AN-1875 LM5073HE Evaluation Board With Active Bridge

1 Introduction

The LM5073HE (High Efficiency) evaluation board is designed as a high performance solution for both IEEE802.3af fully compliant and non-compliant High Power over Ethernet (HPoE) applications. The possible intake power of the unit is a minimum of 26.6W for a minimum input voltage of 37VDC.

To make a complete evaluation possible, the board also includes integrated Ethernet RX and TX magnetics and an RJ45 interface.

2 Features

- IEEE 802.3af fully compliant
- Programmable maximum input dc current through PD interface: 800mA
- Input voltage ranges:
  - PoE input voltage range at startup: 40 to 57V
  - PoE input voltage range with normal operation: 33 to 57V
- Efficient Mosfet Bridge polarity protection at input
- Measured Efficiency: 98% @ 37VDC, 720mA input
- Measured Efficiency: 98.5% @ 48VDC, 555mA input

3 Theory of Operation

The LM5073 is a 100V Power over Ethernet PD interface with auxiliary support. The low $R_{DS(ON)}$ PD interface hot swap MOSFET and programmable DC current limit extend the range of LM5073 applications up to twice the power level of IEEE 802.3af compliant devices. In a typical configuration, the input is polarity protected by a bridge rectifier that can cause an efficiency loss of up to 3.5%. This configuration assumes that the design requirements include maximum possible efficiency. Therefore, the polarity protection is provided by an input controlled mosfet bridge which yields a typical worse case loss of 0.44%. For a more detailed description of the various features and customizations afforded, please refer to *AN-1574 LM5073 Evaluation Board User's Guide* (SNVA214).

4 Important Information About the Maximum Power Capability, Cable Usage, and PoE Input Potentials

The LM5073HE evaluation board supports a maximum intake power of 26.6W. The user must make sure that the Power Sourcing Equipment (PSE) used can provide at least 30W, more if long cables are used.

Important: Please note that the CAT-5 cable may not supportthe maximum power over two pairs of twisted wires under strict safety considerations. Users shall select the proper cable wires to support the design power level without compromisingthe applicable safety standards. Using an improper cable at such power levels may violate various safety regulations and may cause damage.

Polarity Precaution: PoE applications are typically -48V systems, in which the notations GND and -48V normally refer to the high and low input potentials, respectively. However, for easy readability, the LM5072 datasheet was written in the positive voltage convention with positive input potentials referenced to the VEE pin of the LM5073. Therefore, when testing the evaluation board with a bench power supply, the negative terminal of the power supply is equivalent to the PoE system's -48V potential, and the positive terminal is equivalent to the PoE system ground. To prevent confusion between the datasheet and this application note, the same positive voltage convention is used.

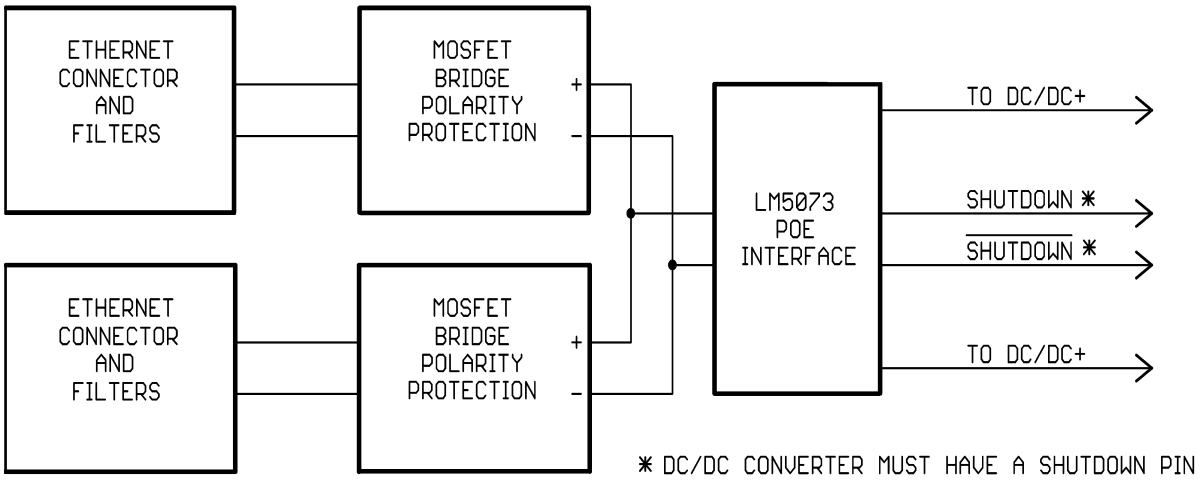

Figure 1. LM5073HE Evaluation Board Block Diagram

5 Loading

If using an electronic load, be sure that the "LOAD ON" switch does not cause a large current surge when turned on. The LM5073 cannot have a load applied until one of the shutdown outputs attempts to turn on the DC/DC converter. At this time, too much startup current may cause the LM5073 to detect an over-current condition. The typical DC/DC converter has a soft-start feature to prevent this from being a problem. If unable to monitor the shutdown outputs, simply wait a couple of seconds after applying input power before turning on the load.

