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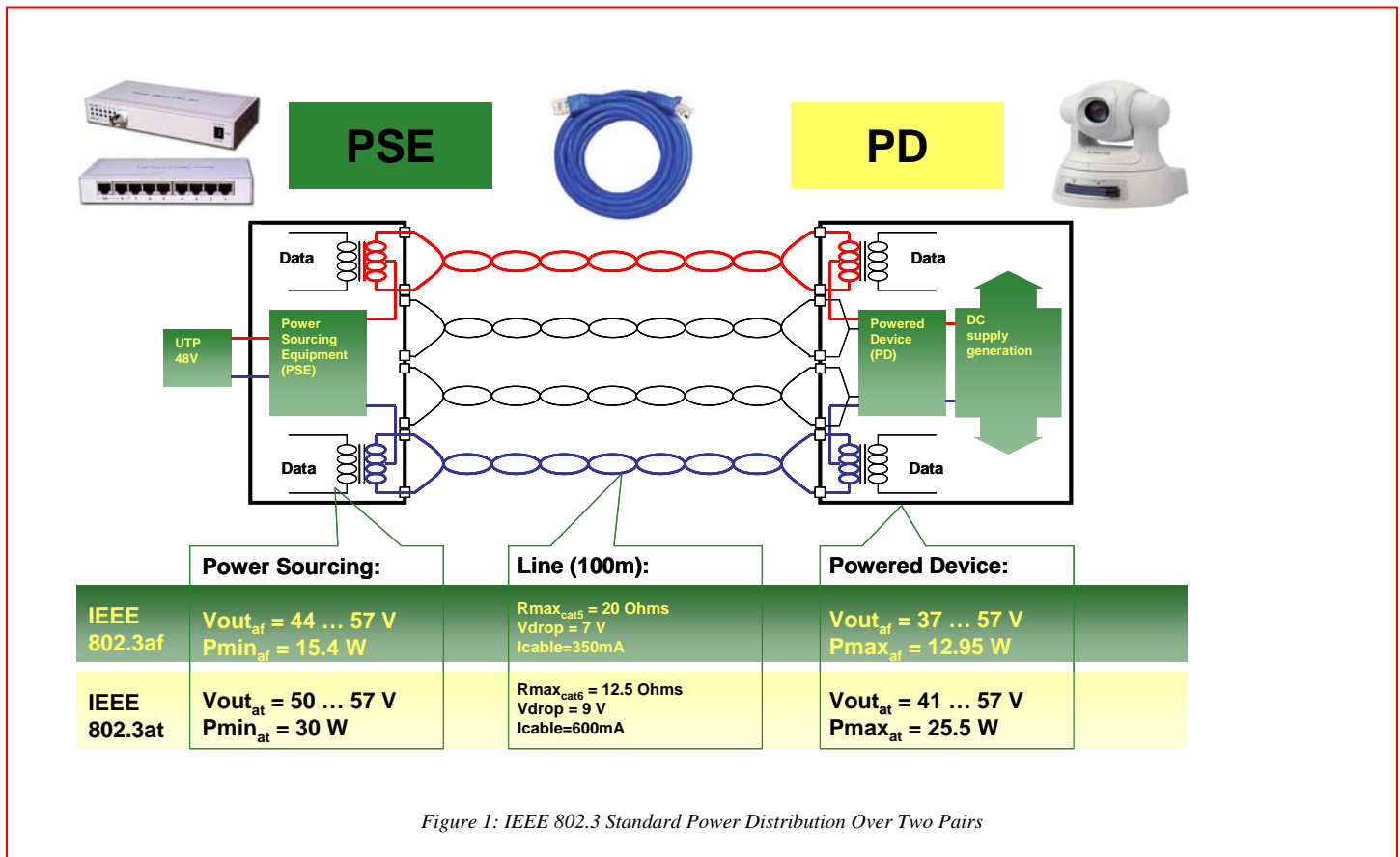
1.0 Scope

This application note explains how the NCP1081 PoE-PD device can be used to deliver high power levels to applications over the Ethernet cable. Sufficient information is included to create complete end-to-end solutions with high power PoE-PSE equipment available on the market. An overview of different options and configurations is provided.

