

Hot-Swap Testing Results for the A5977 and A5979 Microstepping DMOS Drivers

Introduction

Hot-swapping, disconnecting, or connecting power supply inputs and/or power outputs of an IC while in operation is not recommended, but it is normal practice in some applications. One of these applications is in textile machines, where the motor and power supply leads can be connected and disconnected while the current is supplied to both motor windings. In this application, the IC motor outputs and power supply are connected to the motor driver PC board (6 pins) via a switching relay arrangement.

This report outlines hot-swap test results for A5977 and A5979 stepper motor drivers. To duplicate the hot-swap conditions, we have selected an IC motor supply voltage (V_{BB}) of 24 V and motor current of 1.5 A per winding for our tests. Testing was performed with different microstepping resolutions and with the following hot-swap methods:

- Hot-swapping between two sets of motors and power supplies
- Hot-swapping a single motor from on-line to off-line
- Hot-swapping between two sets of motors with motor driver always powered up
- Hot-swapping a single motor with motor driver always powered up
- Faulty conditions during single phasing of stepper motor
- Switching the power supply on-off with stepper motor terminals always connected

Objective

To evaluate the hot-swapping performance of the A5977 and A5979 microstepping DMOS driver ICs.

Experimental Setup

Figure 1 shows the test connections for hot-swapping the stepper motor driver (A5977/A5979). The experimental test prototype of the same has been developed in lab as shown in Figure 2. In this setup, a 6-pole, double-throw switch is used for hot-swapping between the motors and the power supply. Two power supplies of 100 W each and two stepper motors are connected on six poles of the switch as depicted in Figure 1. The evaluation board used is a standard A5977/79 socket board.

Figure 3 shows the front and rear-view images of the 6-pole, double-throw switch used for development of the hot-swap testing setup.

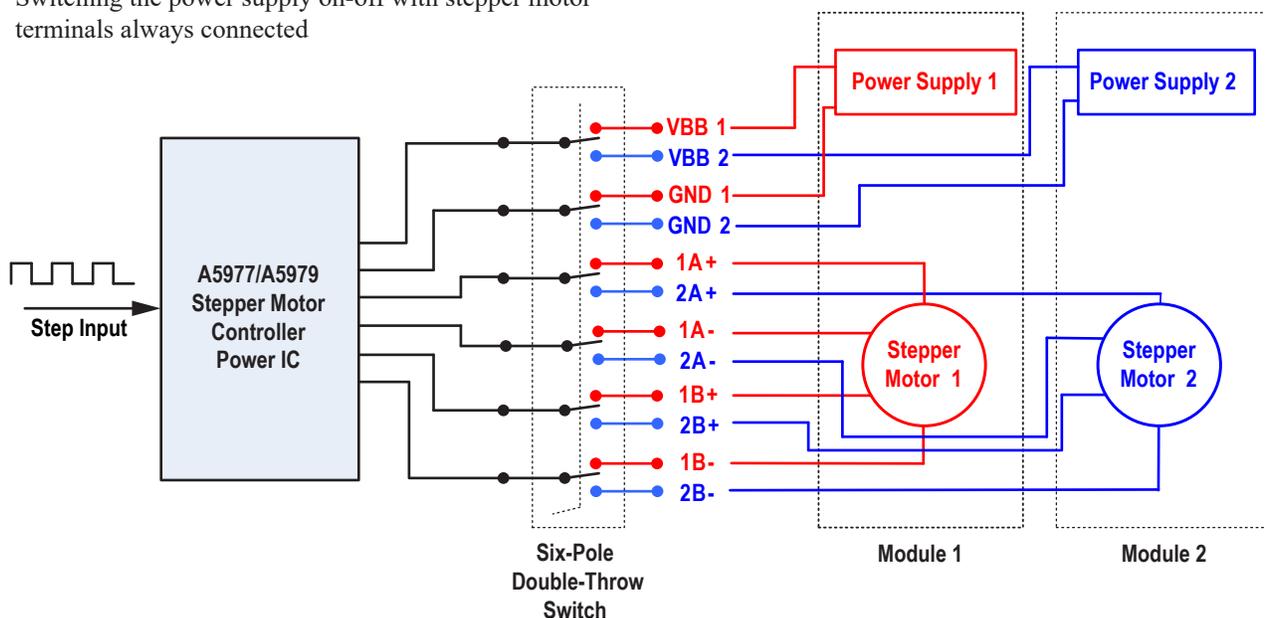
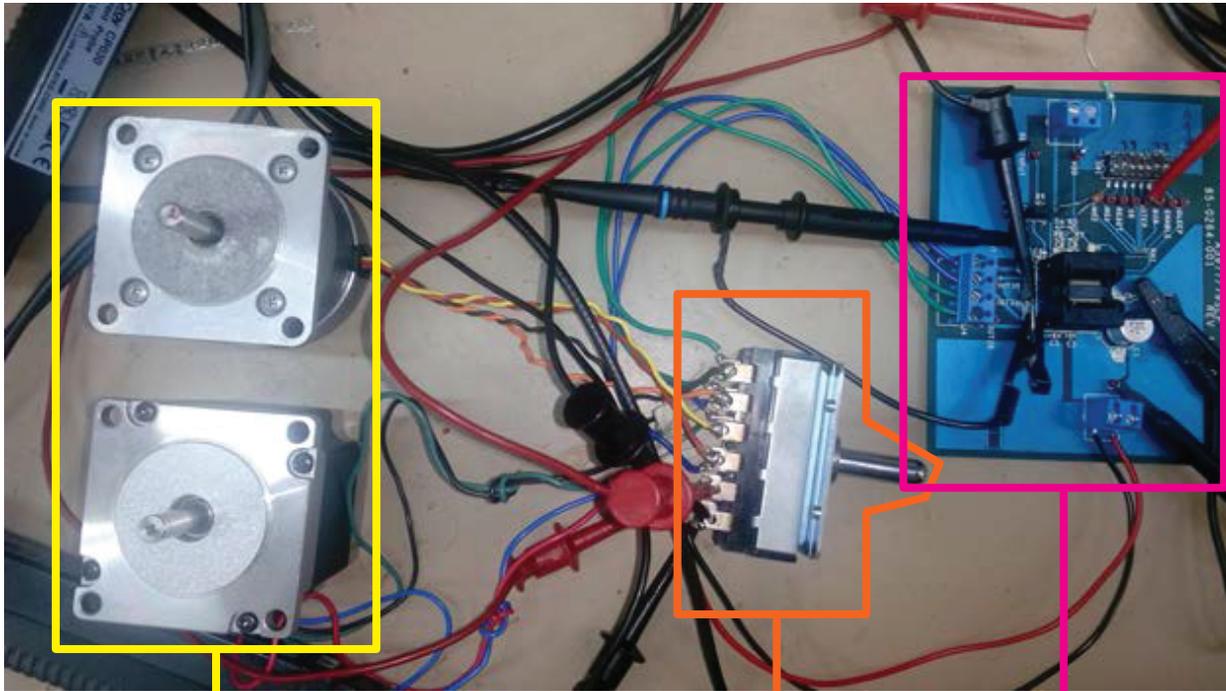


