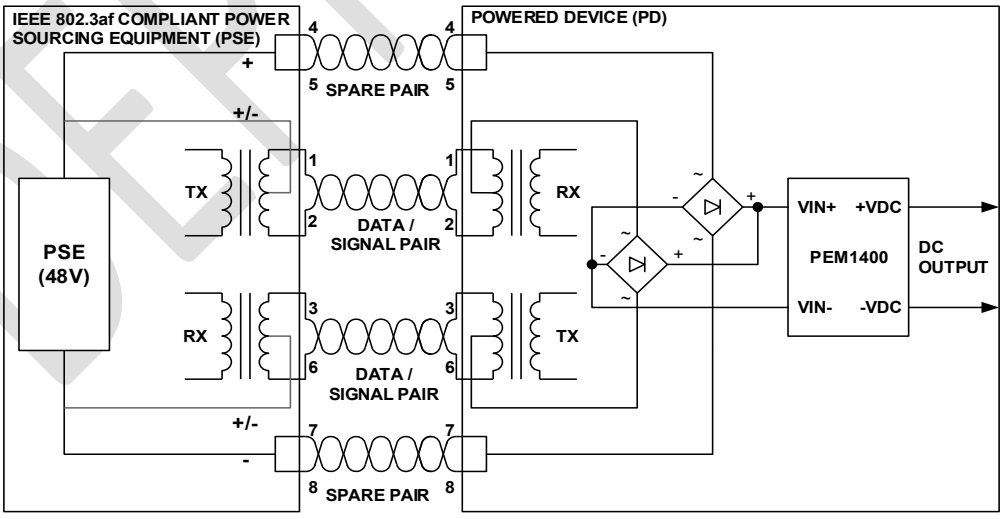

Figure 4- Typical System configuration

[10] Max. Current 4A per pin for PEM1403

POWERED DEVICE (PD) SIGNATURE

When the PEM1400 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 PEM1400 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 PEM1400 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 19- 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 PEM1400 is mounted to ensure compliance with the isolation requirements.

FREQUENCY DITHERING

The PEM1400 series is built with a frequency dithering circuit to help better control EMI (electromagnetic interference) emissions. The nominal switching frequency of the PEM1400 series is 300 kHz, with a dithering range of ±10%.

OUTPUT VOLTAGE ADJUSTMENT

The PEM1400 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.