2.0 High Power Equipment

2.1 High Power PSE Equipment: Midspans and Power Injectors

The IEEE802.3af standard supports up to 13W of power distributed over the Ethernet cable. The IEEE802.3at (Draft 3.0) standard supports power levels up to 25.5W. Both standards describe power distribution over two pairs from the four pairs of the Ethernet cable as shown in Figure 1.



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The higher power level for the IEEE802.3at standard is accomplished by raising the minimum IEEE803.3af standard voltage on the cable from 44V to 50V. CAT5e/6 cable is proposed for high power applications due to lower resistance. The power level in IEEE802.3at is increased from 13W to 25.5W by also changing the maximum cable current from 350mA to 720mA. Note that the 25.5W power budget is not fully available for the PD load due to losses which occur in the PD circuit between the Ethernet input jack and the voltage regulator output. Power losses occur in the DC-DC converter block, in the input diode bridge and also in the PoE-PD device. An overall efficiency of 85 percent is realistic. This results in an application power budget of 11W for IEEE802.3af and 20.4W for IEEE802.3at.

Table 1: Power Budget Levels

	IEEE 802.3af	IEEE 802.3at	Option A	Option B	Option C	Option D
Cable (length 100m)	Cat 3	Cat 5e	Cat 5e	Cat 5e	Cat 5e	Cat 5e
Pairs used	2	2	2	2	4	4
Cable resistance (Ohm)	20	12.5	12.5	12.5	12.5	12.5
Max. current per pair (mA)	350	600	720	1100	550	720
Voltage by PSE (V)	44	50	56	56	56	56
Power by PSE (W)	15.4	30	40.3	61.6	61.6	80.6
Max. cable power loss (W)	2.4	4.5	6.48	15.1	7.5	12.9
Input power PD (W)	12.9	25.5	33.8	46.4	54.0	67.6
Efficiency of PD+ converter	85%	85%	85%	85%	85%	85%
Output power PD (W)	11.0	20.4	28.7	39.5	45.9	57.5
Overall efficiency	71%	70%	71%	64%	75%	71%

Some PoE applications require more power than the 25.5W possible with the IEEE802.3at (Draft 3.0) standard which limits the current to 600mA. The main reason for this limit is to reduce the generation of heat when a large number of Ethernet cables are bundled. Fortunately, it is possible to achieve higher power levels with proprietary configurations. Option A achieves higher power levels by increasing the minimum voltage level to 56V and the current up to 720mA. Option B combines raising the voltage to 56V and the current to 1100mA over two pairs. Option C delivers more output power than Option B but distributed over four pairs with a lower current 520mA per pair. Option D delivers about twice the power of Option A by distributing power over four pairs instead of two.

