EV6631B-L-00A

35V, 3A Peak Phase Current, 3-Phase BLDC Motor Driver Evaluation Board

DESCRIPTION

The EV6631B-L-00A is an evaluation board designed to demonstrate the capabilities of the MP6631B, a 3-phase brushless DC (BLDC) motor driver with integrated power MOSFETs. The MP6631B drives a 3-phase BLDC motor with 1 or 3 external Hall sensors. It can achieve a peak phase current up to 3A across the 3.6V to 35V input voltage (V_{IN}) range.

The MP6631B controls the motor speed through the pulse-width modulation (PWM) signal, or through the DC signal on the PWM/DC pin. The device provides closed-loop and open-loop control and a built-in, configurable speed curve function. The device also features a sinusoidal drive for maximum torque, as well as low speed ripple and noise across the entire speed range.

The MPQ6631B features rotational speed detection. The rotational speed detector (the FG/RD pin) is an open-drain output. FG/RD outputs a high or low voltage relative to the Hall sensor comparator's output. In addition to rotational speed detection, the direction is controlled via the DIR pin's input.

Protection features include input over-voltage protection (OVP), under-voltage lockout (UVLO), locked-rotor protection, over-current protection (OCP), and thermal shutdown.

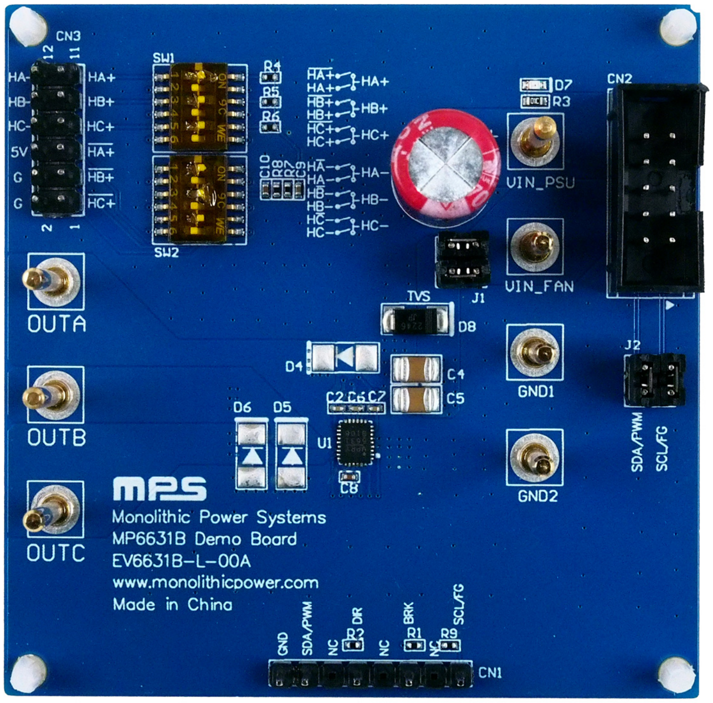
The MP6631B is available in a QFN-26 (3mmx4mm) package.

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C, unless otherwise noted.

Parameters	Conditions	Value
Input voltage (V_{IN}) range		5V to 35V
Maximum output phase current (I_{OUT})	V_{IN} = 5V to 35V	3A
Input PWM frequency		1kHz to 100kHz
Switching frequency (f_{SW})		25kHz

EVALUATION BOARD



LxWxH (7cmx7cmx2.2cm)

Board Number	MPS IC Number
EV6631B-L-00A	MP6631BGL-0000

QUICK START GUIDE

Quick Start Using the Communication Interface (MPS Fan Driver Communication Kit):

1. Preset the DC power supply, then turn off the power supply.
2. Connect the power supply output terminals to (see Figure 1):
    a. Positive (+): VIN_PSU
    b. Negative (-): GND
3. Connect the communication interface to the EV6631B-L-00A via CN2.
4. Connect the motor phase terminals to:
    a. Motor phase A: OUTA
    b. Motor phase B: OUTB
    c. Motor phase C: OUTC
5. Connect the motor's Hall sensor outputs to the corresponding connectors.
6. Connect the communication interface to the computer.
7. Turn on the power supply.
8. Run the "MP6631B" GUI and select the MP6631B. (1)

Figure 1 shows the equipment set-up with the communication interface.

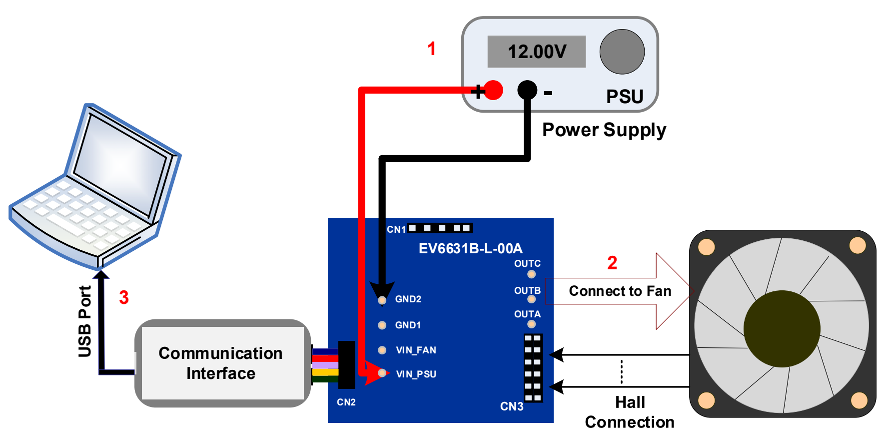


Figure 1: EVB Connection with the Communication Interface

Note:

1) Contact an MPS FAE to obtain the MP6631B GUI.

