

Demonstration Board for the SA306

INTRODUCTION

The DB73HU is designed to demonstrate the capabilities of the SA306 3 phase brushless DC (BLDC) motor driver IC. This fully assembled demonstration allows the user to directly control the speed and direction of the motor. An onboard controller decodes HALL Effect sensor inputs for commutation in either direction and provides four quadrant PWM signals to control the power outputs of the SA306. LEDs provide visual feedback for motor control status and fault conditions. Provisions on the DB73HU allow the user to bypass the onboard control circuit and directly interface with the SA306 brushless motor driver.

The DB73HU demonstrates proper layout techniques for the SA306 high current switching amplifier. The economical construction uses only a two-sided PCB and allows the SA306 to deliver peak power of over 1kW.

THERMAL CONSIDERATIONS

The SA306 is offered in a surface mount package which can deliver peak power of over 1kW. This presents an obvious and significant thermal challenge. The DB73HU offers a compact design which can deliver 17A peak current. The DB73HU assembly can dissipate approximately 20W in still air at 25°C ambient temperature. To use the DB73HU in higher power applications, use of a fan is recommended. Although the SA306 is rated for operation from -25 to +85°C, the other components on the DB73HU are limited to 0 to 70°C ambient temperature.

CIRCUIT OPERATION

The DB73HU control circuit receives power via two terminal block connections. The Vs connection supplies power to drive the motor and must be above the under-voltage lock-out threshold of the SA306, approximately 8.3V. The control circuit requires 12V for proper operation. A regulator on the DB73HU provides the 5V logic supply for the SA306. There are no special considerations for sequencing the two supplies.

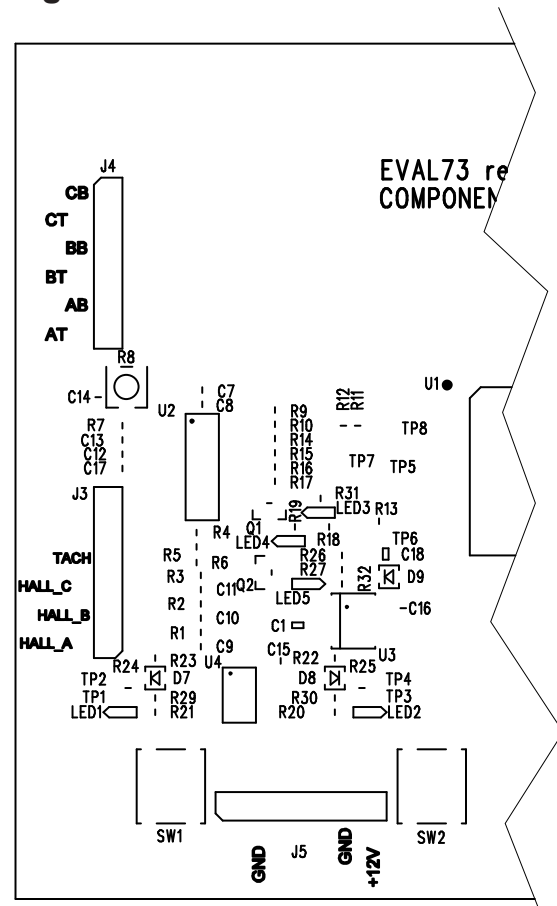
Figure 1 shows the user control features of the DB73HU. The PWM duty cycle is controlled with the potentiometer. LED5 will illuminate when the 12V supply is connected. The DB73HU will power up with the SA306 disabled. SW2 will toggle the SA306 on and off with LED2 illuminating to indicate the enable status. Direction of the motor is similarly controlled with SW1 and is indicated by LED1.

The DB73HU monitors the temperature warning status pin of the SA306. If this pin goes high LED4 illuminates and the enable circuit is forced to a disable status. The temperature LED is not latched and may stay illuminated only briefly while the temperature of the SA306 is above 135°C. The temperature decrease rapidly via the heatsink once the SA306 is disabled.

