AN4923
Application note

STSPIN220: step-mode selection and on-the-fly switching to full-step

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Introduction

The STSPIN220 is a stepper motor driver designed for portable applications thanks to the 3 x 3 mm package and the standby consumption below 80 nA.

The integrated sequencer can provide a resolution up to 256 microsteps, but it is always possible to switch to the full-step operation on-the-fly.

This document describes how to select the step resolution and manage the switch between the microstep and full-step operation.

Contents

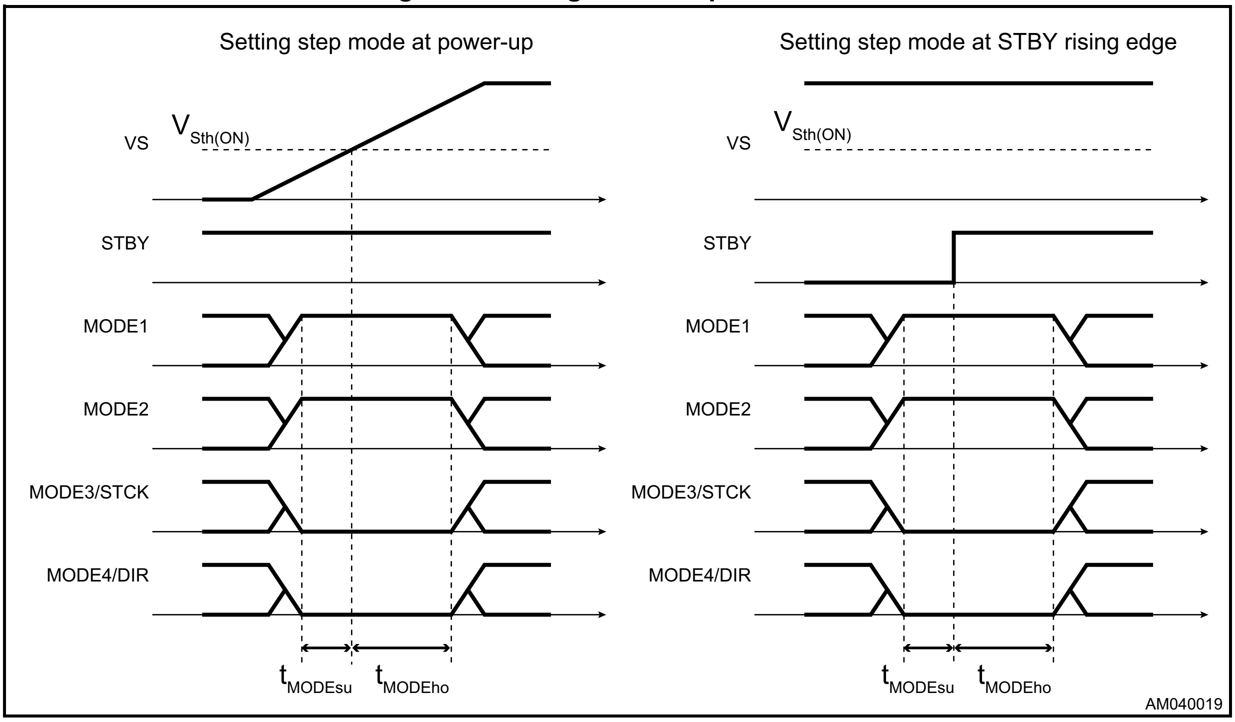
1 Selecting step resolution

The resolution of the integrated microstepping sequencer is selected through the following digital inputs:

- MODE1
- MODE2
- MODE3/STCK
- MODE4/DIR

The value of these inputs is latched at the power-up, i.e. when the supply voltage rises above the turn-on threshold ($V_{Sth(ON)}$), or at the rising edge of the standby input (*Figure 1*). In both cases, the logic signals must remain asserted for a time greater than t_{MODEsu} before the latching event and t_{MODEho} after the latching event.

Figure 1. Setting of the step resolution



After the configuration is set, the logic inputs change functionalities as listed below:

- MODE1 and MODE2 force the device to the full-step mode as described in *Section 3 on page 8*.
- MODE3/STCK is the step-clock input
- MODE4/DIR is the direction input

The correspondence between the MODEx logic inputs and the step resolutions is listed in *Table 1*.

