Introduction

This document explains a latent phenomenon that can arise when connecting two PD69012 or PD69008 output terminals of Power over Ethernet (PoE) switches together.

Operating a PoE Switch Connected to a Non Operating Switch

A PoE switch connected to a non operating PoE switch can deliver power to a non-operating switch port. The non-powered switch may then be improperly powered and as a result may attempt to connect its ports. This is considered an abnormal system operation and rarely happens. Figure 1 describes a typical connection utilizing Microsemi's PD64012 PD690xx and PD64004 where such a scenario might occur. In normal topologies, where switches are linked via an uplink port (coax, optic or other non-PoE ports), the problem will not arise.
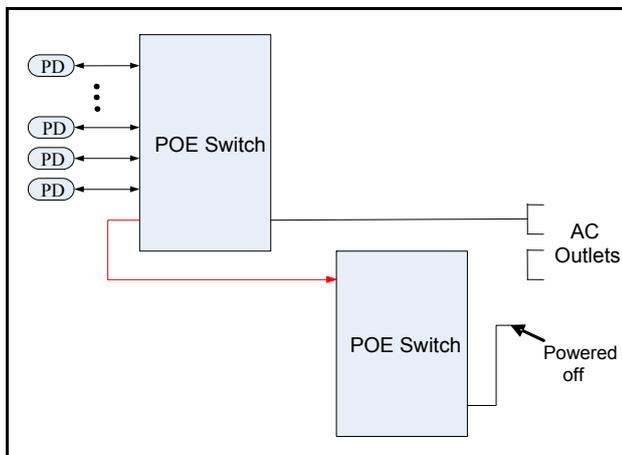

Figure 1: PoE Switch Connected to a Non-Powered PoE Switch

Root Cause Analysis

Figure 2 shows a detection path which is part of a PD69012 application, using the DC disconnection method.

PD69012 #1 is on and PD69012 #2 is off; Legacy Detection is enabled in PD69012 #1.

During Legacy Detection, the capacitance in V2 is detected by PD69012 #1 as a valid legacy powered device, and therefore PD69012 #1 turns its port on.

Note

In case both V1 and V2 are on, and the difference between both power-supplies is a small amount of voltage, then the higher voltage level PD69012 might turn the other PD69012.

For example if:

- V1 = 57 Vdc
- V2 = 44 Vdc

then it is possible that PD69012 #1 turns on the ports connected to PD69012 #2 port.
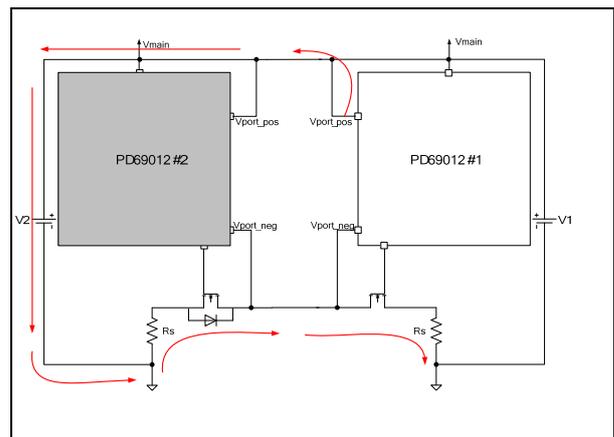
Figure 2: Detection Path via PD69012 Using DC Disconnection Method

Corrective Action

- PD69012 and PD69008 are designed to startup and deliver power to devices with an input capacitance of up to 540μF. Therefore, if the total capacitance of V2 is above 540μF, PD69012 #1 does not detect it as a valid legacy PD, and does not turn its port on.
- PD69012/PD69008 has an advanced internal mechanism. When this mechanism detects negative current through the port, the PD69012/PD69008 does not turn on new ports. In this situation, the powered port will not overload the other power supply equipment (PSE).

Operating a PoE Switch Connected to an Operating PoE Switch

Figure 3 illustrates a detection path which is part of the PD69012 and PD69008 applications, using the AC disconnection method.