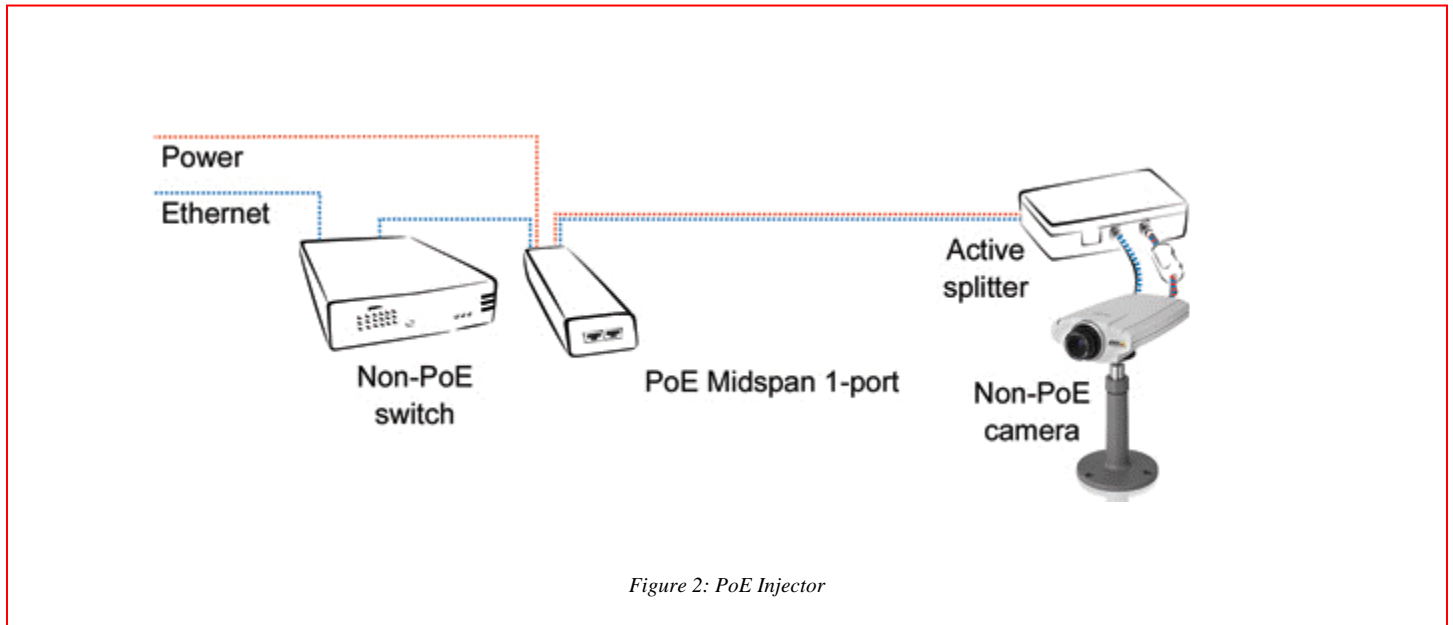


Figure 2: PoE Injector

Midspans are multiport power injectors placed in series with switches. An injector is a single port midspan. Figure 2 gives an overview on how a single port midspan (injector) injects power into the Ethernet cable. The power is retrieved from the cable via a splitter box. The NCP1081 can replace the high power splitter box delivering the required high power levels.

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Table 2 lists high power PSE switches, midspans and injector equipment currently available on the market. Two- and four-pair configurations are available.

- Pihong
 - Pihong has midspans and injectors in their product line.
 - Pihong has two-pair configurations up to 30W and 36W and four-pair versions up to 60W and 80W. The four-pair configurations have proprietary detection and the two-pair configurations have Class 4 classification. Class 4 classification does not include a Layer 2 handshake since the midspan had no data communication channel.
 - One NCP1081 device in combination with the Pihong two-pair 36W device can deliver 25W output power to the application with Class 4 classification (single-finger IEEE802.3at classification).
 - Two NCP1081 devices in combination with the Pihong two-pair Option C and D approach can be implemented with four-pairs to deliver more than 40W to the application.
- Korenix
 - Korenix has Ethernet switches with 30W per port. The equipment uses Class 4 and some include Layer 2 handshaking.
 - The NCP1081 can only deliver 20W to the application in combination with this equipment.
- Panduit
 - Panduit midspan delivers 30W per port. Classification is via Class 4 without Layer 2 handshaking.
 - The NCP1081 can only deliver 20W to the application in combination with this equipment.

Table 2: Overview of High Power PSE Equipment

Company	Type	Name	Power Watt	PSE Power Power Output/Port	PD Power PD Output	Ports	Pairs	Voltage Volt	Current mA/per Pair	Handshake
Pihong	Injector	POE20U	19.6	19.6	14	1	2	56	350	Class 4
	Injector	POE30U	30	30	20	1	2	56	550	Class 4
	Injector	POE60U	60	60	40	1	4	56	550	Proprietary 12.5K detection
	Injector	POE80U	80	80	57	1	4	56	720	Proprietary 12.5K detection
	Midspan	POE480U-4UP	240	60	40	4	4	?	?	Proprietary 12.5K detection
	Midspan	POE480U-8UP	480	60	40	8	4	?	?	Proprietary 12.5K detection
Pihong	Midspan	POE576U-8HP	288	36	25	8	2	?	550	Class 4
	Midspan	POE576U-16HP	576	36	25	16	2	?	550	Class 4
Korenix	Switch	Jetnet 4706	120	30	20	4	2	55	650	Class 4 Layer 2
	Switch	Jetnet 3706	120	30	20	4	2	55	650	Class 4 Layer 2
Panduit	Midspan	DPOE8	240	30	20	8	2	?	?	Class 4

2.2 Handshaking Protocols

The NCP1081 can handle all defined types of handshaking and is compatible with all the PSE equipment described above.

