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Power over ethernet / Mohd Faiz Kamarudin.

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**POWER OVER ETHERNET**

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**BEKE**

**APRIL 2009**

"I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Electronic Power and Drives)"

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**POWER OVER ETHERNET**


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**This Report is submitted in Partial Fulfillment of Requirements for The Degree of  
Bachelor in Electrical Engineering (Power Electronic and Drive)**

**Faculty of Electrical Engineering  
Universiti Teknikal Malaysia Melaka**

May 2009

"I hereby declared that this report is a result of my own work except for the excerpts that have been cited clearly in the references."

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Date : 11/05/09

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## ABSTRACT

Power over Ethernet is the newest technology that supplies DC power through the single network cable (CAT5 Cable). Power over Ethernet is threatened by the fact that Ethernet cords are almost universally being phased out in favor of wireless network. The entire laptop and desktop computer in the future may be powered with only a network cable without attaching it to the power cord supply. This technology also transmits the data at the same time. Power over Ethernet technology is facilitated with a simple adaptor. This project is proposed to design a compact, low cost, portable and reliable power over Ethernet DC adaptor that is able to give a stable DC output of 48 VDC. This project consists of two circuit designs to perform data analysis for and adaptor designing. Voltage regulator and injector 48 are the two circuits that consist in this project. At the end of this project, the PoE circuit is successfully built and well function.

## ABSTRAK

Power over Ethernet (PoE) adalah teknologi terkini yang membekalkan kuasa arus terus menerusi kabel rangkaian (Cat5 cable) yang serupa dimana data Ethernet dihantar menggunakannya. Dengan adanya teknologi ini, alat-alat elektrik yang menggunakan rangkaian tidak perlu lagi menggunakan kuasa luar untuk menghidupkannya. Pada masa hadapan, komputer riba, computer dan alat – alat lain yang menggunakan rangkaian tidak perlu lagi menggunakan kuasa luar. Ini dapat membataskan pendawaian elektrik sekaligus dapat menjimatkan kos. Pada masa yang sama, ia juga menghantar data tanpa sebarang gangguan. PoE adalah teknologi yang dibantu oleh satu penyesuaian (adaptor) yang mudah. Oleh itu, sasaran utama projek ini adalah untuk melihat adaptor menerima kuasa elektrik dan menghantarnya terus kepada kabel serentak dengan data. Cadangan projek adalah untuk mereka cipta litar padat yang murah, mudah alih dan dapat menghasilkan keluaran voltan 48Vdc keluaran. Dalam project ini terdapat dua litar yang dicadangkan untuk mereka adaptor iaitu “Voltage Regulator” dan “injector 48”. Pada akhir projek ini, litar PoE telah siap dibina dan telah diuji. Litar ini berfungsi dengan sempurna.

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## CHAPTER 1

### INTRODUCTION

Power over Ethernet (PoE) is the solution where electrical current is run to networking hardware over the Ethernet Category 5 or higher data cabling. There is no extra AC power cord is needed at the device location, minimizing the amount of cables needed and hassle of installing extra outlet.

PoE also brings the host of benefits to design, implementation and long-term usability of wired Ethernet local area networks (LANs). PoE is the lowest cost, flexibility and even safety application compare to the traditional technology that use external power supply to turn on the device.

The PoE system carry the data along with power supply included at the same time. In this system, it has two main parts which is Power Sourcing Equipment indicated as PSE and Power Device indicated as PD.

Power Sourcing Equipment (PSE) is the devices that supply the power and inject it into the Ethernet cable (CAT5). There are two type of PSE which is the end-point hub and the mid-span hub. But the most popular is the mid-span hub. The term "PoE Injector" refer to mid-span hub and it place next to a switch. An end-span hub is the same thing as a mid-span except the switch is built-in. PSE has some that must be abided. Most of the rule is for protection of the c abling, legacy equipment, and PoE compliant device. If the Power Device (PD) has too much current, the PSE must shut the device off and enter a safe state where it begins searching for device again. Also the PSE must be capable of detecting legacy equipment to prevent damage mostly for the non-Poe devices.

Power Device (PD) is the device at the opposite end of the PSE end of the LAN cable that is serving some type of purpose. PD includes but are no limited to, wireless access points, VoIP phones, and cameras.