Both PD69012s are on, and Legacy Detection is enabled in PD69012 #1.

During Legacy Detection, the total resistance in PD69012 #2 might be detected by PD69012 #1 as

a valid legacy PD (with certain input capacitance), and therefore PD69012 #1 turns its port on.
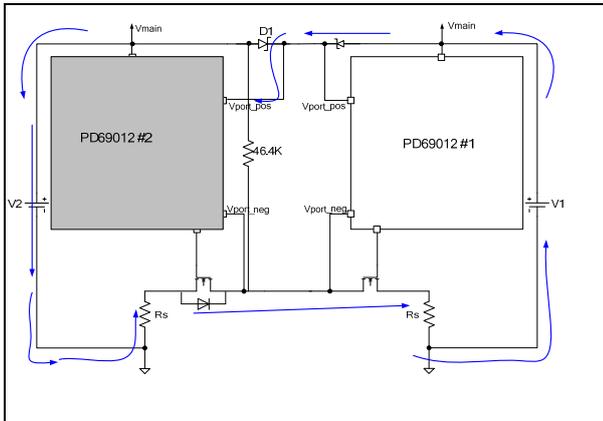

Figure 3: Detection Path via PD69012 in AC Disconnection Method

Corrective Action

Replacing D1 diode with a 68 V Zener diode prevents current flow through the detected port to switches' V_{main}.

Diode suggestion: On Semi 1SMA5945BT3G

Conclusion

In all the scenarios mentioned in this document, damage is not caused to any PSE due to low current path and to an advanced internal mechanism.

Microsemi Line Detection, Technical Explanation

Microsemi 3 Stage Detection

- **Pre-detection (Stage 1)**: Detects that a port is connected to an end device that can be standard, pre standard or LAN termination. This test is performed using low voltage and low current, and guarantees no hot insertion issues.

- **IEEE802.3af-2003/IEEE802.3at-2009 Standard Line Detection (a.k.a. standard detection)**: This detection is initiated only if:
  - Stage 1 has passed
  - An end device is connected to the port which needs to be detected.

  Standard detection complies with industry standards.

- **Legacy Detection**: This detection method is designed to detect passive components on a regular DC to DC power supply input that is being used for non compliant pre standard PDs. These types of PDs are common in the market today. This type of detection will be generated only if the user requires it and pre detection passed.

  Due to the large variety of DC to DC front ends in pre standard PDs, Legacy Detection has a wider positive detection range than standard detection.

  Legacy Detection is designed in such way that it guarantees rejection of Data Terminated Equipment (DTEs) that are not ready to accept power (such s LAN termination resistance) from powering up. Legacy Detection generates a low energy signal (about 1/3 of the maximum permitted by the standard when complaint detection is used).

  Legacy Detection has been successfully implemented in tens of millions of PoE ports with zero failures and zero problems.

Detection Sequence

1. Pre detection: The PSE searches continuously as long as the end device is not connected.

2. If the PSE has detected that the port is loaded, it performs standard detection.

3. If standard detection passed successfully, the PSE classifies and powers up the port.

4. If standard detection fails and Legacy Detection is enabled, then the PSE performs legacy detection.

5. If Legacy Detection passes successfully, the PSE powers up the port.

6. If Legacy Detection fails, the PSE does not turn on the power and a new detection cycle begins.

Detection Energy

According to both IEEE802.3af-2003 and IEEE802.3at-2009 the detection source may drive up to 5mA, 30V and can last up to 500mSec (see IEEE802.3-2008 clause 33.2.5 table 33-2 and clause 33.2.8 table 33-5 or IEEE802.3at-2009 clause 33.2.5 table 33-4 and clause 33.2.7 table 33-11).

This energy equals **75mJ**.

Microsemi Legacy Detection is 15 mA, 54 V, and is limited in time to 32mSec.

The maximum energy is **26mJ**.

Microsemi Legacy Detection energy is about 1/3 from the standard limit, which well within limits for any detected device. In cases where Legacy Detection detects no load, it ends after 4mSec.