The classification process defined in the high power IEEE802.3at standard extends beyond the one defined in the low power 802.3af standard because it can be done in several ways. First the classification current in the PoE-PD must be set to the Class 4. Then the PoE-PD can be classified by the IEEE802.3at PSE based on Two Event Physical Layer classification (so called Layer 1), Data Link Layer classification (so called Layer 2) or a combination of both. However, high power PSE which are non compliant with the previous process can also be used with the NCP1081 if they use a proprietary current classification.

These handshaking protocols are explained in more detail in the following paragraphs.

2.2.1. High Power Classification: Two Event Physical Layer Classification (Layer 1)

This first method is characterized by a classification event being performed twice, meaning the PSE forces the PD to enter in the classification range two times. This is implemented in the hardware of the PSE and PD devices. Interest in this Layer 1 approach is mainly driven by the need for basic midspan equipment where it is desirable to avoid having to access the data channel stream. None of the equipment above is using this classification principle but the standard is evolving in this way for midspans and injectors.

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2.2.2. High Power Classification: Layer 2 Classification

A PSE performing Layer 2 classification classifies the PD in two phases. In the first phase the PSE performs a physical classification with one event (same procedure used in the IEEE802.3af standard). The classified PD is then powered up by the PSE under low power conditions, meaning that the power can not exceed the IEEE802.3af limits. The second phase occurs a very short period after power-up; the PD will communicate its required power level to the PSE via an Ethernet data packet. The IEEE802.3at draft specification suggests using the link layer discovery protocol (LLDP) according to the IEEE802.1AB-2005 specification that is being reworked and follows the messages described in the IEEE802.3at specification.

The designer will have to implement a LLDP agent, a software routine implementing a state machine that is providing access to the internal data base of the network device. Not all of the databases, such as management information base (MIB) that are commonly accessible via LLDP need to be implemented, but for sure the IEEE802.3at power management data sets needs to be implemented.

2.2.3. High Power Classification: Proprietary

A third method is proprietary. Since most midspan equipment does not currently support Layer 1 handshaking, most of the PSE equipment today uses a proprietary classification, typically using a one event physical classification handshake.

- Proprietary detection resistors are possible to enable four-pair configurations. The Pihong equipment uses a 12.5K Ohm resistor instead of 25K Ohm detection resistor.
- Another option is to use a one event Layer 1 classification using Class 4 to enable higher power levels without doing a Layer 2 classification. Most of the equipment above is using this principle. This principle is actually a single-finger Layer 1 handshake with reserved Class 4.

2.2.4. Handshaking Indication

The nCLASS_AT pin on the NCP1081 indicates to the microcontroller if a two event physical classification event occurred. Once it has been detected, the nCLASS_AT open drain pin goes low. In all other conditions, such as a one event physical classification handshake, the nCLASS_AT pin stays high.

