

DESIGN AND DEVELOP A 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 Drives)**

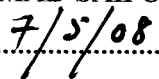
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“ I hereby declared that this report is a result of my own work except for the excerpts that have been cited clearly in the references.”

Signature : 

Name : MUHAMAD SAIFUL BIN IBRAHIM

Date : 

To
Mom and Dad
Your prayers keep me moving forward
Teachers
Fill my heart with the truth and knowledge
Beloved friends
Make my world happens
Every Muslims
May Allah bless you all here and hereafter
-Al-fatihah-

ACKNOWLEDGEMENT

In the name of Allah, The Most Gracious, The Most Merciful. Peace be upon the Messenger of Allah, Prophet Muhammad s.a.w, his companions (r.a) and followers until the end of day. Thanks to Allah, with His blessing, this final project is successfully delivered.

First of all, I want to thanks my beloved mom and dad, whom keep prays for me, gives me freedom and show understanding to me as a student because their loves keep me moving forward.

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Last but not least, to all my friends, thank you for making my life happens.

Wassalam.

ABSTRACT

Power over Ethernet (PoE) is an evolving technology that extends the already ultra-broad functionality of Ethernet by supplying reliable DC power over the same cables that currently carry Ethernet data. Power over Ethernet is convenient whenever there is an Ethernet cable available but plugging into a wall outlet is a hassle. Power over Ethernet technology is threatened by the fact that Ethernet cords are almost universally being phased out in favour of wireless networks. The entire desktop or laptop computer in the future may be powered with only an internet cable without attach it to the power cord supply; this is the Power over Ethernet future applications. Power over Ethernet is also ideal for older building with limitations on pre-existing electrical wiring. Power over Ethernet technology is facilitated by a simple adapter. The adaptor “probes” a target first, to see if it can accept electrical power. After this is verified, power is sent through the cable concurrently with data. The proposed project is to design a compact, portable, low cost and reliable power over Ethernet DC adapter that capable producing stable DC source from +5 VDC to +12 VCD to any electrical devices that required DC supply i.e. headphone, VOIP, camera, sensor, buzzer etc. this enables replacement of conventional DC power supply adapter. For this project, it consists of three circuits design to perform data analysis for an adaptor designing. Those three circuits included with IC LM5070, voltage regulator and injector 48. Last but not least, to sustain the project development it should deal with the software and hardware parts.

ABSTRAK

Power over Ethernet (PoE) adalah satu perkembangan teknologi yang merangkumi “Ultra board functionality” dengan cara membekalkan kuasa arus terus kepada kabel-kabel yang serupa dimana data Ethernet dihantar. Power over Ethernet juga adalah satu ideal untuk mengembangkan lebih luas dengan membataskan pendawaian elektrik. PoE adalah teknologi yang dibantu oleh satu penyesuai (adaptor) yang mudah. Oleh itu, Sasaran pertama untuk melihat adaptor menerima kuasa elektrik. Selepas itu, pastikan kuasa dihantar terus ke kabel serentak dengan data. Cadangan projek adalah mereka bentuk satu penyesuai (adaptor) yang padat, mudah alih, kos rendah dan kuasa arus terus yang boleh dipercayai dengan berkemampuan mengeluarkan arus terus yang stabil sumber 5 Vdc dan 12 Vdc untuk mana-mana alat elektrik yang menggunakan arus terus, sebagai contoh VOIP, kamera, sensor, penggera dan sebagainya. Ini membolehkan arus terus yang konvensional penyesuai (adaptor) bekalan kuasa. Bagi melaksanakan projek ini terdapat 3 litar direka untuk dianalisis data untuk mereka adaptor. Litar tersebut ialah IC LM5070, voltage regulator and Injector 48. Terdapat dua bahagian utama untuk memastikan projek ini berjalan dengan lancar iaitu bahagian perisian dan perkakasan.