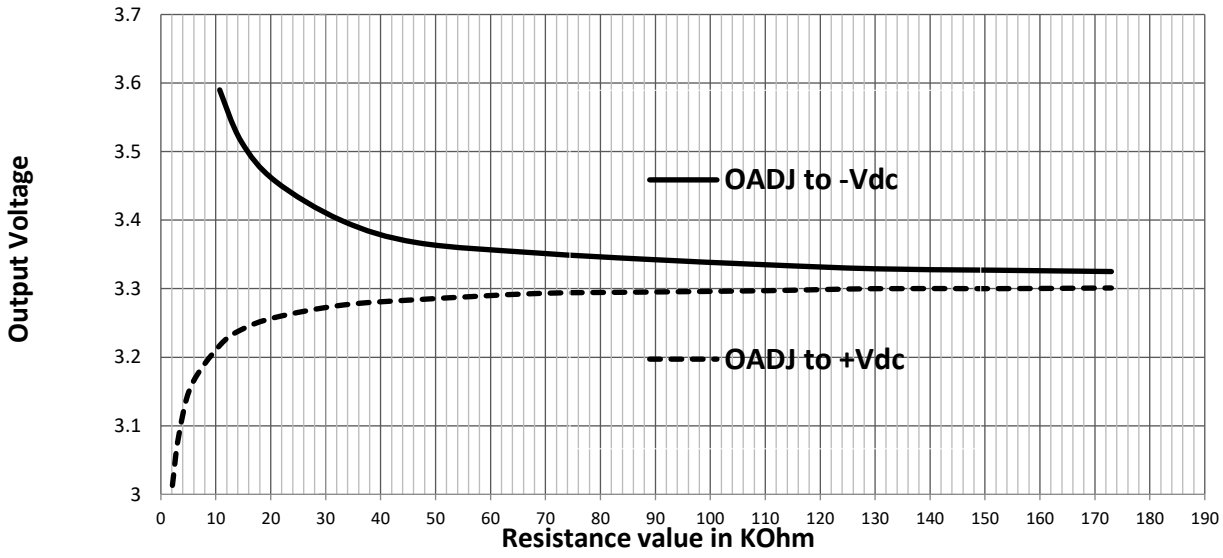

Figure 5- PEM1403 Output Voltage Adjustment

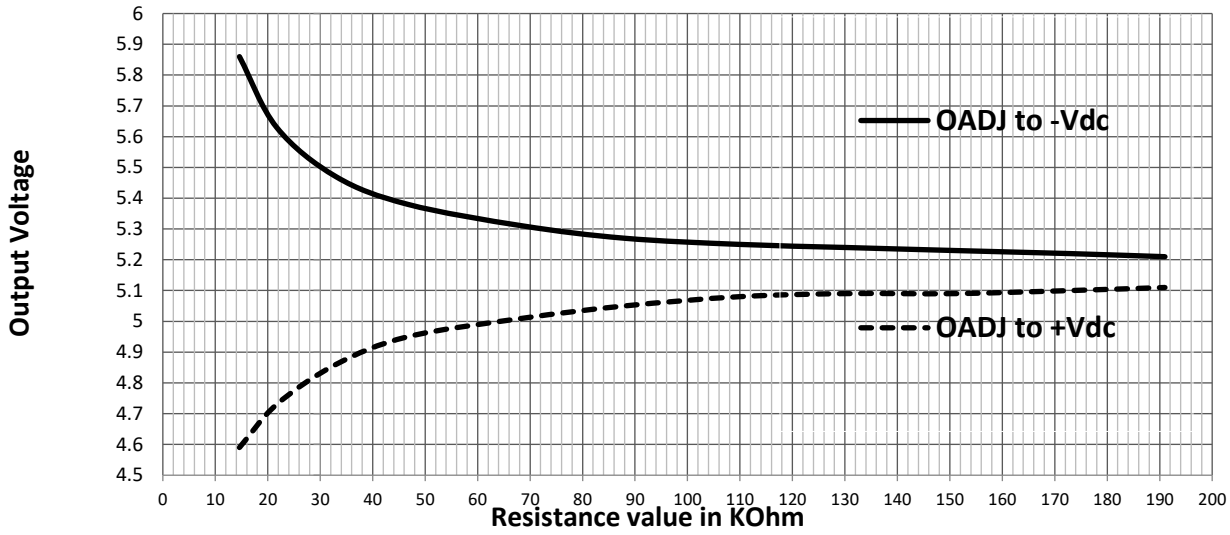

Figure 6- PEM1405 Output Voltage Adjustment

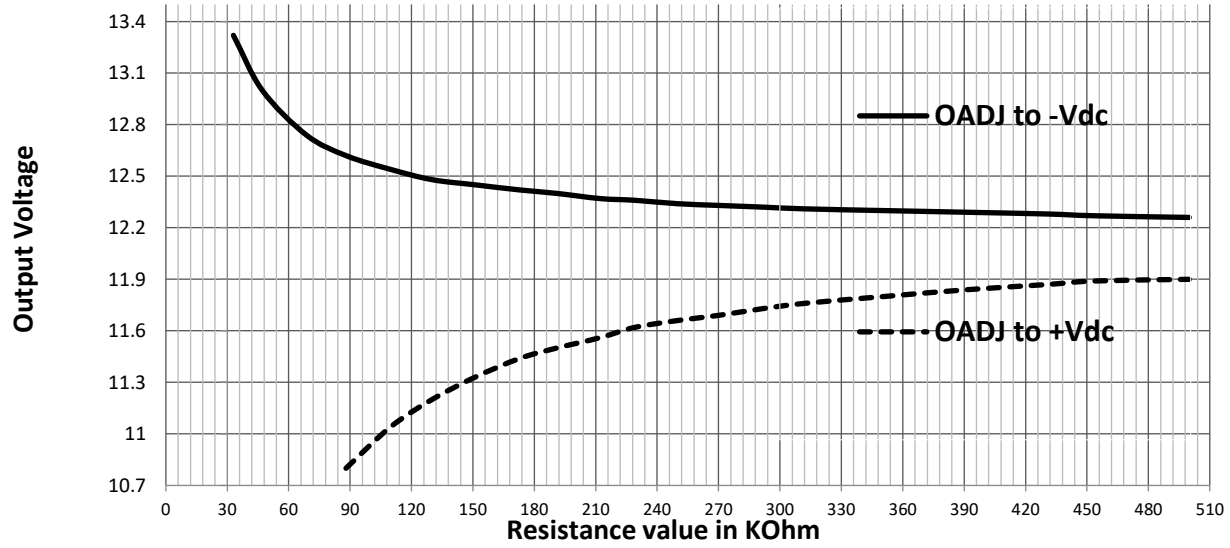

Figure 7- PEM1412 Output Voltage Adjustment

THERMAL MANAGEMENT

As with any power component, the PEM1400 modules generate heat. It is important to ensure adequate ventilation and airflow during the design stage. The amount of heat generated by the PEM1400 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 PEM1400 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 below. These two methods can also be combined for improved thermal management.