Figure 1: Test connection for hot-swap testing of stepper motor driver



Stepper Motors

Six-Pole
Double-Throw Switch

Stepper Motor Driver
in Test

Figure 2: Experimental setup for hot-swap testing of stepper motor driver



Figure 3: A six-pole, double-throw switch showing front view (left) and rear view (right)

Measurement of Parameters

Figure 4 shows the typical setup for the measurement of various parameters during hot-swap testing. V_{DD} and I_{DD} represents the logic supply voltage and current, respectively.

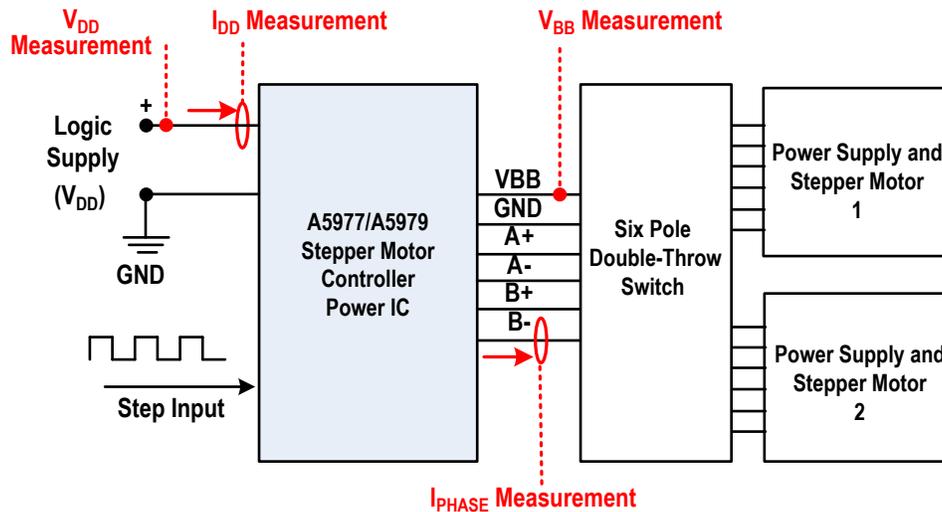


Figure 4: Measurement setup of various parameters

Hot-Swap Test Results for the A5977/A5979 Microstepping Motor Driver ICs

The following section presents the evaluation of the A5977/A5979 stepper motor driver power ICs during various hot-swapping conditions. The various conditions of hot-swapping testing are summarized as follows:

1. Hot-swapping between two sets of motors and power supplies.
2. Hot-swapping a single motor from on-line to off-line.
3. Hot-swapping between two sets of motors with motor driver always powered up.
4. Hot-swapping a single motor with motor driver always powered up.
5. Faulty conditions during single phasing of stepper motor.
6. Switching the power supply on-off with stepper motor terminals always connected.