What Can be Detected as a Legacy PD

Microsemi Legacy Detection is designed to detect a variety of pre standard PDs with wide range of input capacitance, different levels of DCDC UVLOs and different startup delay times. Some PDs may look like small capacitors with current consumption at high voltage levels, while others may behave like low Kohm resistors; for example Cisco's IP Phone 7960G.

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Microsemi
Analog Mixed Signal Group
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1 Enterprise, Aliso Viejo, CA 92656, USA; Within the USA: (800) 713-4113, Outside the USA: (949) 221-7100 Fax: (949) 756-0308

Microsemi Legacy Detection is designed to power all leading manufacturers of pre-standard PD devices. Legacy Detection has been extensively tested, using a wide variety of these units in both Microsemi and end user labs. During this testing, special care was taken to ensure that DTEs that do not accept power (non PDs, for example NIC cards) are not powered.
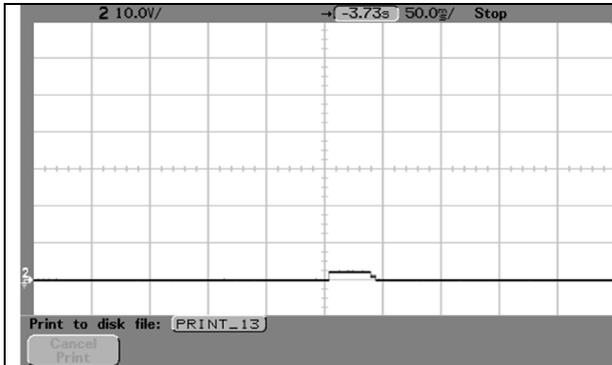

Line detection when NIC card is connected result with no power up
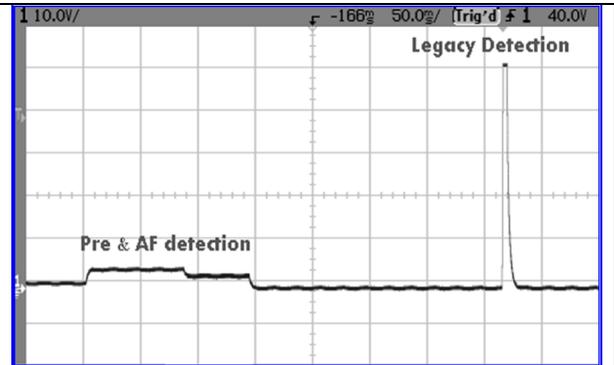
Line detection when 14 kOhm resistor is connected result with no power up
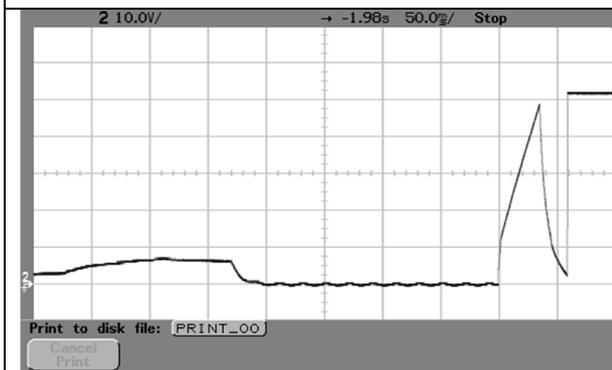
Line detection of a legacy PD from a leading manufacturer result: Power Up.
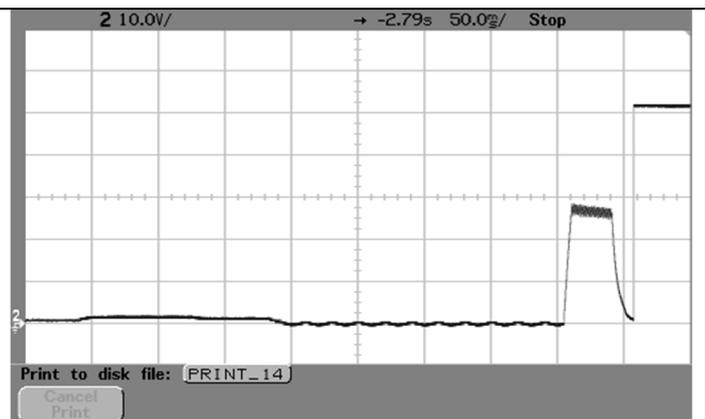
Line detection of legacy PD from a leading manufacturer. Looks like 2 kOhm resistor. Result: Power Up.