If you wish to test the evaluation board with an actual DC/DC converter as a load, be sure to connect the appropriate shutdown pin (or inverted shutdown pin) of the LM5073HE board to the appropriate shutdown pin (or inverted shutdown pin) of the DC/DC converter. The dual row 6 pin socket on the LM5073HE board will mate to a standard 0.1" center dual row header. The pin out is shown below.

The typical evaluation setup shown in Figure 2 uses an LM5030 evaluation board as a load. There are many other possible choices, but make sure that the electronic load at the output of the LM5030 accounts for the efficiency loss of the LM5030 board and does not exceed the limits of the LM5073HE board.

Other possible evaluation boards to consider as loads include:

- **LM5005 Evaluation Board,** a 2.5A buck regulator for low cost non-isolated PD applications
- **LM5020 Evaluation Board,** a current mode flyback converter
- **LM5025 Evaluation Board,** a voltage mode active clamp forward converter
- **LM5026 Evaluation Board,** a current mode active clamp forward converter
- **LM5032 Evaluation Board,** a current mode dual interleaved converter
- **LM5034 Evaluation Board,** a current mode dual interleaved converter with active clamp
- **LM5115 Evaluation Board,** a 5A buck regulator with synchronous rectification

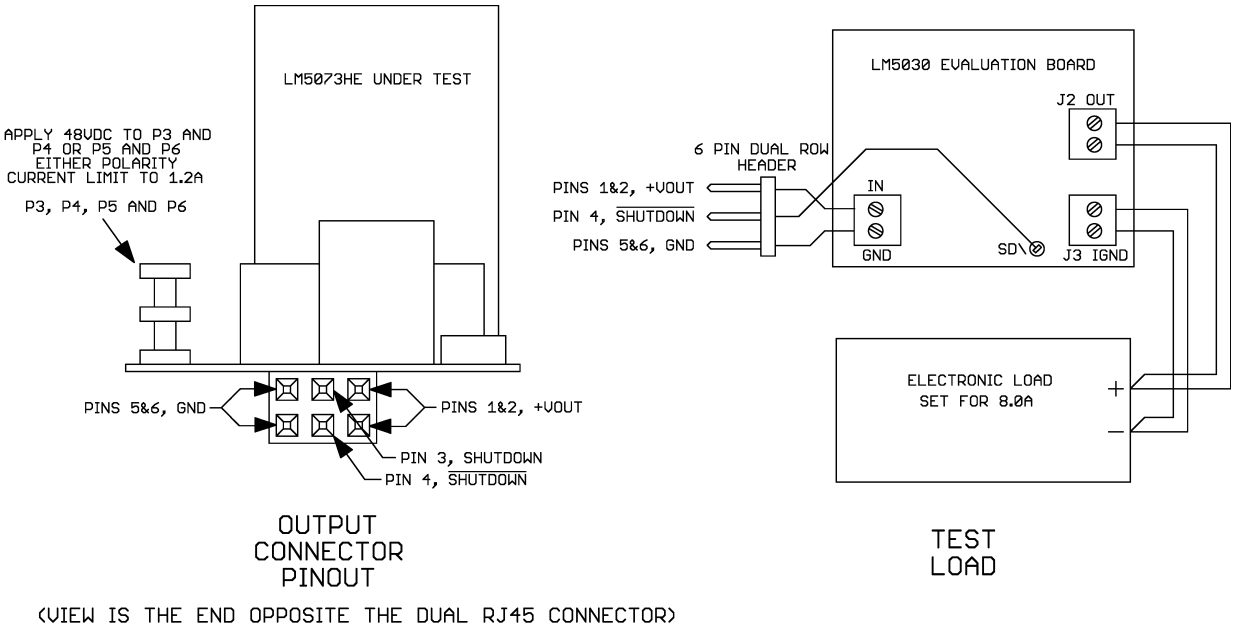

Figure 2. Typical Evaluation Setup

6 Efficiency

Figure 3 shows the typical efficiency curve at 48VDC input verses load. Since losses are almost entirely resistive, a value of 1.05 Ohms may be used to estimate losses for other levels of current and voltage.