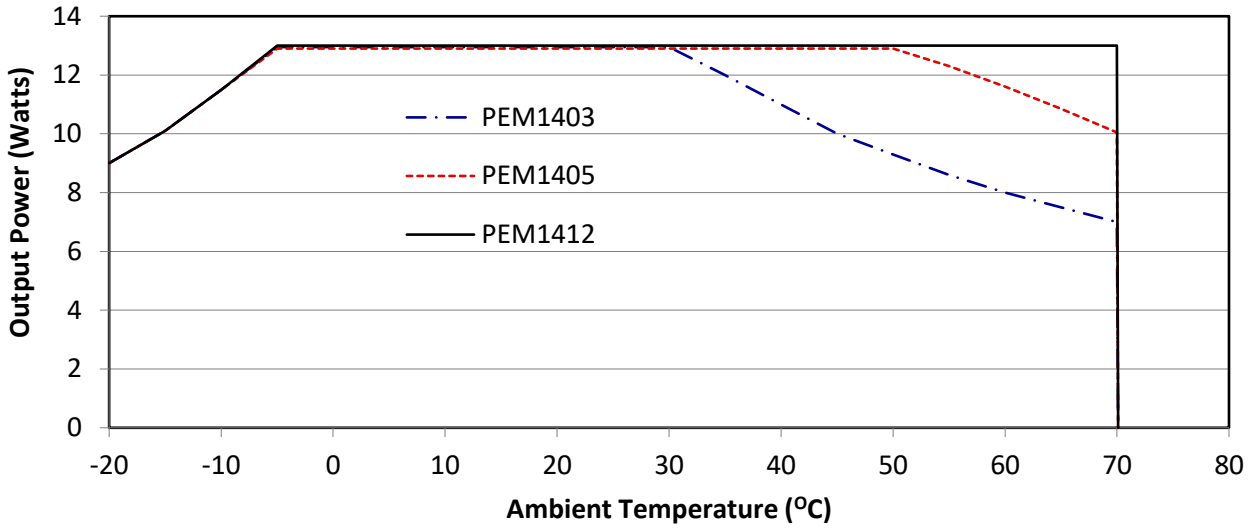

Figure 8- Thermal Performance profile at nominal V_{in}

POWER PLANE HEAT SINK

A power-plane heat sink on the motherboard is a relatively simple method to draw heat away from the PEM1400 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 PEM1400 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.

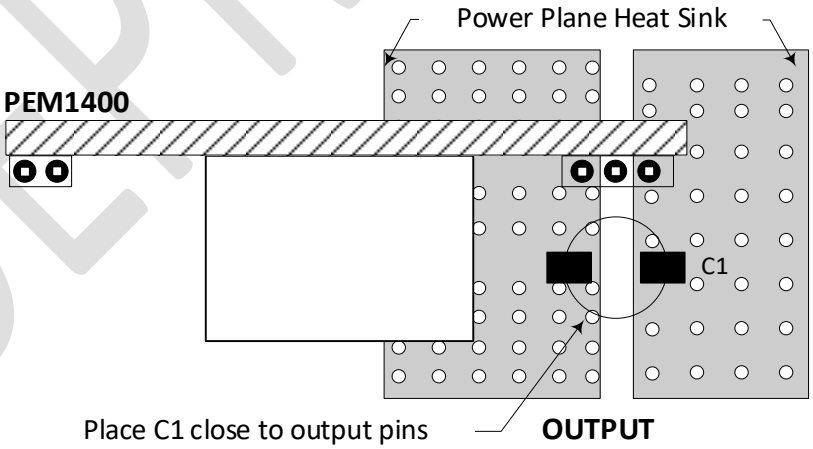

Figure 9- Power Plane Heat Sink

EFFICIENCY v/s OUTPUT LOAD

(indicative values from one of our data)