The stepper motor driver has been tested multiple times for the above-mentioned conditions. Following are the results observed at these conditions.

HOT-SWAPPING BETWEEN TWO SETS OF MOTORS AND POWER SUPPLIES

This case is the most basic case of hot-swapping in which the stepper motor driver is hot-swapped between the two sets of a motor and power supply combination. A 6-pole, double-throw switch is used for hot-swapping the motor driver between the two stepper motors and power supply sets. Figure 5 (a) through (d) shows the results observed during the full-, half-, quarter-, and eighth-step (A5977) modes, respectively. This test has been carried out on 20 ICs with a minimum of 100 hot-swaps. The driver operated normally with no change in performance after each hot-swap.

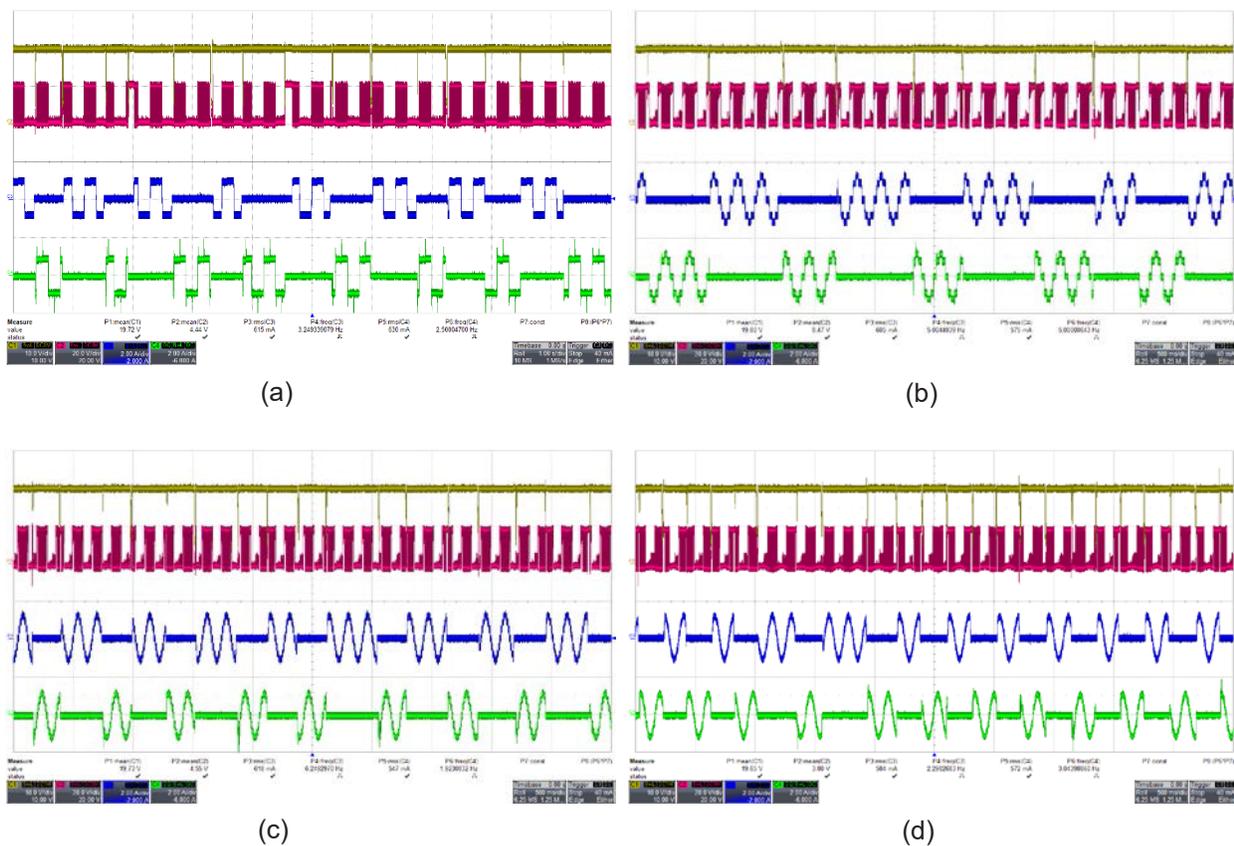


Figure 5: Performance of A5977/A5979 stepper motor drivers during hot-swapping at (a) full-step, (b) half-step, (c) quarter-step, and (d) eighth-step (A5977) modes, showing the DC bus voltage (V_{BB}) (yellow), phase voltage (V_{PHASE}) (pink), stepper motor 1 phase current (I_{PHASE1}) (blue), and stepper motor 2 phase current (I_{PHASE2}) (green).

