# IEEE 802.3at PoE PD with Integrated DC-DC Controller

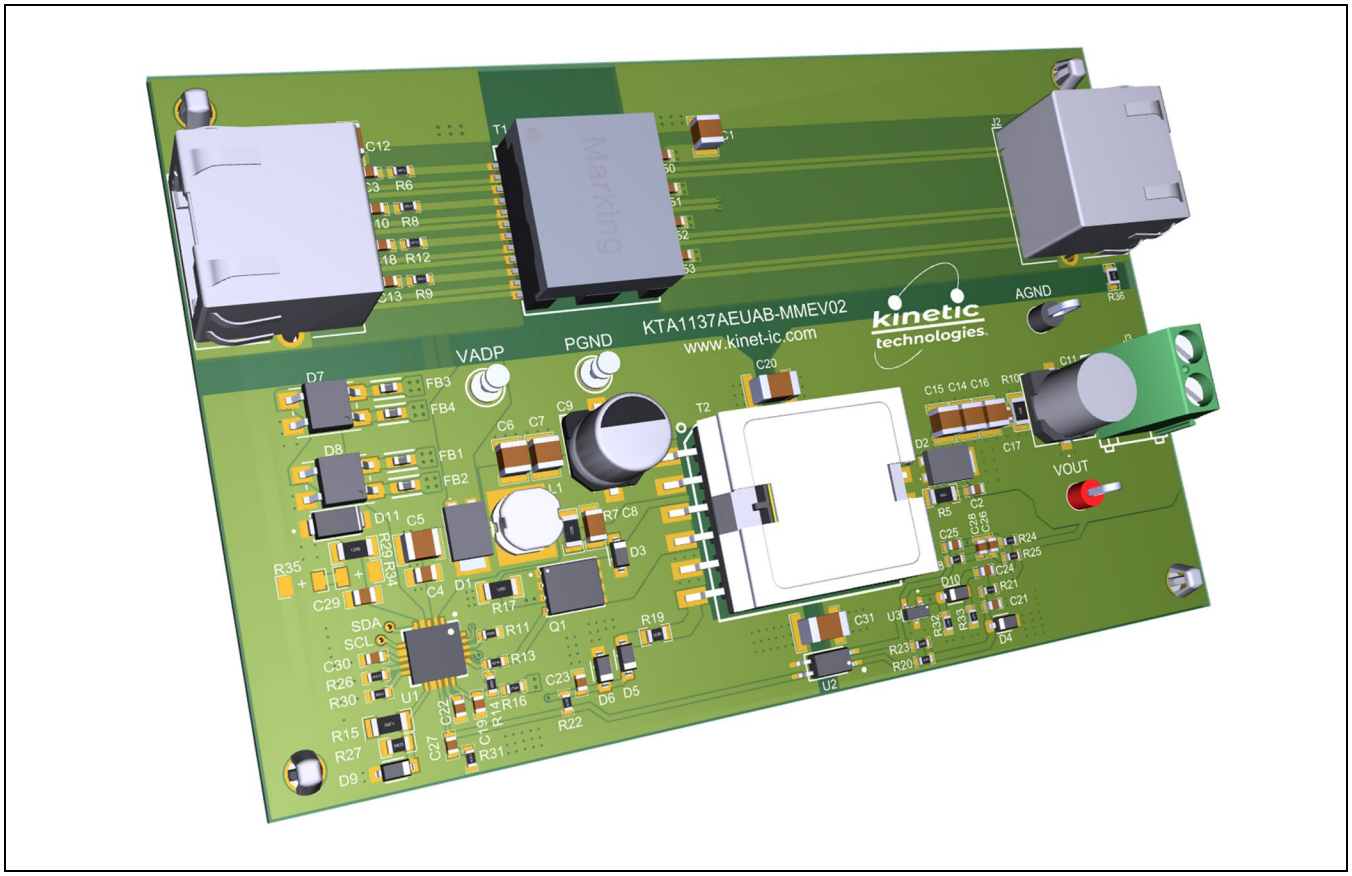
## Brief Description

The KTA1137A Evaluation (EVAL) Kit is used to demonstrate and evaluate the KTA1137A functionality, performance, and PCB layout. The kit includes a fully assembled and tested PCB with the KTA1137A IC installed, and a printed copy of the Quick Start Guide. The KTA1137A device is an IEEE 802.3af/at compliant combination powered device (PD) controller and power supply controller optimized for isolated and non-isolated converter topologies. This KTA1137A EVAL board provides power and signal I/O connections and an array of test points for signal observation. A non-synchronous 12V, 25W flyback topology design is featured, but synchronous rectified designs are also possible using synchronous winding of the transformer.

## Ordering Information

| Part Number | Description | IC Package |
|---|---|---|
| KTA1137AEUAB-MMEV02 | KTA1137A EVAL Kit – Version 2 | QFN55-20 |

## 3D CAD Image



## EVAL Kit Physical Contents

| Item # | Description | Quantity |
|---|---|---|
| 1 | KTA1137A Evaluation board fully assembled PCB | 1 |
| 2 | Anti-static bag | 1 |
| 3 | KTA1137A Quick Start Guide, printed 1 page (A4 or US Letter) | 1 |
| 4 | EVAL Kit box | 1 |

## QR Links for Documents

| IC Datasheet | EVAL Kit Landing Page |
|---|---|
| https://www.kinet-ic.com/kta1137a | https://www.kinet-ic.com/kta1137aeuab-mmev02 |

## User-Supplied Equipment

- Power Sourcing Equipment (PSE) or Bench Power Supply for VIN = 37V-57V and 1A as needed for intended application.
- Digital Multimeter – used to measure input/output voltages and currents.
- Load – either power resistors, an E-Load, or an actual system load.