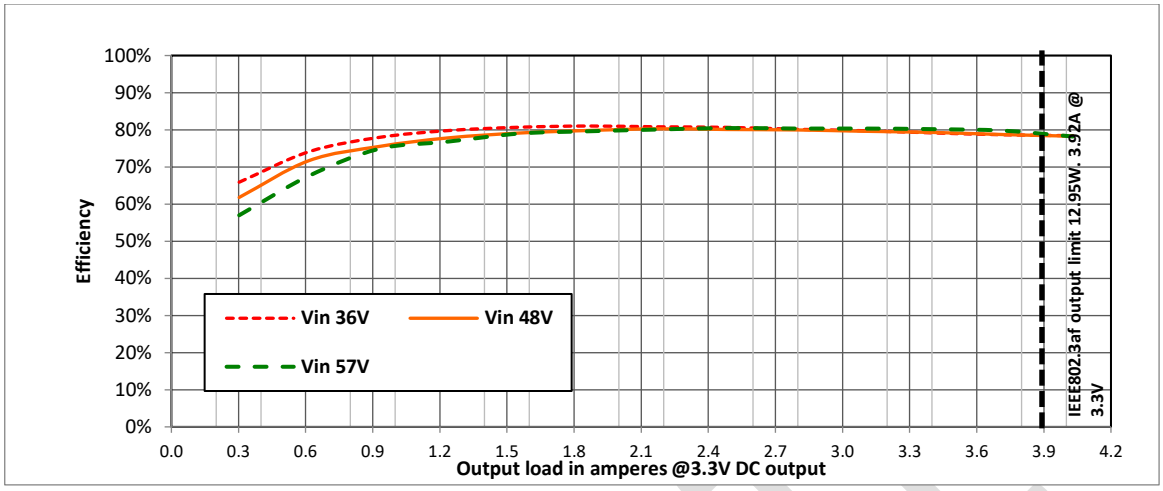

Figure 10- PEM1403 Efficiency vs. Output Load end to end

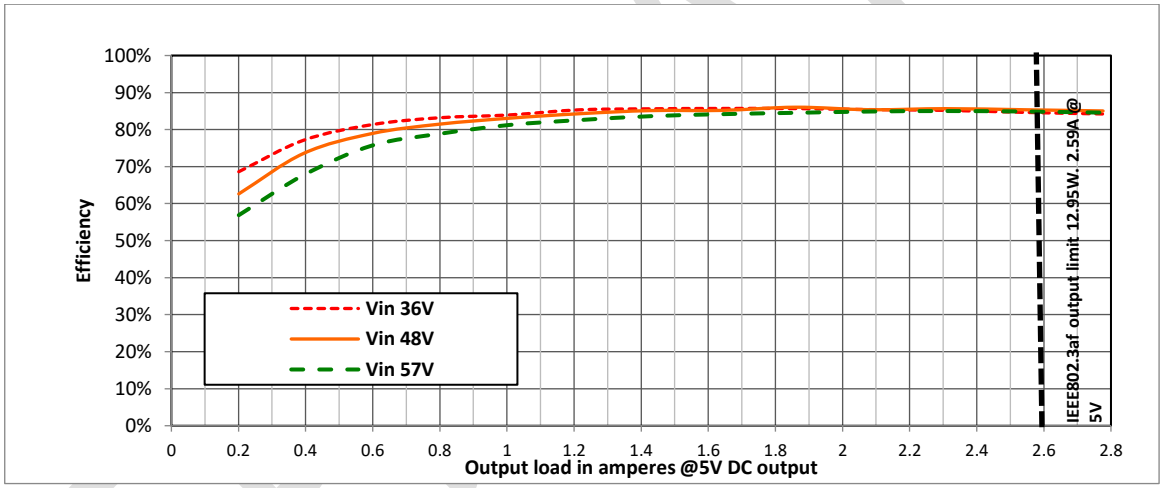

Figure 11- PEM1405 Efficiency vs. Output Load end to end

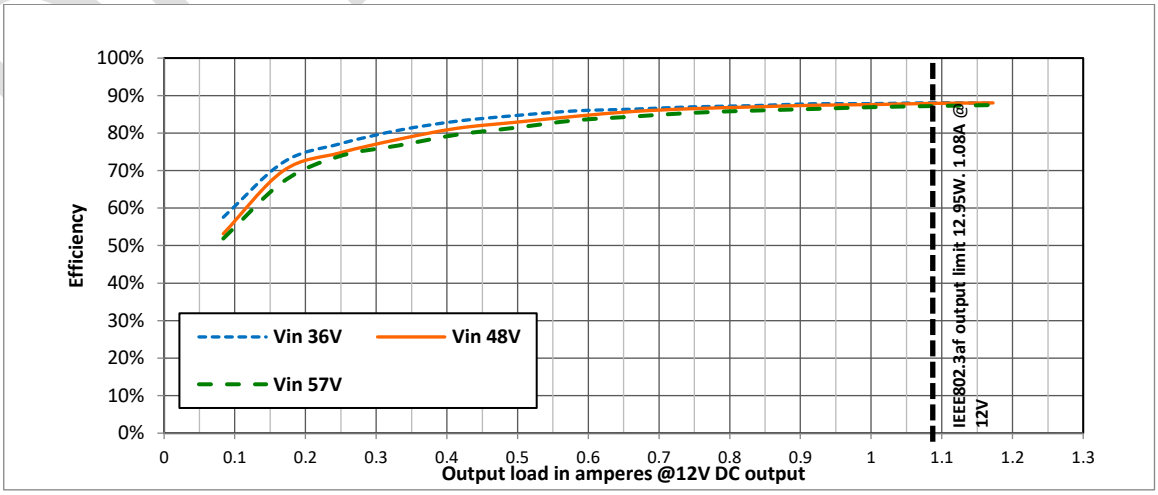

Figure 12- PEM1412 Efficiency vs. Output Load end to end

LOAD REGULATION v/s OUTPUT LOAD

(indicative values from one of our data)

