# SiLinkPS-EVB User's Guide

## Introduction

The SiLinkPS-EVB is a system power supply board that provides all the necessary supply voltages for a variety of Silicon Laboratories' ProSLIC and silicon DAA evaluation boards. When used with an appropriate ac/dc wall adapter, the SiLinkPS-EVB can provide up to 25 W of total output power. Table 1 lists some typical voltages and currents at the power supply outputs.

**Table 1. Power Supply Specifications**

| Input/Output | Voltage | Current | Power |
|---|---|---|---|
| $V_{IN}$ | 9–15 V | 2.5 A | 22–37 W |
| VBRNG | –96 V | 100 mA | 9.6 W |
| VBHI | –52 V or –78 V | 100 mA | 5.2 W or 7.8 W |
| VBLO | –26 V | 200 mA | 5.2 W |
| $V_{DD}$ | 3.3 V/5 V | 1 A | 3.3 W/5 W |

Any combination of outputs is possible as long as the simultaneous total power from all outputs does not exceed the maximum rated 25 W and can be sufficiently supported by the input power from the $V_{IN}$.

The SiLinkPS-EVB is designed with the same footprint as all ProSLIC evaluation board daughter cards allowing it to be used in conjunction with multiple ProSLIC daughter cards to create a modular evaluation platform.

The SiLinkPS-EVB circuit is based on two power supply controllers from Linear Technology that provide high efficiency and low bill-of-materials cost. Both circuits can be synchronized to the same switching frequency to reduce power supply switching noise. The outputs can be configured to support both internal and external ringing architectures by setting the provided jumpers to set the desired output voltages. Further modifications are possible to realize specific output voltage and current requirements provided the total output power does not exceed the rated maximum. Schematic capture and layout gerber files are available for integration into specific applications. Figure 1 illustrates a simplified block diagram of the SiLinkPS-EVB supply board.

## Operating Instructions

The SiLinkPS-EVB board should always be connected to the ProSLIC evaluation board platform prior to turning on the power supply. Plugging any ProSLIC board into a live high-voltage supply can permanently damage the ProSLIC ICs. The user should exercise caution when touching any part of the SiLinkPS-EVB because dangerous high voltages are present and can cause injury.

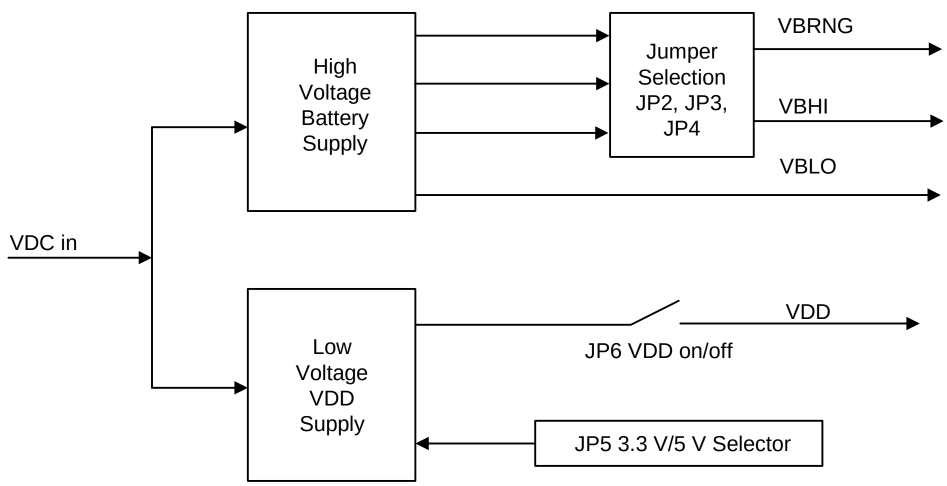


**Figure 1. SiLinkPS-EVB Power Supply Simplified Block Diagram**

## High-Voltage Battery Supply

The schematic for this power circuit is illustrated in Figure 3 on page 4. The LTC3704 dc-dc controller IC is used to drive an external MOSFET and a multi-tap transformer to create four equal high-voltage negative outputs, VNEG (See Table 2), from the dc input supply. Only one output is regulated via close-loop feedback. The other three outputs are cross-regulated to the first output via the transformer ratio. The LTC3704's negative feedback input eliminates inverting circuitry when creating negative outputs from a positive input. The six-winding 1:1 ratio transformer is configured in a manner that minimizes the need for multiple high-voltage output filter capacitors.