## Recommended Operating Conditions

| Parameter | Condition | | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **Power Interface** | | | | | | |
| Input voltage | Applied to power pins of connectors RJ1 or J1 | | 0 | | 57 | V |
| Operation voltage | After start-up with 37V or above | | 34 | | 57 | V |
| Input UVLO | Rising input voltage | | | 34 | | V |
| | Falling input voltage | | | 30 | | V |
| Detection voltage | At device terminals | | 2.7 | | 13 | V |
| Classification voltage | At device terminals | | 11 | | 24 | V |
| Classification current | $R_{CLASS}$ = 63.4kΩ | | 36 | | 44 | mA |
| Inrush current-limit | | | 100 | | 400 | mA |
| Operation current-limit | | | | 1200 | | mA |
| **DC/DC Converter** | | | | | | |
| Output voltage | $34 \le V_{IN} \le 57V$, $I_{LOAD} \leqq I_{LOAD\ (MAX)}$ | 12V output | | | | V |
| Output current | $34 \le V_{IN} \le 57V$ | 12V output | | 2.1 | | A |
| Output ripple voltage (peak to peak) | $V_{IN}$ = 48V, $I_{LOAD}$ = 2.1A | 12V output | | 50 | | mV |
| Efficiency (end to end) | $V_{IN}$ = 48V, $I_{LOAD}$ = 2.1A | 12V output | | 86.61 | | % |
| Switching frequency | | | 110 | | 130 | kHz |

## Quick Start Procedures

The output voltage of this board is set to 12V. There are two methods to start KTA1137AEUAB-MMEV02:

Method 1: Connect to PSE

1. Connect a voltage meter to the output VOUT and AGND test pins, it should measure the output voltage.
2. Connect the load to the output VOUT and AGND test pins.
3. Connect the cable coming from the PSE into the Ethernet Jack J1. The board will automatically startup.

Method 2: Connect to Local Power Supply

1. Connect one pair of power cables to the connector of EVAL Kit at VADP (9.5V ~ 57V) and PGND.
2. Before connecting the EVAL Kit to the bench power supply, turn on the supply and adjust the voltage as close to 0V as possible. Then turn off the supply. While off, connect the power cables ends to the bench supply.
3. Connect a voltage meter to the output VOUT and AGND test pins, it should measure the output voltage.
4. Connect the load to the output VOUT and AGND test pins.
5. Turn on the VIN bench supply and very slowly ramp its voltage to an appropriate voltage, such as 48V. While ramping VIN slowly, use the bench supply's output current indication (or a digital multimeter) to monitor the VIN current. If the current becomes high, reduce the VIN voltage quickly to prevent damage. Then inspect the setup for any wiring errors.

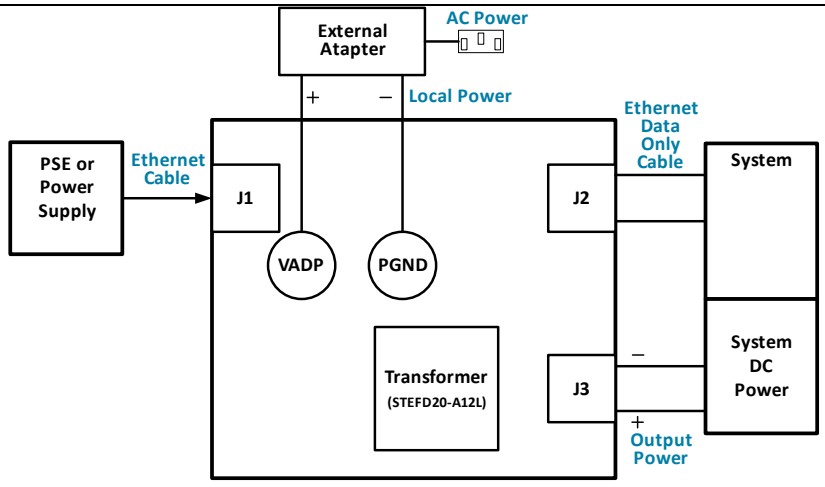
## General Configuration

### Connector Functionality

| Connector | Description |
|---|---|
| J1 | Ethernet power input connector (RJ45 style connector) |
| J2 | Ethernet data port connector (RJ45 style connector) |
| J3 | VOUT (output) to system DC power |
| PGND | Adapter ground |
| VADP | External adaptor input (9.5V ~ 57V) |

## Typical Test Setup

The figure below shows a typical setup for KTA1137A EVB. Input voltage can be applied as described in the Connector Functionality table above.



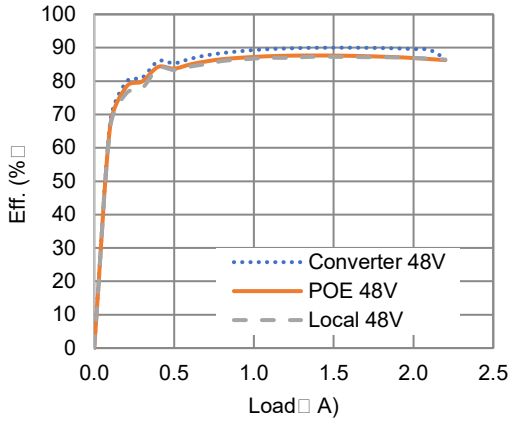

**Typical KTA1137AEUAB-MMEV02 Test Setup**

## Typical Performance Data

### 12V Output DC/DC Efficiency

The Figure below illustrates three different 48VDC input efficiency plots:

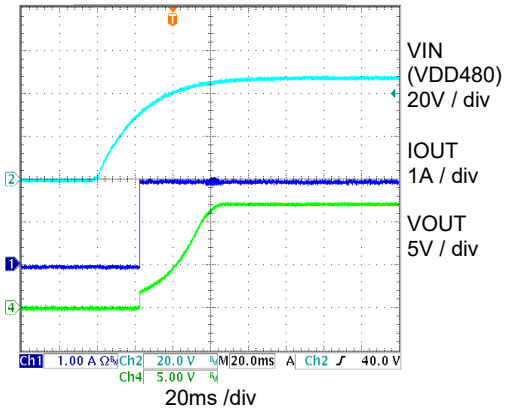
1. POE, 48V from RJ1
2. Converter only 48V
3. Adaptor 48V from J1



