by INFOMART

Low Cost Full Power IEEE802.3af POE PD Module

PRODUCT OVERVIEW

Infomart's® PoweredEthernet™ PEM1600 series of power extraction modules have compliance with the IEEE 802.3af Power-Over-Ethernet (PoE) standard, and are designed to extract power from CAT5 or higher ethernet cable when sourced from an IEEE 802.3af / 3at compliant Power Sourcing Equipment (PSE).

PEM1600, with its high efficiency DC-DC converter, provides a well-regulated, low noise and low ripple, output with the in-built overload and output short-circuit protection, and on board input ESD protection. It provides a quick, easy, and low cost method for Ethernet equipment manufacturers to "PoE enable" their equipment.

All variants of the PEM1600 deliver the full IEEE 802.3af specified 12.95W of power.

PEM1600 are featured with built-in frequency dithering. The output ripple is controlled within IEEE specifications.

PRODUCT FEATURES

- Fully IEEE 802.3af compliant
- 12.95 watt output load
- Wide input voltage (36V to 57V DC)
- 3.3V, 5V, 12V, 19V, 24V DC output voltage models
- Built-in input ESD protection
- Frequency dithering
- Adjustable output voltage
- RoHS compliant
- Stable efficiency even at high ambient
- Low output ripple and noise
- Overload and short circuit protection[1]
- Minimal external components required
- 1500 Volt DC isolation (Input to Output)
- Compact dimension of 52mm x 14mm
- Low cost

[1] If maximum power is exceeded, the PEM1600 will operate in over current mode and will auto recover when the over load condition is removed.

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1. PRODUCT SELECTOR[2]

Part Number*	Marking	Nominal Input Voltage (Volts DC)	Output Voltage[3, 6] (Volts DC)	Efficiency[4, 5] (%)	Power (Maximum)[5] (Watts)
PEM1603N	03N	48	3.3	81	12.95
PEM1605N	05N	48	5	83	12.95
PEM1612N	12N	48	12	88	12.95
PEM1619N	19N	48	19	86	12.95
PEM1624N	24N	48	24	86	12.95
PEM1603R	03R	48	3.3	79	12.95
PEM1605R	05R	48	5	81	12.95
PEM1612R	12R	48	12	86	12.95
PEM1619R	19R	48	19	84	12.95
PEM1624R	24R	48	24	84	12.95
*R= on board bridge rectifier for input polarity protection. N = no input bridge rectifier on board					

2. INPUT CHARACTERISTICS

Parameter	Symbol	Min.	Typ[6].	Max.	Units
Input Voltage[7]	V_{IN}	36	48	57	Volts
Under Voltage Lockout[8]	V_{UVLO}	30		36	Volts
Input Current[9]	I_{IN}		350	400	mA
Operating Temperature[10]	T_{OP}	-20	25	70	^{O}C
IEEE 802.3af Power Classification[11]	Class 0				

3. DC OUTPUT CHARACTERISTICS

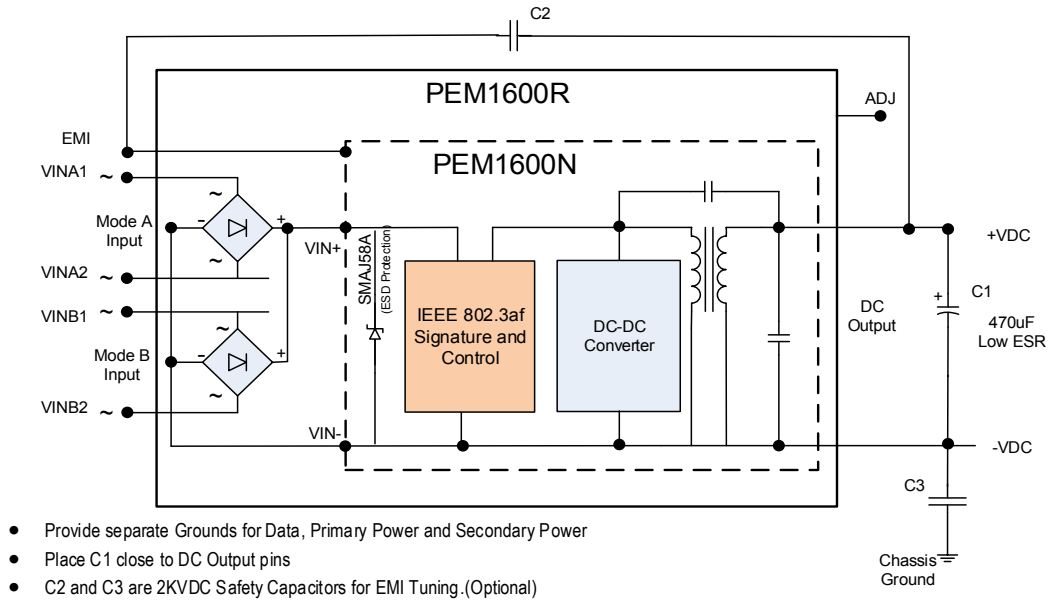
Parameter		Symbol	Min.	Typ[5].	Max.	Units
Line Regulation		V_{LNRG}		0.2%		
Load Regulation	PEM1603N / PEM1603R	V_{LDRG}		0.8%		
	Other models			0.5%		
Output Ripple and Noise		V_{RIP}		80		mV p-p
Isolation Voltage		V_{ISOL}			1500	V DC
Temperature Coefficient (Slope)		TC		100	300	ppm ^{O}C

[2] Electrical specifications and measurements in this data sheet are considered to be at the respective input and output pins, wherever applicable.
[3] Output voltage typical ± 3% at T_A of 25^{0}C with a nominal input voltage, rated output current and typical connections. Maintain minimum load 1Watt or 100mA, whichever is higher
[4] At nominal Vin and at full load.
[5] Refer to section 13. Thermal management
[6] All specifications typical are at T_A of 25^{0}C with a nominal input voltage, rated output current and typical connections, unless otherwise noted. These are meant as a design aid only and are indicative, and not guaranteed
[7] PEM1624x will deliver output power only at input voltages greater than 42V. Hence for certain Cat5e cables (Cu-Al cable / low cost cable) and lower V_{PORT} POE PSEs (like some models of Netgear with V_{PORT} 44V), the maximum cable length should be 50 meters. No such limitations with a higher V_{PORT} POE PSEs.
[8] For PEM1624x, $V_{UVLO\_OFF} \approx$ 39V and $V_{UVLO\_ON} \approx$ 42V
[9] Please refer to IEEE802.3af standards document. Maximum input current is dependent on power class, and input voltage. Input current (DC or RMS) at V_{PORT} =37vDC is 350mA, at V_{PORT} =57vDC is 230mA. Peak inrush current is 400mA for 50mS max at duty cycle of 5% max.
[10] Please see section 13– Thermal Management
[11] Please see section 9 – Powered Device Signature

4. ABSOLUTE MAXIMUM RATINGS,[12]

Supply Voltage (V_{CC})	0V – 57V DC
Storage Temperature (T_S)	-25 ^{O}C – 100 ^{O}C
Output Voltage (V_{OUT})	0V to controlled output voltage (operating or non-operating)

5. BLOCK DIAGRAM and TYPICAL CONNECTIONS



- Provide separate Grounds for Data, Primary Power and Secondary Power
- Place C1 close to DC Output pins
- C2 and C3 are 2KVDC Safety Capacitors for EMI Tuning.(Optional)

Figure 1

[12] 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.

