IEEE 802.3at Compliant 30W PoE PD Module

Features

- Compact IEEE 802.3at Class 4 PoE PD module
- 12V and 24V DC output voltage models
- Adjustable operating frequency[1]
- 30W peak and 24W continuous output power[2]
- Low output ripple and noise
- Continuous output short circuit and overload protection[3]
- Dedicated pin for Auxiliary Power & Remote Shutdown
- High efficiency 1500V isolated DC-DC converter
- Low EMI with in-built frequency dithering
- "AT Detect" pin for layer 2 classification
- Adjustable output voltage
- Minimal external component required (1 x 470µF ECAP on the output side)

Applications

- 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

Brief Description

The KPM5500 is one of the world's smallest full-power IEEE 802.3at and IEEE 802.3af compliant Power over Ethernet (PoE) Powered Device (PD) extraction modules. It delivers up to 30W peak power when powered by a compliant IEEE802.3at Power Sourcing Equipment (PSE) over twisted-pair CAT5e or higher Ethernet cable.

The KPM5500 supports fixed PoE Class 4 and two-event Physical Layer (Layer 1) classification, as per IEEE802.3at and supports Layer 2 classification through the dedicated "AT Detect" pin. It also supports Type 1 and Type 2 PD operation as defined in the IEEE 802.3bt standard.

Output ripple is controlled within IEEE specifications. For improved EMI performance, the KPM5500 features in-built frequency dithering along with a dedicated pin to adjust the switching frequency, enabling additional tuning for targeted EMI filtering. The module also supports an external auxiliary DC power input and provides a remote shutdown function, allowing the PoE supply to remain in standby mode.

The module is designed with the Kinetic Technologies' **KTA1137A** (PoE PD and DC-DC controller) and features a high-efficiency, 1500V safety-isolated DC-DC converter with in-built under-voltage, over-voltage, output overload, and short-circuit protection. It requires minimal external components and provides a quick, easy, and cost-effective method for system designers to "PoE enable" their end device.

1. Please refer to FREQUENCY ADJUSTMENT section for details.
2. 30 Watt peak for a maximum of 30 seconds at a 10% duty cycle. Refer to the THERMAL MANAGEMENT section for operating temperature limits.
3. If the maximum power is exceeded, Module will operate in overcurrent mode and will auto recover once the overload condition is removed.

Ordering Information[4]

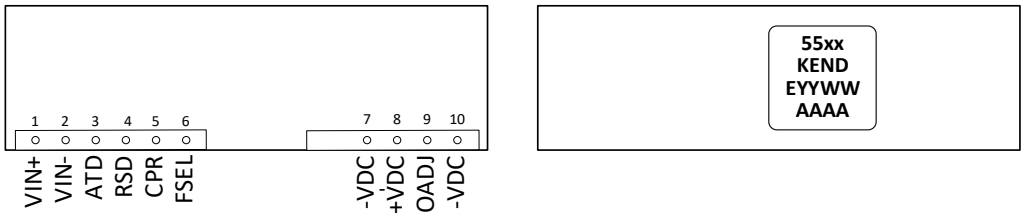
Part Number[5]	Marking[6]	Output Voltage[7]	Efficiency[8]	IEEE Power Classification	Maximum Output Power
		(Volts DC)	(%)	(%)	(Watts)
KPM5512KEND-TV	5512 KEND EYYWW AAAA	12	89	Class 4	24 continuous 30 peak
KPM5524KEND -TV	5524 KEND EYYWW AAAA	24	86	Class 4	

Pin Descriptions

	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.
3	**ATD**: AT Detect Pin. Refer to the AT DETECTION (ATD Pin) section for details.
4	**RSD**: This pin can be used to remotely shutting down the module from the target device. For more details refer to the REMOTE SHUTDOWN (RSD) section.
5	**CPR**: This pin is used for Remote shutdown. For more details refer to the REMOTE SHUTDOWN (RSD) section.
6	**FSEL**: This pin can be used to adjust the switching frequency. For more details refer to the FREQUENCY ADJUSTMENT section.
	OUTPUT PINS
7	**-VDC**: The ground return for the +VDC output (internally connected to pin 10).
8	**+VDC**: This pin provides the regulated output from the DC-DC converter.
9	**OADJ**: The output voltage can be adjusted from its nominal value. For more details refer to the OUTPUT VOLTAGE ADJUSTMENT section.
10	**-VDC**: The ground return for the +VDC output. (Internally connected to pin 7).
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 Package Information.	