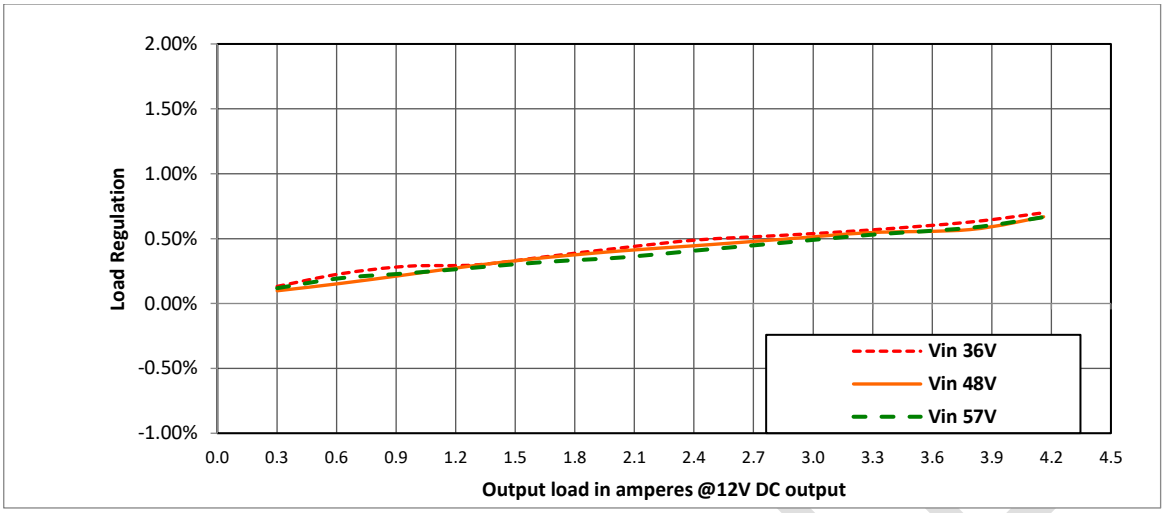

Figure 13- PEM1403 Load Regulation vs. Output Load end to end

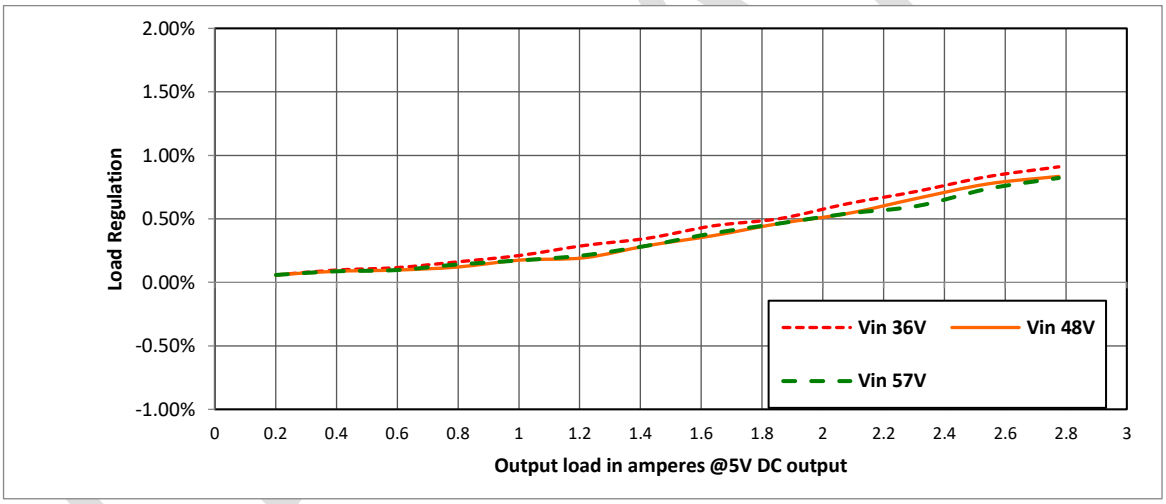

Figure14- PEM1405 Load Regulation vs. Output Load end to end

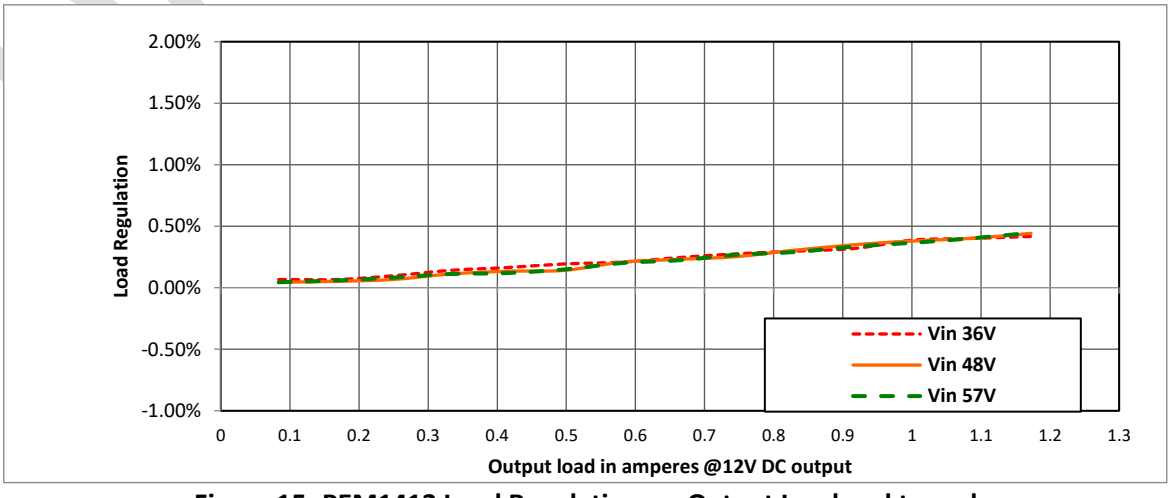

Figure 15- PEM1412 Load Regulation vs. Output Load end to end

LINE REGULATION

(indicative values from one of our data)