Table 1. Step resolution configuration inputs

Step resolution	MODE4/ DIR	MODE3/ STCK	MODE2	MODE1
Full-step	0	0	0	0
½ step	0	1	0	1
¼ step	1	0	1	0
1/8th step	0	1	1	1
	1	1	0	1
1/16th step	1	1	1	1
1/32nd step	0	0	1	0
	1	**0**	**0**(1)	**0**(1)
1/64th step	1	0	1	1
	1	1	1	0
1/128th step	0	0	0	1
	0	**1**	**0**(1)	**0**(1)
1/256th step	0	0	1	1
	0	1	1	0
	1	0	0	1
	1	**1**	**0**(1)	**0**(1)

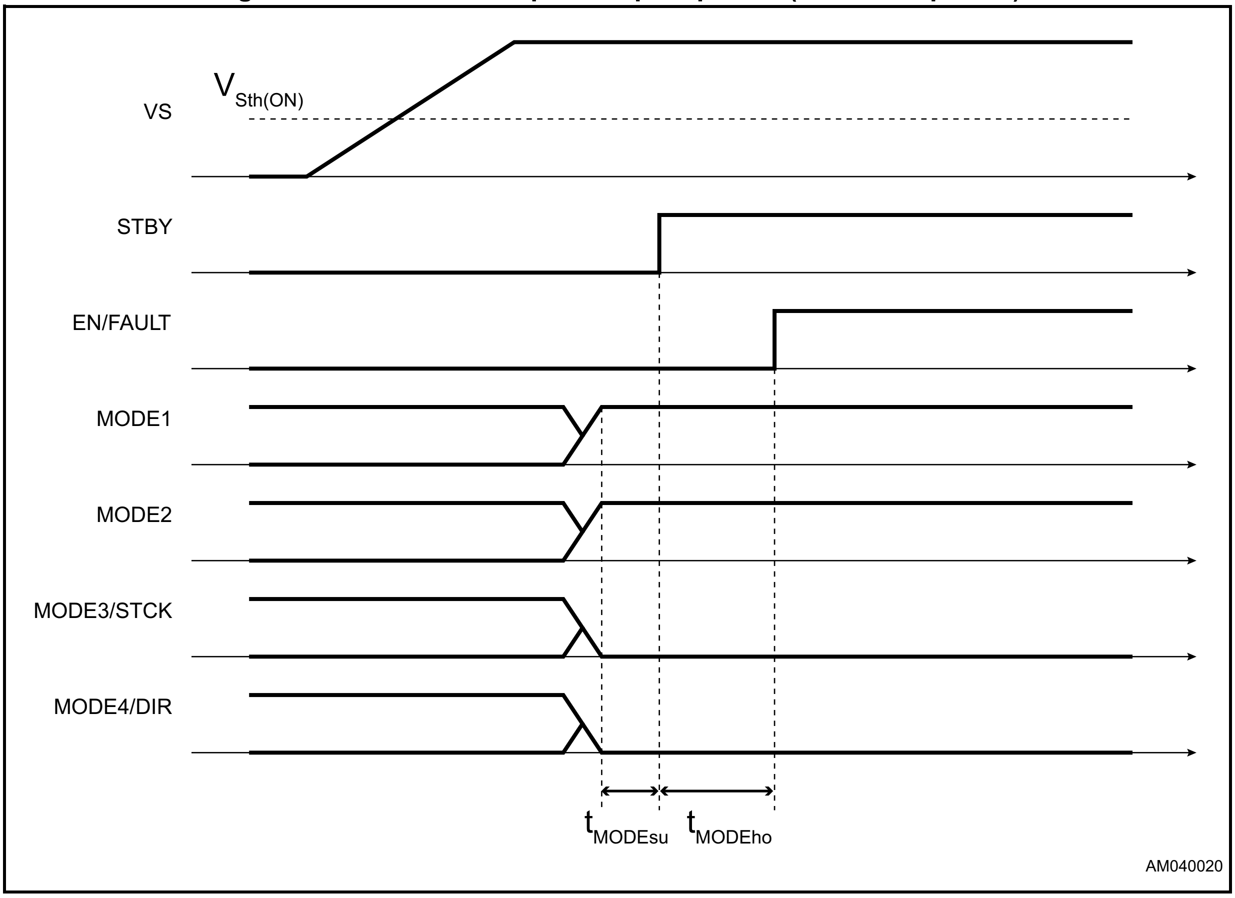
1. Keeping the MODE1 and MODE2 inputs low after the step resolution configuration forces the full-step mode instead of the selected configuration. See *Section 2.2* for the details.