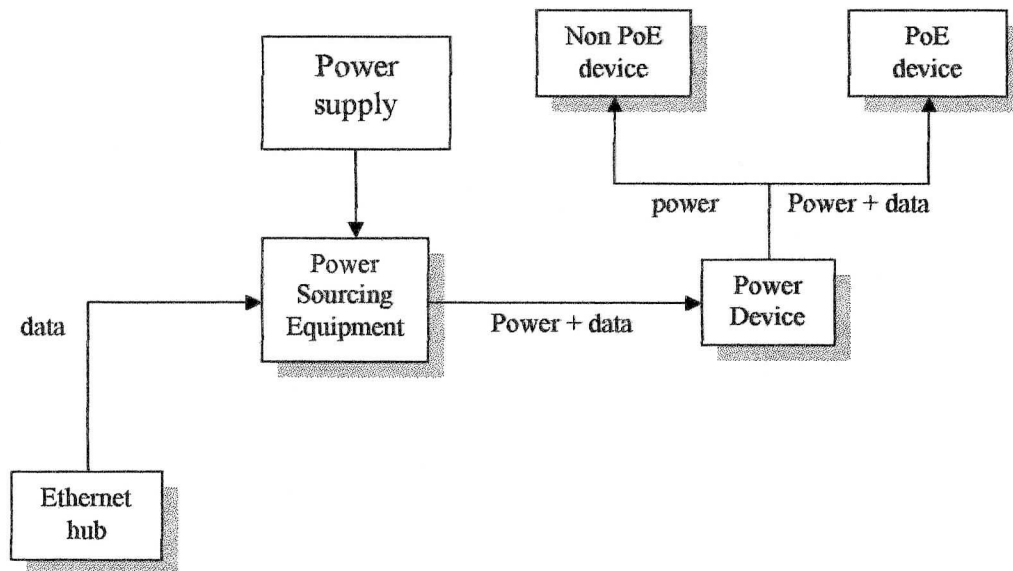


Figure 1.1: Block diagram of PoE



## **1.1 Problem Statement**

Most of the electronic equipment while using networking must have another power supply. This will cause more costing to pulling the cable if the power point is far away from the location acquire, also costing for more man power. For example, network camera, and VoIP. Besides, the entire outlet provides the AC output. The equipment must use additional adapter to convert the AC to DC. By using the PoE's technology, devices can be operate without external power supply and carry data at the same time.

## **1.2 Project Objective**

The objective of this project is to design and develop a portable Power over Ethernet without attaching any extra power supply to the PoE devices. The portable PoE must capable to produce stable DC source with output voltage of 48Vdc that can supports any electrical device that required DC power supply, for example VoIP, cameras, sensor etc. For Non-PoE device, the output voltage must reach 24Vdc, 12Vdc and 5Vdc.

1. To design and develop a portable Power over Ethernet.
2. To design and develop a portable Power over Ethernet DC/DC

## **1.3 Project Scope**

Flyback converter is the suitable circuit to boost the output voltage. OrCAD software is choose to design this circuit and able to simulate the circuit. Flyback converter is easy to control the output.

## **1.4 Expected Result**

The expected result in this project is able to producing an output voltage between 5Vdc to 12Vdc stable voltage at PD's. The electric device (camera) will fully operate when the device connected to the network.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Power over Ethernet system

Basically PoE has two part which is Power Sourcing Equipment and Power Device.