Pin Diagram

Top View



Top Mark

55xx = Device ID,
KEN = Part Number Extension, D = Dithering Function
EYYWW = Date Code
AAAA = Serial Number

4. Electrical specifications and measurements in this datasheet are referenced to the respective input and output pins, wherever applicable. All readings in this data sheet are taken at an ambient temperature of 25°C, unless otherwise specified.
5. Part numbers in **Bold**, are available today. For non-bold part numbers, please contact your local sales representative for availability.
6. 55xx = Device ID, KEN = Part Number Extension, D = Dithering Function, E = Manufacturing Code, YYWW = Date Code, AAAA = Serial Number.
7. Output voltage is typical ±3% at an ambient temperature of 25°C with nominal input voltage and rated output current.
8. Typical values are measured at nominal V_{IN} with 67% output load at an ambient temperature of 25°C.

Absolute Maximum Ratings[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)

Electrical Characteristics

INPUT CHARACTERISTICS

Parameter	Symbol	Min.	Typ.	Max.	Units
Input Voltage (DC)[10]	V_{IN}	36	51	57	V
Under Voltage Lockout	V_{UVLO}	30		36	V
Input Current (DC)[11]	I_{IN}	100[12]		600	mA
Operating Temperature	T_{OP}	-20	25	70	°C
IEEE 802.3at/af Power Classification[13]	Class 4				

DC OUTPUT CHARACTERISTICS

Parameter	Symbol	Min.	Typ.[14]	Max.	Units
Line Regulation[12]	V_{LNRG}		0.2		%
Load Regulation[12]	V_{LDRG}		0.5		%
Output Ripple and Noise[4, 12, 15]	V_{RIP}		50	150	mV
Isolation Voltage (DC)	V_{ISOL}			1500	V
Temperature Coefficient (slope)	TC		100	300	ppm/ °C
Output Short Circuit Duration (at ambient 25°C)				—	Sec

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.
10. Ensure minimum output load of 1W or 100mA input current whichever is higher.
11. Refer to the IEEE 802.3at/af standards document.
12. A minimum current is required to maintain the power signature as defined by IEEE 802.3af/at standards
13. Refer to the POWERED DEVICE (PD) SIGNATURE and POWER CLASS PROGRAMMING section for more details.
14. Typical values are measured at nominal V_{IN} with 67% load at an ambient temperature of 25°C.
15. Output Ripple is measured along with and across the Output ECAP under typical connection conditions.