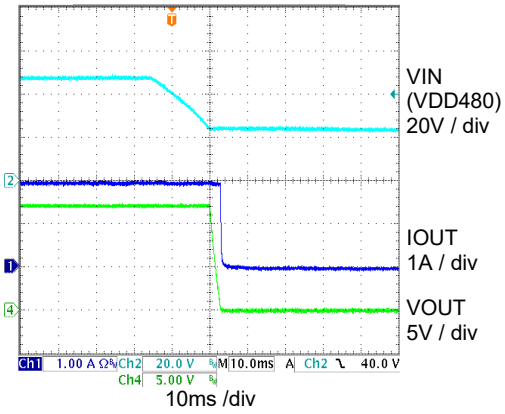

**KTA1137A EVB Efficiency with 12V Output**

## Operational Waveforms

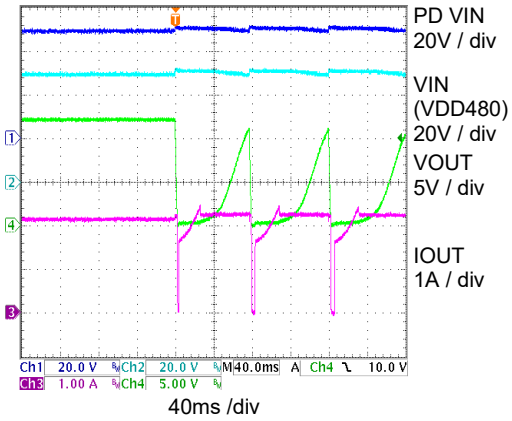
### Power Up



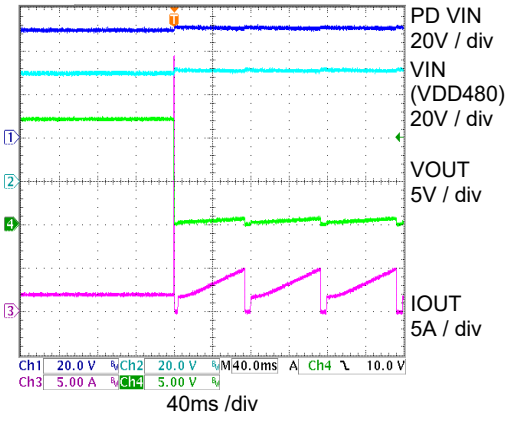

### Power-down



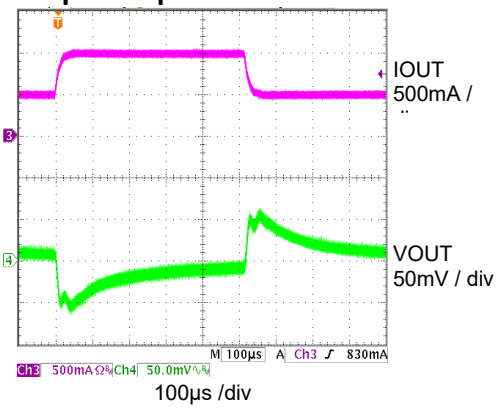

### Over Current Protection (Overload)



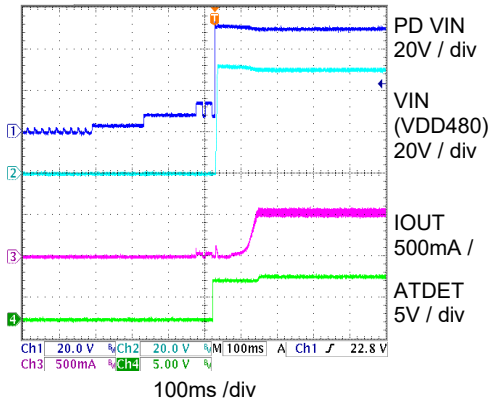

### Over Current Protection (Short Circuit)



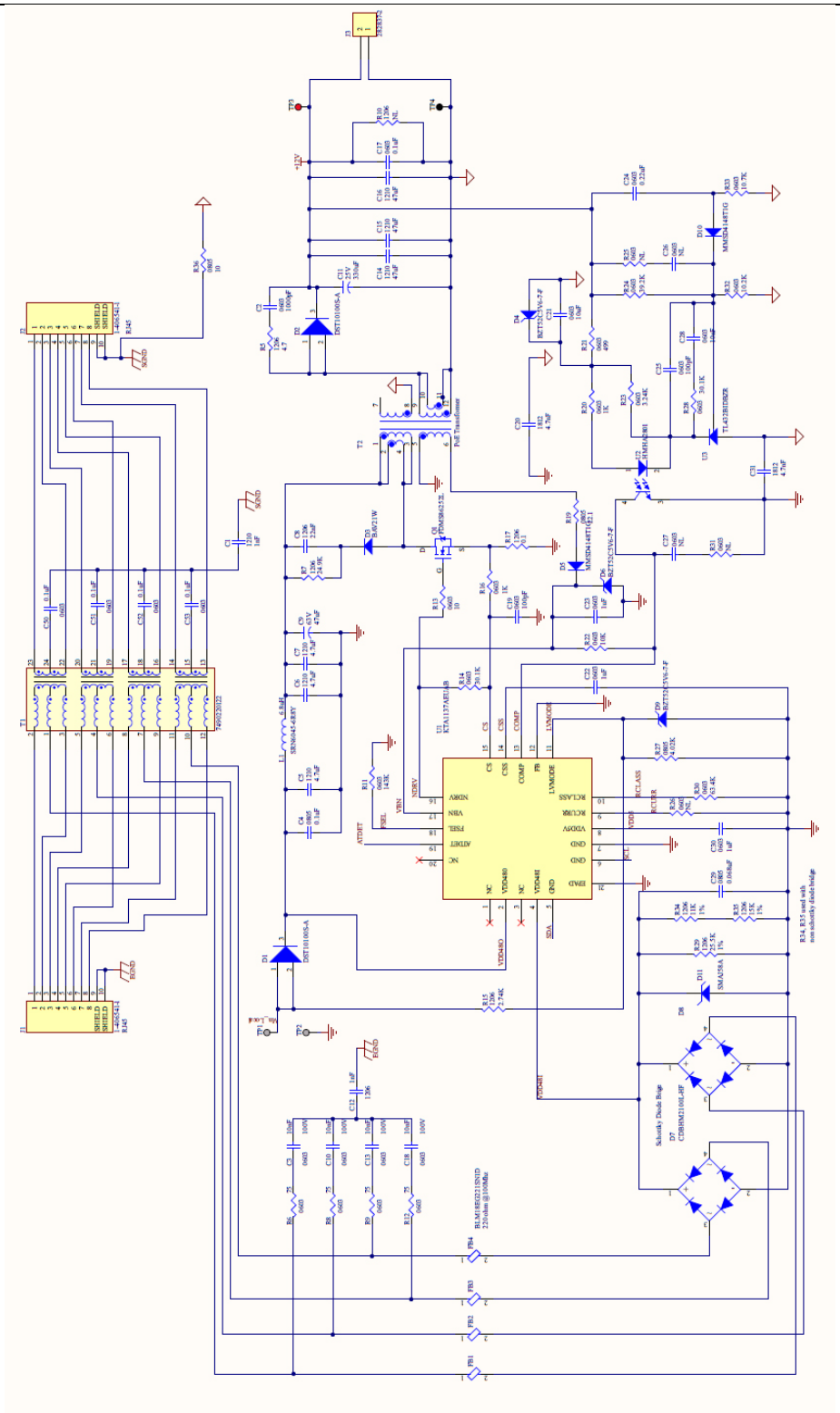

### DC-DC Output Step Load




### AT Detection



## Electrical Schematic



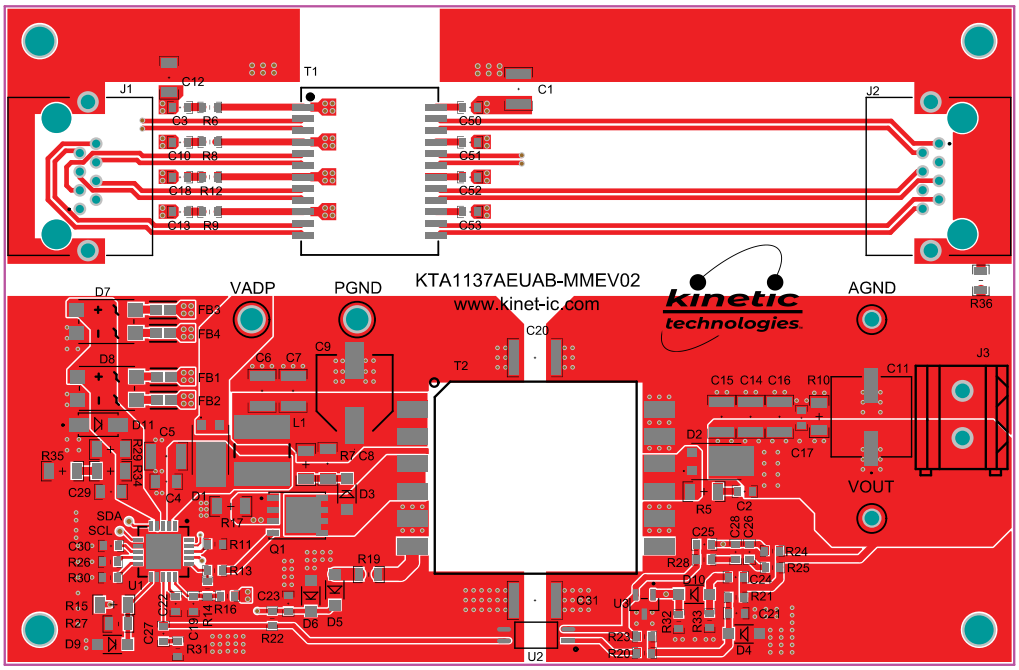
## Bill of Materials (BOM)

| Designator | Description | Value | Package | Manufacturer | Manufacturer Part Number |
|---|---|---|---|---|---|
| C1 | CAP CER 1000pF 2KV X7R 1210 | 1nF | 1210 | Johanson Dielectrics Inc. | 202S41W102KV4E |
| C2 | CAP CER 1000pF 100V X7R 0603 | 1000pF | 0603 | Samsung | CL10B102KC8NNNC |
| C3, C10, C13, C18 | CAP CER 10nF 100V X7R 0603 | 10nF | 0603 | Samsung | CL10B103KC8NNNC |
| C4 | CAP CER 0.1µF 100V X7R 0805 | 0.1µF | 0805 | Yageo | CC0805KKX7R0BB104 |
| C5, C6, C7 | CAP CER 4.7µF 100V X7S 1210 | 4.7µF | 1210 | Taiyo Yuden | HMK325C7475KN-TE |
| C8 | CAP CER 0.022µF 100V X7R 1206 | 22nF | 1206 | Yageo | CC0805KRX7R0BB223 |
| C9 | CAP ALUM 47µF 20% 63V SMD | 47µF | SMD | Panasonic | EEE-HA1J470UP |
| C11 | CAP ALUM 330µF 20% 25V SMD | 330µF | SMD | Wurth Electronics | 865060453008 |
| C12 | CAP CER 1000pF 2KV X7R 1206 | 1nF | 1206 | Yageo | CC1206KKX7RDBB102 |
| C14, C15, C16 | CAP CER 47µF 16V X5R 1210 | 47µF | 1210 | Murata | GRM32ER61C476KE15L |
| C17, C50, C51, C52, C53 | CAP CER 0.1µF 16V X7R 0603 | 0.1µF | 0603 | Samsung | CL10B104KO8NNNC |
| C19, C25 | CAP CER 100pF 50V C0G/NP0 0603 | 100pF | 0603 | Samsung | CL10C101JB8NNNC |
| C20, C31 | CAP CER 4700pF 2KV X7R 1812 | 4.7nF | 1812 | Yageo | CC1812KKX7RDBB472 |
| C21 | CAP CER 10µF 16V X5R 0603 | 10µF | 0603 | Murata | GRM188R61C106MA73D |