2 Recommended power-up sequence and setups

The recommended power-up sequence is following:

1. Power-up the device applying the VS supply voltage but keeping both STBY and EN/FAULT inputs low.
2. Set the MODEx inputs according to the target step resolution (see *Table 1*).
3. Wait for at least 1 μs (minimum t_{MODEsu} time).
4. Set the STBY high. The MODEx configuration is now latched inside the device.
5. Wait for at least 100 μs (minimum t_{MODEho} time).
6. Enable the power stage releasing the EN/FAULT input and start the operation.

Figure 2. Recommended power-up sequence (1/256th step case)



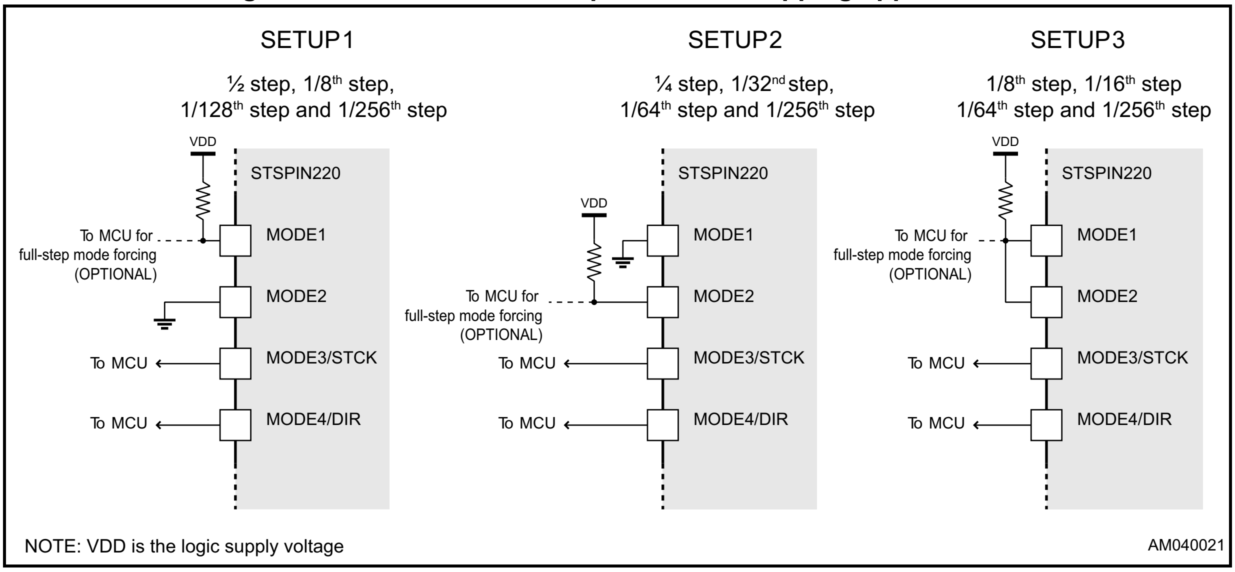
2.1 Half-step and microstepping applications

The recommended setups for the microstepping operation are shown in *Figure 3*; for the full-step application refer to *Section 2.2*.

Each setup allows operating with different step resolutions according to the MODE3/STCK and MODE4/DIR values applied during the power-up sequence:

- **SETUP 1** (MODE1 = high, MODE2 = low)
  - MODE3/STCK = high and MODE4 = low → ½ step
  - MODE3/STCK = high and MODE4 = high → 1/8th step
  - MODE3/STCK = low and MODE4 = low → 1/128th step
  - MODE3/STCK = low and MODE4 = high → 1/256th step
- **SETUP 2** (MODE1 = low, MODE2 = high)
  - MODE3/STCK = low and MODE4 = high → ¼ step
  - MODE3/STCK = low and MODE4 = low → 1/32nd step
  - MODE3/STCK = high and MODE4 = high → 1/64th step
  - MODE3/STCK = high and MODE4 = low →1/256th step
- **SETUP 3** (MODE1 = high, MODE2 = high)
  - MODE3/STCK = high and MODE4 = low → 1/8th step
  - MODE3/STCK = high and MODE4 = high → 1/16thstep
  - MODE3/STCK = low and MODE4 = high → 1/64th step
  - MODE3/STCK = low and MODE4 = low → 1/256th step