## VNEG Voltage Adjustment

The transformer, T1, has four secondary windings, each producing an equal negative voltage, VNEG. These four windings are connected in series through the diode rectifying circuits to produce four negative voltage potentials with voltage levels equal to multiples from 1 to 4 of the VNEG magnitude. Any adjustment made to the VNEG has a direct effect on the voltage levels on all negative outputs.

Resistor R23 can be modified to realize custom output voltages as defined in the following equation.

VNEG = (1.23 x R23/R22) + 1.23

The SiLinkPS-EVB is shipped with R23 = 33.2 k and R22 = 1.65 k for VNEG equal to 26 V.

The VBLO is normally used for off-hook state and its voltage level can be programmed by the setting on the JP7 jumper. The voltage on the VBHI and VBRNG outputs can be programmed by moving the jumper settings on JP2, JP3, and JP4. Table 2 provides several popular configurations and the required jumper settings.

## Frequency Adjustment

The LTC3704 can be configured to run at switching frequencies from 50 kHz to 1 MHz allowing flexibility to choose the optimal efficiency/cost point for each specific application. Resistor R18 programs the switching frequency according to the characteristic curve shown in Figure 2.

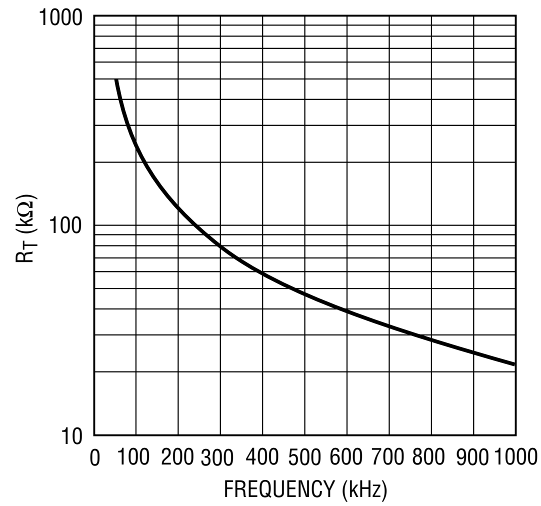


**Figure 2. Timing Resistor R18 Value**

**Table 2. Popular Application Configurations and Jumper Settings**

| Dual ProSLIC Part Number | PK-PK Ringing Amplitude | VBRNG | VBHI | VBLO | JP2 | JP3 | JP4 | JP7 |
|---|---|---|---|---|---|---|---|---|
| Si3211/Si3212<br>Si3220/Si3232 | 75 V | — | –78 V<br>3xVNEG | –26 V<br>VNEG | 2–3 | 2–3 | 1–2 | 2–3 |
| | 90 V | –104 V<br>4xVNEG | — | –26 V<br>VNEG | 1–2 | — | — | 2–3 |
| Si3225 | N/A (external) | — | –52 V<br>2xVNEG | –26 V<br>VNEG | 2–3 | — | 2–3 | 2–3 |

## Low Voltage $V_{DD}$ Supply

The low-voltage supply provides a switchable 3.3 V or 5 V output with a 1 A maximum load current. The schematic for this power supply circuit is illustrated in Figure 4 on page 5. The LT1375 IC integrated 1.5 A bipolar switching transistor and current-sensing circuitry eliminate external power transistors and sense resistors and provide a high-efficiency $V_{DD}$ supply in a small footprint. The switching frequency is internally fixed at 500 kHz and can be synchronized to higher frequencies up to 1 MHz when a higher frequency signal (above 550 kHz) is provided on the SYNC pin. Table 3 provides the jumper settings for selecting a 3.3 V or 5 V output as well as for disconnecting the $V_{DD}$ supply altogether.