| C22, C23, C30 | CAP CER 1µF 16V X5R 0603 | 1µF | 0603 | Samsung | CL10A105KO8NNNC |
| C24 | CAP CER 0.22µF 25V X7R 0603 | 0.22µF | 0603 | Samsung | CL10B224KA8NNNC |
| C26, C27 | CAP 0603 | DNP | 0603 | | |
| C28 | CAP CER 0.01µF 50V X7R 0603 | 10nF | 0603 | Samsung | CL10B103KB8NNNC |
| C29 | CAP CER 0.068µF 100V X7R 0805 | 0.068µF | 0805 | Yageo | CC0805KKX7R0BB683 |
| D1, D2 | DIODE SCHOTTKY 100V 10A TO277B | | | LITTELFUSE | DST10100S-A |
| D3 | DIODE GEN PURP 200V 200MA SOD123 | | SOD123 | SMC Diode Solutions | BAV21W |
| D4, D6, D9 | DIODE ZENER 5.6V 500MW SOD123 | | SOD123 | Diodes Inc | BZT52C5V6-7-F |
| D5, D10 | DIODE ZENER 27V 500MW SOD123 | | SOD123 | onsemi | MMSD4148T1G |
| D7, D8 | BRIDGE RECT 1PHASE 100V 2A MBS-2 | | TO-269AA | Comchip Technology | CDBHM2100L-HF |
| D11 | TVS DIODE 58VWM 93.6VC DO214AC | | DO-214AC | Littelfuse Inc. | SMAJ58A |
| FB1, FB2, FB3, FB4 | FERRITE BEAD 220Ω 0603 1LN | 220 | 0603 | Murata Electronics | BLM18EG221SN1D |
| H1, H2, H3, H4 | BRD SPT SNAP LOCK REST MNT 4MM | | | Essentra Components | PSD-4M-19 |
| J1, J2 | CONN MOD JACK 8P8C R/A SHIELDED | | None | TE Connectivity | 1-406541-1 |
| J3 | TERM BLK 2P SIDE ENT 5.08MM PCB | | | TE Connectivity | 282837-2 |
| L1 | FIXED IND 6.8µH 2.8A 47.3MΩ SM | 6.8µH | SMD | Bourns Electronics | SRN6045-6R8Y |
| Q1 | MOSFET N-CH 150V 4.4A 8PQFN | | PQFN-8 | ON Semiconductor | FDMS86252L |
| R5 | RES SMD 4.7Ω 1% 1/4W 1206 | 4.7 | 1206 | Yageo | RC1206FR-074R7L |
| R6, R8, R9, R12 | RES SMD 75Ω 1% 1/10W 0603 | 75 | 0603 | Yageo | RC0603FR-0775RL |
| R7 | RES SMD 24.9KΩ 1% 1/4W 1206 | 24.9K | 1206 | Yageo | RC1206FR-0724K9L |
| R10 | RES 1206 | DNP | 1206 | | |
| R11 | RES SMD 143K 1% 1/10W 0603 | 143K | 0603 | Yageo | RC0603FR-07143KL |
| R13 | RES SMD 10Ω 1% 1/10W 0603 | 10 | 0603 | Yageo | RC0603FR-0710RL |
| R14 | RES SMD 30K 1% 1/10W 0603 | 30.1K | 0603 | Yageo | RC0603FR-0730K1L |
| R15 | RES SMD 2.74k 1% 1/4W 1206 | 2.74K | 1206 | Yageo | RC1206FR-072K74L |