6. PIN CONNECTIONS

A. PEM1600N

INPUT PINS (J1)			OUTPUT PINS (J2)	
1	**VIN+**. This pin connects to the positive (+) output of the input bridge rectifiers (internally connected to pin 3).		6	**-VDC.** The ground return for +VDC output. Max. Current 3A per pin[13].
2	**VIN-**. This pin connects to the negative (-) output of the input bridge rectifiers (internally connected to pin 4).		7	**+VDC**. This pin provides the regulated output from the DC/DC converter. Max. Current 3A per pin[13].
3	**VIN+**. This pin connects to the positive (+) output of the input bridge rectifiers (internally connected to pin 1).		8	**OADJ.** The output voltage can be adjusted from its nominal value, by connecting an external resistor from this pin to either +VDC pin or -VDC pin. For more details please see section *12. Output Voltage Adjustment*.
4	**VIN-**. This pin connects to the negative (-) output of the input bridge rectifiers (internally connected to pin 2).		**To maintain isolation integrity, always connect respective input and output poles only via X or Y safety capacitor. Maintain 1500V isolation barrier on motherboard PCB as per physical package.**	
5	**EMI**. Connect this pin only to the Output (J2) Pin 6 through 2KVDC Safety capacitor, (if required for EMI tuning)			

B. PEM1600R

INPUT PINS (J1)			OUTPUT PINS (J2)	
1	**VINA1**. This pin connects to the output of the data transformer centre-tap (for Mode A PoE injection). Not polarity sensitive.		6	**-VDC.** The ground return for +VDC output. Max. Current 4A per pin.
2	**VINA2**. This pin connects to the output of the data transformer centre-tap (for Mode A PoE injection). Not polarity sensitive		7	**+VDC**. This pin provides the regulated output from the DC/DC converter. Max. Current 4A per pin.
3	**VINB1**. This pin connects to the output of the data transformer centre-tap (for Mode B PoE injection). Not polarity sensitive.		8	**OADJ.** The output voltage can be adjusted from its nominal value, by connecting an external resistor from this pin to either +VDC pin or -VDC pin. For more details please see section *12. Output Voltage Adjustment*.
4	**VINB2**. This pin connects to the output of the data transformer centre-tap (for Mode B PoE injection). Not polarity sensitive		**To maintain isolation integrity, always connect respective input and output poles only via X or Y safety capacitor. Maintain 1500V isolation barrier on motherboard PCB as per physical package.**	
5	**EMI**. Connect this pin only to the Output (J2) Pin 7 through 2KVDC Safety capacitor, (if required for EMI tuning)			

[13] Max. Current 4A per pin for PEM1603

7. INPUTS

The PEM1600 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 section 8. Typical System Configuration. As per IEEE 802.3af, it is specified that the PSE does not apply power to both the outputs at the same time i.e. 4 pair injection. (Refer to IEEE802.3af standards for more information).

PEM1600 is provided with on-board TVS diode SMAJ58A for protection against input over-voltage surges and for system EMC compliance.

The PEM1600N variant provides for external input bridge rectifiers for improved system design flexibility, and distribution of heat generation. This allows the system designer to control the type and costs of the input rectification diodes.

The PEM1600R variant provides on-board bridge rectifiers for input polarity protection and for improved system integration. This helps minimising the external components.

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.

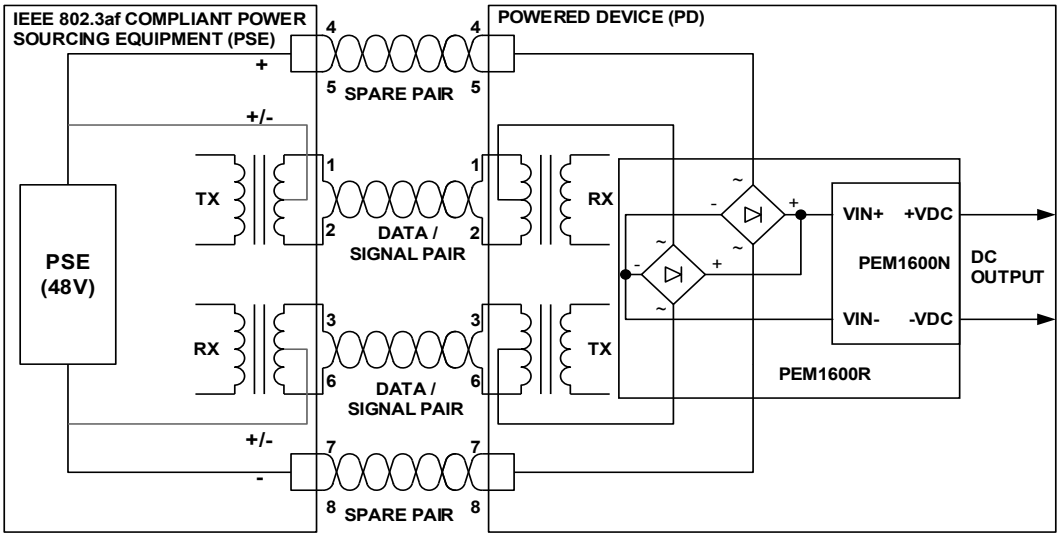


Figure 2

9. POWERED DEVICE (PD) SIGNATURE

When the PEM1600 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 recognise that a PD is connected to that line and supply power.

The PEM1600 presents class 0 detection to the PSE.

10. ISOLATION

IEEE802.3af 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™ PEM1600 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. FREQUENCY DITHERING

The PEM1600 series is built with Frequency Dithering to help better controlling of EMI (electromagnetic-interference) emissions. The nominal switching frequency of PEM1600 series is 300KHz, with a dithering range of +/- 10%.

12. OUTPUT VOLTAGE ADJUSTMENT

The PEM1600 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 shown below. Only one connection i.e. either 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. **(PEM1624x, 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.