**Table 3. $V_{DD}$ Supply Jumper Settings**

| Function | JP5 | JP6 | Comments |
|---|---|---|---|
| $V_{DD}$ output enable | — | 1–2 | $V_{DD}$ connected |
| | — | 2–3 | $V_{DD}$ disconnected |
| 3.3 V/5 V configuration | 1–2 | — | 5 V selected |
| | 2–3 | — | 3.3 V selected |

## Frequency Synchronization

The LTC3704 is wired as a clock master device to provide its switching frequency to the SYNC pin on the LT1375 IC. To synchronize the frequency between the two power circuits, R18 needs to be adjusted to set the LTC3704 switching frequency at or above 550 kHz. The LT1375 IC operates at its internal fixed 500 kHz and is only synchronized with the LTC3704 frequency when it senses the frequency on the SYNC pin going above 550 kHz. The SiLinkPS-EVB power circuits are designed to operate safely with switching frequency on the LTC3704 ranging from 200 kHz to 1 MHz.

## Initialization Steps

1. Configure all jumpers according to the application requirements.
2. (Optional) Plug in the input power source and measure all outputs to verify correct settings.
3. Unplug input power source.
4. Assemble all ProSLIC daughter cards.
5. Plug in the input power source.

## Cost-Optimized Design

The negative high-voltage circuit can be reduced for cost optimization. The four equal VNEG outputs in series arrangement provide some discrete voltage adjustments to the outputs but require additional rectifying diode circuits and increase cost. Figure 6 on page 8 illustrates a lost-optimized design with two negative outputs. The first secondary winding produces a negative voltage according to the VNEG equation described in the previous section to produce the VBLO voltage. The other three secondary windings are connected in series to produce a negative voltage with an amplitude of 3 x VNEG. This output is connected in series with the VBLO output to generate VBHI output with a voltage level of 4 x VNEG.

The use of the simplified secondary rectifying circuit, smaller transformer, and switching MOSFET lower the component costs and also reduce the maximum output power of the negative high-voltage circuit to 13 W.