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LIST OF ABBREVIATION

DC	Direct Current
AC	Alternating Current
PCB	Printed Circuit Board
PWM	Pulse Width Modulation
IC	Integrated Circuit
CCTV	close camera television
UPS	interruptible power supply
PoE	Power over Ethernet
PD	Powered Device
PSE	Power Sourcing Equipment
LAN	local area network

CHAPTER 1

INTRODUCTION

Power over Ethernet (PoE) brings a host of benefits to the design, implementation and long-term usability of wired Ethernet local area networks (LANs). Cost, flexibility and even safety are all enhanced. It overcomes the major limitation that system designers often encounter whereby they must locate powered network devices within close proximity to AC power outlets. With PoE, both data and power at a safe nominal 48 Vdc are carried over the same Ethernet cable. If network devices can be configured to run from 48 Vdc, the need for devices on the network to be supplied with intrinsically unsafe AC power from a separate power cable connected to a building's AC ring main is eliminated. The freedom this gives to position devices where they are needed rather than where power cords dictate, and the long-term flexibility to move devices around to suit the changing operational needs of the business, are both highly desirable benefits for any organisation. As an example, networked security cameras benefit from PoE as they normally need to be sited high up on walls, away from AC outlets. Typical devices used on a powered Ethernet such as VoIP phones and cameras may need to be specially designed or adapted to run from Ethernet 48 Vdc. DC/DC converters in the network devices will normally be required to drop and isolate the 48V supply down to a lower voltage such as +5 Vdc and +12 Vdc, suitable for the device circuitry. To take full advantage of PoE, the network devices will also be required to handle the hand-shaking process that allows the network hub to recognise a device as being PoE enabled and understand and manage its specific power needs. There are two main elements to a PoE system, the power sourcing equipment (PSE) and the powered device (PD).

There are two basic components in power over Ethernet network:

1. Power Sourcing Equipment (PSE) is a device that supplies power
2. Powered Device (PD) is a device that receives and utilizes the power

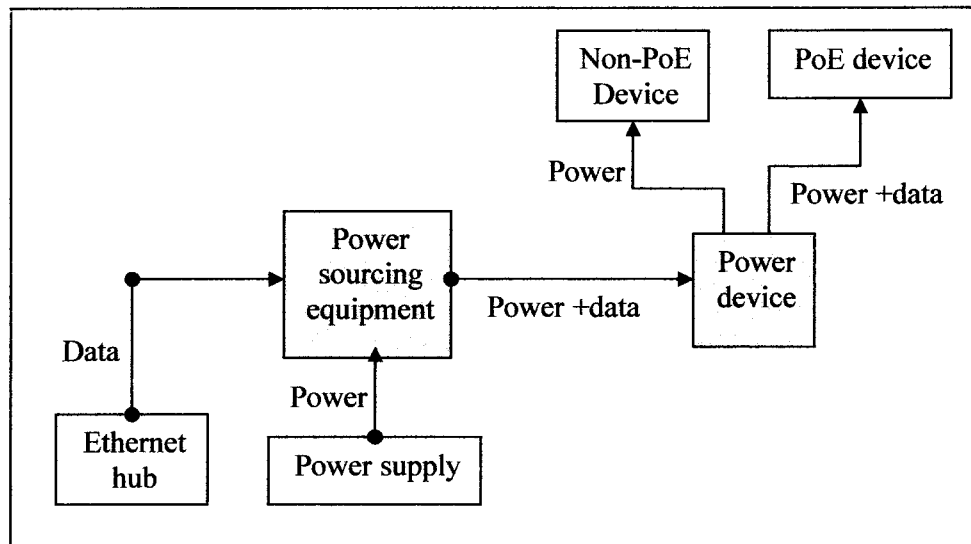


Figure 1.1: Block Diagram System PoE

When the PSE connects to a network device, the PSE determines or “discovers” if the device is a PD or not. This prevents non-PoE enabled Ethernet equipment from receiving power, which could cause damage. The PSE applies two small current-limited voltage signals across the cable as it checks for the presence of a characteristic resistance. If resistance is detected, power is provided. A PD may also classify how much power it will require from the PSE. This feature supports the PSE by helping it supply power in an efficient way. After the PSE has discovered a PD, it supplies 48 V. Once the PSE begins to provide power, it continuously monitors the PD current draw. Once the PD current consumption drops below a minimum value, for example when the device is unplugged, the PSE discontinues supplying power and the discovery process begins again. The management and conversion of the incoming power is normally handled by a DC/DC converter in the PD. DC/DC converter is used to drop and isolate the 48V supply down to a lower voltage such as 5V to 12V, suitable for his device circuitry.

The motivation for power over Ethernet is almost all appliances require both data connectivity and a power supply. In a familiar example, telephones are powered from the telephone exchange through the same twisted pair that carries the voice. Now we can do the same thing with Ethernet devices.