Figure 3. Recommended setups for microstepping applications

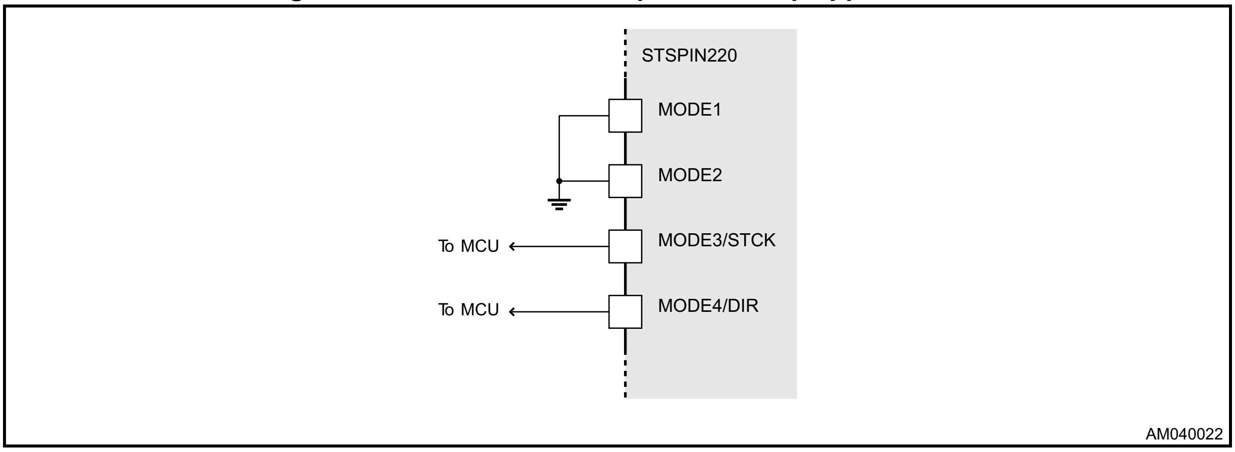


2.2 Full-step applications

If the device is used in an application only requiring the full-step operation, the MODE1 and MODE2 inputs can be shorted to ground.

In this way, whatever are the values of the MODE3/STCK and MODE4/DIR during the power-up sequence, the device always operates in the full-step.

Figure 4. Recommended setup for full-step applications



3 Switching to full-step on-the-fly

The STSPIN220 device has the possibility to switch to the full-step resolution on-the-fly forcing low both the MODE1 and MODE2 inputs. Thanks to this feature, the application can take all the advantages of a high resolution microstepping (smoothness and precision) at low speeds without incurring in the respective limitations when the high speed operation is required (lower torque and high step-clock frequency).

Switching from the microstepping to the full-step:

- The counter of the sequencer is increased of one full-step at each STCK rising edge
- The target current is increased up to the peak value ($I_{peak} = V_{REF}/R_{sense}$)

In order to make the switching between the microstepping and full-step operation smoother and safer possible, synchronization with the microstepping sequence is required. The switching between the two modes should be performed when the electrical position is a multiple of 45°, i.e. when the phase currents of the stepper motor are equal in the module (see from *Figure 5* to *Figure 8*). This way, even if the current increases from $I_{peak}/\sqrt{2}$ to I_{peak}, the electrical and mechanical positions are unchanged. *Table 2* lists the number of STCK pulses required to reach the recommended switching position starting from the reset state.

Table 2. Number of STCK pulses required to reach 45° position from the reset position

½ step	¼ step	1/8th step	1/16th step	1/32nd step	1/64th step	1/128th step	1/256th step
1	2	4	8	16	32	64	128
3	6	12	24	48	96	192	384
5	10	20	40	80	160	320	640
7	14	28	56	112	224	448	896

Figure 5. Switching to full-step (1/8th step microstepping)