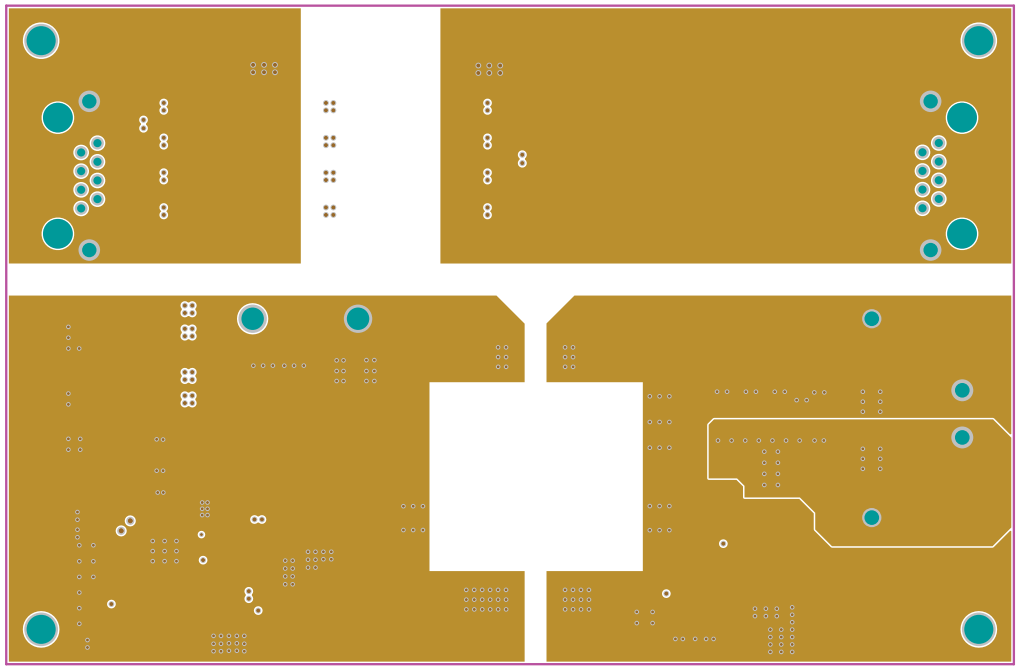
| Designator | Description | Value | Package | Manufacturer | Manufacturer Part Number |
|---|---|---|---|---|---|
| R16, R20 | RES SMD 1K 1% 1/10W 0603 | 1K | 0603 | Yageo | RC0603FR-071KL |
| R17 | RES SMD 100mΩ 1% 1/4W 1206 | 0.1 | 1206 | Yageo | RL1206FR-070R1L |
| R19 | RES SMD 22.1Ω 1% 1/10W 0805 | 22.1 | 0805 | Yageo | RC0805FR-0722R1L |
| R21 | RES SMD 499 Ω 1% 1/10W 0603 | 499 | 0603 | Yageo | RC0603FR-07499RL |
| R22 | RES SMD 10K 1% 1/10W 0603 | 10K | 0603 | Yageo | RC0603FR-0710KL |
| R23 | RES SMD 3.24K 1% 1/10W 0603 | 3.24K | 0603 | Yageo | RC0603FR-073K24L |
| R24 | RES SMD 39.2K 1% 1/10W 0603 | 39.2K | 0603 | Yageo | RC0603FR-0739K2L |
| R25, R26, R31 | RES 0603 | DNP | 0603 | | |
| R27 | RES SMD 4.02K 1% 1/10W 0805 | 4.02K | 0805 | Yageo | RC0805FR-074K02L |
| R28 | RES SMD 30.1K 1% 1/10W 0603 | 30.1K | 0603 | Yageo | RC0603FR-0730K1L |
| R29 | RES SMD 25.5K 1% 1/4W 1206 | 25.5K | 1206 | Yageo | RC1206FR-0725K5L |
| R30 | RES SMD 63.4K 1% 1/10W 1206 | 63.4K | 0603 | Yageo | RC0603FR-0763K4L |
| R32 | RES SMD 10.2K 1% 1/10W 0603 | 10.2K | 0603 | Yageo | RC0603FR-0710K2L |
| R33 | RES SMD 10.7K 1% 1/10W 0603 | 10.7K | 0603 | Yageo | RC0603FR-0710K7L |
| R34 | RES SMD 11K 1% 1/4W 1206 | 11K | 1206 | Yageo | RC1206FR-0711KL |
| R35 | RES SMD 15K 1% 1/4W 1206 | 15K | 1206 | Yageo | RC1206FR-0715KL |
| R36 | RES SMD 10Ω 1% 1/10W 0805 | 10 | 0805 | Yageo | RC0805FR-0710RL |
| T1 | WE-LAN LAN Transformer, SMT, 1000 Base-T, 1 port | | | Wurth Elektronik | 7490220122 |
| T2 | Power Transformer | | | SamWha | STEFD20-A12L |
| TP1, TP2 | TERM TURRET SINGLE L=5.56MM TIN | | TH | Keystone | 1502-2 |
| TP3 | PC TEST POINT MULTIPURPOSE RED | | TH | Keystone | 5010 |
| TP4 | PC TEST POINT MULTIPURPOSE BLACK | | TH | Keystone | 5011 |
| U1 | IEEE 802.3at PoE PD with Integrated DC-DC Controller | | QFN55-20 | Kinetic Technologies | |
| U2 | OPTOISO 3.75KV TRANSISTOR 4SMD | | 4-SOIC | ON Semiconductor / Fairchild | HMHA2801A |
| U3 | IC VREF SHUNT ADJ 0.5% SOT23-3 | | SOT-23-3 | Texas Instruments | TL432BIDBZR |