Quick Start without the Communication Interface:

1. Connect the power supply output terminals to:
    a. Positive (+): VIN_FAN
    b. Negative (-): GND
2. Connect the motor phase terminals to:
    a. Motor phase A: OUTA
    b. Motor phase B: OUTB

c. Motor phase C: OUTC

3. Connect the motor's Hall sensor outputs to the corresponding connectors. See The Hall Connection section for more details.
4. Turn on the power supply. The motor should begin working.
5. Set the function generator to pulse mode, such that the high level is 3.3V and the low level is 0V. Adjust the pulse duty cycle to adjust the motor's speed.

Figure 2 shows the equipment set-up without the communication interface.

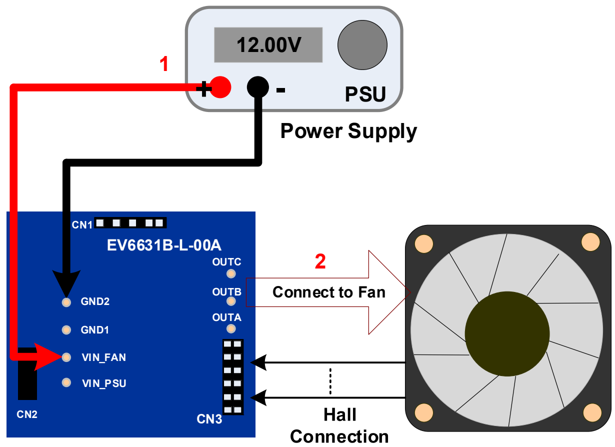


Figure 2: EVB Connection without the Communication Kit

The Hall Connection

The EV6631B-L-00A supports either a Hall IC (logic polarity input) or a Hall element (differential input) as the Hall input signal. Figure 3 shows the Hall IC that outputs a logic polarity signal.

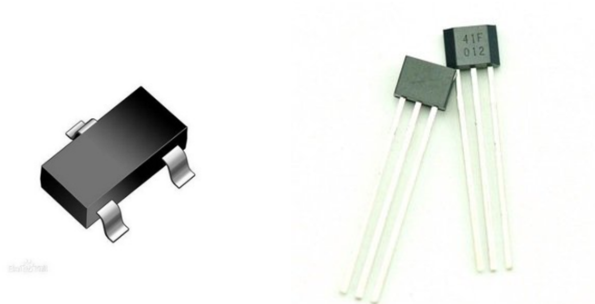


Figure 3: Hall IC (Outputs Logic Polarity Signal)

Figure 4 shows the Hall element that outputs a differential signal.

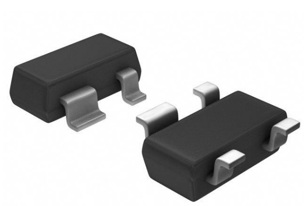


Figure 4: Hall Element (Outputs Differential Signal)

Hall IC Connection

1. Connect CN3 (5V) to the Hall IC's supply terminal.
2. Connect CN3 (GND) to the Hall IC's ground.
3. Connect the CN3 terminals (HA+, HB+, and HC+) to their corresponding terminals in the Hall IC's output. Do not make connections for HA-, HB-, and HC-.

   Then use SW1 and SW2 to switch to the correct terminal (see Figure 5).

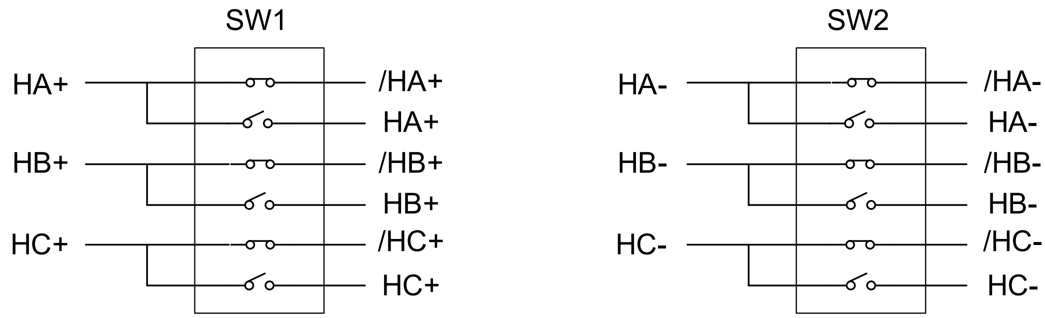


Figure 5: SW1 and SW2 with a Hall IC Connection

Hall Element Connection

1. Connect CN3 (5V) to the Hall element's supply terminal.
2. Connect CN3 (GND) to the Hall element's ground.
3. Connect the CN3 terminals to:
   a. Hall element positive (+) output: HA+, HB+, and HC+
   b. Hall element negative (-) output: HA-, HB-, and HC-

   Then use SW1 and SW2 to switch to the correct terminal (see Figure 6).

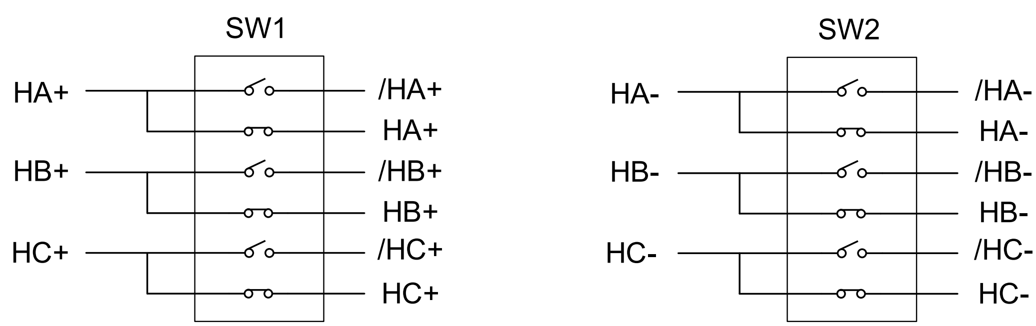


Figure 6: SW1 and SW2 with a Hall Element Connection

GUI Operation Guide

1. Install the MP6631B GUI. [2]
2. Double-click "MP6631B.exe" to start the GUI. The first page of the GUI should show the features and typical application circuit (see Figure 7).