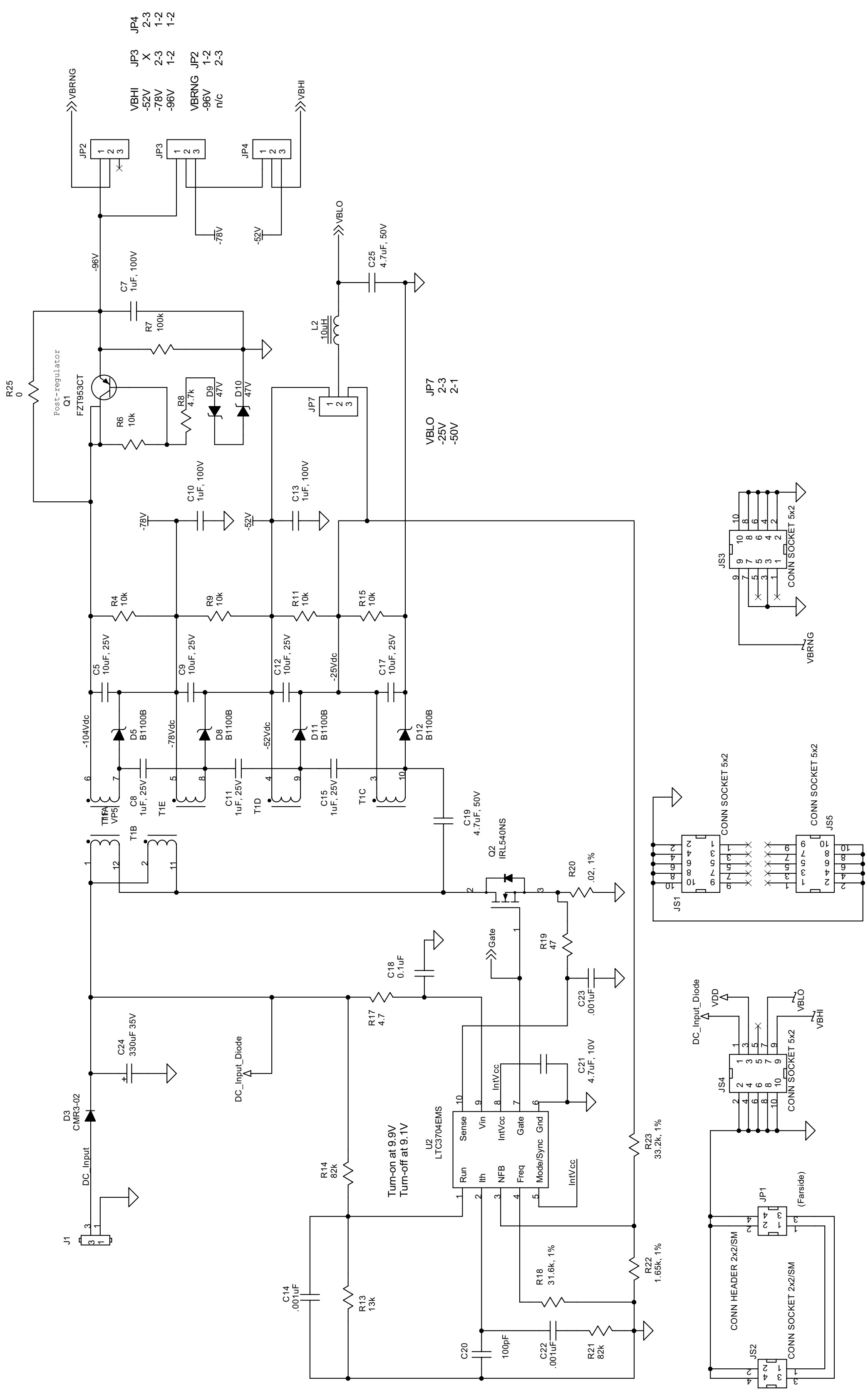


Figure 3. High-Voltage Negative Battery Supply

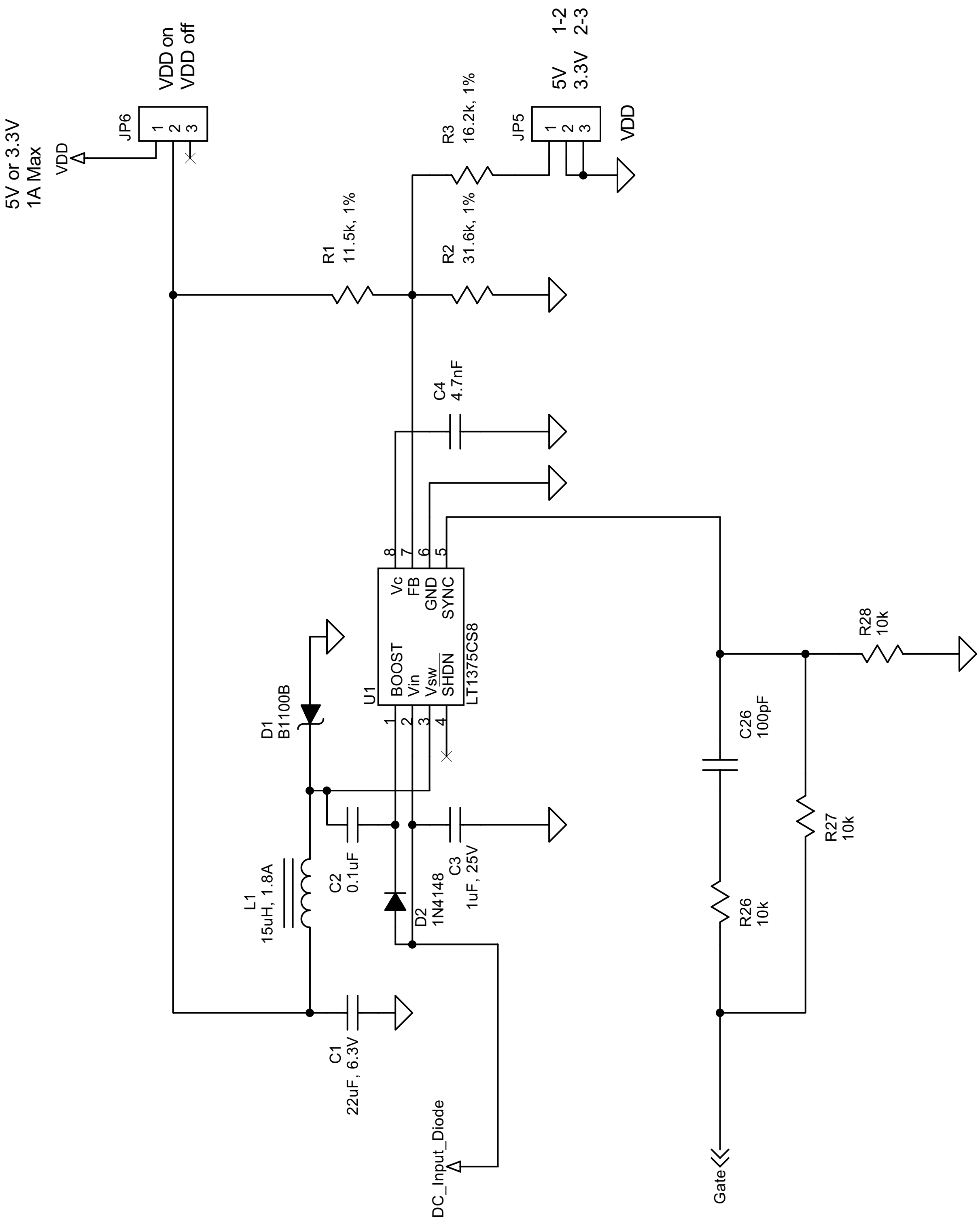


**Figure 4. Low-Voltage $V_{DD}$ Supply**

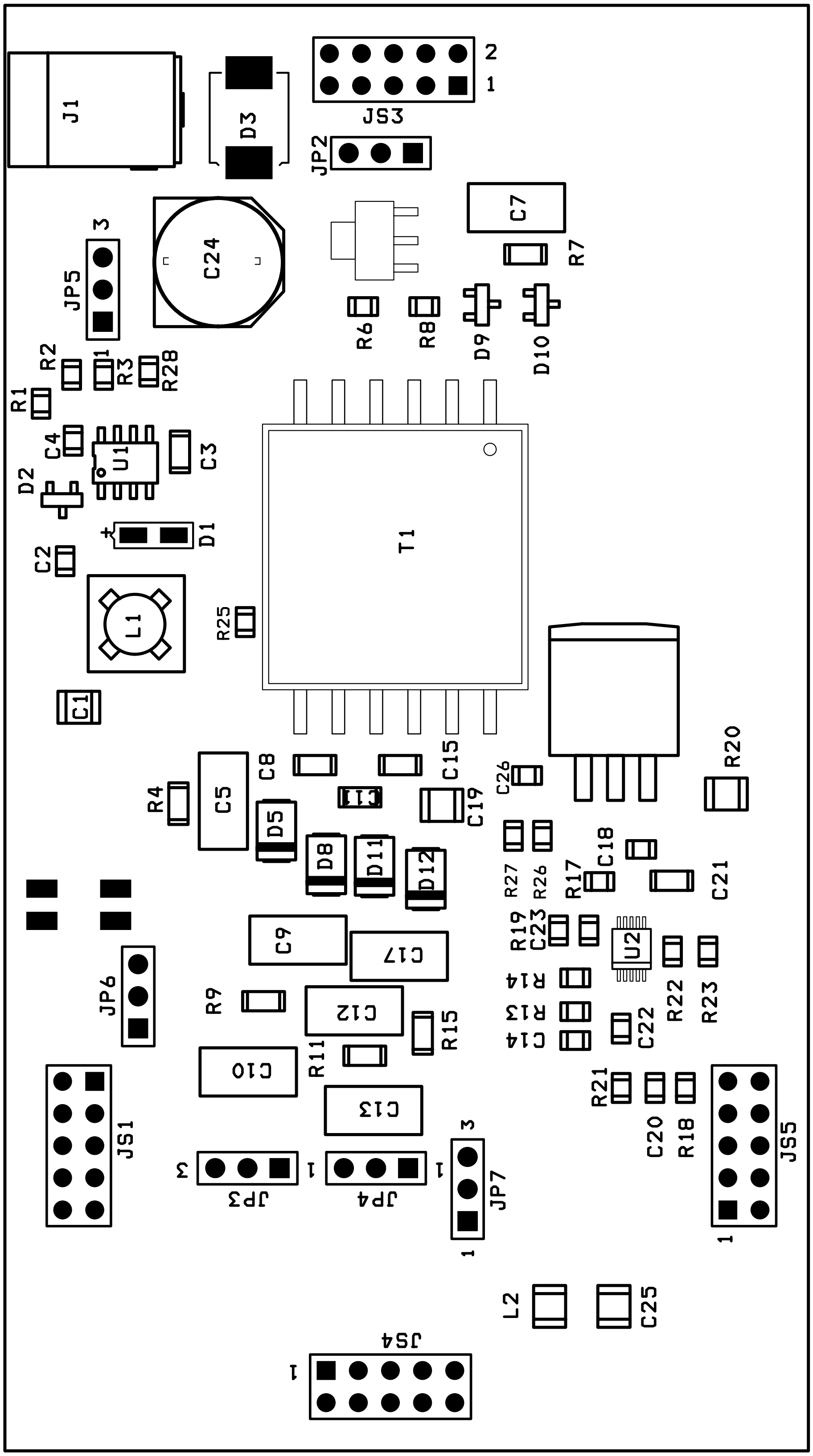


Figure 5. PS Board Silkscreen

## Si Link PS–EVB Bill of Materials

| Reference | Description | Part Number | Manufacturer |
|---|---|---|---|
| C1 | 22uF, 6.3V | | |
| C2 | 0.1uF, 10V | | |
| C3,C8,C11,C15 | 1uF, 25V | | |
| C4 | 4.7nF, 10V | | |
| C5,C9,C12,C17 | 10uF, 25V | TMK432BJ106KM | Taiyo Yuden |