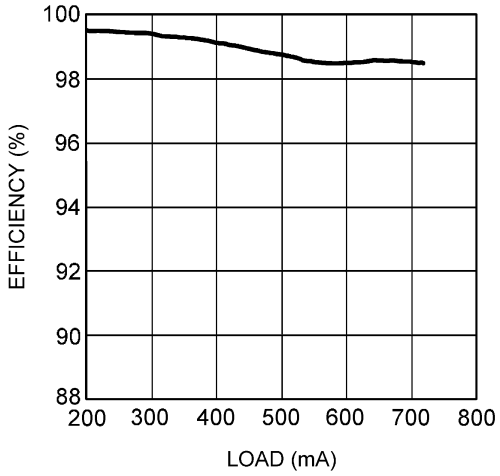

Figure 3. Efficiency at 48V Input

7 Printed Circuit Layout

The layers of the printed circuit board are shown in top down order in Figure 4 to Figure 6. View is from the top of the board. Scale is approximately X1.5. The printed circuit board consists of 2 layers of 2 ounce copper on FR4 material with a total thickness of 0.065 inches.

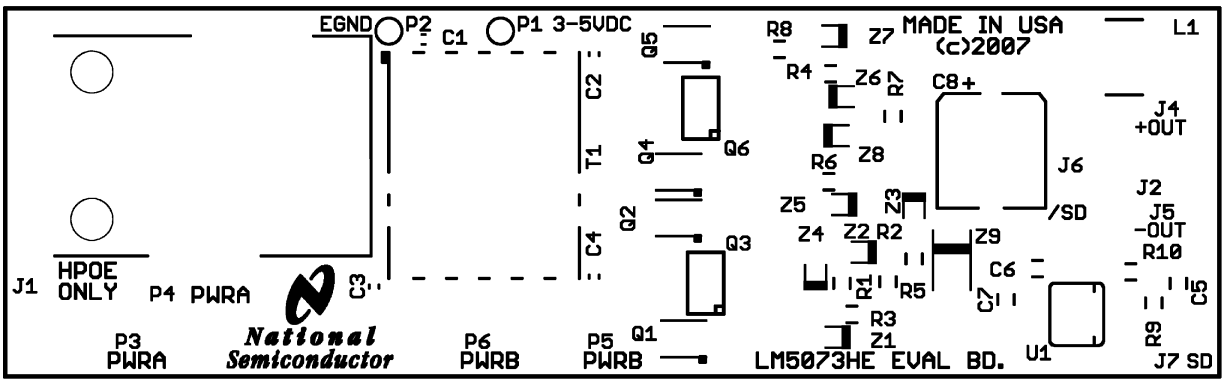

Figure 4. Top Silkscreen

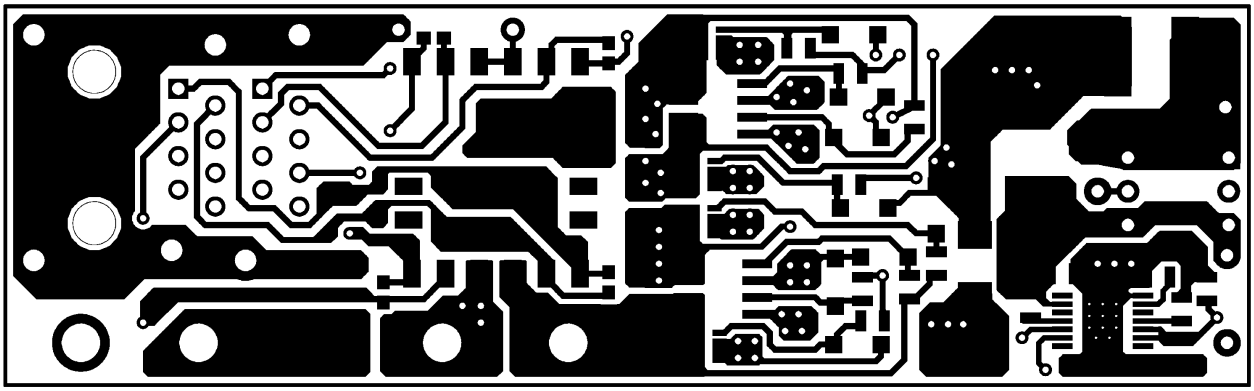

Figure 5. Top Copper

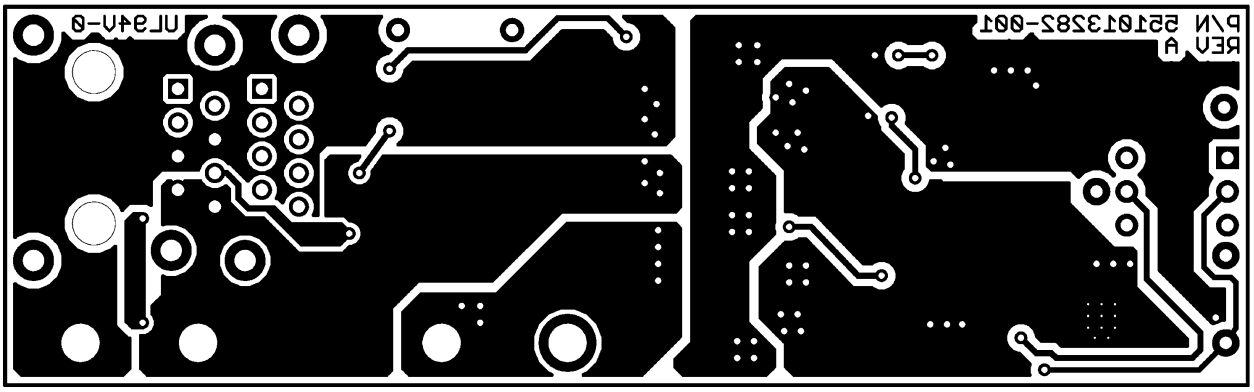

Figure 6. Bottom Copper

8 Bill of Materials

Table 1. Bill of Materials

Item	Description	Manufacturer	Part Number
C1	8.0 pF, 50V, CER, NPO, 0603	AVX	06031A8R0CAT2A
C2	8.0 pF, 50V, CER, NPO, 0603	AVX	06031A8R0CAT2A
C3	8.0 pF, 50V, CER, NPO, 0603	AVX	06031A8R0CAT2A
C4	8.0 pF, 50V, CER, NPO, 0603	AVX	06031A8R0CAT2A
C5	0.047 µF, 100V, X7R, 0805	TDK	C2012X7R2A473K
C6	0.047 µF, 100V, X7R, 0805	TDK	C2012X7R2A473K
C7	0.047 µF, 100V, X7R, 0805	TDK	C2012X7R2A473K
C8	22 µF, 100V, ALUM ELECT, LOW ESR	PANASONIC	EEV-FK2A220P
J1	JACK, MODULAR, 2 PORT RJ45	TYCO	5569381-1
J2	SOCKET, .025" SQ POST, 3 × 2, R/A	TYCO	6-535512-2
L1	INDUCTOR, 4.7 µH, 1.8A, 56m	COILCRAFT	MSS6132-472ML
P1	TEST POINT, MINIATURE	KEYSTONE	5002
P2	TEST POINT, MINIATURE	KEYSTONE	5002
P3	TERMINAL, TURRET	KEYSTONE	1503
P4	TERMINAL, TURRET	KEYSTONE	1503
P5	TERMINAL, TURRET	KEYSTONE	1503
P6	TERMINAL, TURRET	KEYSTONE	1503
Q1	MOSFET, P-CH, 100V, 134 mΩ, 1212-8	VISHAY	SI7113DN