The SA306 current limit feature is set to limit at approximately 15A to provide a demonstration of the full capabilities of the SA306. LED3 will illuminate if the SA306 cycle-by-cycle current limit circuit engages. The thermal and current limit fea-



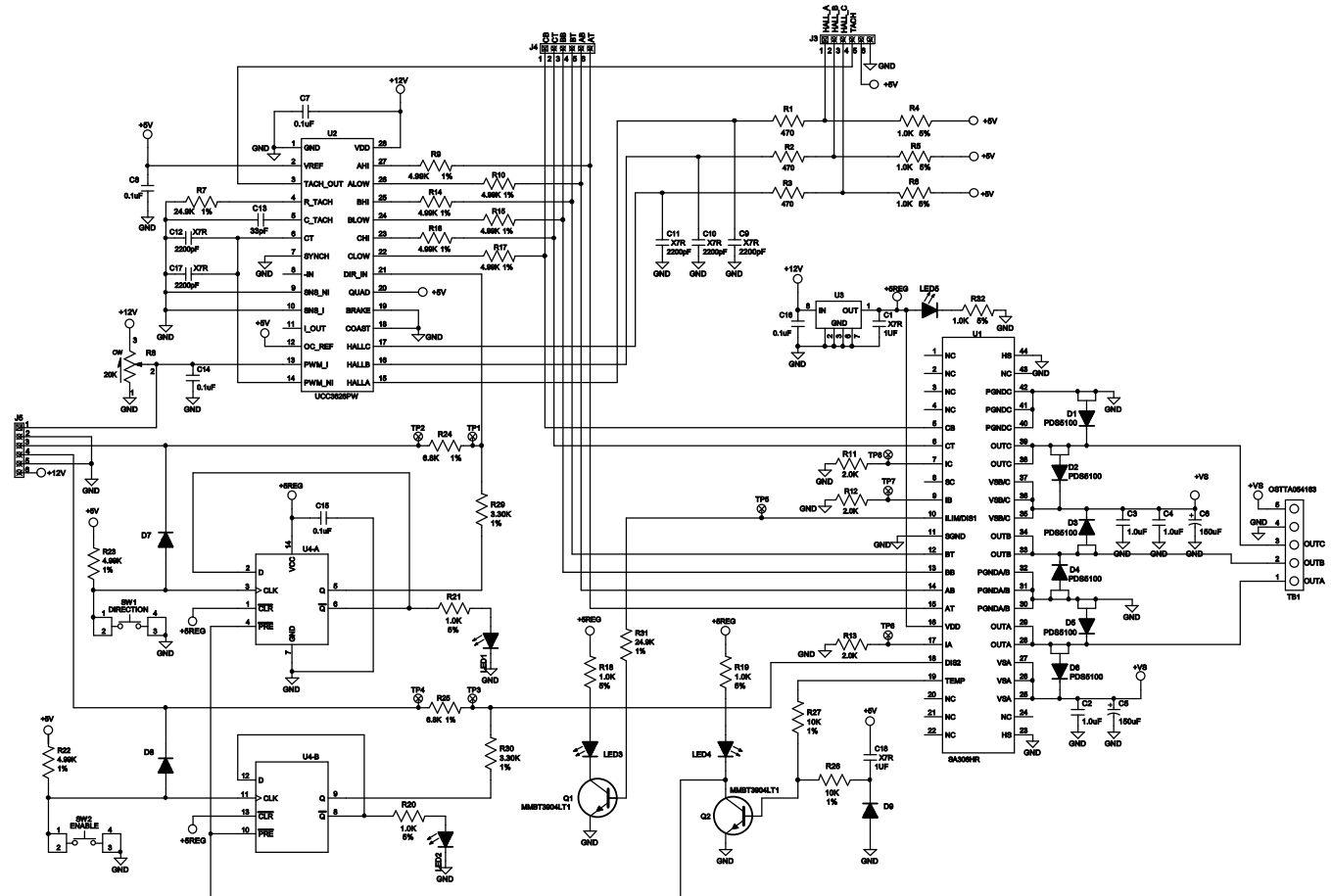
Figure 1 – User Control Features



tures are robust, but will not protect the SA306 in all circumstances. The user must consider the worst case thermal and power dissipation conditions.

Hall Effect inputs to connector J3 (9) are required to commute the motor correctly. Filtering networks and 5V pull-up are provided for glitch-free operation. The Hall sensor connector, J3 (9), also includes a tachometer output which is based on the commutation signals from the Hall inputs. Power for the Hall sensors is provided by U2 in Figure 2, an integrated brushless motor controller IC. The controller decodes the Hall sensor inputs and generates six PWM control signals directly to the SA306. Push-button switches 1 and 2 trigger latches (U4) for direction and enable control, respectively. Diodes D7 & D8 and resistors R24, 25, 29 & 30 provide a means of bypassing the DB73HU control circuit. The 5V regulator, U3, provides 5V to the SA306, the latches, and the status LEDs.