HOT-SWAPPING A SINGLE MOTOR FROM ON-LINE TO OFF-LINE

In this case, a single stepper motor and power supply set is connected to the motor driver; therefore, all the six lines, including VBB, GND, OUT1A, OUT1B, OUT2A, and OUT2B are connected and disconnected during hot-swapping. Figure 6 (a) through (d) shows the results observed during the full-, half-, quarter-, and eighth-step (A5977) modes, respectively. This test has been carried out on 20 ICs with a minimum of 100 hot-swaps. The driver operated normally with no change in performance after each hot-swap.

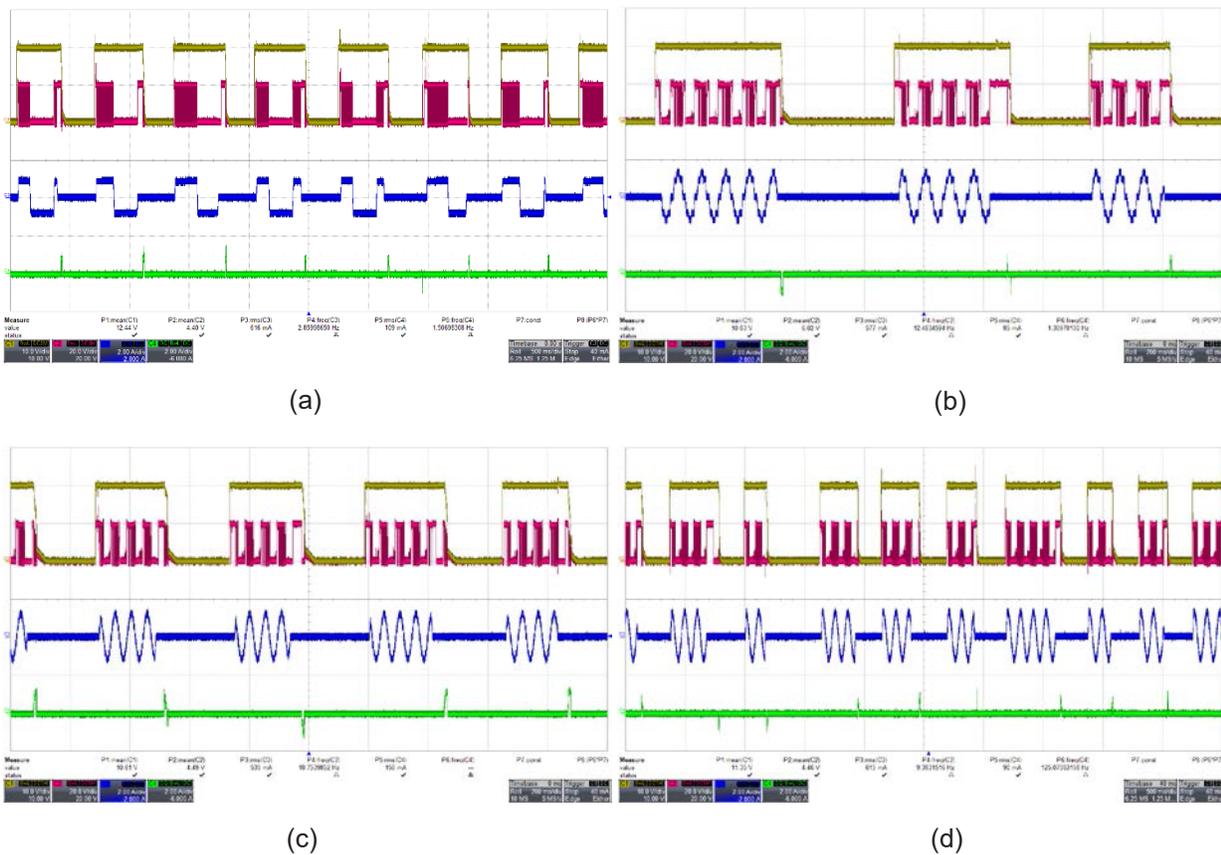


Figure 6: Performance of A5977/A5979 stepper motor drivers during hot-swapping at (a) full-step, (b) half-step, (c) quarter-step, and (d) eighth-step (A5977) modes, showing the DC bus voltage (V_{BB}) (yellow), phase voltage (V_{PHASE}) (pink), stepper motor 1 phase current (I_{PHASE1}) (blue), and stepper motor 2 phase current (I_{PHASE2}) (green).