1. Only one set of wires to bring to your appliance – simplifies installation and saves space.
2. There is no need to pay for an expensive electrician, or delay your installation to meet the electrician's schedule – saves time and money.
3. The appliance can be easily moved, to wherever you can lay a LAN cable – minimal disruption to the workplace.
4. Safer – no mains voltage anywhere.

1.1 Objective of the Project

The proposed project is to design a compact, portable, low cost and reliable power over Ethernet DC adapter that capable producing stable DC source from +5V to +12 Vdc to any electrical devices that required DC supply i.e. hand phone, VOIP, camera, sensor buzzer etc. this enables replacement of conventional DC power supply adapter.

1. To design and develop a portable Power over Ethernet DC/DC Adapter.
2. To produce output voltage: +5 Vdc to +12 Vdc.

1.2 Scope of the Project

In designing the Power over Ethernet system it should have a scope to become a guideline. Below are the scopes for this PoE system project.

1. To design Power Sourcing Equipment (PSE) where it can merge power and data in a single cable RJ-45.

2. To design Power Device (PD) where it can separate both PoE device circuit and DC adaptor of 5 Vdc and 12 Vdc circuit. This PD circuit is designed into three kinds of circuits, where both of them will be comparing in term of performance. Three of the circuits are DC/DC converter (flyback converter using IC LM5070), voltage regulator (using LM7805 and LM7812) and injector 48 Vdc (using voltage regulator).
3. In addition, the project will be cover on doing the simulation and hardwareconstruction for PSE and PD with PCB layout development for those circuits. It also consists of making an attachment and testing the RJ-45 cable with Plug and Jack Modular for network cable setup.

1.3 Problem Statement

Power over Ethernet hopes to supplant traditional power supplies for computing worldwide. Plug and sockets vary by country, but Ethernet technology and cord are universal. For this reason, it needs to be design and develop for general applications such as consumer and industrial products, and to operate in different countries. Once end devices, such as a network camera or an access control terminal are up and connected to the LAN, they still require power to run. Power over LAN technology enable LAN enabled devices to be powered over the network-cabling infrastructure, thus avoiding the need for separate power and data cable infrastructure and costly AC outlets near cameras. Network camera are traditionally installed in open high places, such as corridor ceilings, airport or lecture halls, etc. the adding of power infrastructure was a costly and long affair, requiring dedicated electrician teams for pulling of power cable, changes of building plans and safety approvals. By allowing the network cameras to be installed where they are most effective and not where the AC sockets are, the actual number of cameras may also be reduced, further reducing the surveillance implementation costs.

CHAPTER 2

LITERATURE REVIEW

Literature review is done to achieve the objective of research. The literature review for this research is focusing the Power over Ethernet (PoE) system. It got 3 basic elements for PoE systems which are Power Sourcing Equipment (PSE), Power Device (PD) and network cable. Throughout reading of books, paper works and internet it concludes that the PoE is the new method on Direct Current (DC) supply technology applications where the DC supply is transmitted to the long distance load through cable network. This method is applied by using 3 elements which are Power Sourcing Equipment (PSE), Power Device (PD) and network cable (RJ45). PSE is the main element for this PoE system; where it merges the DC supply with the data altogether and transmits it through cable network to the Power Device (PD). Aside from that, PD works as a receiver of power and data that come in from the PSE part. Last but not least, the network cable role as a medium of transmitting and receiving data and power. Refer to page 14. From the regulation of IEEE802.3af, a normal DC supply that being used in the whole world for supplying equipment through PoE is 48 Vdc, but the value can still be tolerate from range of 44 Vdc to 57 Vdc. If the voltage values do not achieve the desired value it maybe affected the PoE device not work properly and maybe damaged. For the network cable, the standard type of cable that commonly used is CAT5 (RJ45). This cable consists of four twisted pair cable where only two pairs is used for transmitting the data and the other two pairs for transmitting the DC supply to the device. Refer to page 12. To go into more details for the research of Power over Ethernet, one product of PoE that available in the market has been used to get more informative source for this research.