| C7,C10,C13 | 1uF, 100V | 18121C105KAT9A | United Chemi-con |
| C22,C14 | .001uF, 25V | 08055C102KAT | AVX |
| C18 | 0.1uF, 35V | 08053C104KAT | AVX |
| C16, C19 | 4.7uF, 50V | C5750X7R1H475K | TDK |
| C20,C26 | 100pF, 25V | 08055A101KAT | AVX |
| C21 | 4.7uF, 10V | LMK316BJ475 | Taiyo Yuden |
| C23 | .001uF, 25V | | |
| C24 | 330uF, 35V | | |
| D2 | 1N4148 | | Diodes, Inc. |
| D3 | ES3A/B | ES3A/B | Diodes, Inc. |
| D1,D5,D8,D11,D12 | B1100B | B160B | Diodes, Inc. |
| D9,D10 | 47V Zener | | |
| JP1 | CONN HEADER 2x2/SM | TSM-102-02-T-DV | Samtec |
| JP2,JP3,JP4,JP5,JP6,JP7 | HEADER 3X1 | 2303-6111TN | 3M |
| JS1,JS3,JS4,JS5 | CONN SOCKET 5x2 | SSQ-1-05-24-F-D | Samtec |
| JS2 | CONN SOCKET 2x2/SM | SSM-102-L-DV-TR | Samtec |
| J1 | CONN PWR 2-P | ADC-002-1 | Adam Tech |
| L1 | 15uH, 1.8A | UP1B-150 | Coiltronics |
| L2 | 10uH | CTX32CT-100 | Coiltronics |
| Q1 | FZT953CT | FZT953CT | Zetex |
| Q2 | IRL540NS | IRL540NS | Int. Rectifier |
| R1 | 11.5kΩ, 1% | | |
| R2 | 31.6kΩ, 1% | | |
| R3 | 16.2kΩ, 1% | | |
| R4,R9,R11,R15,R26,R27,R28 | 10kΩ, 5% | | |
| R6 | 10kΩ, 5% | | |
| R7 | 100kΩ, 5% | | |
| R8 | 4.7kΩ, 5% | | |
| R13 | 13kΩ, 5% | | |
| R21,R14 | 82kΩ, 5% | | |
| R17 | 4.7Ω, 5% | | |
| R18 | 120kΩ, 5% | | |
| R19 | 47Ω, 5% | | |
| R20 | 15mΩ, 5% | LRC1206-R015K | IRC |
| R22 | 1.65kΩ, 5% | | |
| R23 | 33.2kΩ, 5% | | |
| R25 | 0Ω | | |
| T1 | VP5 | VPH5-0155 | Coiltronics |
| U1 | LT1375CS8 | LT1375CS8 | LTC |
| U2 | LTC3704EMS | LTC3704CMS | LTC |