Detection of a PSE Device using Legacy Detection

The reason for detection algorithms is to avoid powering DTEs that are not power ready. According to the standard, PSEs must withstand at least 60V on their ports whether the port is on or off. See IEEE802.3at-2009, clause 33.7.5 or IEEE802.3-2008, clause 33.5.6.

Microsemi Legacy Detection is designed to power all leading pre standard PD devices and guarantees that DTEs that are not designed to accept power (for example NIC cards) are not powered.

In some cases a PSE may represent a legacy PD signature due to the bus capacitance and some power consumption. In that case, the PD may be powered. The standard clearly defines that any PSE should be designed in such way that it will stand at least 60V across the port when exposed to external voltage source connected to the PSE port. All Microsemi devices are designed to support that requirement per the international standard test setups.

Line detection of BRCM 59101 looks like a legacy PD result: Power Up

Line detection of 8 kOhm resistor looks like a legacy PD result: Power Up

Line detection when NIC card is connected result with no power up

Line detection when 14 kOhm resistor is connected result with no power up. From 14 kOhm and up, legacy detection does not power up.
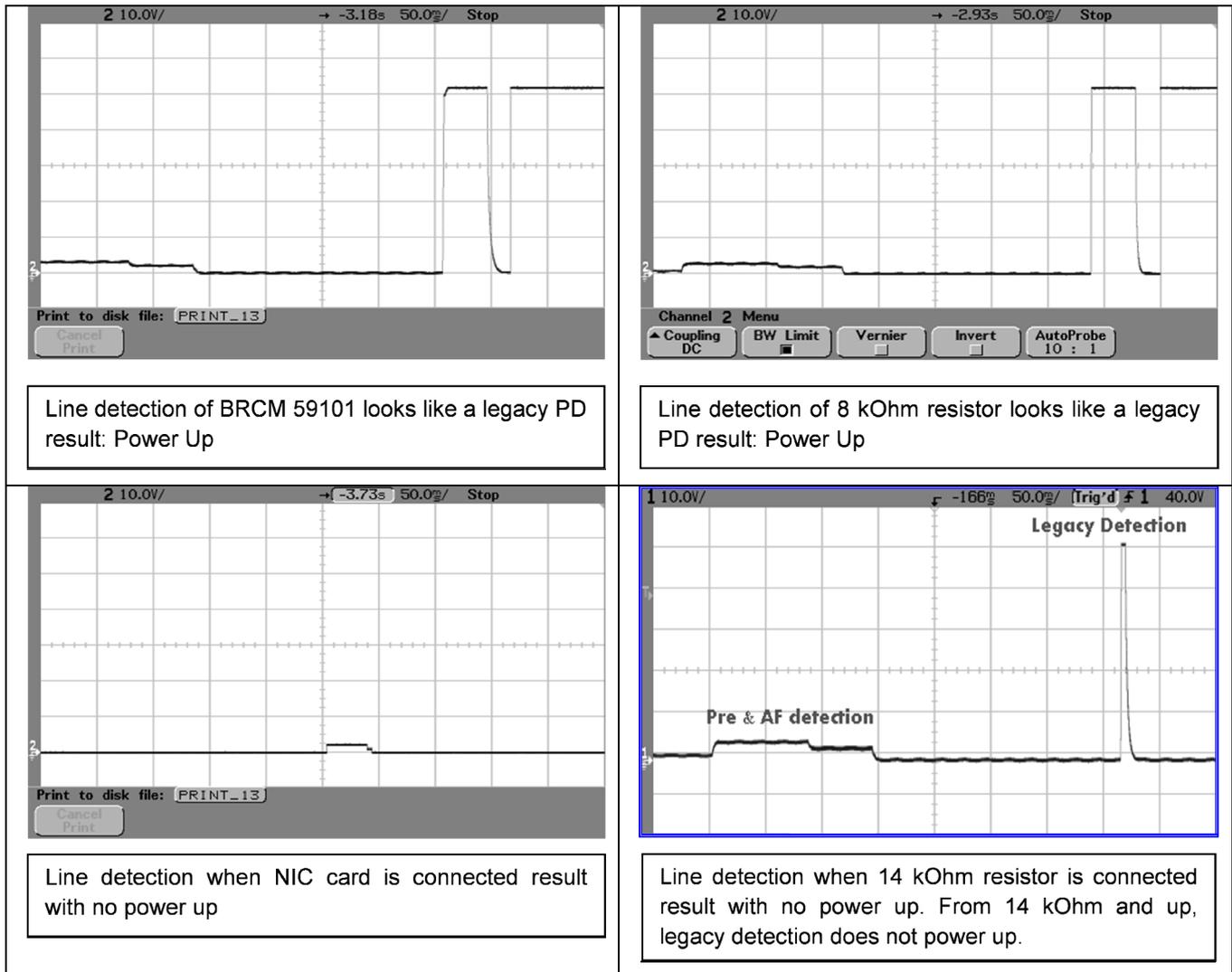
Cases in which Legacy Detection Can Detect a PSE as a Legacy PD and Power It