Functional Block Diagram

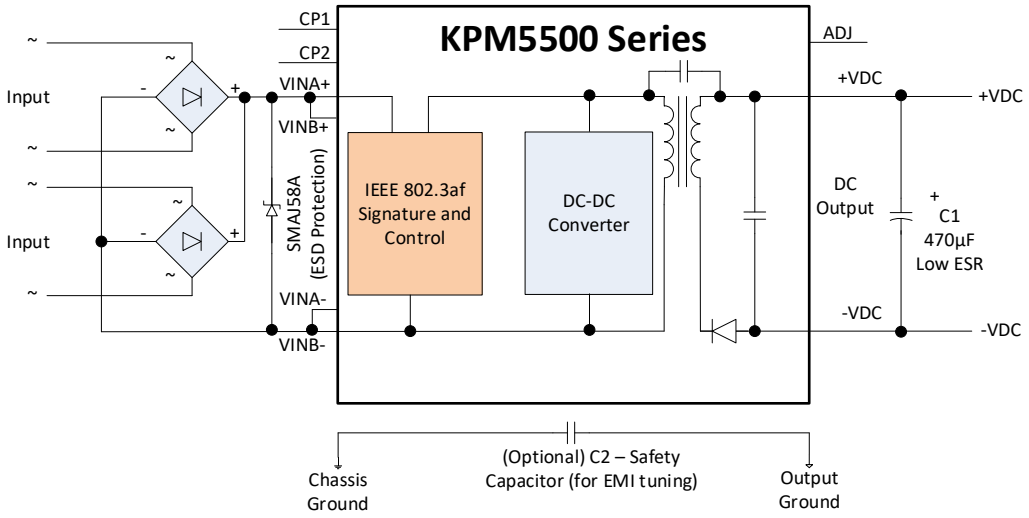


Figure 1. KPM5500 Series Block Diagram

Functional Description

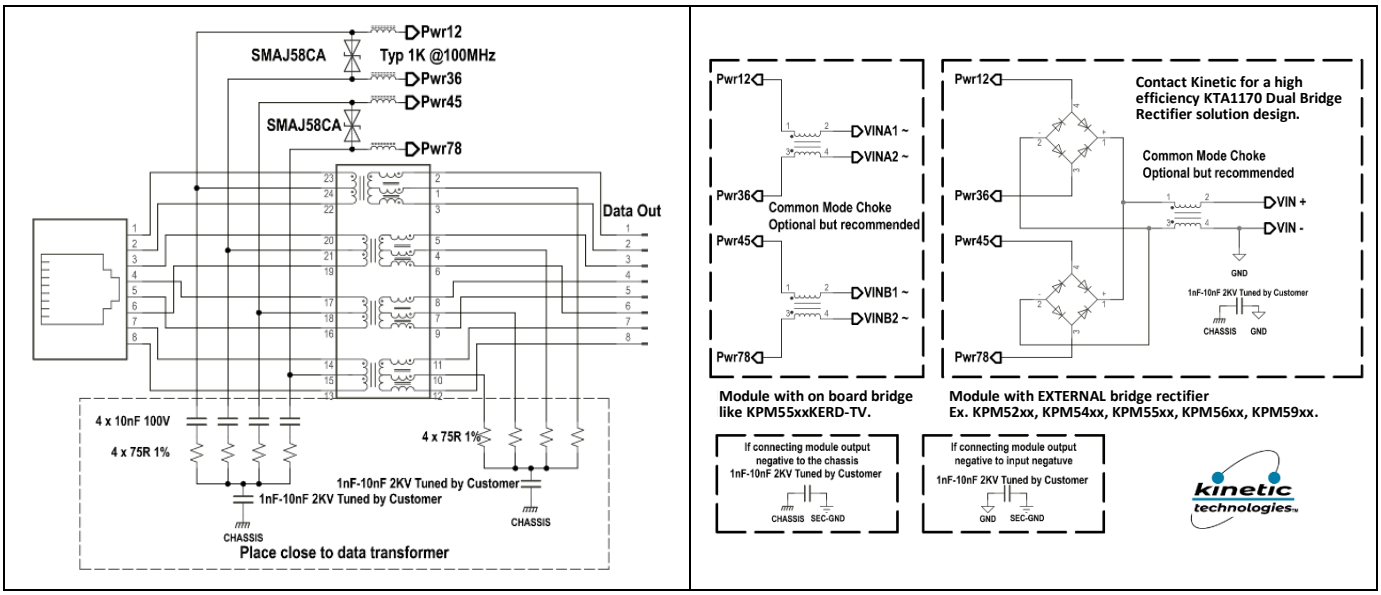


Figure 2. Typical Input Connections

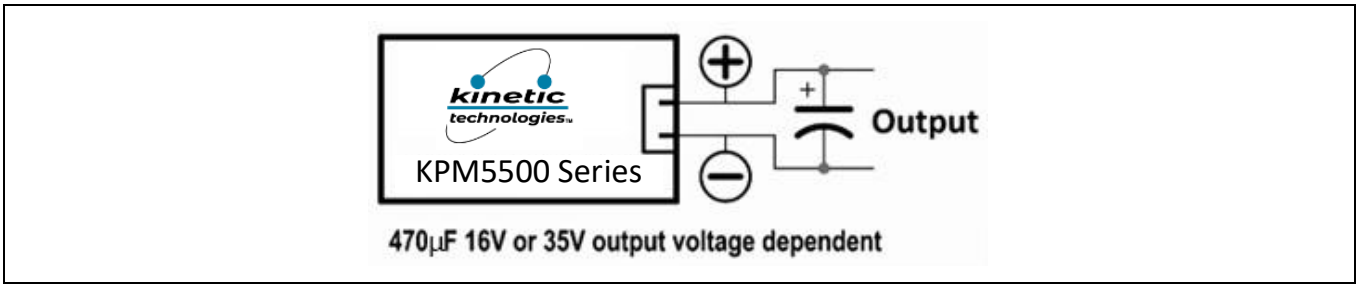


Figure 3. Typical Output Connections

INPUTS

The KPM5500 is compatible with all IEEE 802.3af/at compliant Power Sourcing Equipment (PSE) and supports the different power injection options data/signal pairs (Mode A) or spare pair (Mode B). For more information, refer to the IEEE 802.3af and IEEE 802.3at standards.