HOT-SWAPPING BETWEEN TWO SETS OF MOTORS WITH MOTOR DRIVER ALWAYS POWERED UP

In this case, two stepper motors are hot-swapped while the power supply is always connected to the motor driver. Therefore, only four lines, including OUT1A, OUT1B, OUT2A, and OUT2B, are connected and disconnected during hot-swapping. Figure 7 (a) through (d) shows the results observed during the full-, half-, quarter-, and eighth-step (A5977) modes, respectively. This test has been carried out on 20 ICs with a minimum of 100 hot-swaps. The driver operated normally with no change in performance after each hot-swap.

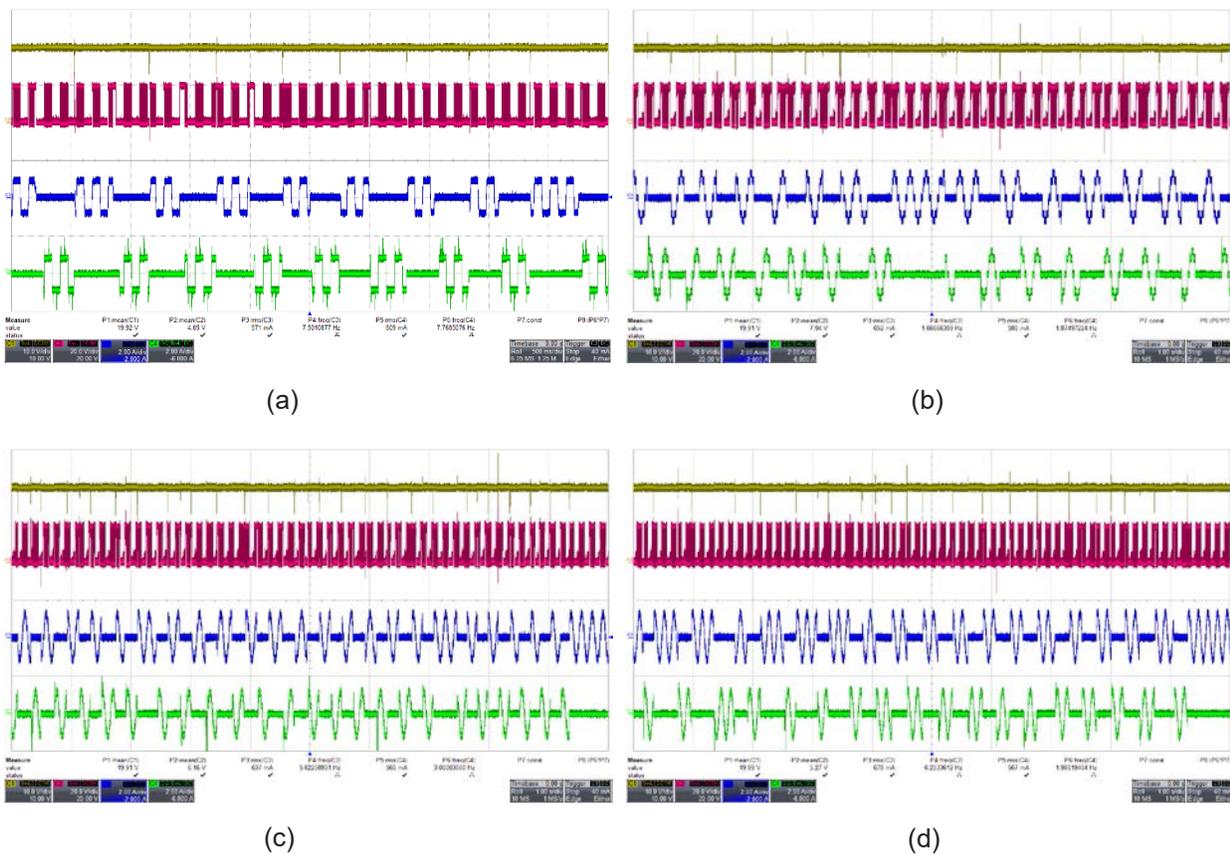


Figure 7: Performance of A5977/A5979 stepper motor drivers during hot-swapping at (a) full-step, (b) half-step, (c) quarter-step, and (d) eighth-step (A5977) modes, showing the DC bus voltage (V_{BB}) (yellow), phase voltage (V_{PHASE}) (pink), stepper motor 1 phase current (I_{PHASE1}) (blue), and stepper motor 2 phase current (I_{PHASE2}) (green).