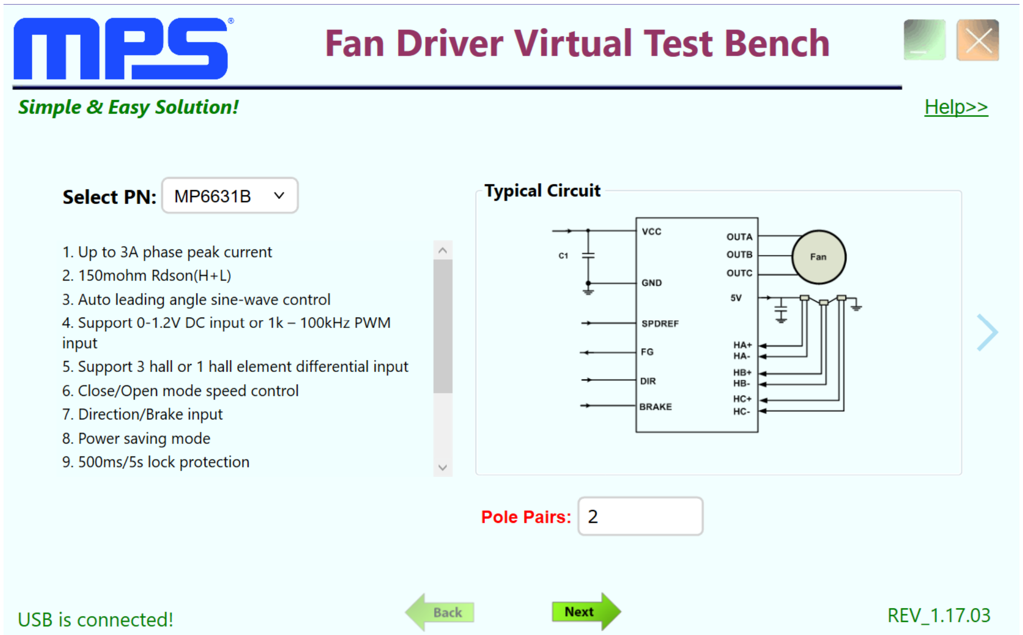


Figure 7: MPS BLDC Virtual Bench GUI

3. Insert the motor's pole pairs, then click "Next."

Note:

2) Contact an MPS FAE to obtain the MP6631B GUI.

General Settings

There are a few general settings in the GUI, described below:

1. Test Mode: Use test mode to begin a new design. When test mode is automatically selected, all internal register can be accessed.
2. Bench Verification: Automatically tests the RPM curve.
3. Reset Fan: Resets the hardware and the motor if a fault occurs.
4. Programming: Use the programming feature to load code files and make configurations via the one-time programmable (OTP) memory.

Figure 8 on page 7 shows the general settings page.

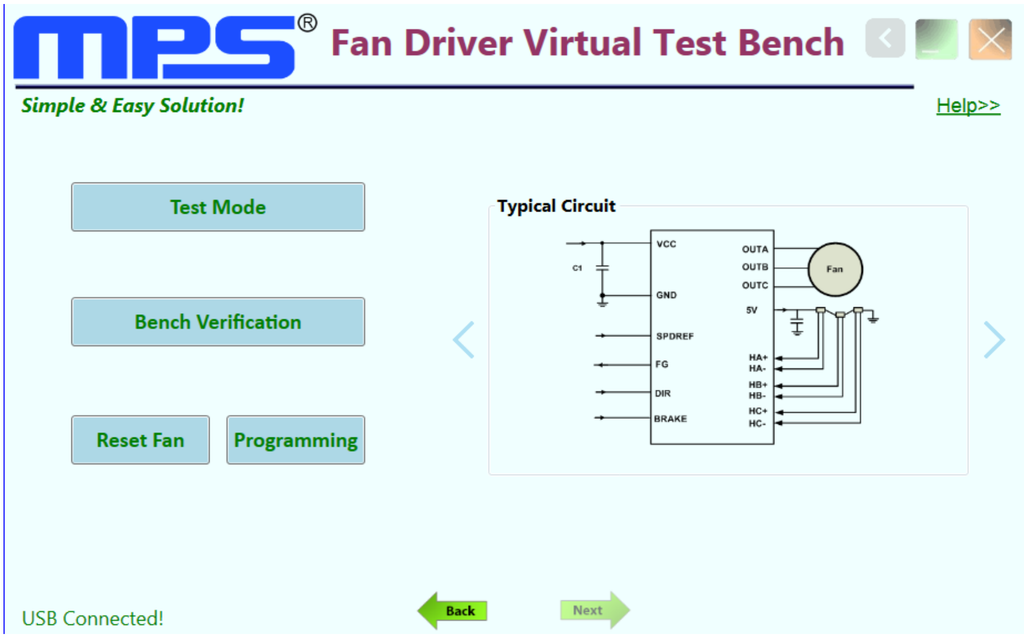


Figure 8: MPS BLDC Virtual Bench General Settings Page

Click "Test Mode" to enter the test mode interface.