The KPM5500 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 KPM5500 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.

POWERED DEVICE (PD) SIGNATURE and POWER CLASS PROGRAMMING

When the KPM5500 is connected to a CAT5e or higher Ethernet cable from an IEEE 802.3af/at 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.

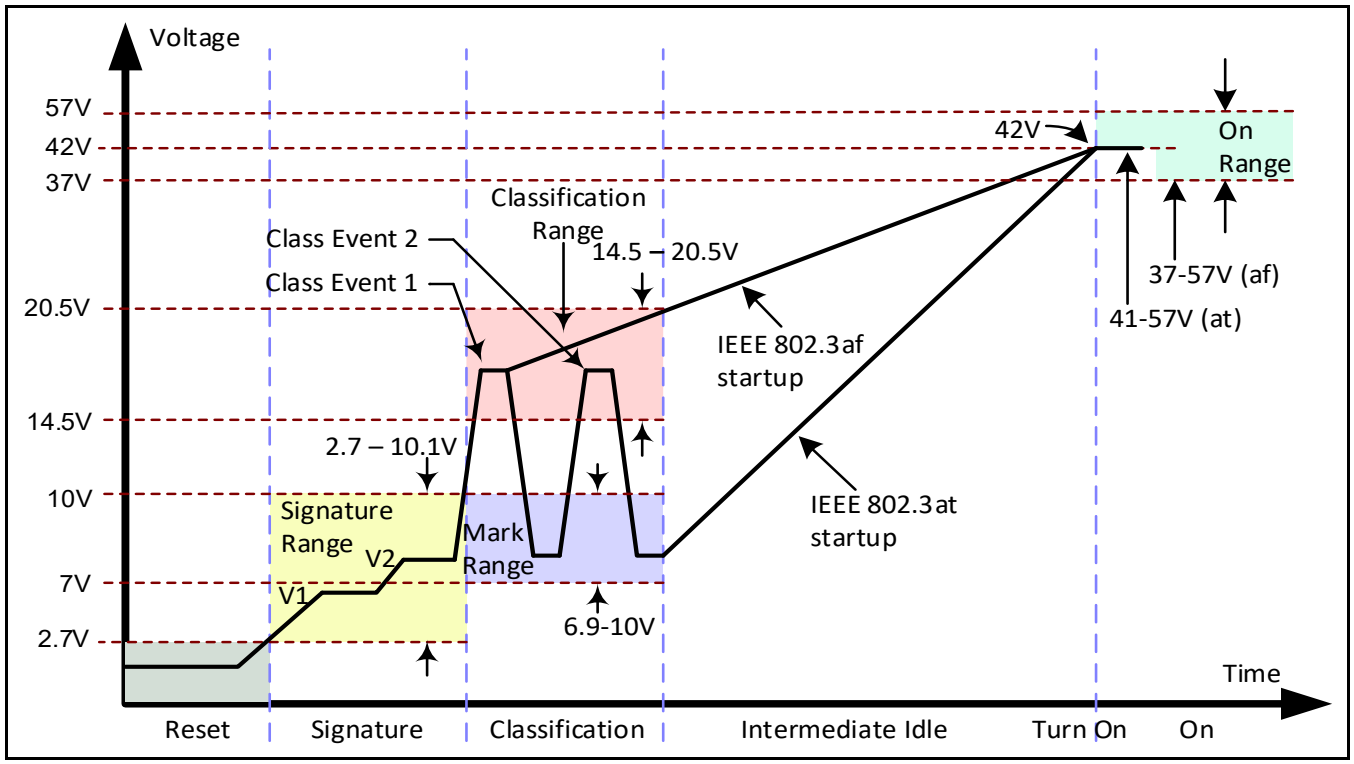


Figure 4. Two Event Physical Layer (Layer 1) Classification

ISOLATION

The IEEE802.3af/at standards requires that a Powered Device (PD) meet safety isolation requirement by passing the electrical strength test specified in IEC 60950, sub-clause 6.2. The KPM5500 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 9, 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 KPM5500 is mounted to ensure compliance with the isolation requirements.