## Printed Circuit Board (PCB)

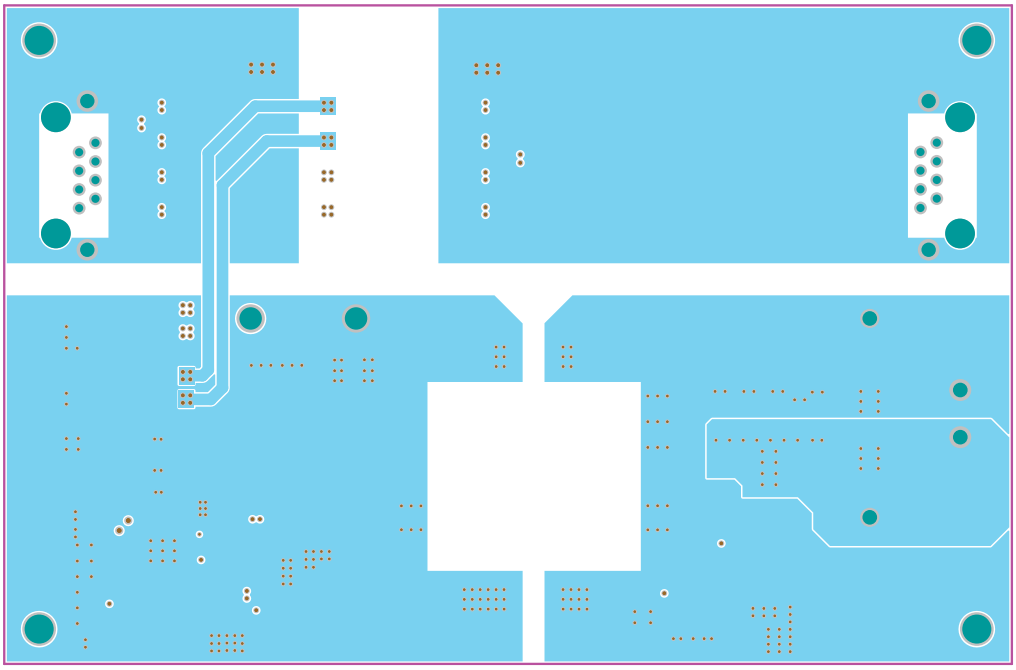
Top Side Layout/Routing



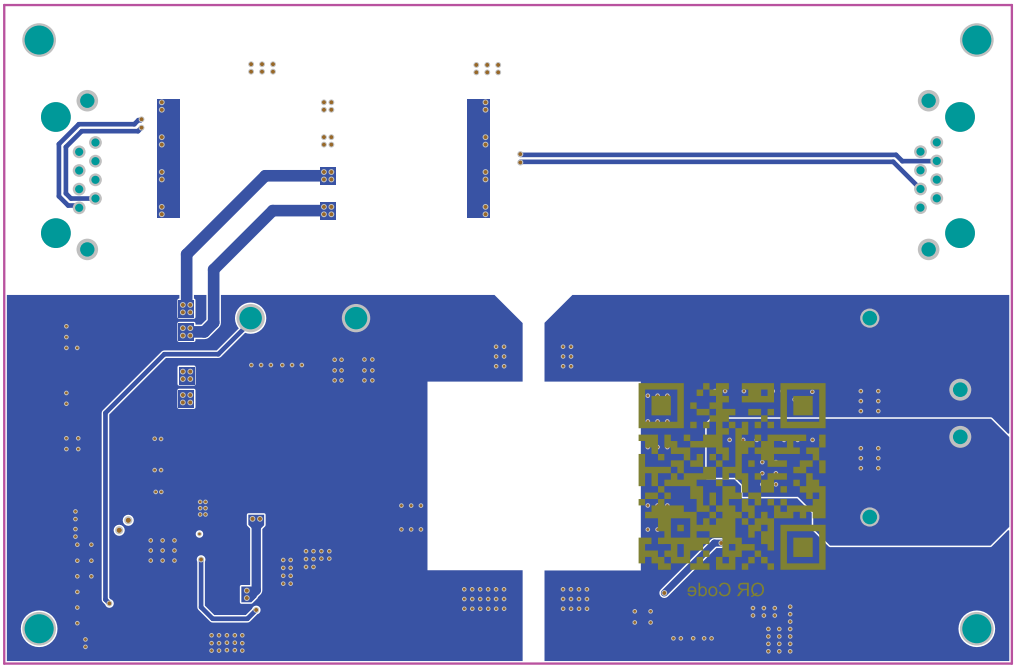

Layer Two Routing



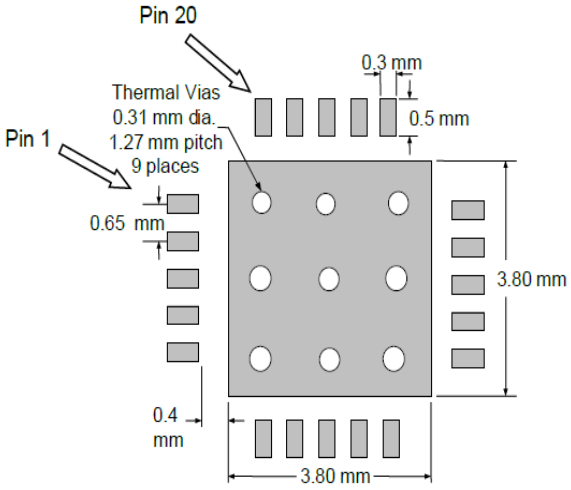
Layer Three Routing



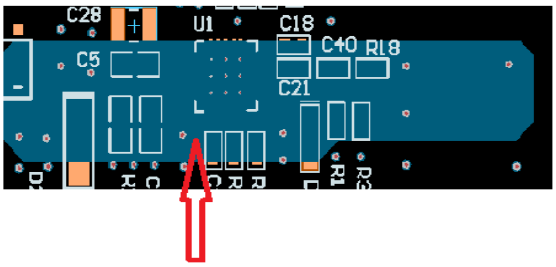
Bottom Layer Routing



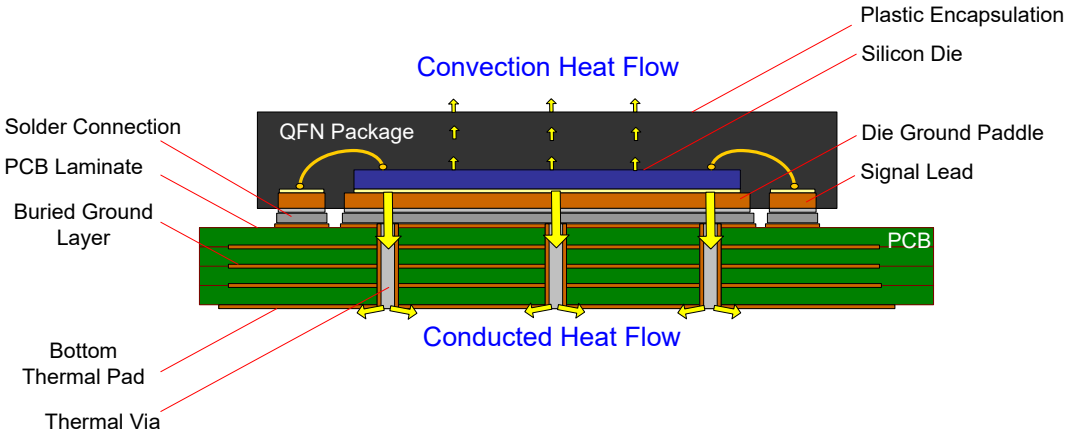
## Layout Guidelines




**KTA1137A Footprint (Top View)**

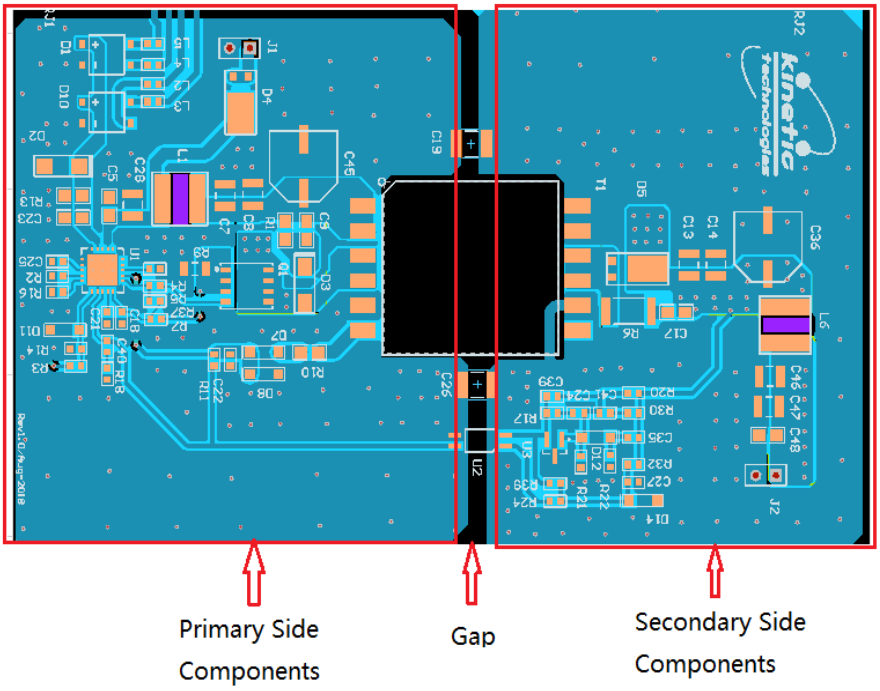



**Bottom Solder Mask**



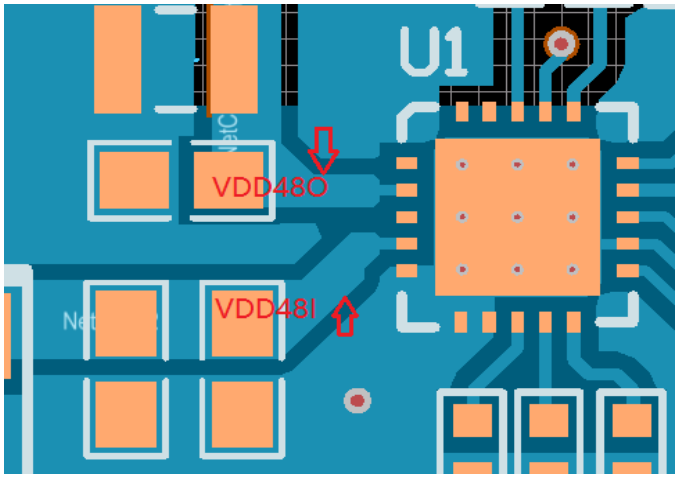

**KTA1137A PCB Footprint and Conducted Heat Flow**

The PCB layout is divided into primary (input) side and secondary (output) side components and typically separated by an isolation barrier. The primary components should be grouped together, and the secondary components should