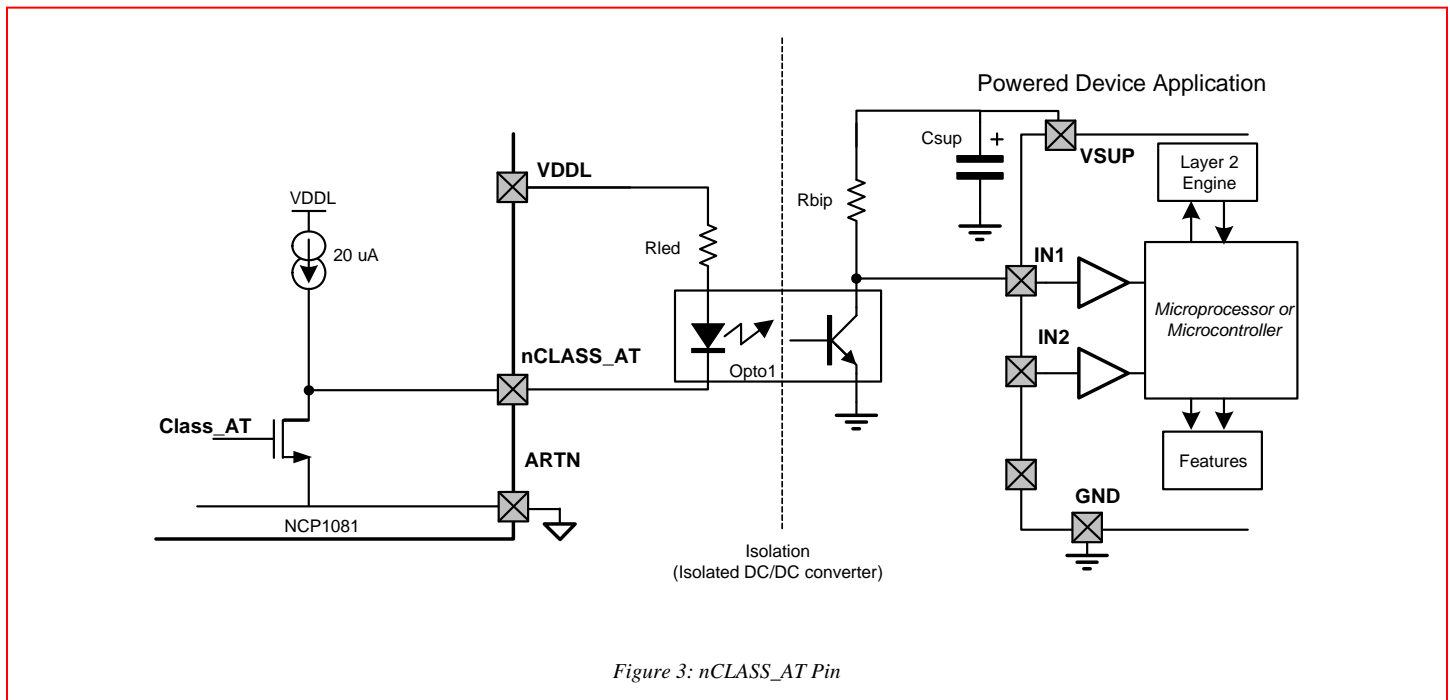


Figure 3: nCLASS_AT Pin

- Connecting the NCP1081 to a Pihong midspan keeps the nClass_AT pin high.
- Connecting to an IEEE802.3at compliant midspan will bring the nClass_AT pin low.

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3.0 High Power Configurations