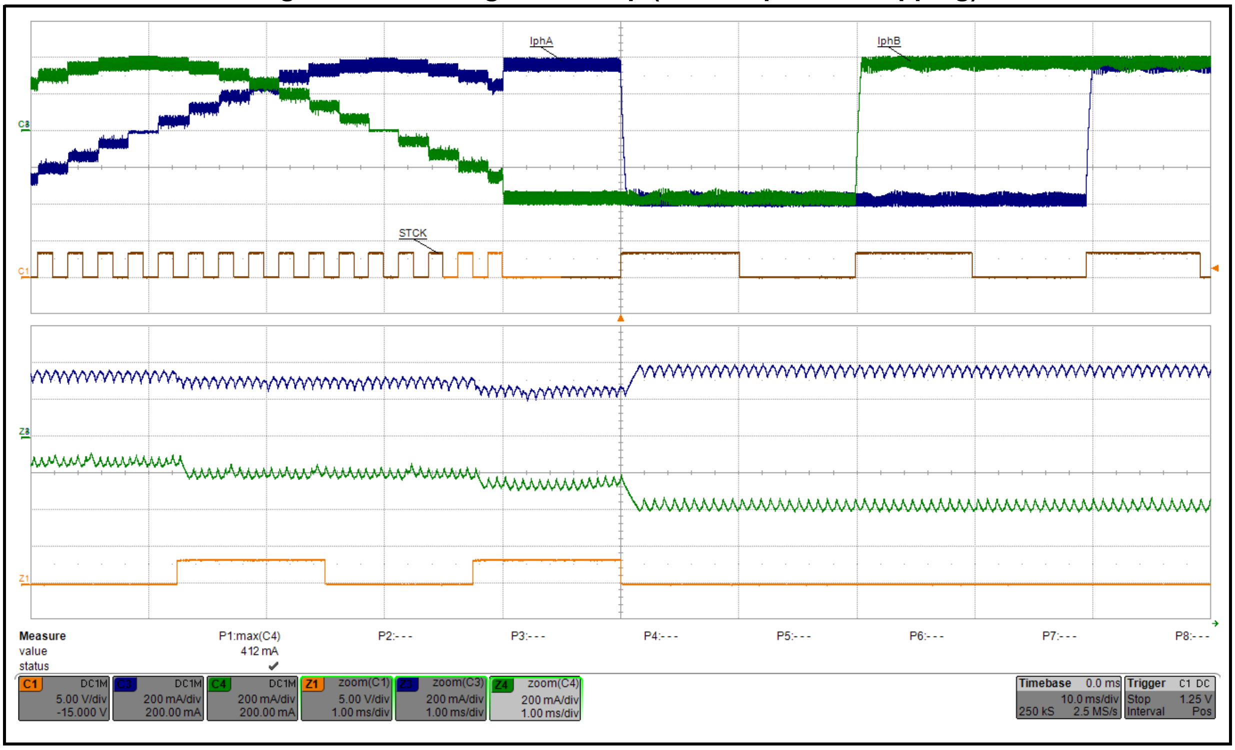


Figure 6. Switching back to microstepping (1/8th step microstepping)