be grouped together. T1, U2, C20 and C31 are the only components bridging the isolation barrier between the primary and secondary circuitry. Primary and secondary traces, planes and other conductive items should be separated by a gap specified by the safety agency requirements appropriate for the insulation classification required by the application. The minimum spacing (creepage distance) for up to 63V input and Basic insulation is 1.25mm (IEC60950-1 Edition 2.2 2013-05). It is best practice to create a defined gap under T1, U2, C20 and C31 between primary side and secondary side as shown below.



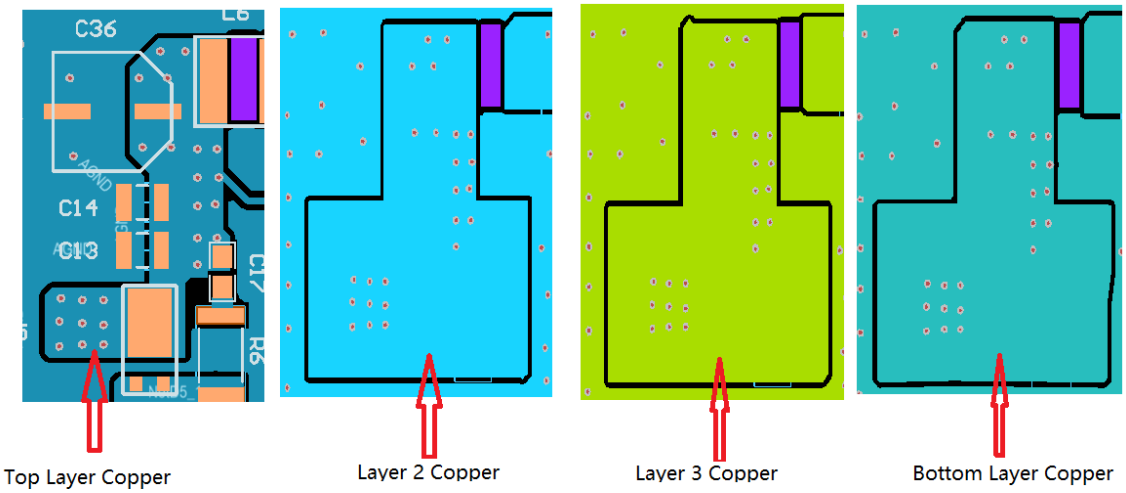

**Primary Side and Secondary Side Components Placement**

Please note: There should be no crossover between VDD48I and VDD48O.