HOT-SWAPPING A SINGLE MOTOR WITH MOTOR DRIVER ALWAYS POWERED UP

In this case, a single stepper motor is hot-swapped while the power supply is always connected to the motor driver. Therefore, only four lines, including OUT1A, OUT1B, OUT2A, and OUT2B, are connected and disconnected during hot-swapping. Figure 8 (a) through (d) show the results observed during the full, half, quarter, and eighth step (A5977) modes, respectively. This test has been carried out on 20 ICs with a minimum of 100 hot-swaps. The driver operated normally with no change in performance after each hot-swap.

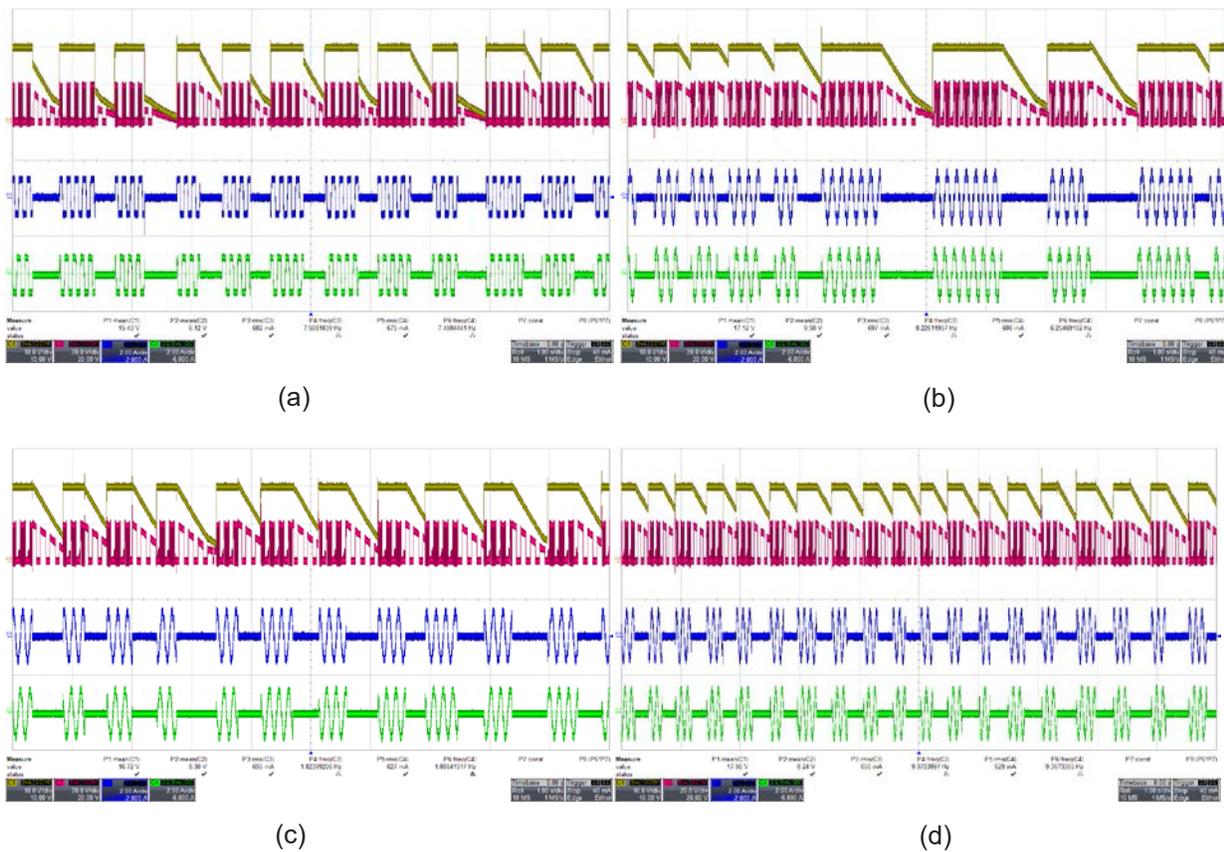


Figure 8: Performance of A5977/A5979 stepper motor drivers during hot-swapping at (a) full-step, (b) half-step, (c) quarter-step, and (d) eighth-step (A5977) modes, showing the DC bus voltage (V_{BB}) (yellow), phase voltage (V_{PHASE}) (pink), and stepper motor phase currents (I_{PHASE1} and I_{PHASE2}) (blue and green).