Q2	MOSFET, P-CH, 100V, 134 mΩ, 1212-8	VISHAY	SI7113DN
Q3	MOSFET, DUAL N-CH, 100V, 62mΩ, SO8	FAIRCHILD	FDS3992
Q4	MOSFET, P-CH, 100V, 134 mΩ, 1212-8	VISHAY	SI7113DN
Q5	MOSFET, P-CH, 100V, 134 mΩ, 1212-8	VISHAY	SI7113DN
Q6	MOSFET, DUAL N-CH, 100V, 62 mΩ, SO8	FAIRCHILD	FDS3992
R1	RESISTOR, 150K, 1%, 1/8W, 0805	VISHAY	CRCW0805150KF
R2	RESISTOR, 150K, 1%, 1/8W, 0805	VISHAY	CRCW0805150KF
R3	RESISTOR, 150K, 1%, 1/8W, 0805	VISHAY	CRCW0805150KF
R4	RESISTOR, 150K, 1%, 1/8W, 0805	VISHAY	CRCW0805150KF
R5	RESISTOR, 150K, 1%, 1/8W, 0805	VISHAY	CRCW0805150KF
R6	RESISTOR, 150K, 1%, 1/8W, 0805	VISHAY	CRCW0805150KF
R7	RESISTOR, 150K, 1%, 1/8W, 0805	VISHAY	CRCW0805150KF
R8	RESISTOR, 150K, 1%, 1/8W, 0805	VISHAY	CRCW0805150KF
R9	RESISTOR, 31.6, 1%, 1/8W, 0805	VISHAY	CRCW080531R6F
R10	RESISTOR, 15.0K, 1%, 1/8W, 0805	VISHAY	CRCW080515K0F
T1	SIGNAL PATH HPOE MAGNETICS	COILCRAFT	ETH1-230L
U1	IC, POE INTERFACE, TSSOP-14 EP	TEXAS INSTRUMENTS	LM5073
Z1	ZENER, 15V @ 50 µA, SOD-123	CENTRAL SEMICONDUCTOR	CMHZ4702
Z2	ZENER, 15V @ 50 µA, SOD-123	CENTRAL SEMICONDUCTOR	CMHZ4702
Z3	ZENER, 15V @ 50 µA, SOD-123	CENTRAL SEMICONDUCTOR	CMHZ4702
Z4	ZENER, 15V @ 50 µA, SOD-123	CENTRAL SEMICONDUCTOR	CMHZ4702
Z5	ZENER, 15V @ 50 µA, SOD-123	CENTRAL SEMICONDUCTOR	CMHZ4702
Z6	ZENER, 15V @ 50 µA, SOD-123	CENTRAL SEMICONDUCTOR	CMHZ4702
Z7	ZENER, 15V @ 50 µA, SOD-123	CENTRAL SEMICONDUCTOR	CMHZ4702
Z8	ZENER, 15V @ 50 µA, SOD-123	CENTRAL SEMICONDUCTOR	CMHZ4702
Z9	DIODE, TVS, 60V, SMA	DIODES INC.	SMAJ60A-13