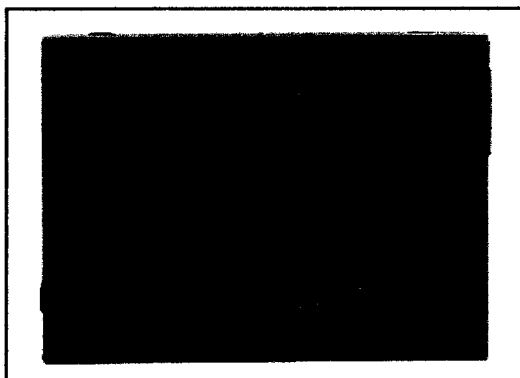


Figure 2.1: Power over Ethernet injector.

Figure 2.1 shows one of the products from DANTEK of Power over Ethernet injector

DANTEK's POE-48V IEEE 802.3af PoE Injector provide DC 48V over Ethernet cables. The Injector IEEE 802.3af Power over Ethernet Injector inserts DC Voltage into Cat.5 cable, allowing the cable Injector to transfer data and power simultaneously. With IEEE 802.3af Power over Ethernet devices installed, the system administrator only have to use a single RJ-45 Ethernet cable to carries both power and data to each devices. Besides, to connect through Injector you could also have following benefit that, cost saving, easy for networking planning and higher reliability

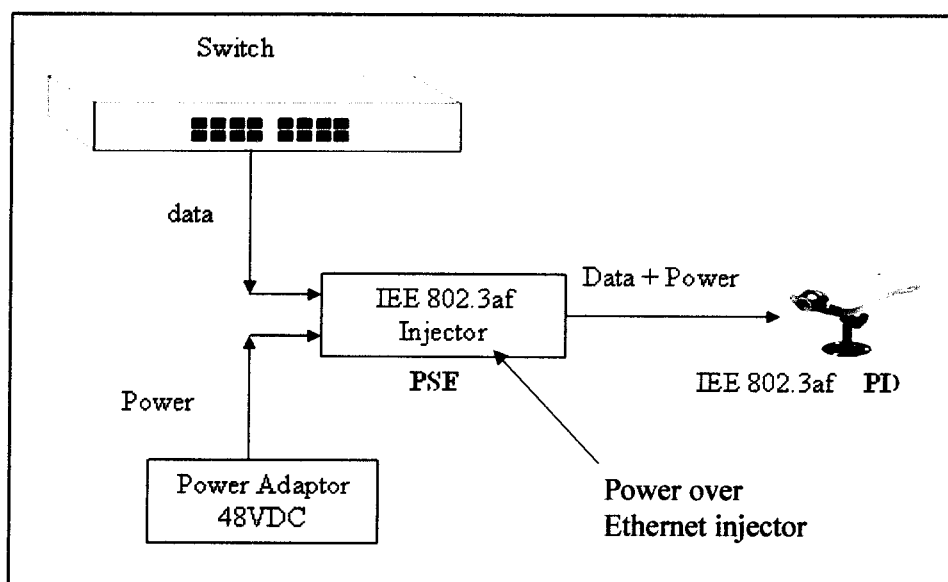


Figure 2.2: Block Diagram Power over Ethernet injector

Figure 2.2 show the injector directly connect with any IEEE 802.3af end-nodes like internet camera, VoIP phones, wireless access point and where support In-line power over Ethernet port.