##### 2.1.1 Power Sourcing Equipment (PSE)

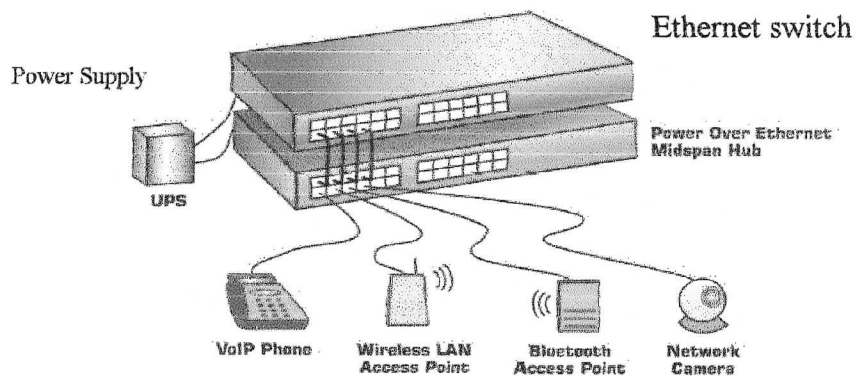
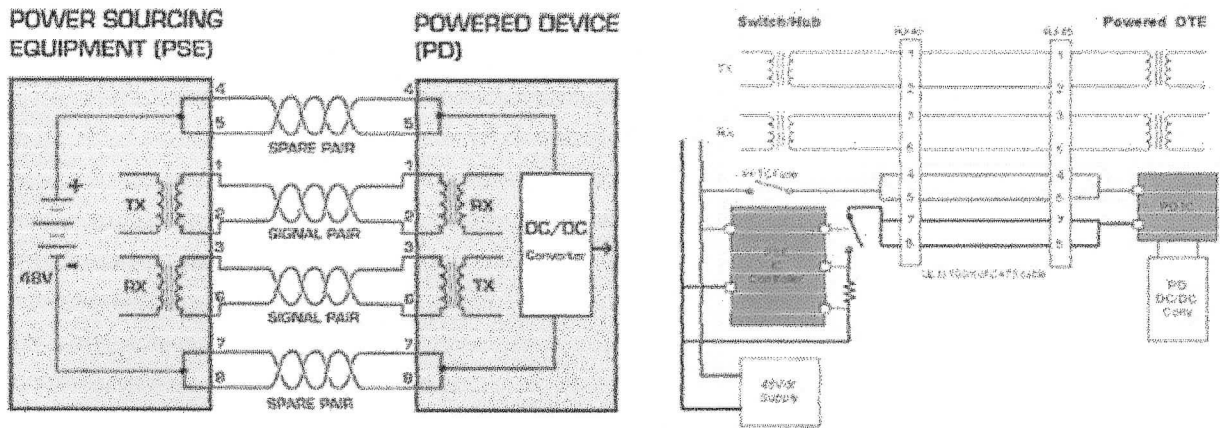
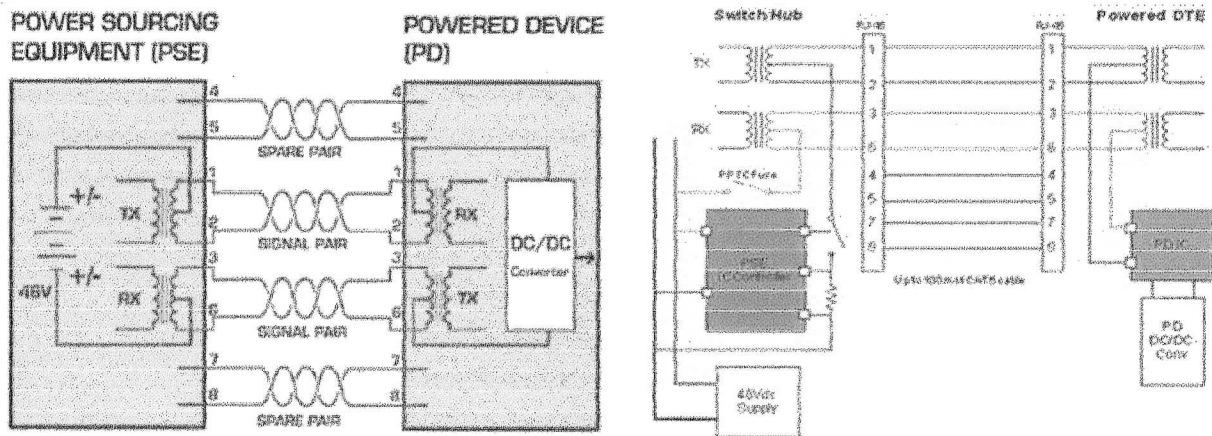


Figure 2.2: Power Sourcing Equipment

PSE is the devices that supply the power to the PD. It delivers the power thru the Cat5 cable (Ethernet cable). In the PSE, it has injector. The injector is function to inject the power into the cable. PSE has two methods to inject the power. First, inject the power using data pair and second, inject the power by using spare pair twisted cable.



Using spare twisted cable



Using data pair

Figure 2.3: Type of PSE

PSE has two types which are mid-span and end-span. Mid-span is design that the power injector stand between a regular Ethernet switch and the power device. This will deliver the power without affecting the data. Midspans are used when there is no desire to replace and configure a new Ethernet switch, and only PoE needs to be added to the network. [1]

End-span is the same thing with the mid-span except the Ethernet switch include the power over Ethernet transmission circuitry. End-span also known as PoE switches. End-spans are normally used on new installations or when the switch has to be replaced for other reasons (such as moving from 10/100 to 1 gigabit or adding security protocols), which makes it convenient to add the PoE capability. [1]

### 2.1.2 Power Device (PD)

Power Device is the device that powered by the PSE and thus consume energy. PD is especially use by the Non-PoE devices.