**VDD48I and VDD48O Route**

Large copper fills and traces should be used on SMT power -dissipating devices, and wide traces or overlay copper fills should be used in the power path, such as D1, D2, D4, D5, L1, Q1, T2 and U1.

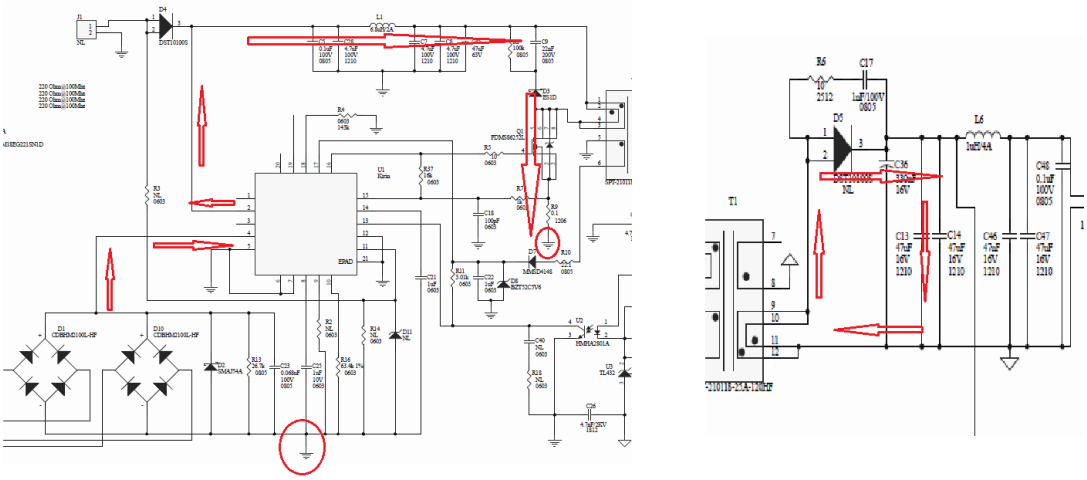



**Power-dissipating Device Route**

- Parts placement should prioritize a minimize trace length with point-to-point connections, i.e. no branch connections.
- High current circuitry should have priority over low power connections. Return paths should be paired with the corresponding source either with a dedicated return path or a ground plane.
- To minimize crosstalk there should not be any crossover of signals from one part of the flow to another.
- Spacing consistent with safety standards such as IEC60950 must be observed between the 48V input rails, primary side signals, and between the input and isolated output.
- Where possible, use vertical pairing of signal and return paths.
- Keep high-current and high-voltage switching nodes away from low-level circuits.
- Pay special attention to spacing between the high-voltage sections of the converter and all other circuitry.

## EMI Containment

- Use compact loops for high frequency and/or high current circuit paths (power loops and gate drives).



**Two Compact Power Loops**

- Use minimal, yet thermally adequate, copper areas for heat sinking of components tied to switching nodes (minimize exposed radiating surfaces).
- Use copper ground planes and top layer floods (surround circuitry with ground floods).
- Use 4-layer PCB if economically feasible.
- Minimize or shield the amount of copper area associated with input traces (to minimize radiated pickup).
- Hide copper associated with switching nodes under shielded magnetics where possible.
- Heat sink the “quiet side” of components instead of the “switching side” where possible (like the output side of inductor).
- Use Bob Smith terminations, Bob Smith EFT capacitor, and Bob Smith plane (add reference).
- Use Bob Smith plane as ground shield on input side of PCB (creating a phantom or lateral earth ground).
- Use LC filter at DC/DC input.
- Dampen high frequency ringing on all switching nodes (allow for possible resistor-capacitor or resistor-capacitor diode snubbers).
- Control rise times with gate drive resistors and possible snubbers
- Observe the polarity dot on inductors (embed noisy end)
- Use of ferrite on input (allow for possible use of ferrite beads)
- Maintain segregation between input-related circuity and power circuity
- A common-mode input inductor may be required.
- Possible use of integrated RJ45-45 jacks (Magjack, for example)
- End-product enclose considerations(shielding)

# Important Notices

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## Life support policy

LIFE SUPPORT: KINETIC TECHNOLOGIES' PRODUCTS ARE NOT DESIGNED, INTENDED, OR AUTHORIZED FOR USE AS COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS. NO WARRANTY, EXPRESS OR IMPLIED, IS MADE FOR THIS USE. AUTHORIZATION FOR SUCH USE SHALL NOT BE GIVEN BY KINETIC TECHNOLOGIES, AND THE PRODUCTS SHALL NOT BE USED IN SUCH DEVICES OR SYSTEMS, EXCEPT UPON THE WRITTEN APPROVAL OF THE PRESIDENT OF KINETIC TECHNOLOGIES FOLLOWING A DETERMINATION BY KINETIC TECHNOLOGIES THAT SUCH USE IS FEASIBLE. SUCH APPROVAL MAY BE WITHHELD FOR ANY OR NO REASON.

“Life support devices or systems” are devices or systems which (1) are intended for surgical implant into the human body, (2) support or sustain human life, or (3) monitor critical bodily functions including, but not limited to, cardiac, respirator, and neurological functions, and whose failure to perform can be reasonably expected to result in a significant bodily injury to the user. A “critical component” is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

## SUBSTANCE COMPLIANCE

Kinetic Technologies IC products are compliant with RoHS, formally known as Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment. However, this evaluation kit does not fall within the scope of the EU directives regarding electromagnetic compatibility, restricted substances (RoHS), recycling (WEEE), FCC, CE or UL, and may not meet the requirements of these or related directives. To the best of our knowledge the information is true and correct as of the date of the original publication of the information. Kinetic Technologies bears no responsibility to update such statement.