FAULTY CONDITIONS DURING SINGLE PHASING OF STEPPER MOTOR

In this case, one phase of the stepper motor is connected and disconnected in hot with power supply always connected to the motor driver. Therefore, in this case, a single line from any of the four lines, i.e., OUT1A, OUT1B, OUT2A, and OUT2B, are connected and disconnected during hot-swapping. Figure 9 (a) through (d) shows the results observed during the full-, half-, quarter-, and eighth-step (A5977) modes, respectively. This test has been carried out on 20 ICs with a minimum of 100 hot-swaps. The driver operated normally with no change in performance after each hot-swap.

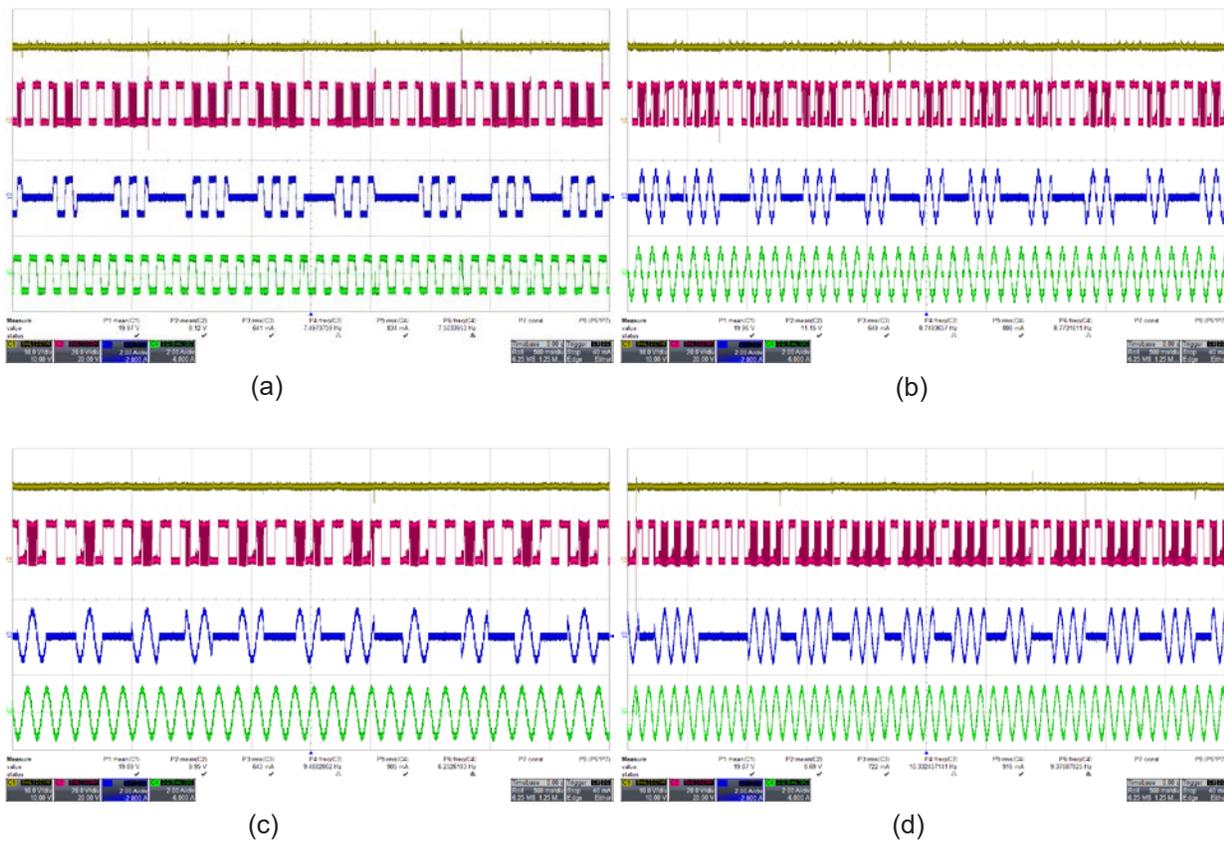


Figure 9: Performance of A5977/A5979 stepper motor drivers during hot-swapping at (a) full-step, (b) half-step, (c) quarter-step, and (d) eighth-step (A5977) modes, showing the DC bus voltage (V_{BB}) (yellow), phase voltage (V_{PHASE}) (pink), and stepper motor phase currents (I_{PHASE1} and I_{PHASE2}) (blue and green).

FAULTY CONDITIONS DURING SINGLE PHASING OF STEPPER MOTOR

In this case, one phase of the stepper motor is connected and disconnected in hot with power supply always connected to the motor driver. Therefore, in this case, a single line from any of the four lines, i.e., OUT1A, OUT1B, OUT2A, and OUT2B, are connected and disconnected during hot-swapping. Figure 10 (a) through (d) shows the results observed during the full-, half-, quarter-, and eighth-step (A5977) modes, respectively. This test has been carried out on 20 ICs with a minimum of 100 hot-swaps. The driver operated normally with no change in performance after each hot-swap.