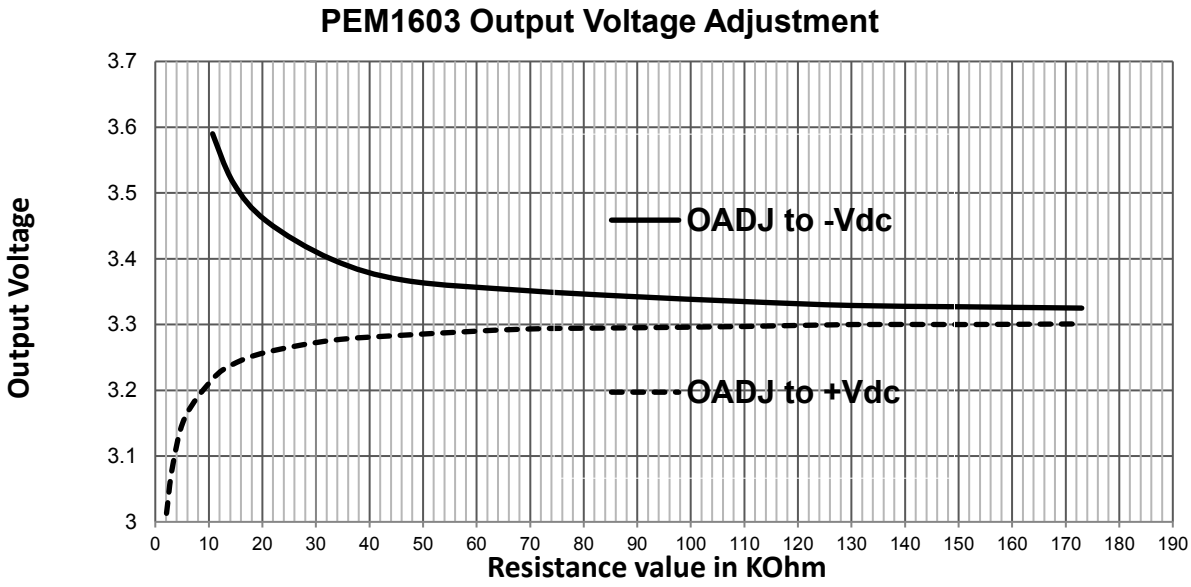


Figure 3

PEM1605 Output Voltage Adjustment

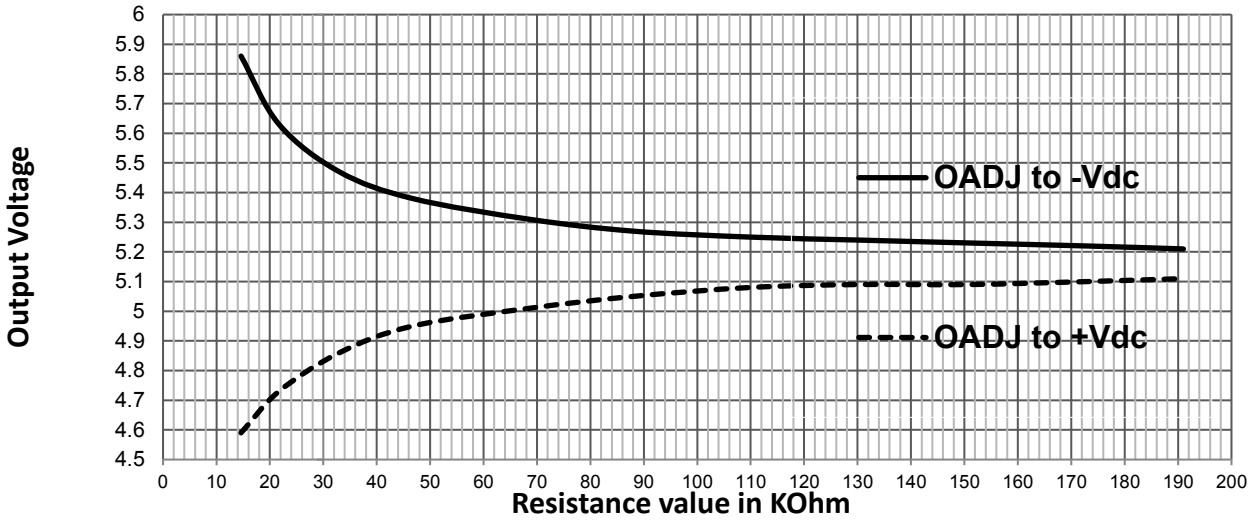


Figure 4

PEM1612 Output Voltage Adjustment

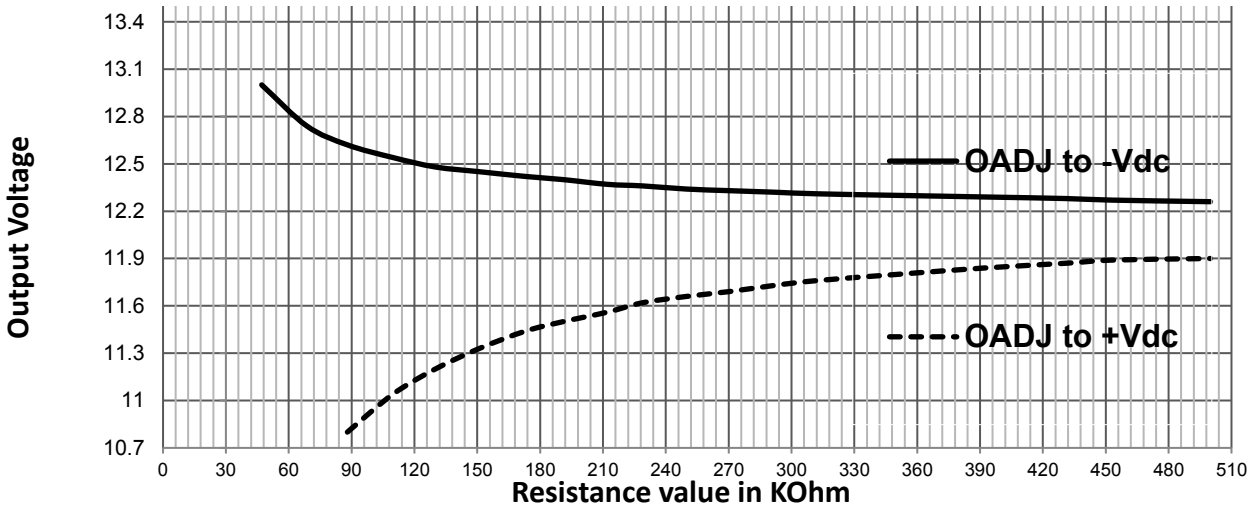


Figure 5

PEM1619 Output Voltage Adjustment

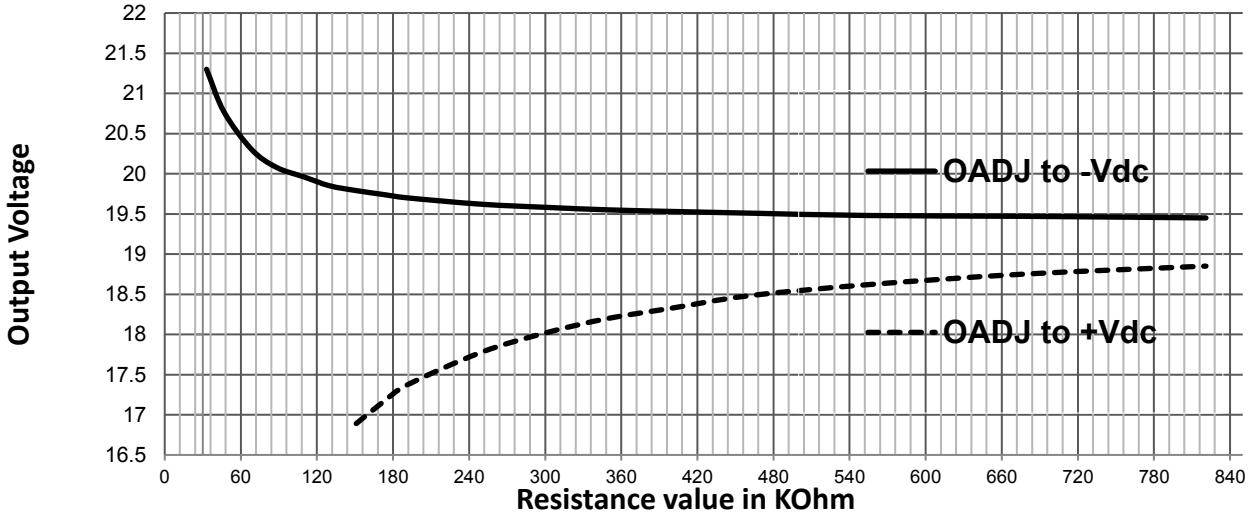


Figure 6

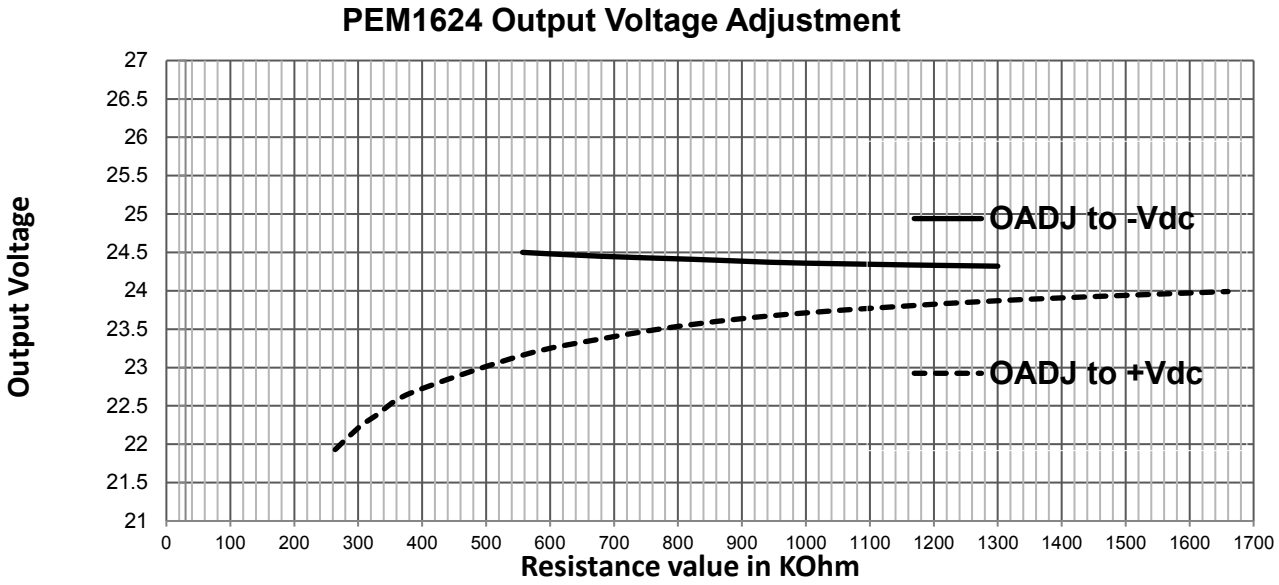


Figure 7

13. THERMAL MANAGEMENT

As with any power component, the PEM1600 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 PEM1600 will depend on the output load it is required to drive. The maximum ambient operating temperature is 70^{O}C. It is recommended to provide adequate air flow around the PEM1600. Figure below shows the thermal performance of the PEM1600 with a nominal 48VDC input. The PEM1600 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.