Figure 2 – Schematic



ENHANCING & BYPASSING THE DB73HU CONTROL CIRCUIT

Connector J5 allows the user to bypass many of the manual control features of the DB73HU. A signal generator can control the duty cycle with a 2.5 to 7.5V signal, overriding the control potentiometer. A rising 5V edge on pin 3 or 4 of connector J5 will toggle the Direction or Enable latches, respectively. By jumping resistors R24 & R25, the latches are bypassed completely and the logic signals on pins 3 & 4 will directly control the direction and enable functions of the DB73HU. With these resistors jumped, the direction and enable LEDs will not represent the states of the DB73HU and the pushbuttons will have no effect on the operation. The Temperature disable feature of the DB73HU will also not function, although the LED will continue to provide over-temperature status.

Connector J4 is connected directly to the PWM input pins of the SA306. This connector may be used to monitor the signals or to bypass the control IC on the DB73HU. The enable function is not controlled via these pins, although pulling all six input pins low provides the same effect. The Enable pushbutton and the connection via J5 are also

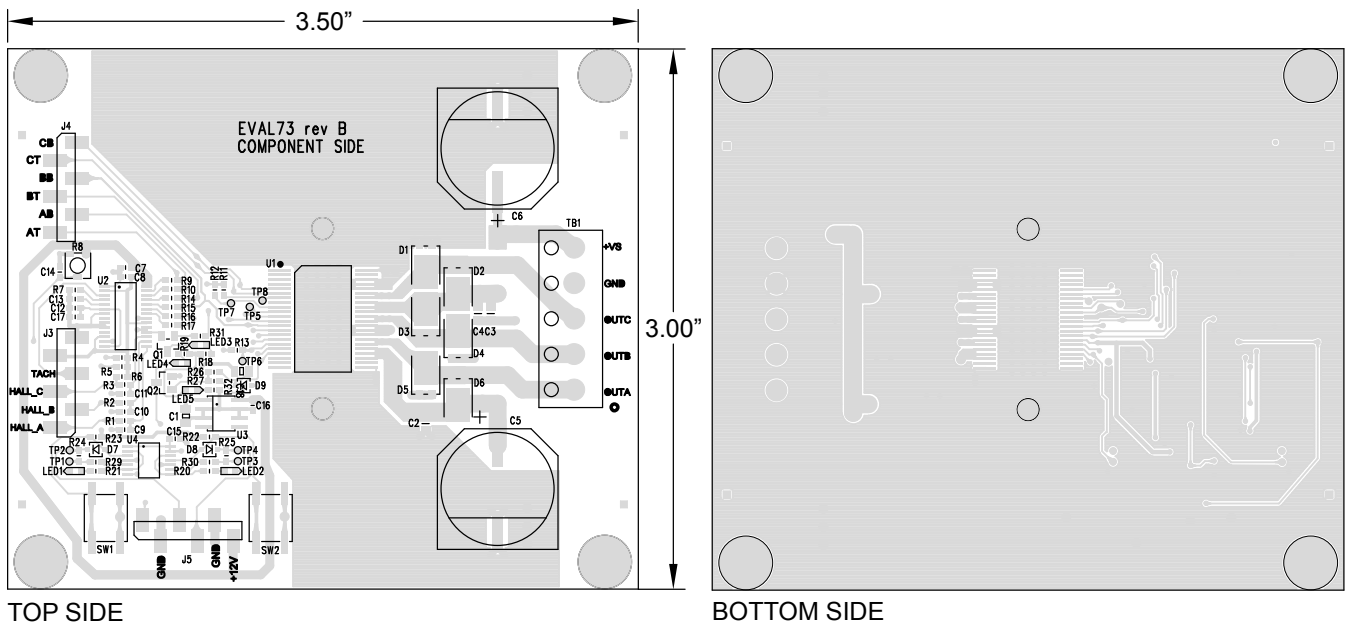
effective as previously described. The circuit shown in Figure 2 in the dashed box is a simple circuit that allows the user to monitor and control the enable or direction status remotely. Either feature can be toggled on the falling edge of the signal at the node labeled TOGGLE.

LAYOUT CONSIDERATIONS

A simple two layer construction is sufficient because of the convenient pinout of the SA306 HSOP package. Input signals are routed into one side of the package and high power output signals are routed from the other side in 2 ounce copper. This eliminates the need to route control signals near motor connections where noise may corrupt the signals. Filling top and bottom layers with copper reduces inductive coupling from the high current outputs. 1nF capacitors with excellent high frequency characteristics bypass the Vs motor supplies on each phase. Two 150µF electrolytic capacitors provide a local, low inductance source to accommodate surge currents up to 17A. Six 100V Schottky diodes conduct the commutation current via low forward voltage paths which reduces the power dissipation in the SA306. These diodes are rated for 5A continuous and are mounted close to the SA306 to reduce inductance in the commutating current loop. For applications with continuous currents less than 5A, the Schottky diodes may not be necessary if the higher forward voltage internal body diodes and the associated power dissipation are manageable during commutation cycles.