IEEE PoE POWER CLASSIFICATION METHOD

The KPM5500 presents a fixed PoE Powered Device (PD) Class 4 classification. When connected to a Type 1 (IEEE 802.3af) Power Sourcing Equipment (PSE), the PSE will default to Class 0 operation. When connected to a Type 2 (IEEE 802.3at) PSE, the PSE will recognize the KPM5500 as a Class 4 PoE PD.

The KPM5500 supports Two-Event Physical Layer (Layer 1) classification in accordance with IEEE 802.3at, as illustrated in Figure 4 above. For Data Link Layer (Layer 2) classification, refer to the AT DETECTION (ATD Pin) section below.

AT DETECTION (ATD Pin)

If the KPM5500 detects a Type 2 PSE using the Two Event Physical Layer classification method, it asserts the ATD pin high (+5V), indicating a connection to a Type 2 PSE. If the PD controller detects only a single classification event, the PSE is identified as Type 1 and the ATD pin is asserted Low.

According to the IEEE 802.3at standards, to extract more than 15.4W power from the PSE, the host board controller must inform the PSE via the Layer 2 (Data Link Layer) that it is a Type 2 PoE PD. Full details are available in the IEEE 802.3at standards document.

The KPM5500 ATD pin can be connected to the host board through an optocoupler as shown in Figure 5 below.

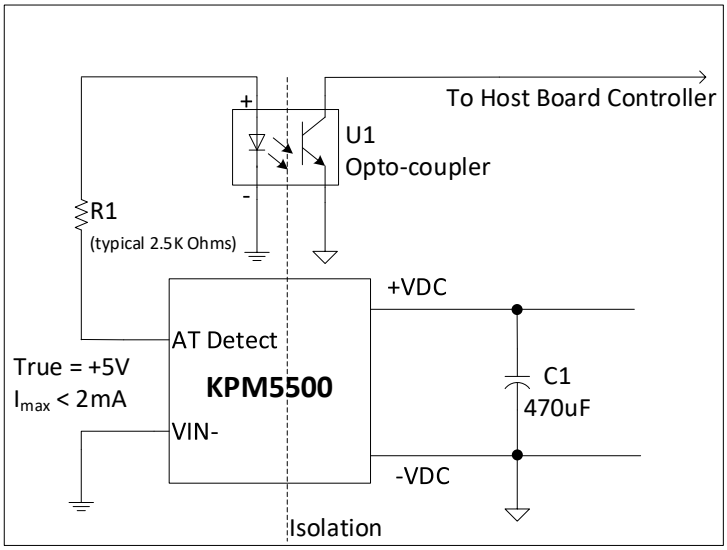


Figure 5. AT Detect Pin Connection

The value of R1 resistor should be selected to ensure the maximum current remains below 2mA under all operating conditions. The collector pin of opto-coupler U1 should be connected to the host board controller through a pull-up resistor.

When the KPM5500 is connected to a Type 2 PSE, the +5V signal on the ATD pin turns on the opto-coupler U1, causing its output to go low (Logic Zero). Using this indication, the host board controller can detect that the PSE is capable of delivering more than 15.4W and can then inform the PSE via the Data Link Layer that it is a Type 2 PD.

If the KPM5500 does not detect a Two-Event Physical Layer classification, the ATD pin remains low. As a result, opto-coupler U1 remains OFF, and its collector output stays high due to the pull-up resistor.

If the PSE does not support Physical Layer classification, opto-coupler U1 will also remain OFF.

REMOTE SHUTDOWN (RSD)

The KPM5500 series features a Remote Shutdown (RSD) function that allows the host board to disable the module output when required. This feature is particularly useful in systems that include an auxiliary power supply, enabling the designer to define the power-source priority between PoE and auxiliary power.

For example, when the auxiliary power supply is available, the host board can disable the KPM5500 output to prevent PoE power consumption. The RSD function can also be used to initiate a hardware reset by the host board based on SNMP.

The RSD pin may be connected to the host board through an optocoupler, as shown in Figure 6. It is required in order to maintain the 1500V isolation barrier between the PoE interface and the host circuitry.