Thermal Performance profile at nominal V_{in}

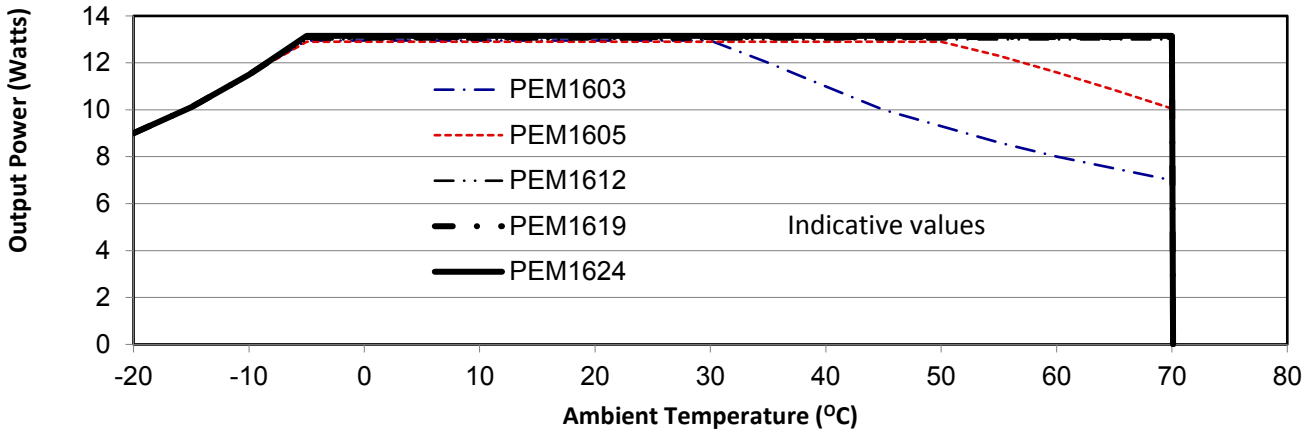


Figure 8

Power Plane Heat Sink

A power plane heat sink on the motherboard is a relatively simple method to draw some heat away from the PEM1600 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 PEM1600 must not be fitted into a socket. This method can be combined with forced airflow cooling, and with a heat sink glued on to the two output diodes using a thermal glue.

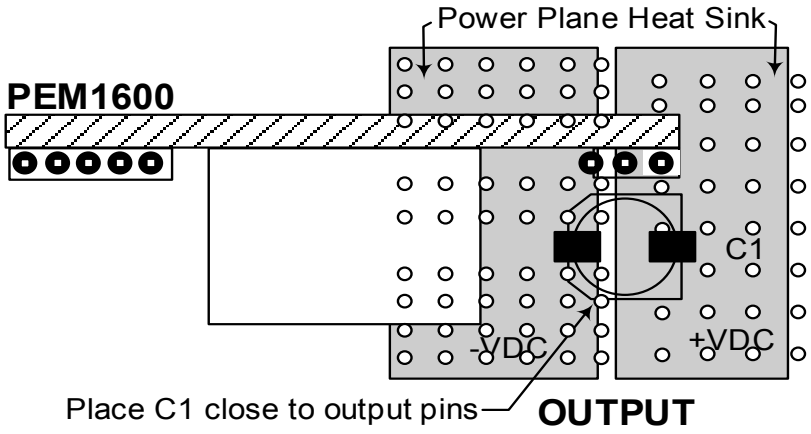


Figure 9

14. EFFICIENCY v/s OUTPUT LOAD

(indicative values from one of our data)