Figure 3 shows the top and bottom layouts of the EVAL73. Gerber files for the circuit board are available upon request.

Figure 3 – PCB Layout (not to scale)



BILL OF MATERIALS

| Designation | Description | P/N |
|--------------------------------|---|--|
| C1,C18 | CAP, 1.0uF, 16V | Kemet, C0805C105K4RAC |
| C13 | CAP, 33pF, 50V | Kemet C0603C330J5GACTU |
| C2,C3,C4 | CAP, 1.0nF,100V | Kemet,C0805C102J1GACTU |
| C5,C6 | CAP, 150uF, 100V | Panasonic, EEVFK2A151M |
| C7,C8,C14,C15,C16 | CAP, 0.1uF, 16V | GRM188F51C104ZA01D |
| C9,C10,C11,C12,C17 | CAP, 2.2nF, 50V | GRM188R71H222KA01D |
| D1,D2,D3,D4,D5,D6 | Diode, 5A Schottky | Diodes Inc. DS5100 |
| D7,D8,D9 | IN4148 | Vishay, 1N4148WS-V-GS08 |
| J3,J4,J5 | Conn, 6 pin .100 ctrs | Samtec TSM-106-01-T-SV |
| LED1,LED2,LED3,LED4,LED5 | LED, Red | Lite-On LTST-C190CKT |
| Q1,Q2 | XTR, NPN, 40V | MMBT3904LT1 |
| R1,R2,R3 | RES, 470, 5% | RK73B1JTDD471J |
| R11,R12,R13 | RES 2.0K, 1% | Vishay,CRCW06032K00FKEA |
| R24,R25 | RES, 6.8K | Vishay,CRCW06036K80FKEA |
| R26,R27 | RES, 10K | Vishay,CRCW060310K0FKEA |
| R29,R30 | RES, 3.3K | Vishay,CRCW06033K30FKEA |
| R4,R5,R6,R18,R19,R20,R21,R32 | RES, 1.0K, 5% | RK73B1JTDD102J |
| R7,R31 | RES, 24.9K, 1/10W, 1% | RK73H1JTDD2492F |
| R8 | POT, 20K | PVG3A203C01R00 |
| R9,R10,R14,R15,R16,R17,R22,R23 | RES, 4.99K | Vishay, CRCW06034K99FKEA |
| SW1,SW2 | Pushbutton, SPST-NO | Panasonic, EVQ-Q2B01W |
| TB1 | Term. Blk., 5.08mm Vert. 5 pos, PCB | OSTTA054163 |
| U1 | SA306HU-FH | Apex Microtechnology, SA306HU-FH |
| U2 | UCC3626 | Texas Instruments, UCC3626PW |
| U3 | LM78L05 | National Semiconductor, LM78L05ACMX/NOPB |
| U4 | 74AC74 | Texas Instruments, SN74AC74PW |
| | Heatsink | Apex Microtechnology, HS36, 2.8°C/W |
| | PCB, 3.0" x 3.5" | Apex Microtechnology, EVAL73 |
| | Screw, #4-40 x 1/2" | 18-8 SS Pan Head Phillips 91772A110 |
| | Solder | Paste INDC121NCSMQ90 83% MTL MSH-325+500 |
| (U1) | Gap Pad, Thermal Interface, 40mils thick, 1°C/W | GP5000S35-0.040-02-43-NA |

DB73HU Quick Start Guide

1. Connect the following:

| Connection | Location | Indicator | Comment |
|---------------|----------|-----------|-----------------|
| Vs | TB1 | | 9-60V |
| Ground | TB1 | | |
| Vctrl | J5-6 | LED 2 | 12V |
| Motor Phase A | TB1 | | |
| Motor Phase B | TB1 | | |
| Motor Phase C | TB1 | | |
| Hall Sensor A | J3-1 | | |
| Hall Sensor B | J3-2 | | |
| Hall Sensor C | J3-3 | | |
| Hall 5V | J3-5 | | Output from PCB |
| Hall ground | J3-6 | | |

2. Apply 12V to Vctrl. LED5 should light.
3. Apply voltage to Vs based on rated motor voltage, normally 12-48V.
4. Press ENABLE SW2. LED2 will light and motor should start.

ORDERING INFORMATION

DB73HU Demonstration Board includes one populated EVAL73 rev B PCB and one SA306HU-FH sample

NEED TECHNICAL HELP? CONTACT APEX SUPPORT!

For all Apex Microtechnology product questions and inquiries, call toll free 800-546-2739 in North America.

For inquiries via email, please contact apex.support@apexanalog.com.

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