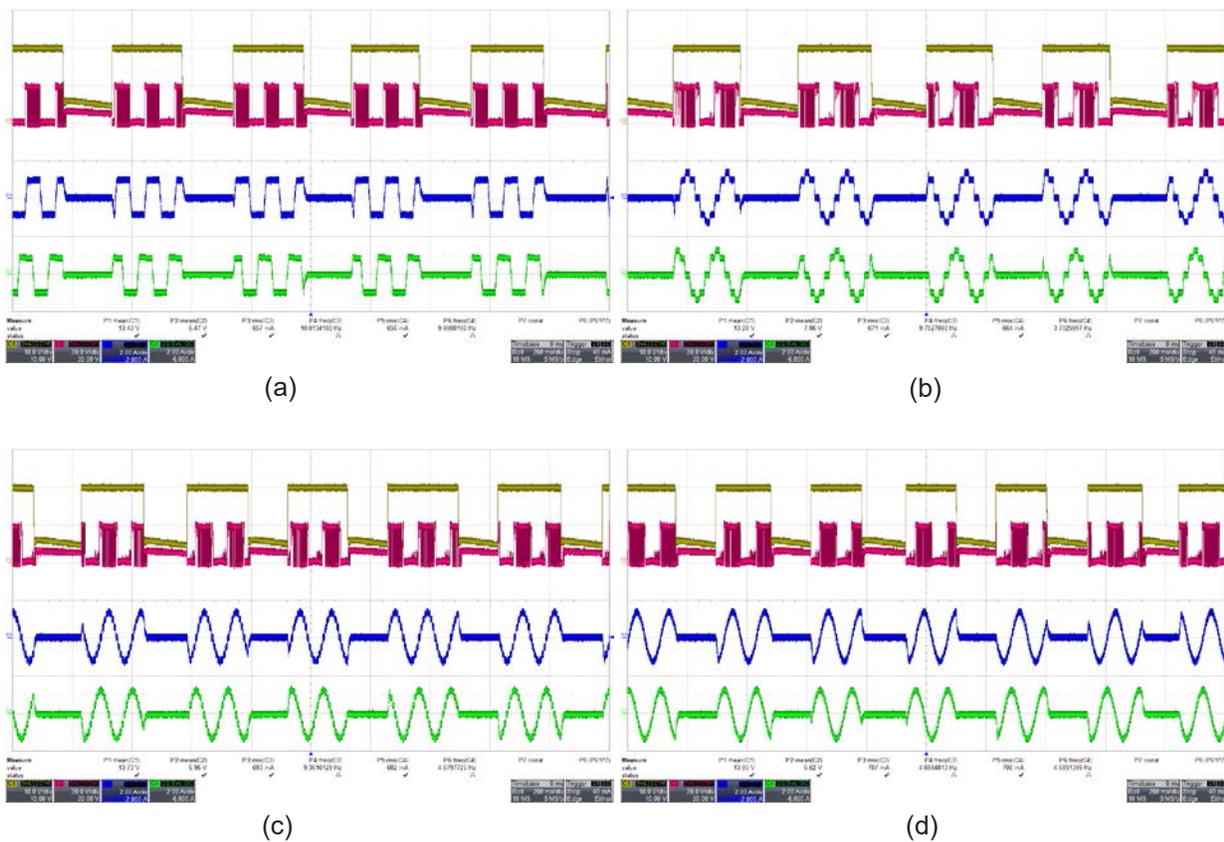


Figure 10: Performance of A5977/A5979 stepper motor drivers during hot-swapping at (a) full-step, (b) half-step, (c) quarter-step, and (d) eighth-step (A5977) modes, showing the DC bus voltage (V_{BB}) (yellow), phase voltage (V_{PHASE}) (pink), and stepper motor phase currents (I_{PHASE1} and I_{PHASE2}) (blue and green).

CONCLUSION

A rigorous hot-swap testing of the A5977 and A5979 stepper motor drivers has been carried out and presented in this report. At least 20 ICs have been tested 100 times each for all 6 mentioned hot-swapping conditions (6 conditions \times 20 ICs \times 100 times each = Total 12000 events).

This hot-swap testing has also been performed on a single device for four different stepping modes, i.e., full-step, half-step, quarter-step, and eighth-step (A5977) modes. The driver operated normally with no change in performance after each hot-swap.

The A5977 and A5979, it can be concluded, have robust hot-swap performance under the conditions presented in this report.

Revision History

Number	Date	Description
–	December 18, 2015	Initial release
1	September 21, 2018	Minor editorial updates
2	October 4, 2019	Minor editorial updates
3	October 18, 2021	Minor editorial updates

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