To shut down the KPM5500, the host board needs to pull the RSD pin from Zero to High. When the RSD pin is activated, the output of the KPM5500 will switch off. The RSD pin is a current-mode input, and its operating limits are specified in Table 1.

If the remote shutdown feature is not used, the RSD pin must be connected to VIN−.

Table 1. Remote Shut Down

Description	Unit	Min.	Typ.	Max.
RSD pin threshold low	µA			20
RSD pin threshold high	µA	100		
Input voltage RSD pin	V			6

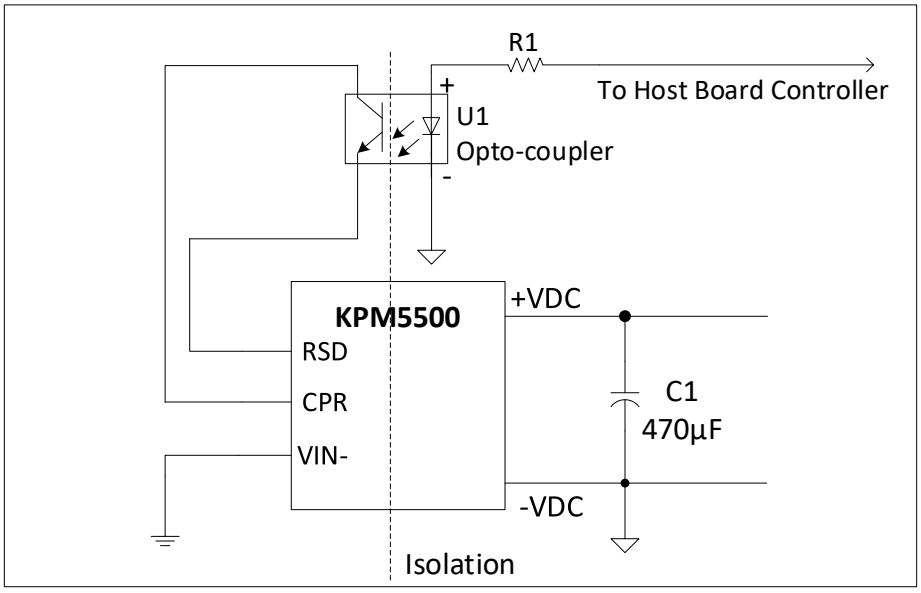


Figure 6. Remote Shut down Connection

When the RSD pin is asserted, the AT Detection (ATD) pin is forced High, irrespective of the PD operating mode. Refer to Table 2 for the ATD output definitions under the various power-up and operating modes. For additional information or application support, please contact Kinetic Technologies technical support.

Table 2. ATD Truth Table

ATD Signal Status	PSE	
	Type 1	**Type 2**
RSD = Low	Low	High
RSD = High	High	High

OUTPUT VOLTAGE ADJUSTMENT

The KPM5500 series feature 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. The output voltage must not be adjusted by more than ±10% or ±1.5V (whichever is lower) from the nominal value to ensure safe and reliable operation. The Maximum output voltage of the KPM5524 is 24.5V. All voltage measurements are specified and must be taken at the output pins of the module. An estimated resistance value for voltage adjustment is provided below. Customers should fine-tune the most appropriate resistance value as required.

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

Table 3. Output Voltage Adjustment

KPM5512			**KPM5524**		
Output Voltage	OADJ to +VDC	OADJ to -VDC	Output Voltage	OADJ to +VDC	OADJ to -VDC
11V	117KΩ		22V	305KΩ	
11.50V	232KΩ		22.99V	606KΩ	
12V	DNP	DNP	24V	DNP	DNP
12.5V		85.6KΩ	24.99V		94.2KΩ
13V		39.5KΩ	25.99V		44.2KΩ

FREQUENCY DITHERING

The KPM5500 series is built with a frequency dithering circuit to help better control EMI (electromagnetic interference) emissions. The nominal switching frequency of the KPM5500 series is 300kHz, with a dithering range of ±10%.

OUTPUT

The system load circuit should be connected across the KPM5500 +VDC and –VDC output pins. To maintain the specified output regulated voltage, a low ESR 470µF capacitor must be connected between the +VDC and -VDC pins external to the KMP5500 module – refer to the Figure 1 Block Diagram and Figure 3 for connection details.