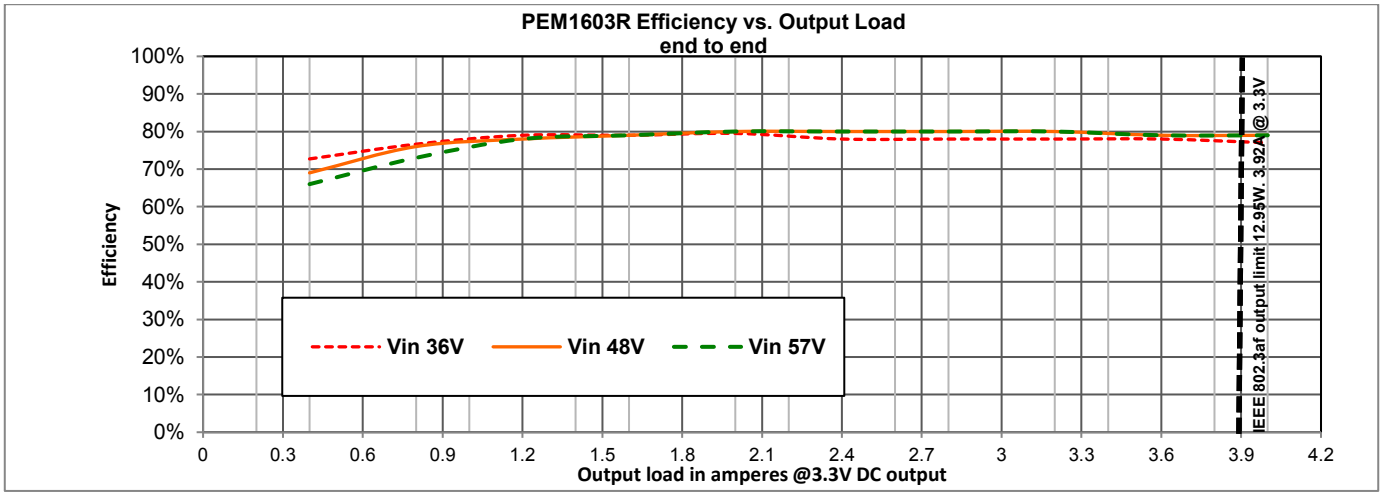


Figure 10

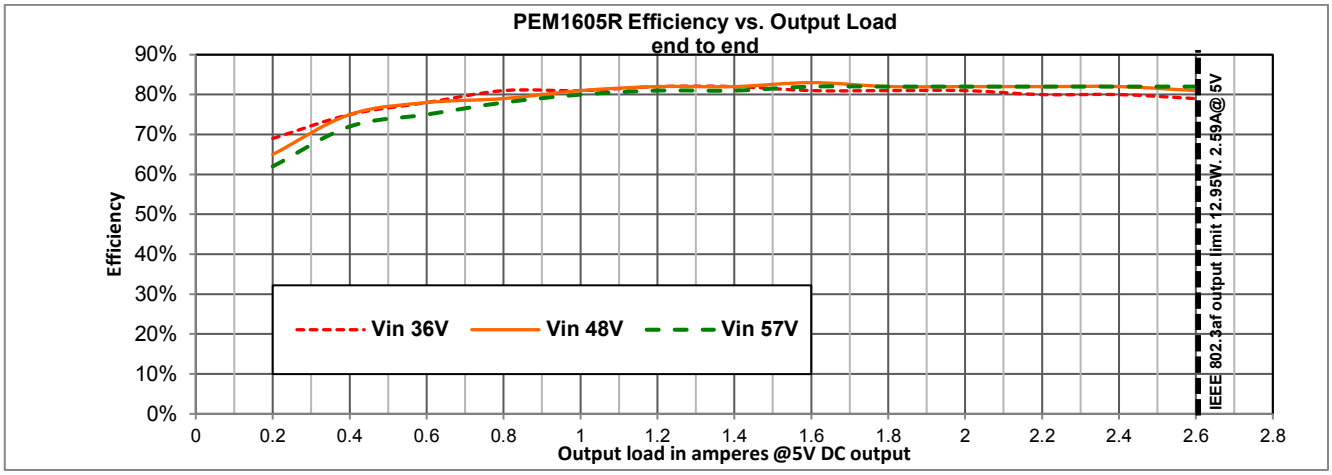


Figure 11

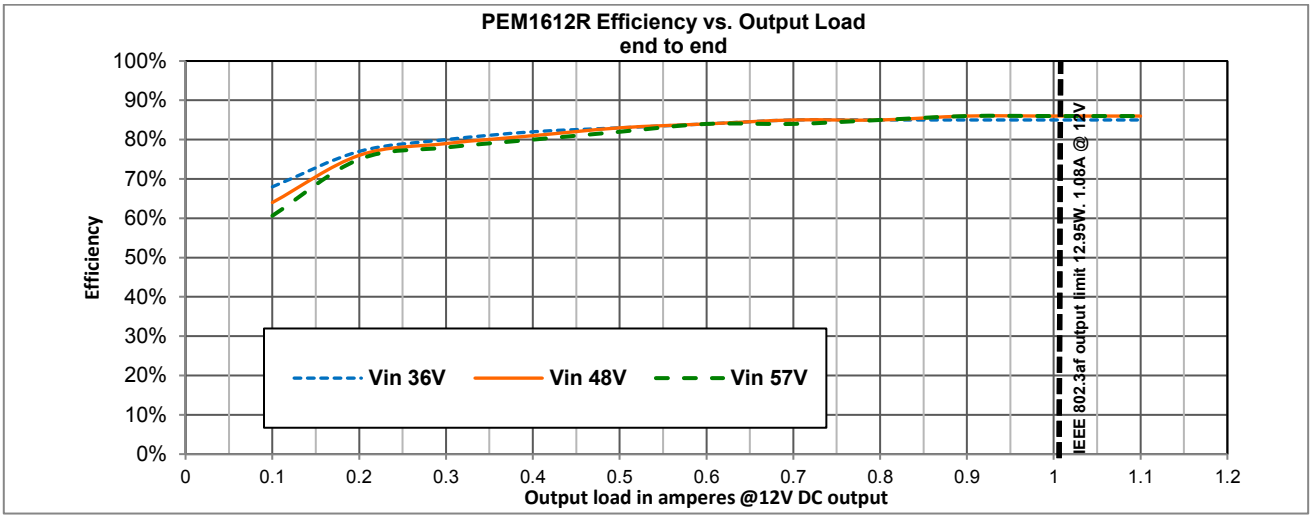


Figure 12

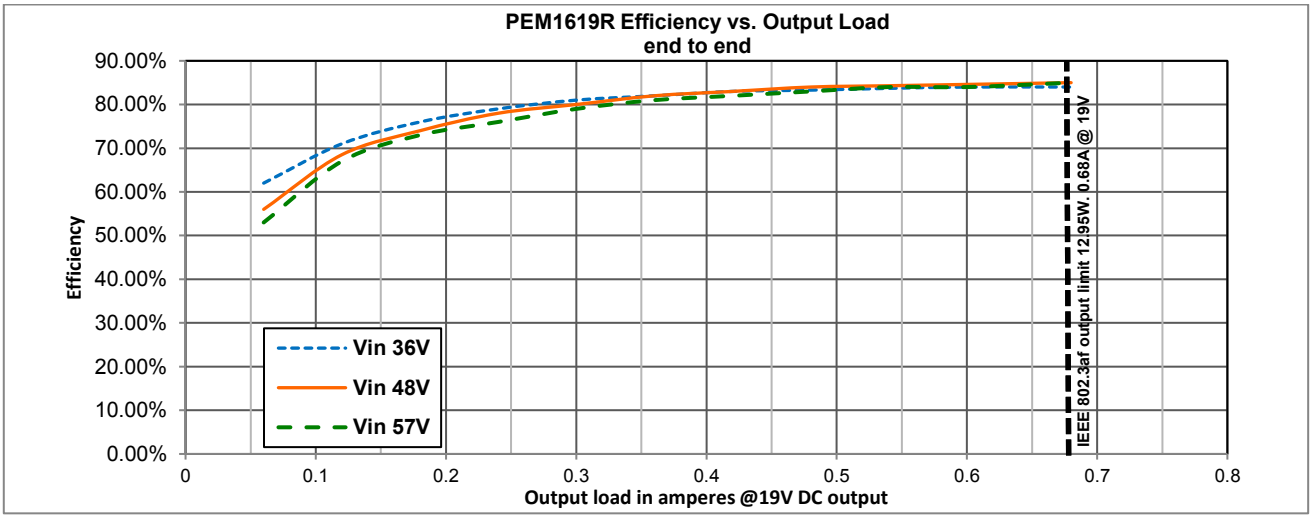


Figure 13

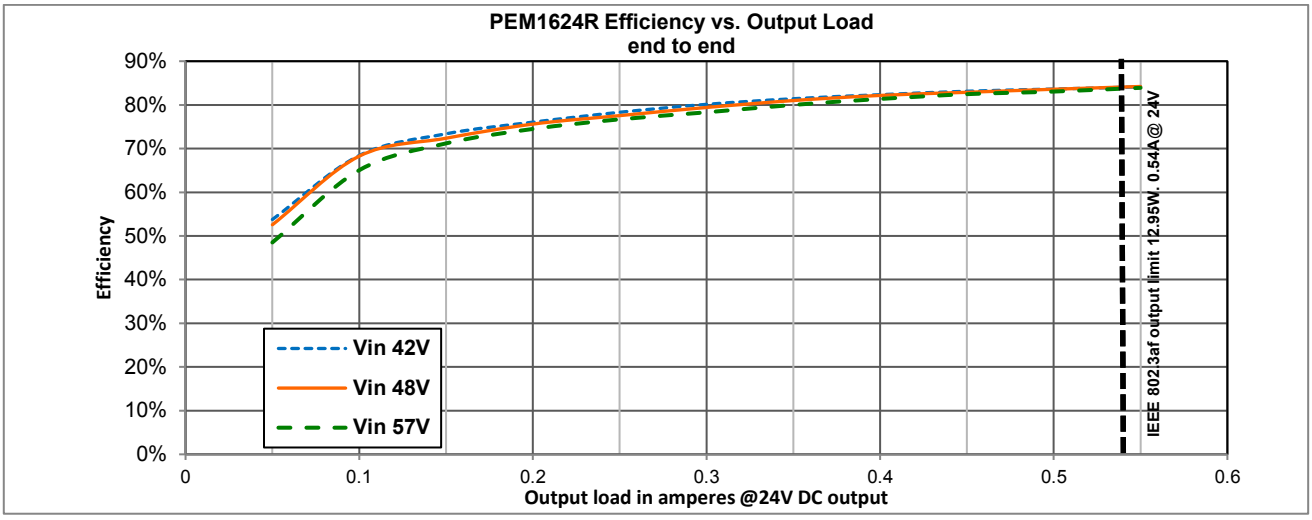


Figure 14

15. LOAD REGULATION V/S OUTPUT LOAD

(indicative values from one of our data)