▪ **PSE powered with equal or lower voltage compared to the external PSE.**

According to IEEE802.3af/at a PSE port should present an equivalent serial resistance > 45kOhm. In such a case, Microsemi Legacy Detection does not power up.

A PSE which does not meet the reverse impedance requirement **might** be powered.

▪ **PSE connected to a non powered external PSE.**

Any PSE that is not internally powered (for example not connected to the main power source) may transmit a Legacy PD signature due to the bus capacitance and its power consumption. In this case the PSE may be powered.

The Microsemi, TI, LT and Broadcom Legacy Detection can detect such cases as a Legacy device and power it up, depending on the system capacitance and reflected load.

▪ **A PSE powered with higher voltage compared to the external PSE.**

In case where:

- a PSE is internally powered
- there is a voltage difference between the PSEs

The lower voltage PSE may present legacy PD signature due to the bus capacitance and power consumption. In that case it might be powered.

All the above cases are safe to operate if the system is designed to meet the standard as defined in IEEE802.3at-2009 clause 33.7.5 or IEEE802.3-2008 clause 33.5.6.

Summary

Microsemi Legacy Detection is designed to power all leading pre standard PD devices; it has been extensively tested using many of these units in Microsemi labs. As part of this design, special care has been taken to guarantee and validate that non-powered devices such as NIC cards are not powered, while the energy during detection is much lower than that allowed under industry standards. The standard clearly defines that any PSE must be designed so that no damage occurs if 60V is applied from an external source directly to the PSE port.

All Microsemi devices are designed to fully support this requirement. During the last 10 years, Microsemi Legacy line detection has been successfully implemented in tens of millions of PoE ports with no reported problems or failures. Any PSE that complies with industry standards is protected.

Any new PSE device being introduced into the market must be designed according to industry standards to work safely in this environment. Furthermore, the device must be designed to handle corner cases of Legacy Detection environment.

PD69012/PD69008 in Automode configuration

When the PD690xx detects it is powered via one of its ports, it does not turn on new ports (already powered ports stay on), and set the ports in error mode.

This feature is intended to protect the IC and the external mosfet of the port which is powered (marked in green), since all the current from #1 to #2 passes via the parasitic diode of the mosfet.

There is a way to bypass the error mode of the ports, by setting bit 7 of registed 0x1160 to "1".

But by doing so, the external mosfet gets heated and after a while might be damaged.

Revision History

Revision Level / Date	Para. Affected	Description
0.2 / 25-April-12	-	Initial Release

For support contact: **sales_AMSG@microsemi.com**

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