EVALUATION BOARD SCHEMATIC

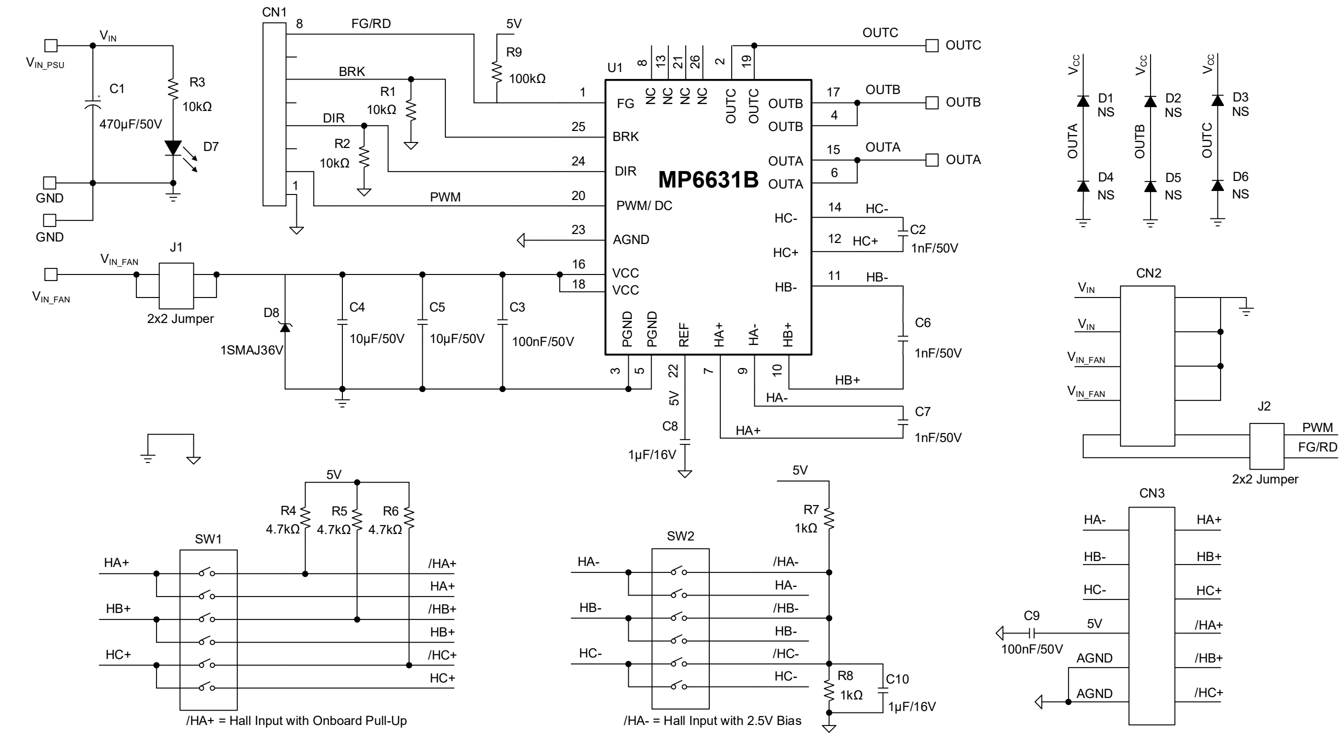


Figure 9: Evaluation Board Schematic

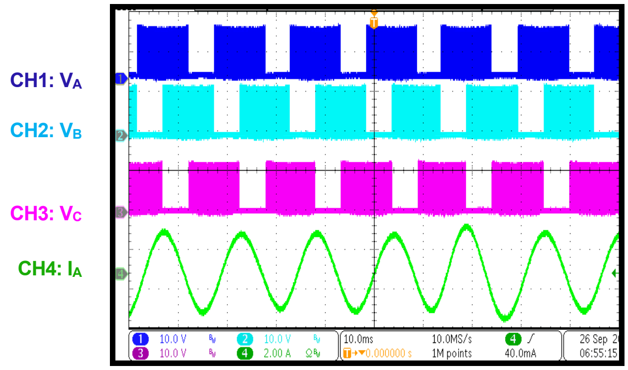
EV6631B-L-00A BILL OF MATERIALS

Qty	Ref	Value	Description	Package	Manufacturer	Manufacturer PN
1	C1	470µF	Electrolytic capacitor, 50V, 470µF	DIP	Wurth	860020675022
3	C2, C6, C7	1nF	Ceramic capacitor, 50V, X7R	0402	Murata	GCM155R71H102KA37D
2	C3, C9	100nF	Ceramic capacitor, 50V, X7R	0402	Murata	GRM155R71H104KE14D
2	C4, C5	10µF	Ceramic capacitor, 50V, X7R	1210	Murata	GRM32ER71H106KA12L
2	C8, C10	1µF	Ceramic capacitor, 16V, X6S	0402	Murata	GRM155C81C105KE11D
2	R1, R2	10kΩ	Film resistor, 1%	0402	Yageo	RC0402FR-0710KL
1	R3	10kΩ	Film resistor, 1%	0603	Yageo	RC0603FR-0710KL
3	R4, R5, R6	4.7kΩ	Film resistor, 1%	0402	Yageo	RC0402FR-074K7L
2	R7, R8	1kΩ	Film resistor, 1%	0402	Yageo	RC0402FR-071KL
1	R9	100kΩ	Film resistor, 1%	0402	Yageo	RC0402FR-07100KL
6	D1, D2, D3, D4, D5, D6	NC				
1	D7	Red	Red LED	0603	Bright LED	BL-HUE36A-AV-TRB
1	D8	36V	TVS diode, 6.9A	SMA	Semtech	1SMA36A
7	GND1, GND2, VIN_FAN, VIN_PSU, OUTA, OUTB, OUTC	2mm	2mm connector	DIP	Any	
1	CN1	2.54mm	1-row, 8-pin connector, header	DIP	Any	
1	CN2	2.54mm	5-pin, dual-row header with frame	DIP	Any	
1	CN3	2.54mm	6-pin, dual-row connector	DIP	Any	
2	J1, J2	2.54mm	2-pin, dual-row jumper connector	DIP	Any	
2	SW1, SW2	1.27mm	6-position pitch switch	SMD	Wurth	416131160806
1	U1	MP6631B	3-phase motor driver with Hall input	QFN-26 (3mmx 4mm)	MPS	MP6631BGL-0000