## 2.2 Project Overview

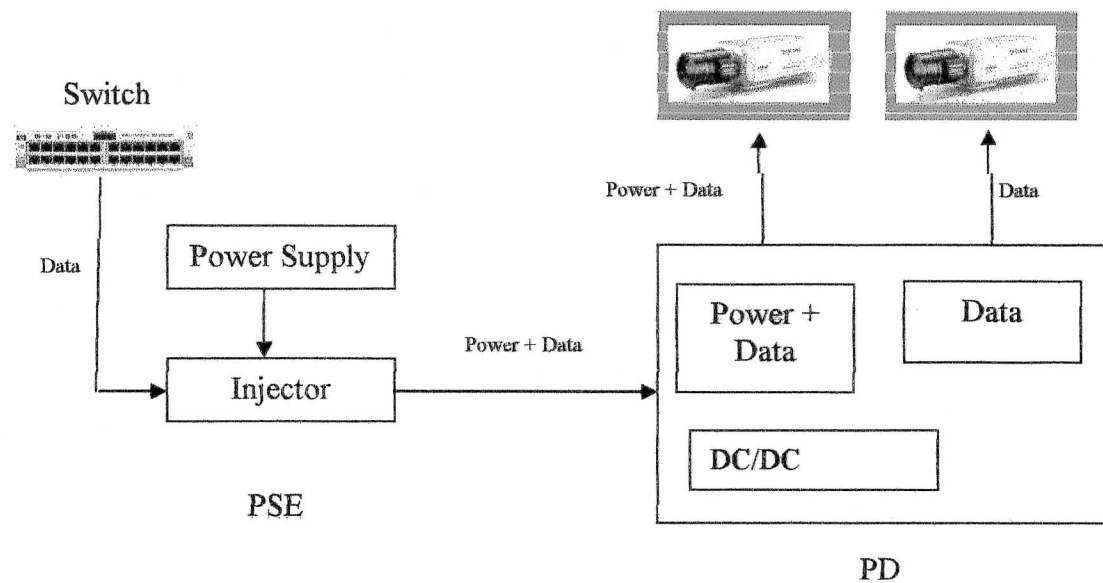


Figure 2.4: Power over Ethernet system



Figure 2.4 shown the overview of this project. From the Ethernet switch, it will only transmit data until it reach the PSE. The PSE will inject the voltage into the Cat5 cable and deliver it without disturbing the data to the PD. When reach PD, the power will reach the DC/DC converter where it will produce an adaptor output voltage between 5Vdc and 12Vdc. These output voltage can be use for application with input voltage of 5V and 12 V. meanwhile, non PoE device also can use the output voltage. For PoE device, it just use the special port to operate. [2]

## **2.3 Benefit of PoE**

By using this system, there a lot of benefit. Nowadays, so many electronic devices use the networking the office, building and other application. PoE system offers the following advantages to the user.

### **2.3.1 Cost Reduction.**

PoE system delivered data and power at the same time. An external power doesn't need to be attaching to the devices. This will reduce the cost for the installation of power plug point around the location of the device. For example, the security cameras. The camera can be installing without the additional expanse of contracting an electrician to install AC outlet where it deployed despite the location is high or to crouch. [3]

### **2.3.2 Flexibility**

Network devices can be installed and relocate where it performance is optimum without concern of an existing AC outlet. This is important especially for wireless network antenna which may require place at the top of ceiling to provide wider broadest coverage. This location is difficult to install an extra AC outlet. PoE system is useful for this situation. [3]

## 2.4 Standard IEEE 802.3af

All of the product must have the specific standard, also same with the Power over Ethernet. All of PoE's devices is referred to the Standard IEEE 802.3af which is all of the device standardize with the requirement.