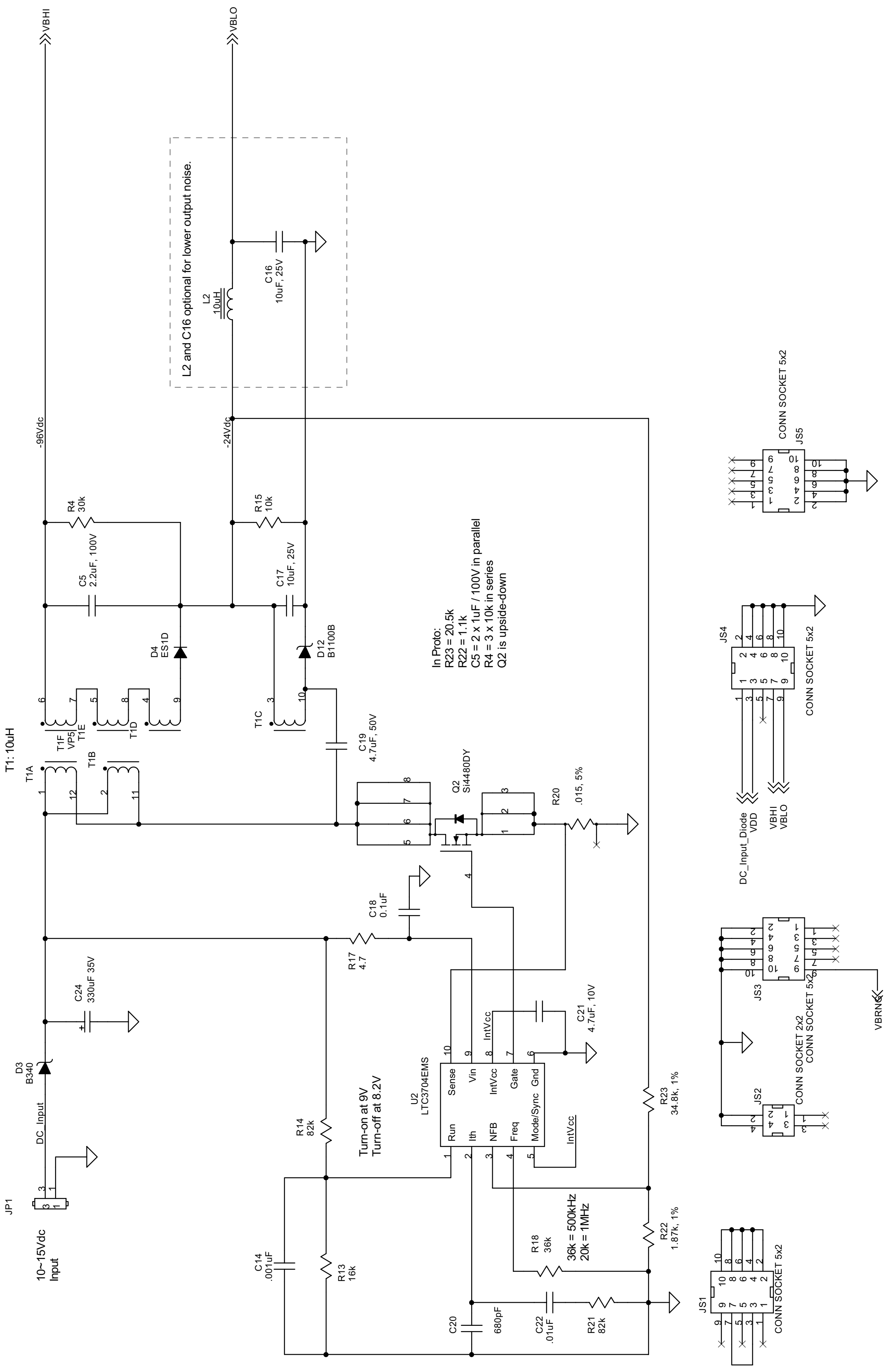


**Figure 6. Cost-Optimized Dual Output Battery Supply**

## Cost-Optimized Dual Output Battery Supply Bill of Materials

| Reference | Description | Part Number | Manufacturer |
|---|---|---|---|
| C18 | 0.1 µF, 25 V, X7R | 08053C104KAT | AVX |
| C5 | 2.2 µF, 100 V, X7R | C5750X7R2A225M | TDK |
| C22, C14 | 1 nF, 25 V, X7R | | |
| C16*, C17 | 10 µF, 25 V, X5R | TMK432BJ106KM | Taiyo Yuden |
| C19 | 4.7 µF, 50 V, X7R | UMK325F475KH | Taiyo Yuden |
| C20 | 100 pF, 50 V, NP0 | 08055A101KAT | AVX |
| C21 | 4.7 µF, 10 V, X5R | LMK316BJ475 | Taiyo Yuden |
| C24 | 330 µF, 35 V | 35CV330AX | Sanyo |
| D3 | 40 V, 3 A | B340 | Diodes, Inc. |
| D4 | 200 V, 1 A | ES1D | Diodes, Inc. |
| D12 | 100 V, 1 A Shottky | B1100B | Diodes, Inc. |
| L2* | 10 µH, 300 mA | CTX32CT-470 | Coiltronics |
| Q2 | 80 V | Si4480DY | Vishay |
| R4 | 30 kΩ, 5%, 0.25 W | | |
| R13 | 16 kΩ, 5%, 0.1 W | | |
| R21, R14 | 82 kΩ, 5%, 0.1 W | | |
| R15 | 10 kΩ, 5%, 0.1 W | | |
| R17 | 4.7 Ω, 5%, 0.1 W | | |
| R18 | 36 kΩ, 5%, 0.1 W | | |
| R20 | 15 mΩ, 5%, 0.25 W | | |
| R22 | 1.87 kΩ, 1%, 0.1 W | | |
| R23 | 34.8 kΩ, 1%, 0.1 W | | |
| T1 | 10 µH | SP36-0100-10 | Transpower |
| U2 | Switching Regulator | LTC3704EMS | LTC |

Note: * Optional components used to reduce output noise if necessary.

## Document Change List

- New power supply schematics
  - Updated Figures 3, 4, and 5.
- Updated document to support two levels of VBATL voltage.

**Notes:**

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