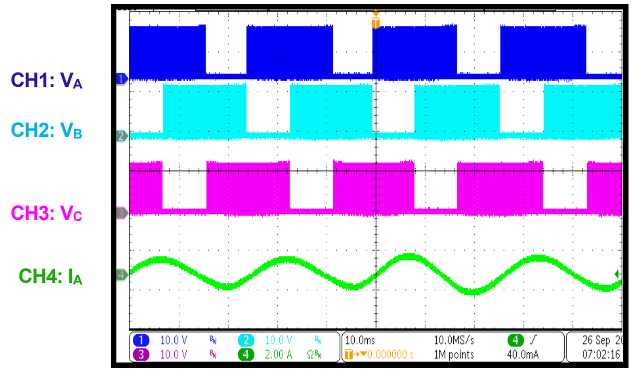
EVB TEST RESULTS

Performance curves and waveforms are tested on the evaluation board, V_{IN} = 12V, PWM frequency = 20kHz, with 1 or 3 external Hall sensors, unless otherwise noted.

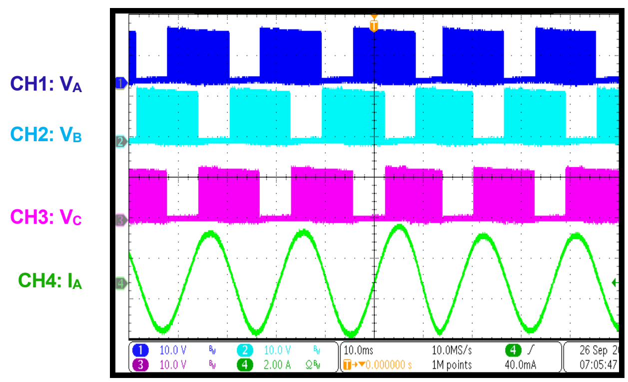
Steady State
PWM duty cycle = 100%, DIR = low, counterclockwise



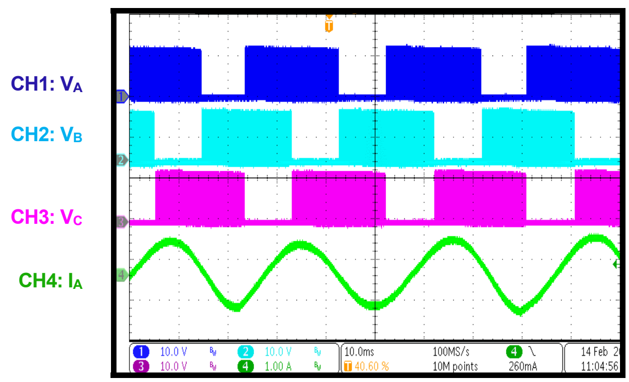
Steady State
PWM duty cycle = 50%, DIR = low, counterclockwise



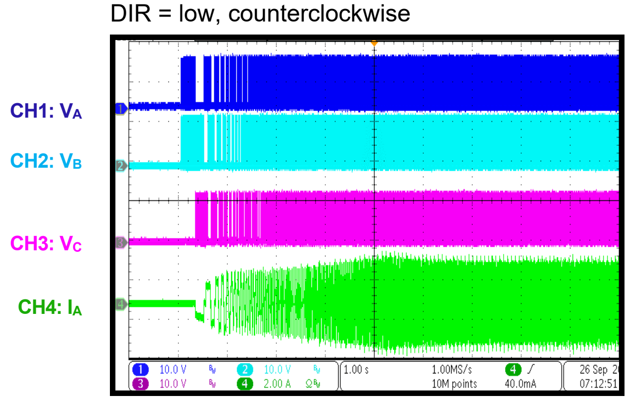
Steady State
PWM duty cycle = 100%, DIR = high, clockwise



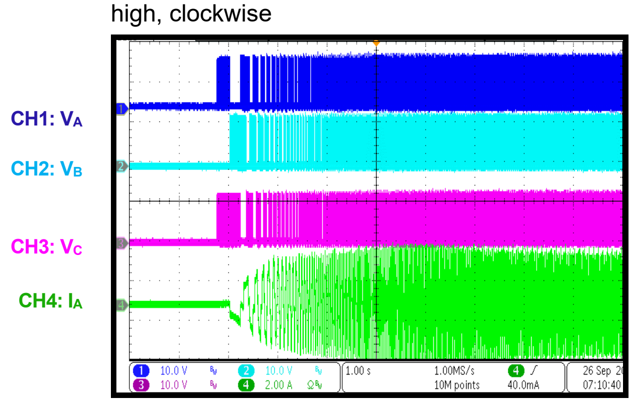
Steady State
PWM duty cycle = 50%, DIR = high, clockwise