2.1 Overview of the Project

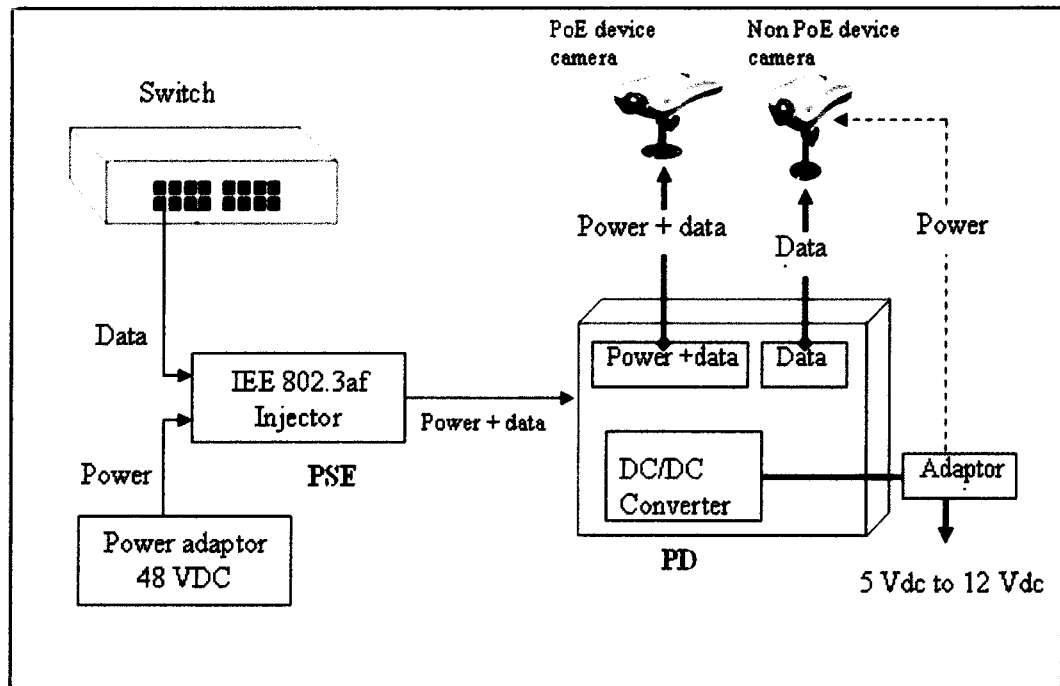


Figure 2.3: Design and develop a Power Over Ethernet DC adapter (Injector and splitter)

Figure 2.3 shows the overview of the project that will expand the applications of Power over Ethernet especially to the Power Device (PD). The power that is transmitted from Power Sourcing Equipment (PSE) to Power Device (PD) will be drop through DC/DC converter where it will produce an adaptor output voltage which is 5 Vdc and 12 Vdc. Those output voltage can be used for applications with input voltage of 5 Vdc and 12 Vdc. Meanwhile, non PoE device also can use the adaptor output voltage but for PoE device it just uses the special port for it.

2.2 Benefit Poe

Network equipment investments are expected to provide functionality that supports current and future productivity enhancements. Deploying a PoE network today offers the following advantages that will also support tomorrow's innovations.

2.2.1 Lower Cost

PoE eliminates the need for running both data and power wires to each network device. WAPs and security cameras can be installed without the additional expense of contracting an electrician to install AC outlets where deployed. PoE also helps protect IT investments as it is forward and backward compatible with other Ethernet protocols. Furthermore, PoE devices that are Simple Network Management Protocol (SNMP) manageable can be remotely monitored and controlled to efficiently manage or troubleshoot power consumption and/or failures.

2.2.2 More Flexible

Network devices can be installed and re-located where performance is optimum, without concern of an existing AC outlet. This is especially important for devices like WAPs, which may require installations in hard to reach locations, such as the ceiling, in order to achieve the broadest coverage.

CHAPTER 3

POWER OVER ETHERNET (PoE)

Power over Ethernet technology allow IP telephones, wireless LAN Access Points and other application to receive power as well as data over existing LAN cabling, without needing to modify the existing Ethernet infrastructure. Power over Ethernet technology is facilitated by a simple adapter. The power is transferred through the cable Power over Ethernet using a standard CAT5 Ethernet cable has four twisted pair, but only two of these are used for 10 BASE-T and 100BASE-T. The specification allows two options for using this cable for power. The options are through the cable on spare pairs and through the cable on the cable on the data pairs.

3.1 Cat5 Cable

CAT5 is Ethernet cable standard defined by the electronic industries association and telecommunications industry association (commonly) know as EIA/TIA). CAT5 is the 5th generation of twisted pair Ethernet cabling and the most popular of all twisted pair cable I use today. CAT5 cable contains four pair of copper wire. CAT5 supports fast (100 Mbps) Ethernet and comparable alternatives such as ATM. As with all other type of twisted pair EITA/TIA cabling, CAT5 cable runs are limited to a maximum recommended run rate of 100m (328 feet). Although CAT5 cable usually contains four pair of copper wire, fast Ethernet communications only utilize two pair. A new specification for CAT5 cable, CAT5 enhanced (CAT5E), support short-run Gigabit Ethernet (1000 Mbps) networking by utilizing all four wire pair and is backward-compatible with ordinary CAT5. Twisted pair cable like CAT5 come in two main varieties, solid and stranded solid CAT5 cable support longer runs