3.1 20W or 30W Single Output

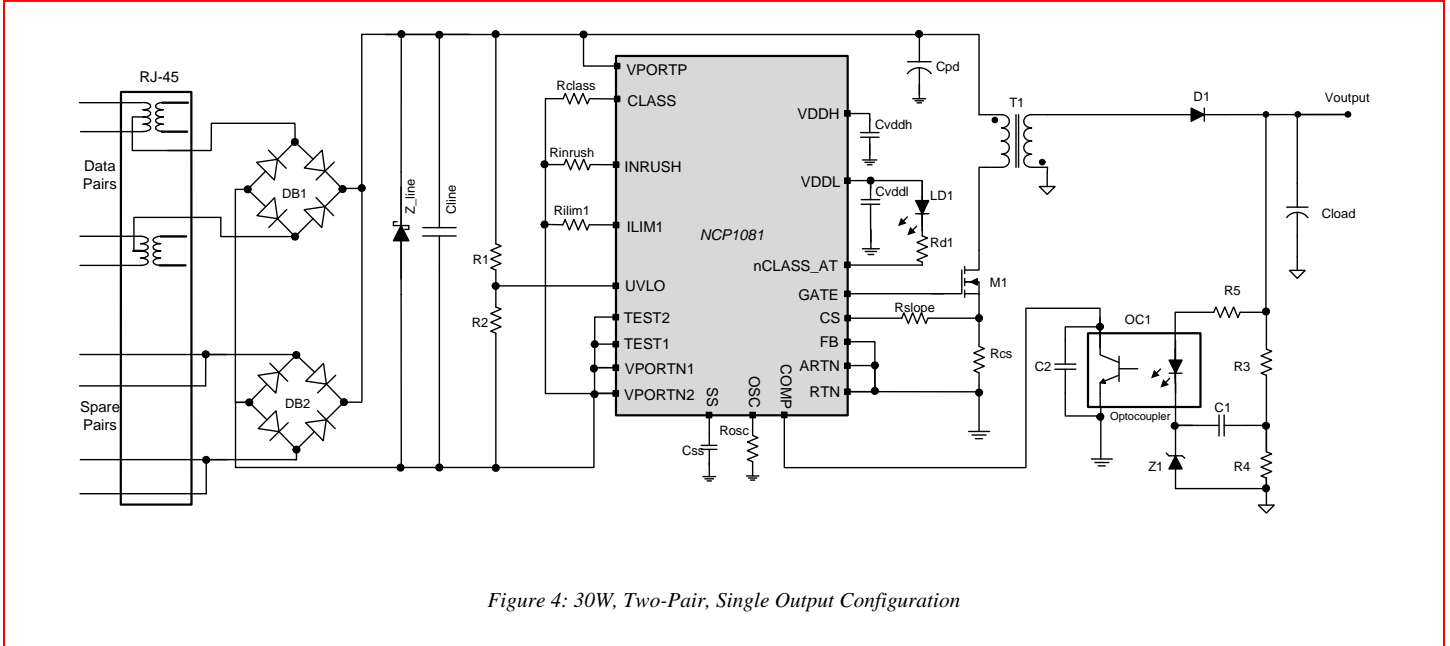


Figure 4: 30W, Two-Pair, Single Output Configuration

- The POE30U midspan can deliver 30W of power to the cable by injecting 550mA at 56V. A single NCP1081 delivers 20W to a 24V output. The PoE-PD efficiency from input RJ45 jack to output is estimated to be 85 percent. Using a Cat5e 100m cable results in an overall efficiency from PSE output to PD converter output of 75 percent.
- The POE480U-4P can deliver 36W of power to the cable by injecting 720mA at 56V. A single NCP1081 delivers 25W to a 24V output. The PoE-PD efficiency from input RJ45 jack to output is estimated on 85 percent. Using a Cat5e 100m cable results in an overall efficiency from PSE output to PD converter output of 71 percent.
- The power can be increased to higher power levels by increasing the voltage or current limit.
- Connecting the NCP1081 to a Phihong midspan keeps the nClass_AT pin high.

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3.2 60W or 80W Triple Output