PWM On
PWM duty cycle = 0% to 100%, 3 Hall sensors, DIR = low, counterclockwise



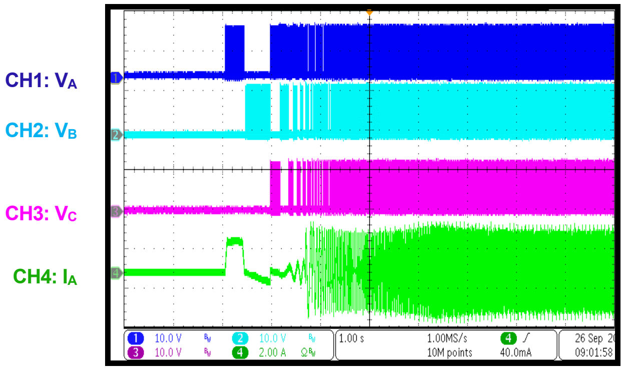
PWM On
PWM duty = 0% to 100%, 3 Hall sensors, DIR = high, clockwise



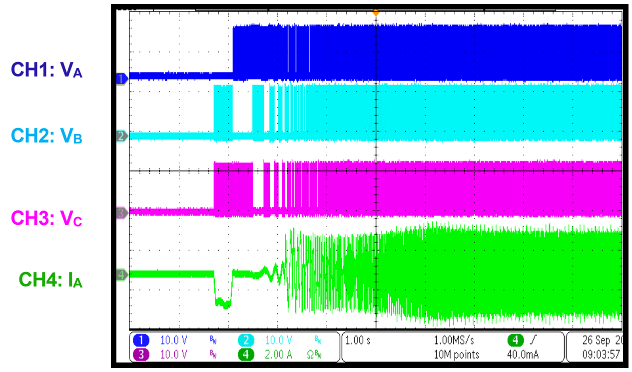
EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, V_{IN} = 12V, PWM frequency = 20kHz, with 1 or 3 external Hall sensors, unless otherwise noted.

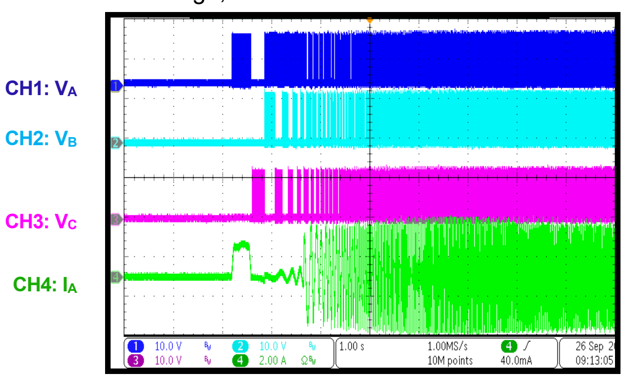
PWM On
PWM duty cycle = 0% to 100%, 1 Hall sensor, DIR = low, counterclockwise



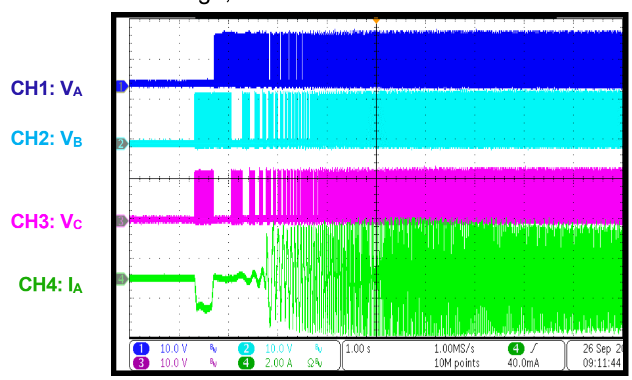
PWM On
PWM duty = 0% to 100%, 1 Hall sensor, DIR = low, counterclockwise



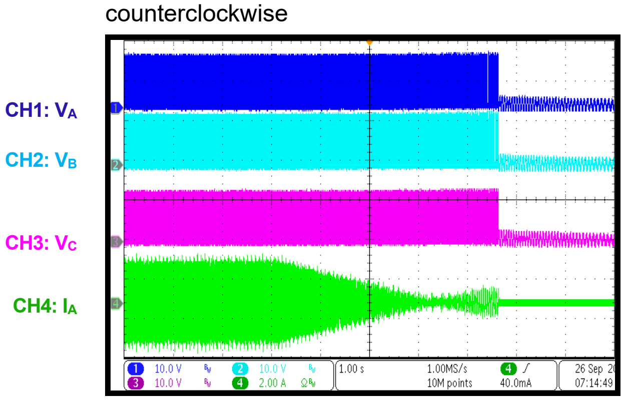
PWM On
PWM duty cycle = 0% to 100%, 1 Hall sensor, DIR = high, clockwise



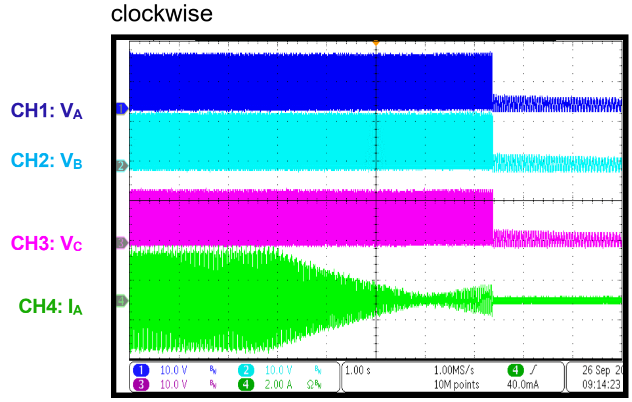
PWM On
PWM duty cycle = 0% to 100%, 1 Hall sensor, DIR = high, clockwise