FREQUENCY ADJUSTMENT

To provide greater flexibility in EMI control, the KPM5500 allows designers to increase the switching frequency via the FSEL pin. This feature must be used with great care and only in consultation with Kinetic technical support. Always use a resistor with maximum 1% tolerance and minimum 1/16W power rating must be connected between the FSEL pin and VIN-.

As an example, a resistance value of approximately 900kΩ will result in an increase of about 10% in the switching frequency.

THERMAL MANAGMENT

As with any power component, the KPM5500 modules generate heat. It is important to ensure adequate ventilation and airflow during the design stage. The amount of heat generated by the KPM5500 depends on the output load it is required to drive. The maximum ambient operating temperature is 70°C. Figure 7 shows the thermal performance of the KPM5500 with a nominal 51V DC input.

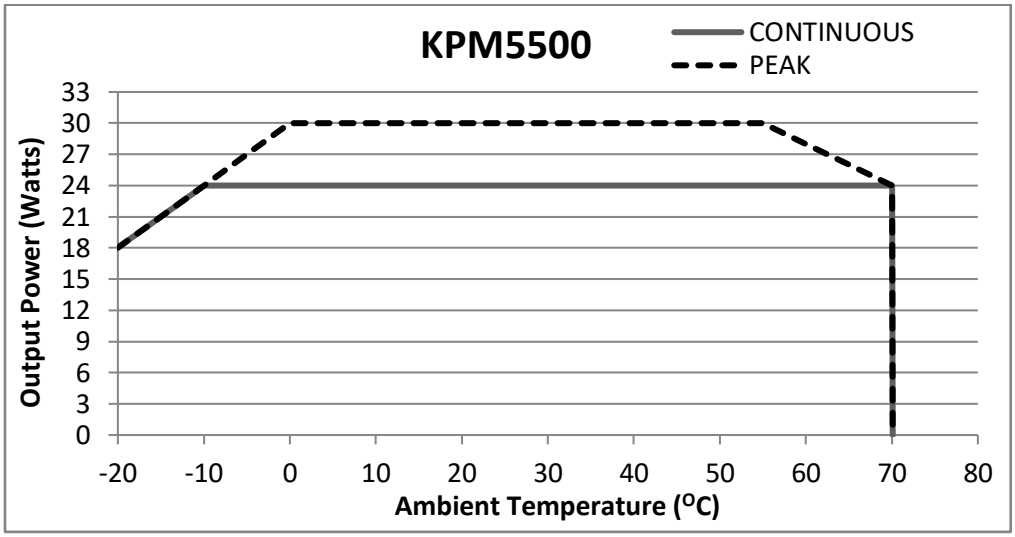


Figure 7. Thermal Performance Profile at Nominal V_{IN}

POWER PLANE HEAT SINK

A power-plane heat sink on the motherboard is a relatively simple method to draw heat away from the KPM5500 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**.

Thermal performance can be improved by applying forced airflow over the module and by using a heat sink (a) glued to the 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.