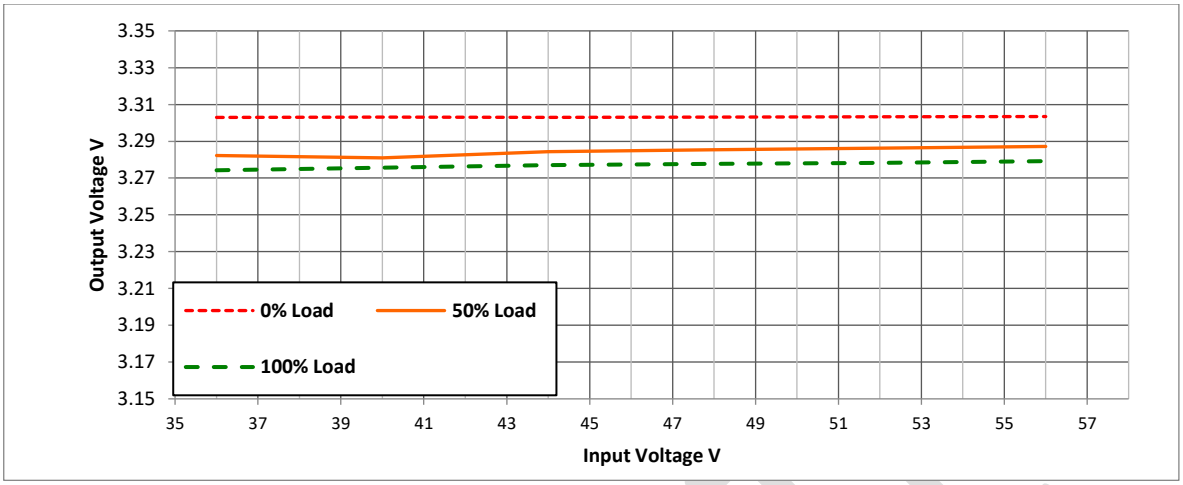

Figure 16- PEM1403 Line Regulation end to end

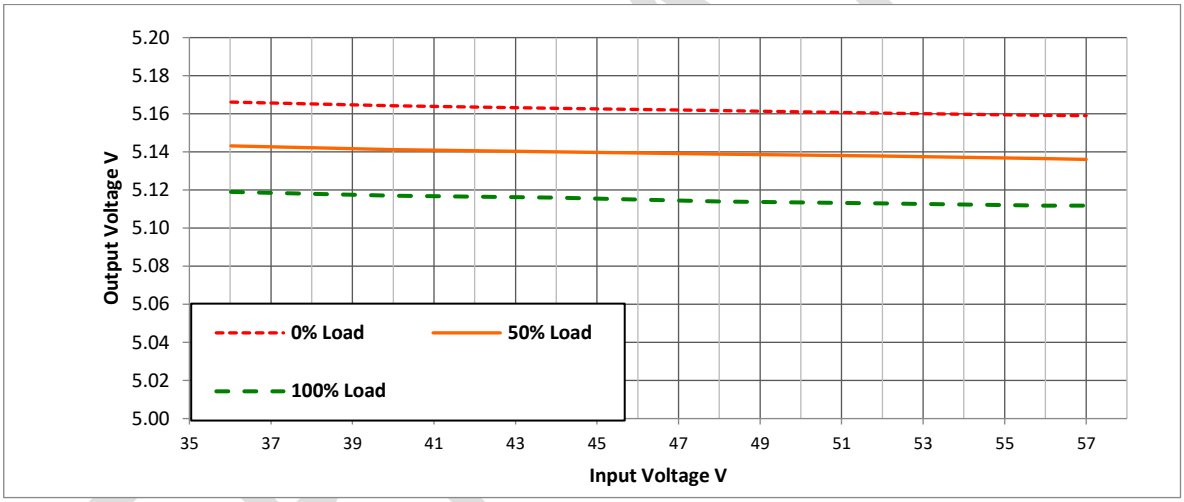

Figure 17- PEM1405 Line Regulation end to end

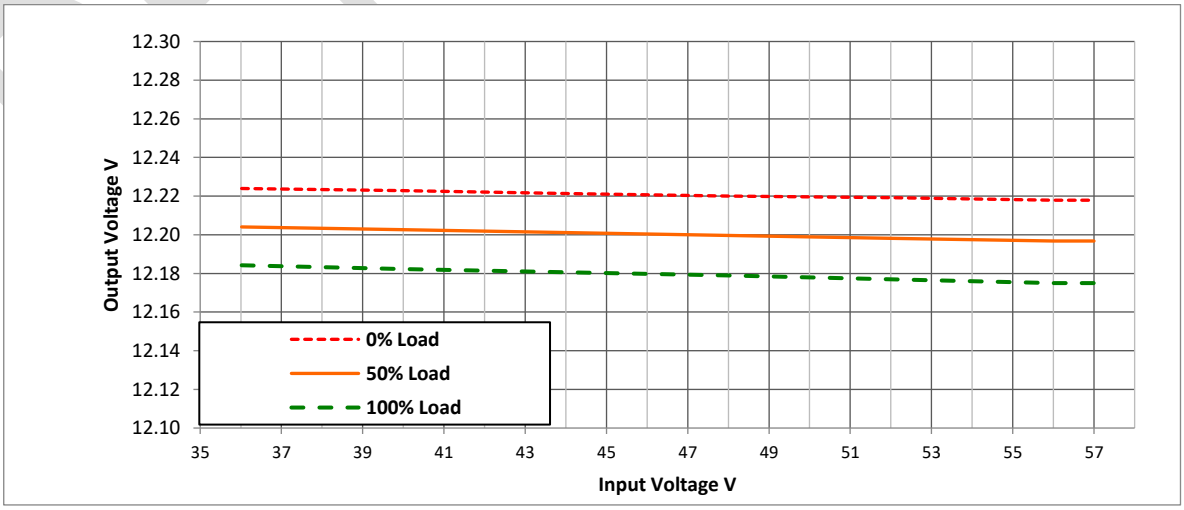

Figure 18- PEM1412 Line Regulation end to end

PHYSICAL PACKAGE

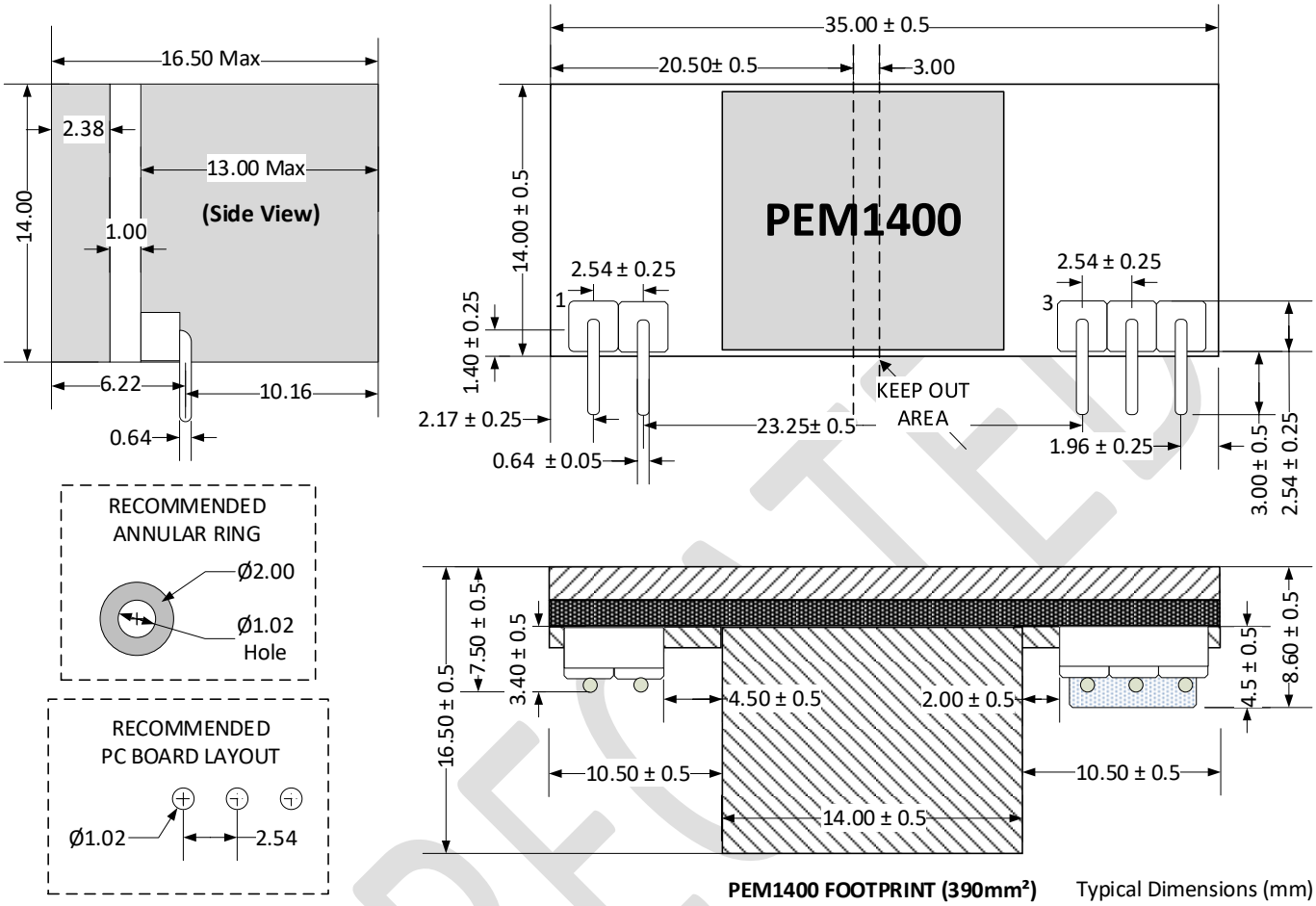

Figure 19- Mechanical Dimensions

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 PEM1400 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 PEM1400 series enables simpler and faster product development while maximizing return on investment.

The PEM1400 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 PEM1400AF 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
21GR1-1	▪ Image of the Product changed ▪ PRODUCT OVERVIEW and PRODUCT FEATURES updated ▪ Clerical and aesthetic changes ▪ Mechanical dimensions updated ▪ Revision History added to Data sheet template
24JR1	▪ Updated OUTPUT CONNECTION diagram
24LR1	▪ Updated IEEE802.3 POWER LEVELS AND CLASSES
25AR4	▪ Updated Dimension of keep out area
25CR5	▪ Update in PHYSICAL PACKAGE
25DR6	▪ Update in TYPICAL INPUT CONNECTIONS
25LR7	▪ Module has been DEPRECATED

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.

Infomart India Pvt. Ltd.
Infomart Tech Park
99, 5th Cross, 5th Block, Koramangala
Bangalore – 560 095, India
Tel: +91 80 4111-7200
Email: pesales@infomartgroup.com

Infomart Technologies
Americas sales office
5904, South Cooper St. #104-96
Arlington, Texas, 76017, USA
Tel: +1 903-270-9090