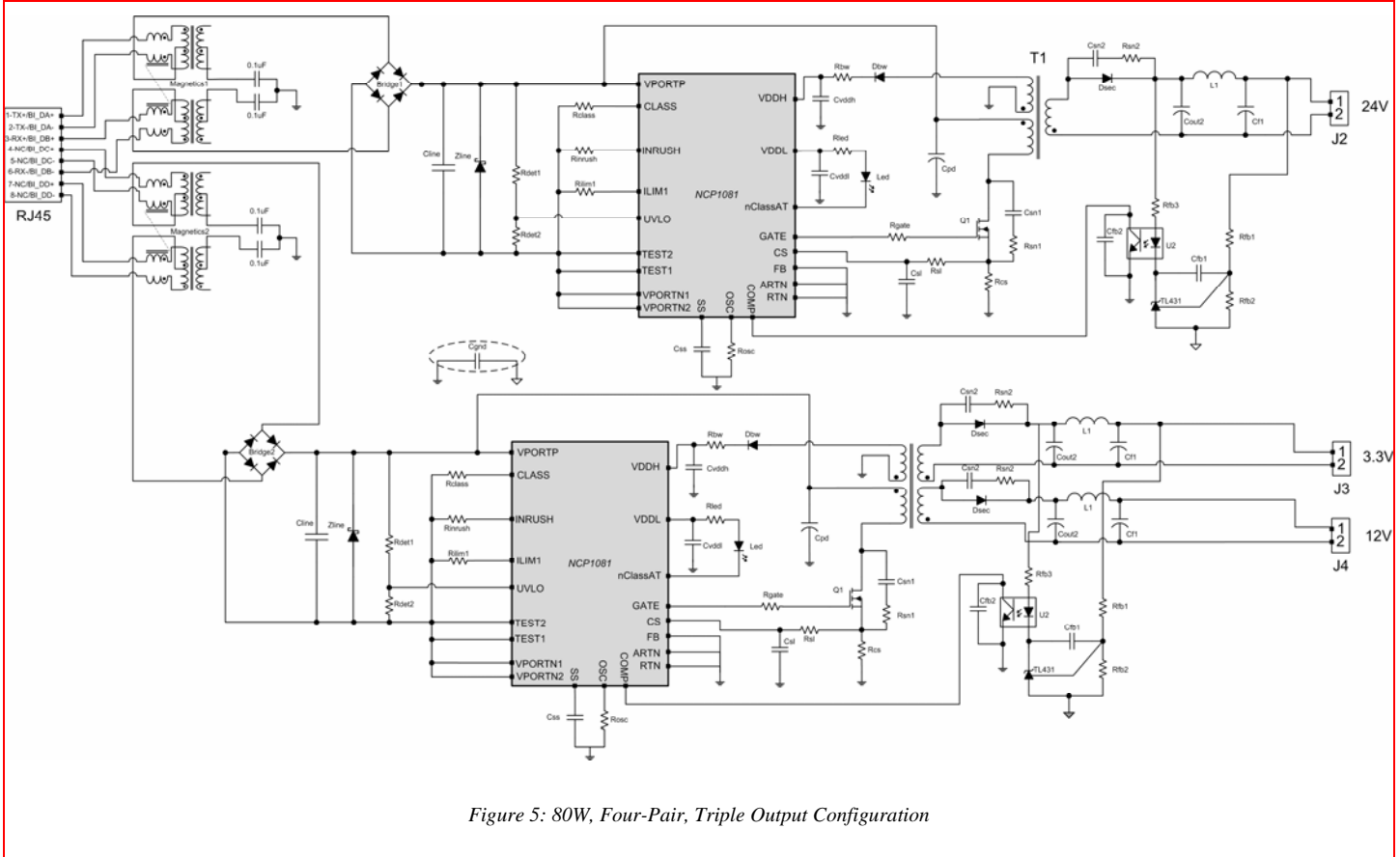


Figure 5: 80W, Four-Pair, Triple Output Configuration

- The POE60U midspan can deliver 60W of power to the cable by injecting 550mA at 56V. Dual NCP1081's deliver 25W to a 24V output, 20W to a 12V output and 5W to a 3.3V output. The PoE-PD efficiency from input RJ45 jack to output is estimated to be 85 percent. Using a Cat5e 100m cable results in an overall efficiency from PSE output to PD converter output of 75 percent.
- The POE80U midspan can deliver 80W of power to the cable by injecting 720mA at 56V. Dual NCP1081's deliver 34W to a 24V output, 30W to a 12V output and 4W to a 3.3V output. The PoE-PD efficiency from input RJ45 jack to output is estimated to be 85 percent. Using a Cat5e 100m cable results in an overall efficiency from PSE output to PD converter output of 71 percent.
- Connecting the NCP1081 to a Phihong midspan keeps the pin nClass_AT high.