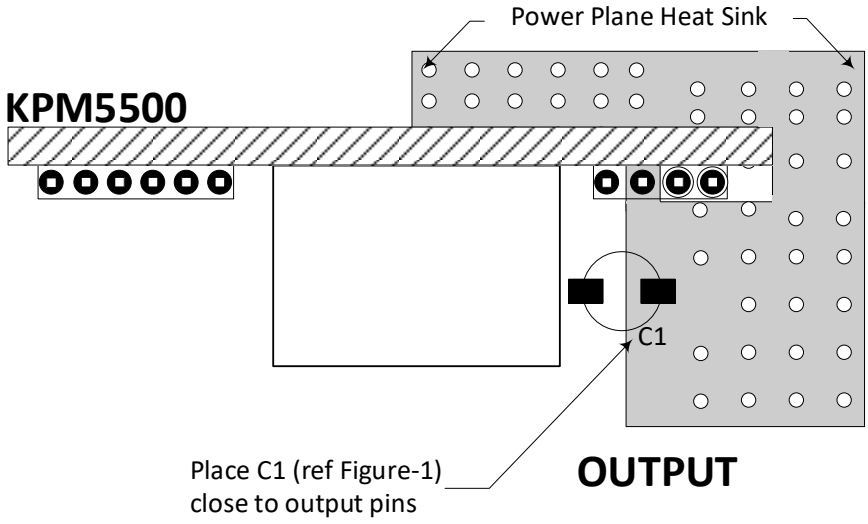


Figure 8. Power Plane Heat Sink

IEEE 802.3 POWER LEVELS AND CLASSES for PoE Powered Devices

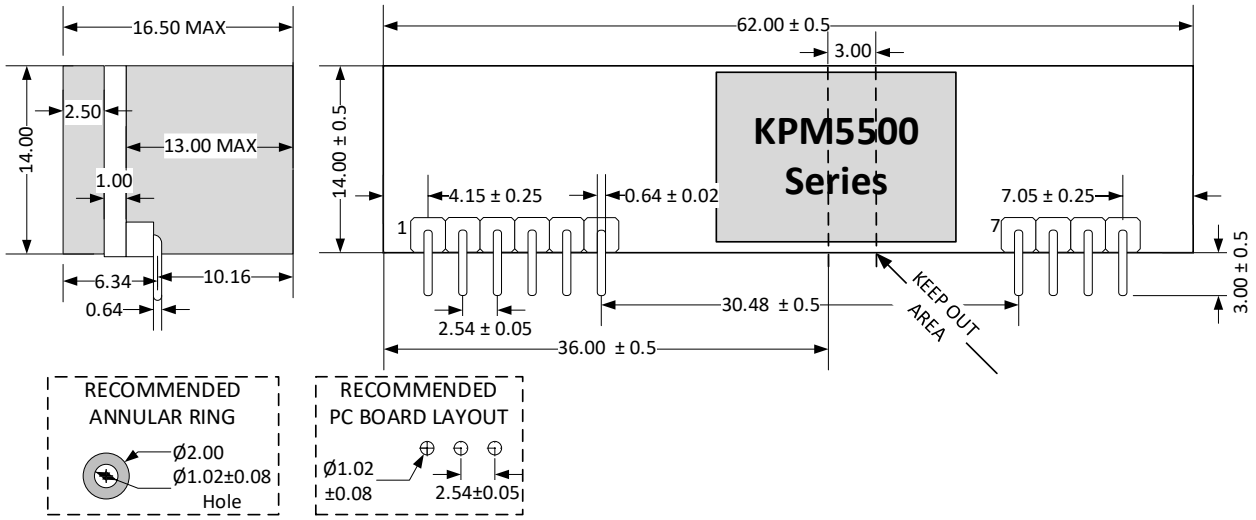
IEEE Standard	Common Name	PD Class	PD/PSE Type	Max Num. of Events	PD Power[1]	PSE Power[2]	Wire Pairs Energised
802.3af	PoE	0	1	–	12.95W	15.4W	2
802.3af	PoE	1	1	1	3.84W	4W	2
802.3af	PoE	2	1	1	6.49W	7W	2
802.3af	PoE	3	1	1	12.95W	15.4W	2
802.3at	PoE+	4	2	2	25.5W	30W	2

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.

Packaging Information

Mechanical Dimensions

All dimensions in mm and nominal unless stated otherwise



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 IEEE 802.3at and IEEE 802.3af. Compliance with this standard ensures inter-operability between devices.

The KPM5500 series modules offering a modular solution, incorporating Layer-1 IEEE 802.3at/af compatibility signature to the PSE and isolated on-board DC-DC converter. The KPM5500 series are ideal modular system blocks allowing manufacturers of Ethernet equipment to “PoE enable” their equipment with minimal effort and cost. The KPM5500 modules series offer simple and quicker product development, maximizing return on investment.

The KPM5500 can be powered using a user designed power supply which has adequate thermal and over-current protection. It is strongly recommended that only IEEE 802.3at/af compliant power supply equipment be used to prevent damage to the module, which lacks output stage thermal protection.

ESD AND SURGE PROTECTION

It is essential for system designers to incorporate Electrostatic Discharge (ESD) and surge protection measures at the input of the KPM55xx to safeguard against damage from over-voltage surges and to ensure compliance with system EMC and ESD standards. This can be achieved by using a TVS diode, such as the SMAJ58A (uni-directional) or SMAJ58CA (bi-directional). These diodes effectively clamp voltage spikes, providing protection for the module and enhancing the overall reliability of the system.

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