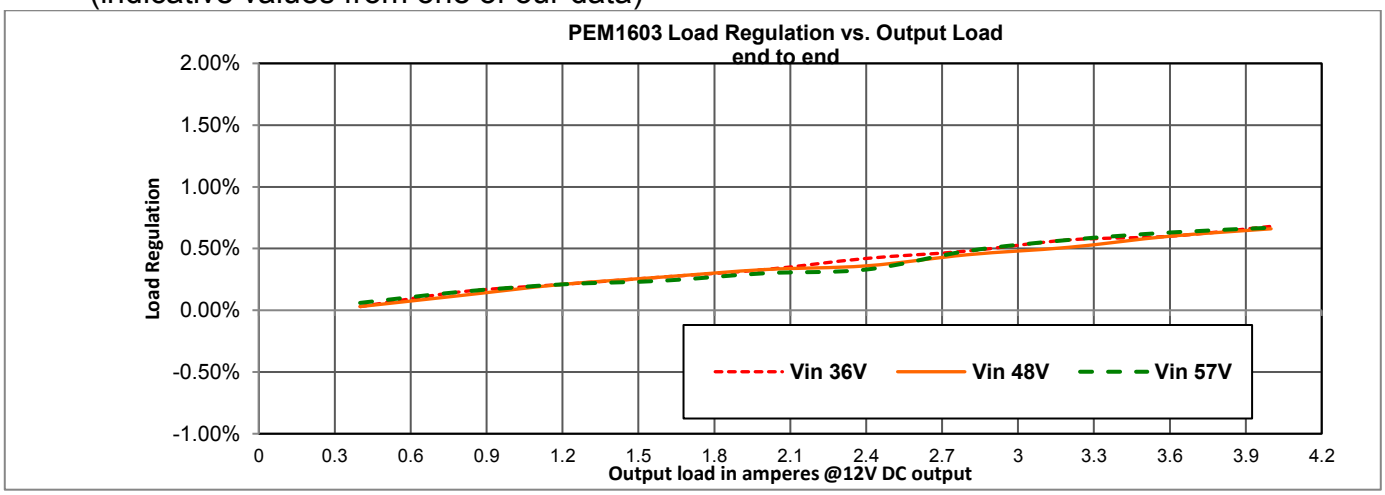


Figure 15

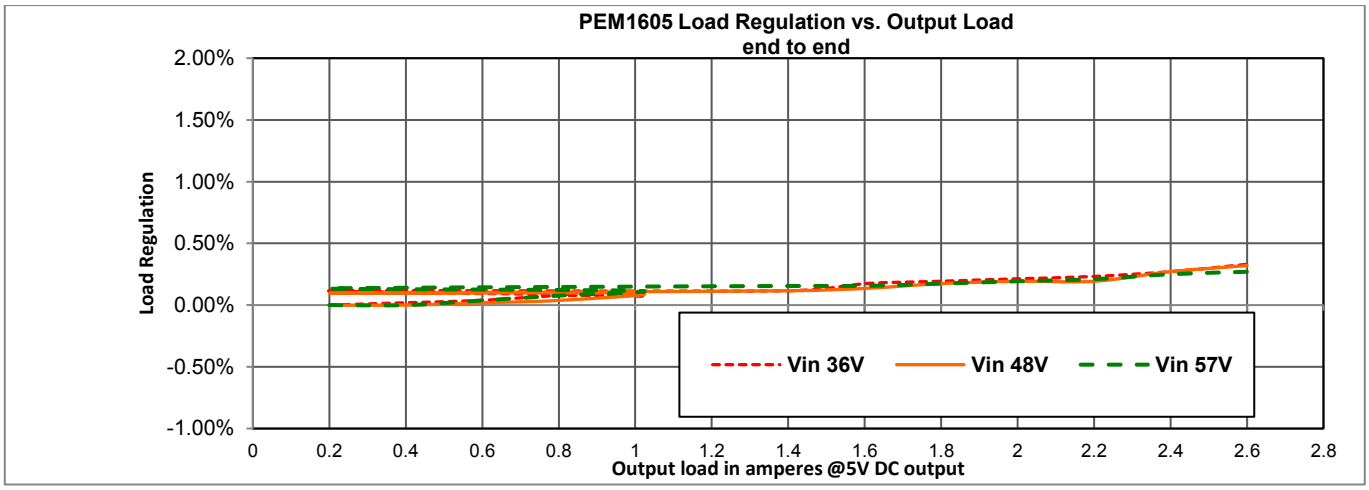


Figure 16

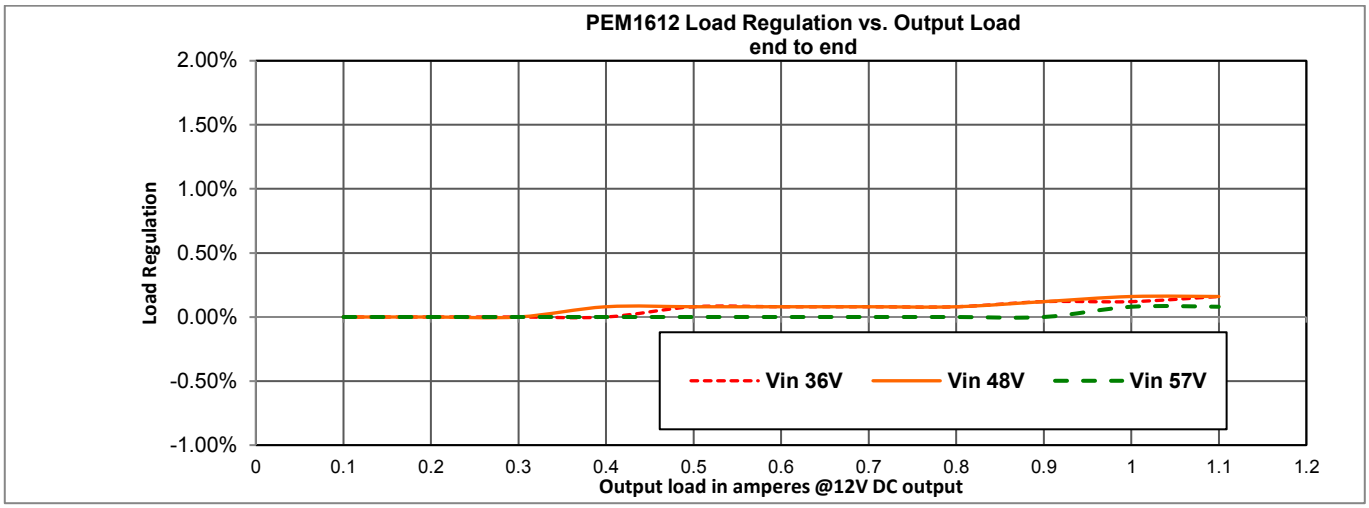


Figure 17

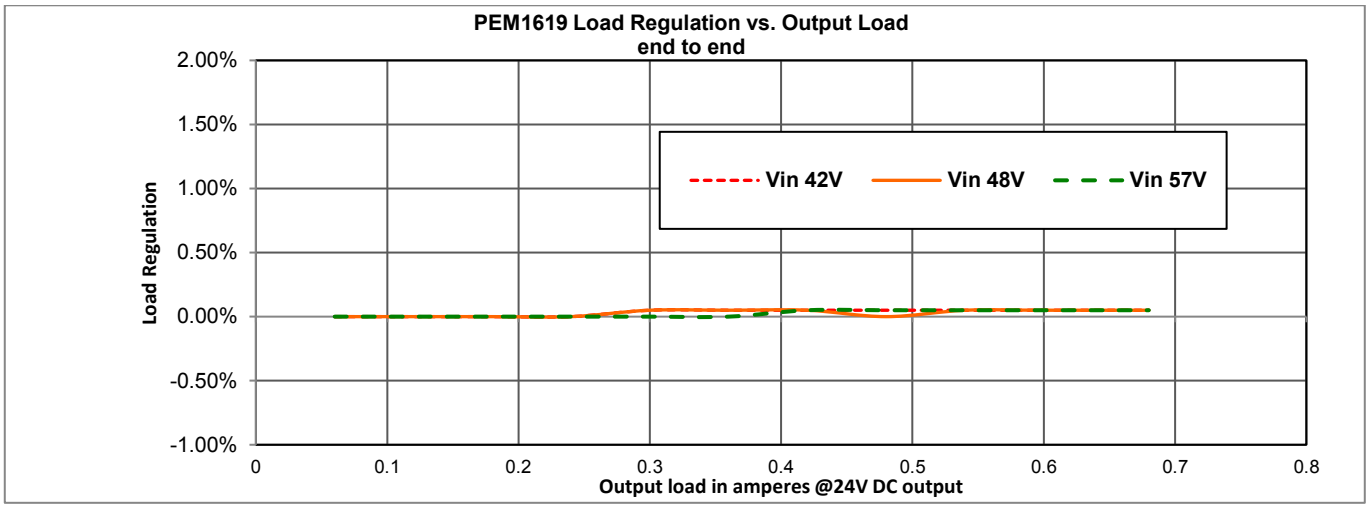


Figure 18

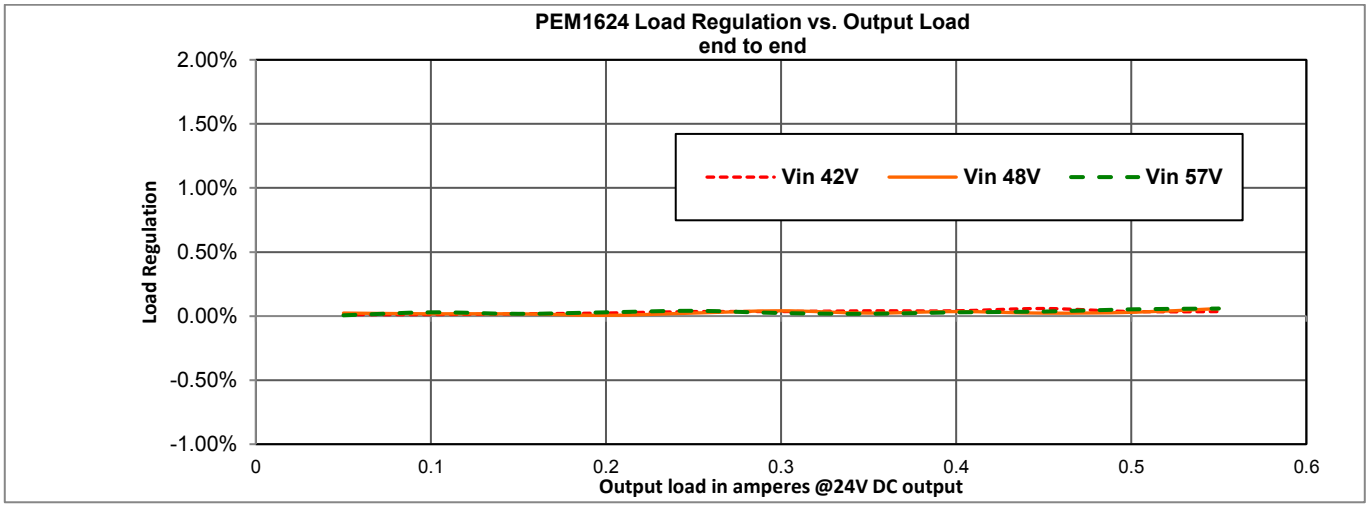


Figure 19

16. LINE REGULATION

(indicative values from one of our data)