9 LM5073 Evaluation Board Schematic

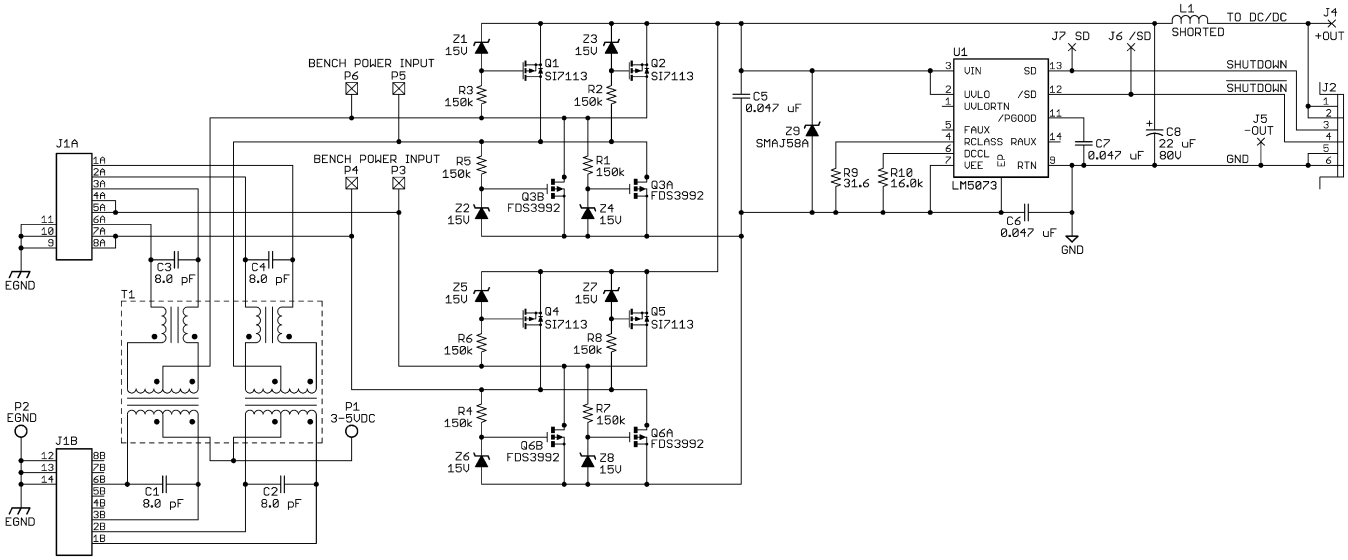

Figure 7. LM5073 Evaluation Board: Input 40-57V Startup, 720 mA

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