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3.3 60W or 80W Dual Output

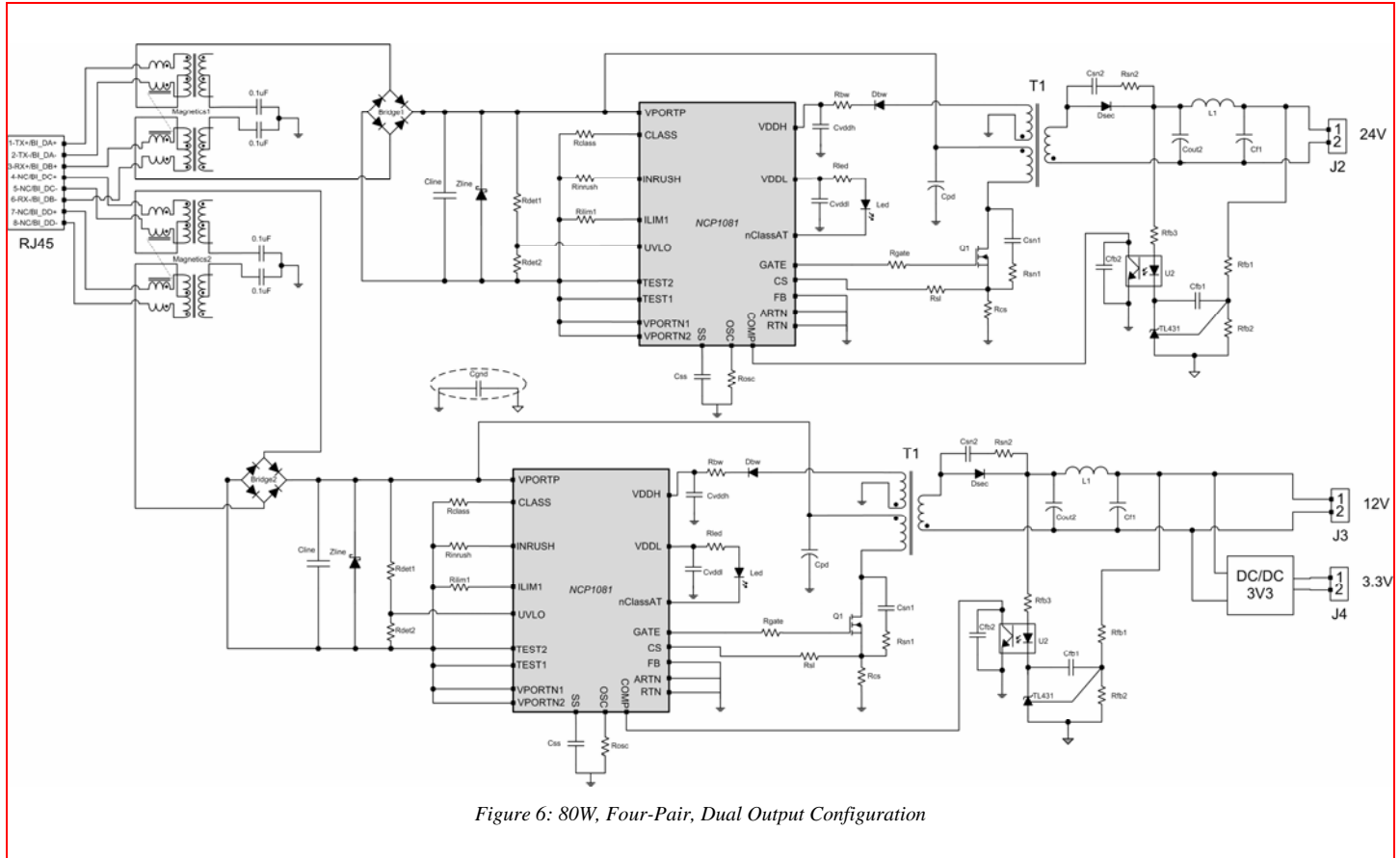


Figure 6: 80W, Four-Pair, Dual Output Configuration

- The POE60U midspan can deliver 60W of power to the cable by injecting 550mA at 56V. Dual NCP1081's deliver 25W to a 24V output and 25W to a 12V output. The PoE-PD efficiency from input RJ45 jack to output is estimated to be 85 percent. Using a Cat5e 100m cable results in an overall efficiency from PSE output to PD converter output of 75 percent. Other voltages can be derived from the 12V output with a separate DC-DC converter.
- The POE80U midspan can deliver 80W of power to the cable by injecting 720mA at 56V. Dual NCP1081's deliver 34W to a 24V output and 34W to a 12V output. The PoE-PD efficiency from input RJ45 jack to output is estimated to be 85 percent. Using a Cat5e 100m cable results in an overall efficiency from PSE output to PD converter output of 71 percent. Other voltages can be derived from the 12V output with a separate DC-DC converter.
- Connecting the NCP1081 to a Phihong midspan keeps the pin nClass_AT high.


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4.0 Company or Product Inquiries

For more information about ON Semiconductor's Power over Ethernet products visit our Web site at <http://www.onsemi.com>

5.0 Revision History

Date	Version	Modifications
January 2008	1.0	Initial release
April 2008	2.0	General update

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