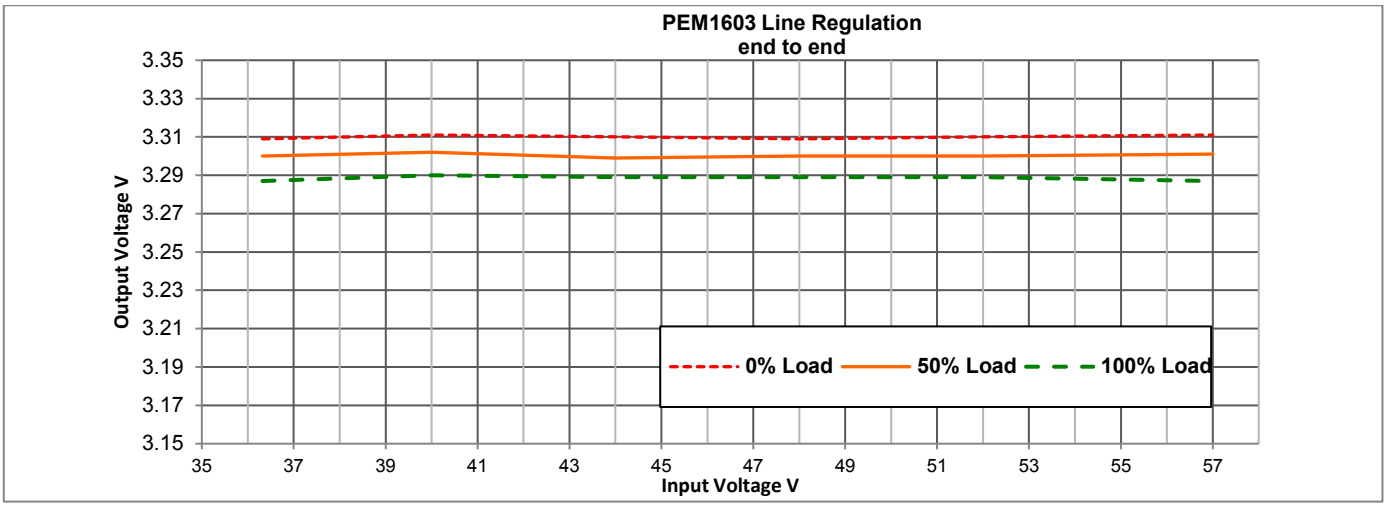


Figure 20

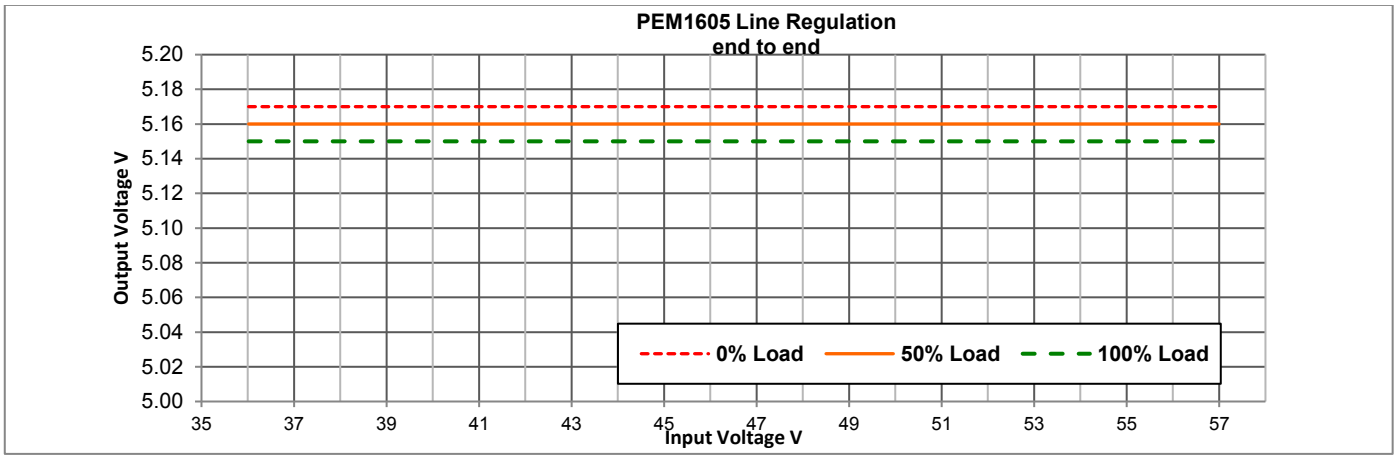
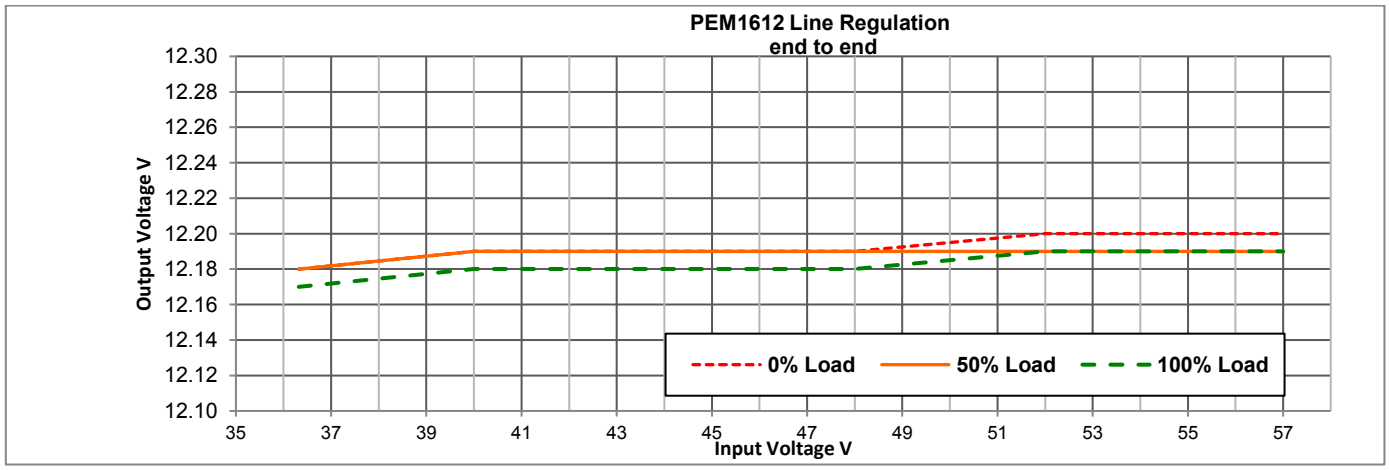


Figure 21



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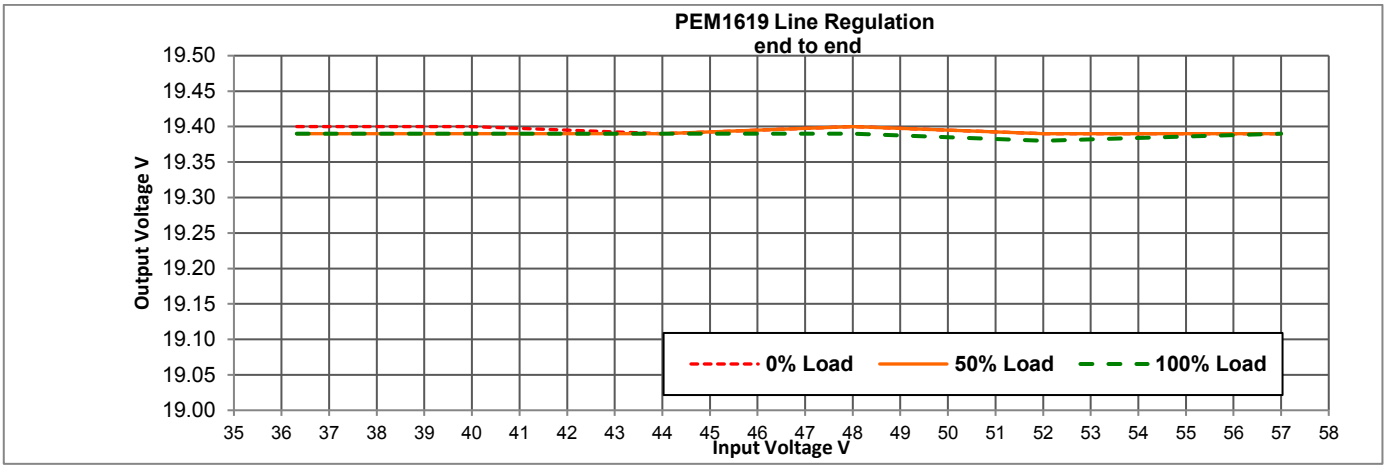