PWM Off
PWM duty cycle = 100% to 0%, DIR = low, counterclockwise



PWM Off
PWM duty cycle = 100% to 0%, DIR = high, clockwise

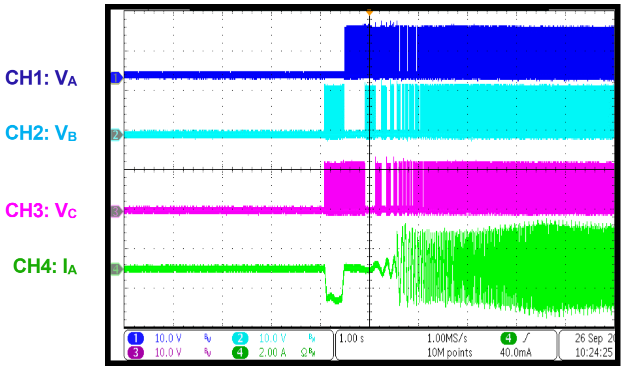


EVB TEST RESULTS *(continued)*

Performance curves and waveforms are tested on the evaluation board, V_{IN} = 12V, PWM frequency = 20kHz, with 1 or 3 external Hall sensors, unless otherwise noted.

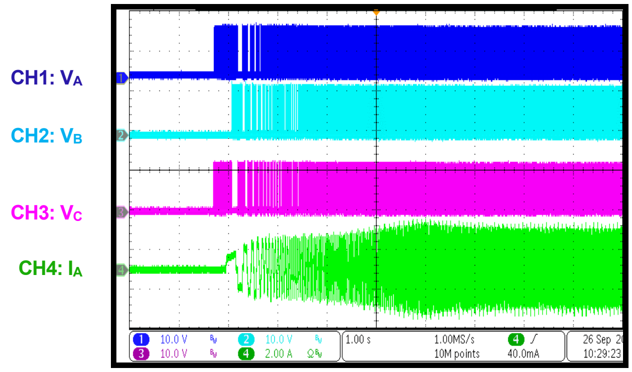
Start-Up through VCC

V_{CC} = 0V to 12V, PWM duty = 100%,
1 Hall sensor, DIR = low, counterclockwise



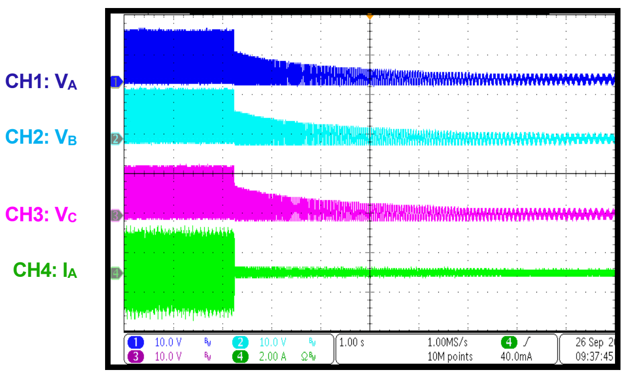
Start-Up through VCC

V_{CC} = 0V to 12V, PWM duty = 100%,
3 Hall sensors, DIR = low, counterclockwise



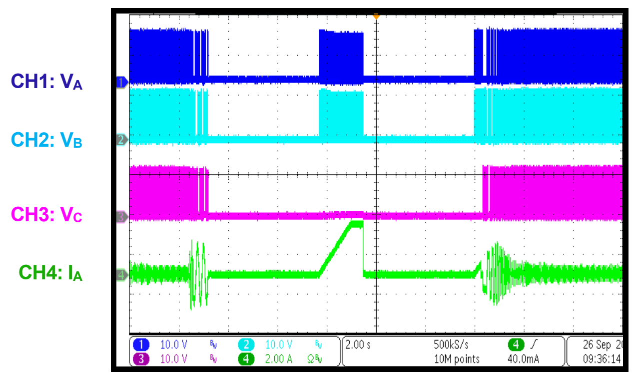