### Currently recommended (IEEE 802.3-2005)

Clause 33 of IEEE 802.3-2005 (commonly referred to as IEEE 802.3af is how Power over Ethernet is usually implemented. The specification allows the powering device to use a voltage between 36–57 V DC, though the nominal voltage is 48 V, over two of the four available pairs on a Cat. 3/Cat. 5e cable with a selectable current of 10–400 mA subject to a maximum load power of 15.40 W. Only about 12.95 W are available after counting cable losses, and most switched power supplies will lose another 10–25% of the available power. A "phantom power" technique is used so that the powered pairs may also carry data. This permits its use not only with 10BASE-T and 100BASE-TX, which use only two of the four pairs in the cable, but also with 1000BASE-T (Gigabit Ethernet), which uses all four pairs for data transmission. This is possible because all versions of Ethernet over twisted pair cable specify differential data transmission over each pair with transformer coupling; the DC supply and load connections can be made to the transformer center-taps at each end. Each pair thus operates in "common mode" as one side of the DC supply, so two pairs are required to complete the circuit. The polarity of the DC supply may be inverted by cross cables; the powered device must operate with either pair: spare pairs 4,5 and 7,8 or data pairs 1,2 and 3,6. Polarity is required on data pairs, and ambiguously implemented for spare pairs, with the use of a bridge rectifier.

The standard describes two types of devices: Power Sourcing Equipment (PSE) and Powered Devices (PD). Power Sourcing Equipment provides power to the Powered Devices.[5]

## Powering devices

There are two methods available used in the Power over Ethernet system. There are Mode A by using the same core transmitted the data and power at the same time. While Mode B use the other spare core to transmit the power. The other paragraph will explain the detail about Mode A and Mode B.

Mode A has two alternate configurations (MDI and MDI-X), using the same pairs but with different polarities. In mode A, pins 1-2 (pair #2 in T568B wiring) form one side of the 48 V DC, and pins 3-6 (pair #3 in T568B) form the other side. These are the same two pairs used for data transmission in 10Base-T and 100BASE-TX, allowing the provision of both power and data over only two pairs in such networks. The free polarity allows for patch cables and automatic RX/TX detection.

In mode B, pins 4-5 (pair #1 in both T568A and T568B) form one side of the DC supply and pins 7-8 (pair #4 in both T568A and T568B) provide the return; these are the "spare" pairs in 10BASE-T and 100BASE-TX. Mode B, therefore, requires a 4-pair cable.

The power sourcing equipment (PSE) decides whether power mode A or B shall be used, not the powered device (PD).

The PSE can implement mode A or B or both (but must not supply power in both modes at the same time). A PD indicates that it is standards-compliant by placing a 25 k $\Omega$  resistor between the powered pairs. If the PSE detects a resistance that is too high or too low (including a short circuit), no power is applied. This protects devices that do not support IEEE 802.3af. An optional "power class" feature allows the PD to indicate its power requirements by changing the sense resistance at higher voltages. To stay powered, the PD must continuously use 5–10 mA for at least 60 ms with no less than 400 ms since last use or else it will be unpowered by the PSE. [5]



## 2.5 Existing PoE

A lot of PoE product was existed out there. Most of the products use the same method and same benefit offered which is lower cost, flexible and easy to use. This is the example for the existing product.

### 2.5.1 PoE 400

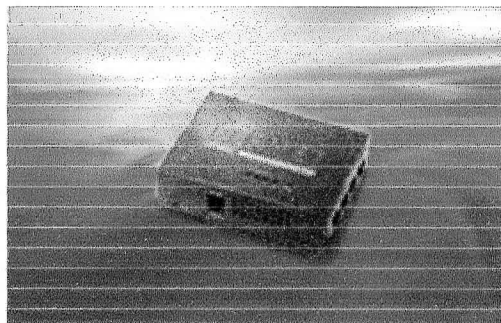


Figure 2.5: PoE 400

courtesy from [www.planet.com](http://www.planet.com)

#### Features

1. For the cost saving, purpose of power management and Small SOHO network application, PLANET releases the new 10/100Mbps Power over Ethernet Injector Hub POE-400.
2. The PLANET POE-400 is a 4-Port IEEE 802.3af Power over Ethernet injector hub complied with IEEE 802.3, IEEE 802.3u and IEEE 802.3af standards. Equipped with 4 10/100Base-TX Fast Ethernet ports, the POE-400 supports full 48VDC power for any remote IEEE 802.3af powered device (PD) like Wireless LAN Access Point, IP phone, and LAN Camera. Supporting power supply of 70 watts, the POE-400 provides sufficient power to the 4 remote devices.
3. There are 8 RJ-45 STP ports on POE-400. Half of the ports on right panel function as "Data" and the other half on left panel function as "Data and Power". Each of the "Data and Power" port is an injector which inserts DC Voltage into the CAT 5 cable for allowing