Figure 23

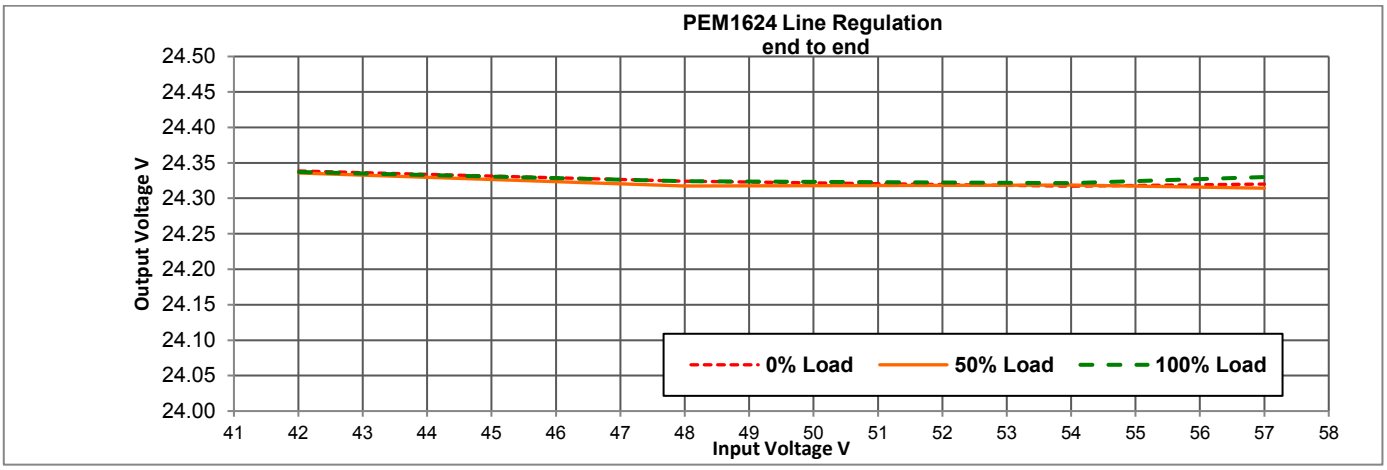

Figure 24

17. PHYSICAL PACKAGE

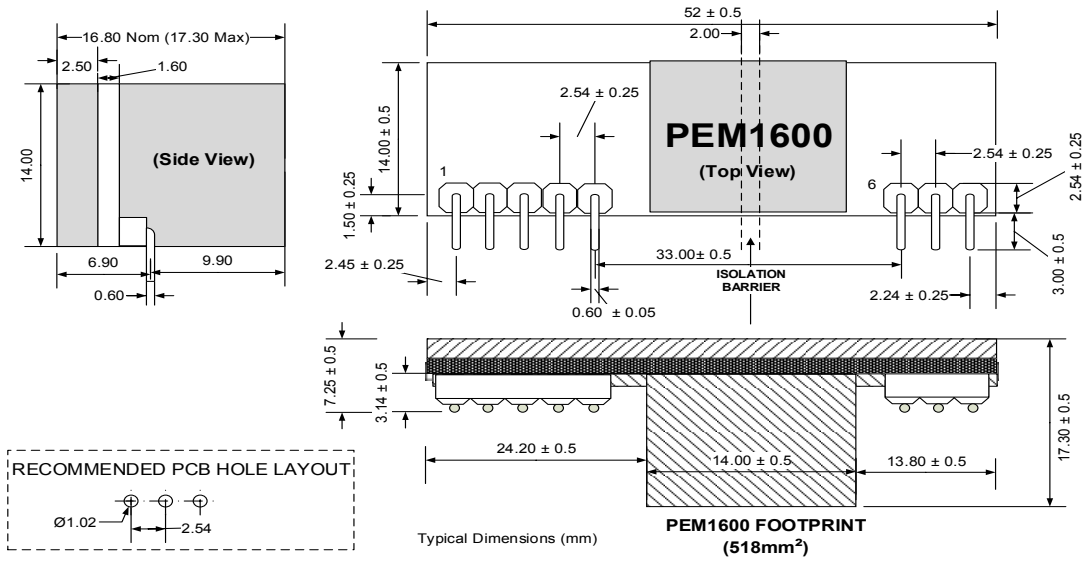

Figure 25

18. APPLICATON 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 PEM1600 series modules offering a modular solution, incorporating full IEEE802.3af compatibility signature to the PSE and isolated on-board DC/DC converter. The PEM1600 series are ideal modular system blocks allowing manufacturers of Ethernet equipment to “PoE enable” their equipment with minimal effort and cost. The PEM1600 modules series offer simple and quicker product development, maximising return on investment.

PEM1600 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.

19. APPLICATION AREAS

- Security and alarm systems
- Voice over IP phones
- Access control systems
- IP Cameras
- Displays, Net Monitors
- IOT (Internet of Things)
- Wireless access points
- Environmental control
- Public address systems
- Remote environmental monitoring

20. SAMPLE PoE SYSTEM CONFIGURATION

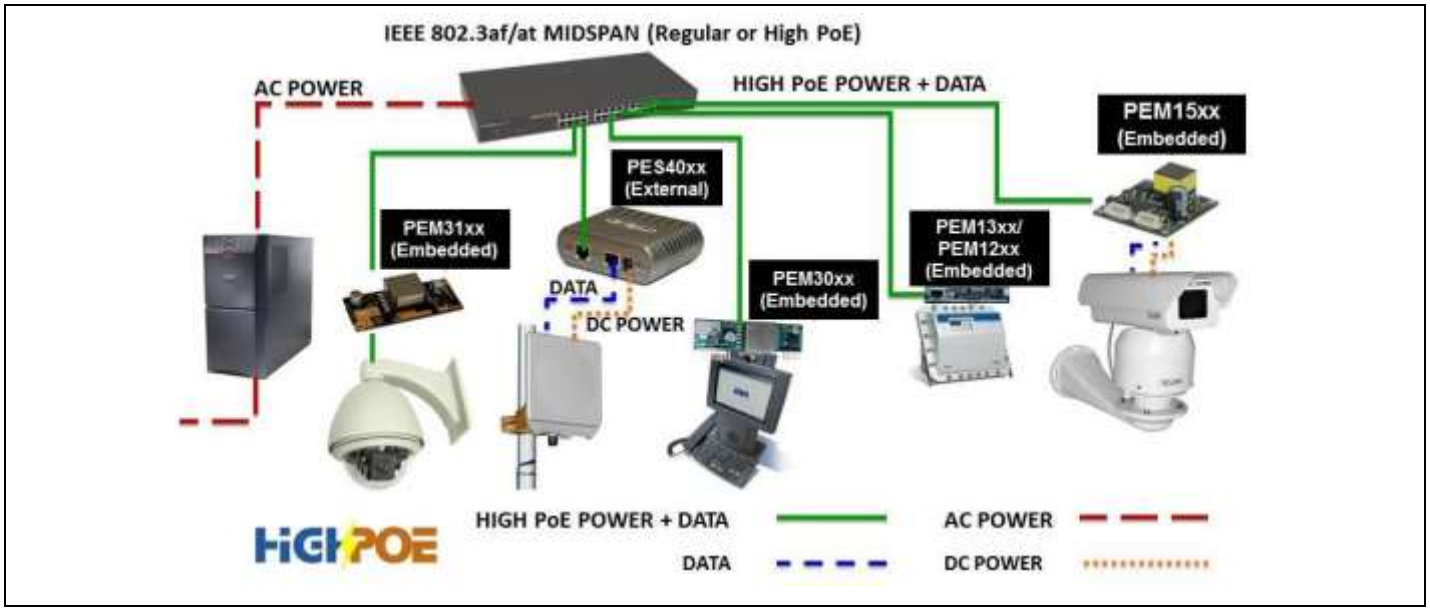

Figure 26

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