Shutdown through VCC

V_{CC} = 0V to 12V, PWM duty = 100%,
DIR = low, counterclockwise



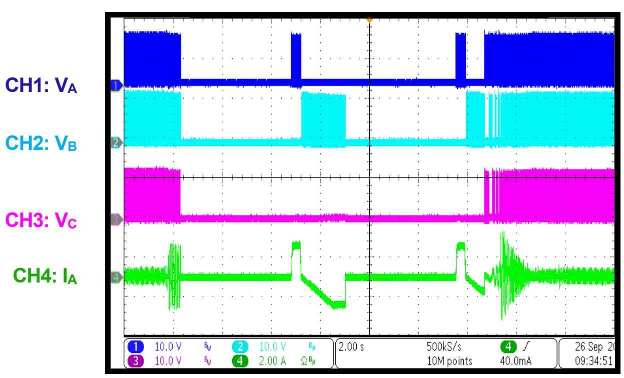
Rotor Lock and Retry

PWM duty = 25%, 3 Hall sensors, lock rotor
then release



Rotor Lock and Retry

PWM duty = 25%, 1 Hall sensor, lock rotor
then release



PCB LAYOUT

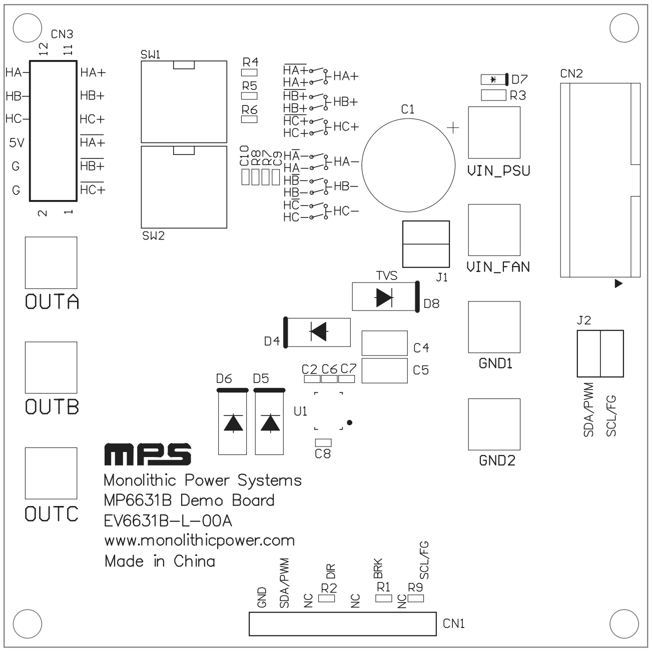


Figure 10: Top Silk

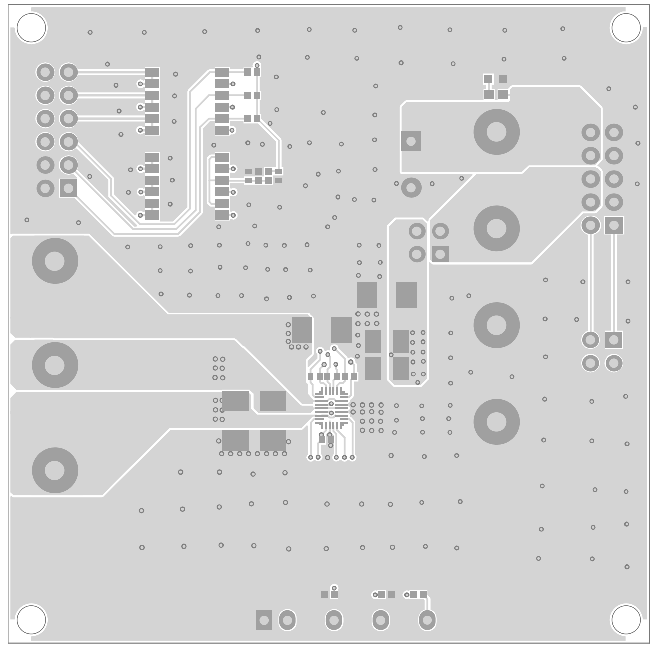


Figure 11: Top Layer

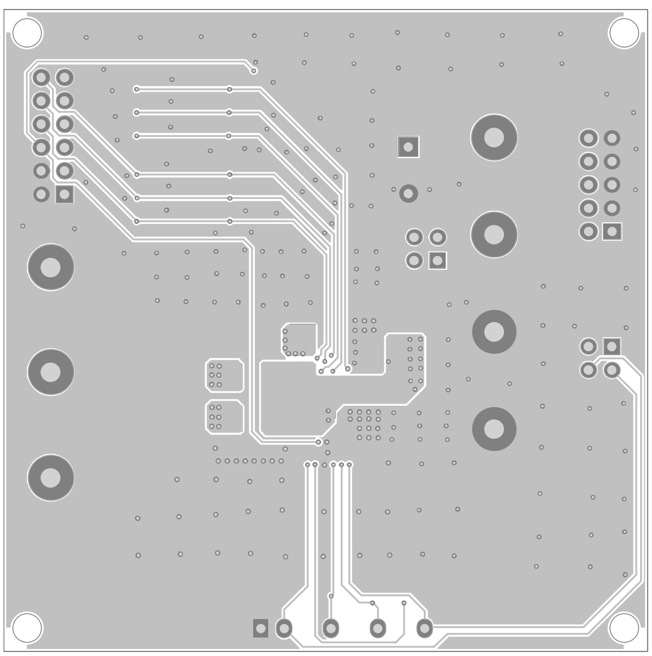


Figure 12: Bottom Layer

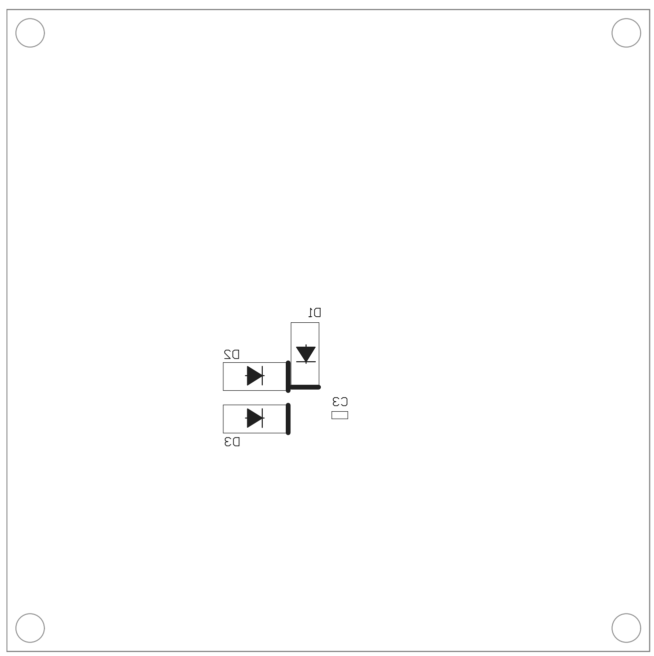


Figure 13: Bottom Silk

REVISION HISTORY

Revision #	Revision Date	Description	Pages Updated
1.0	5/8/2024	Initial Release	-