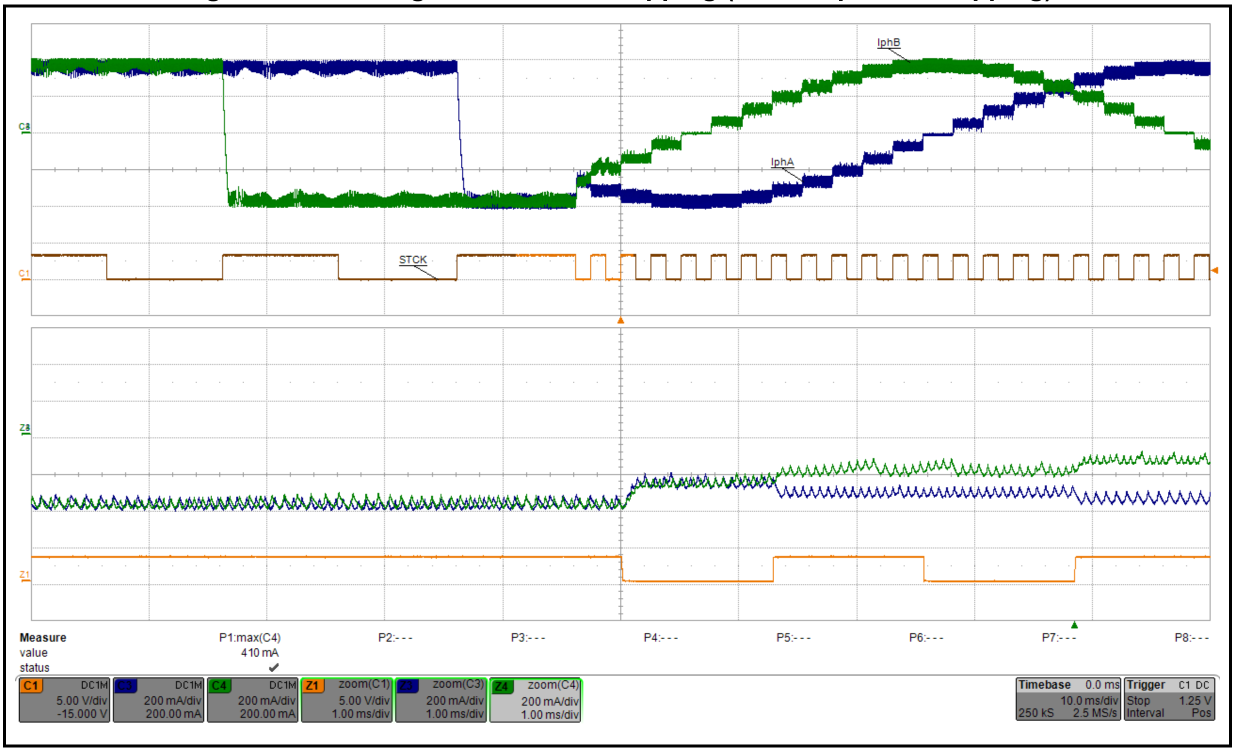


Figure 7. Switching to full-step (1/64th step microstepping)

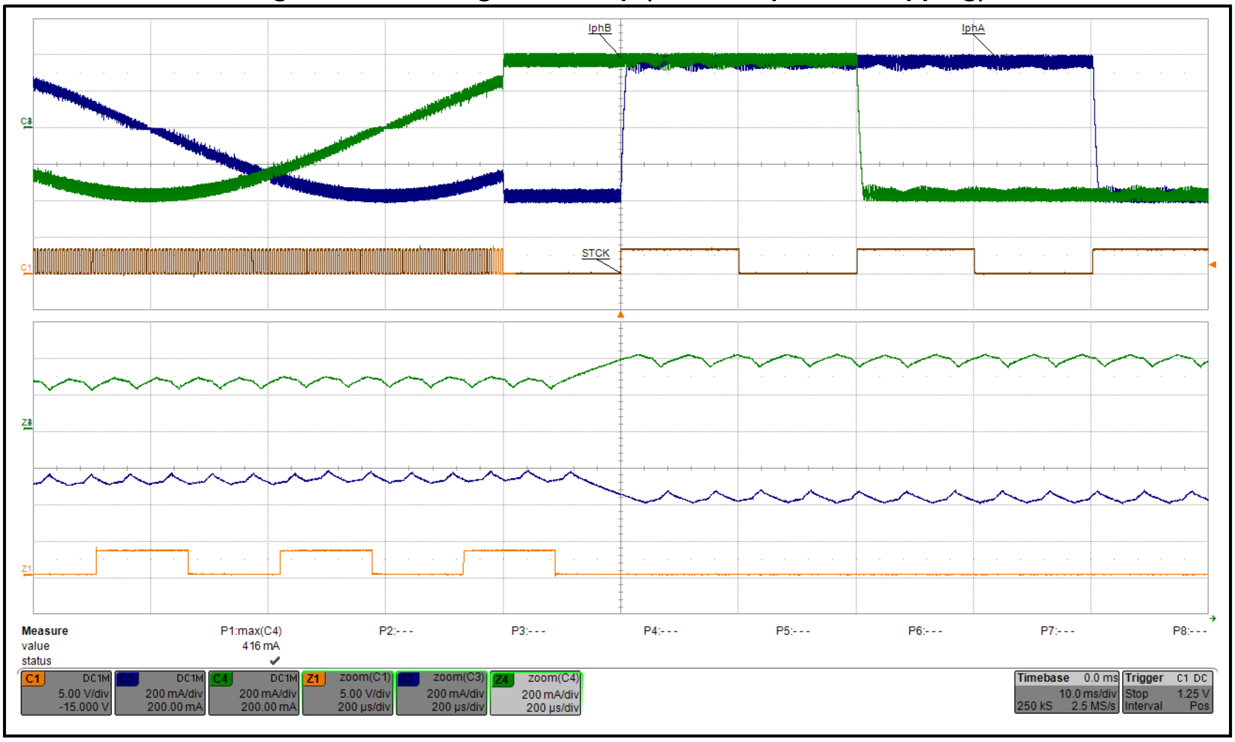
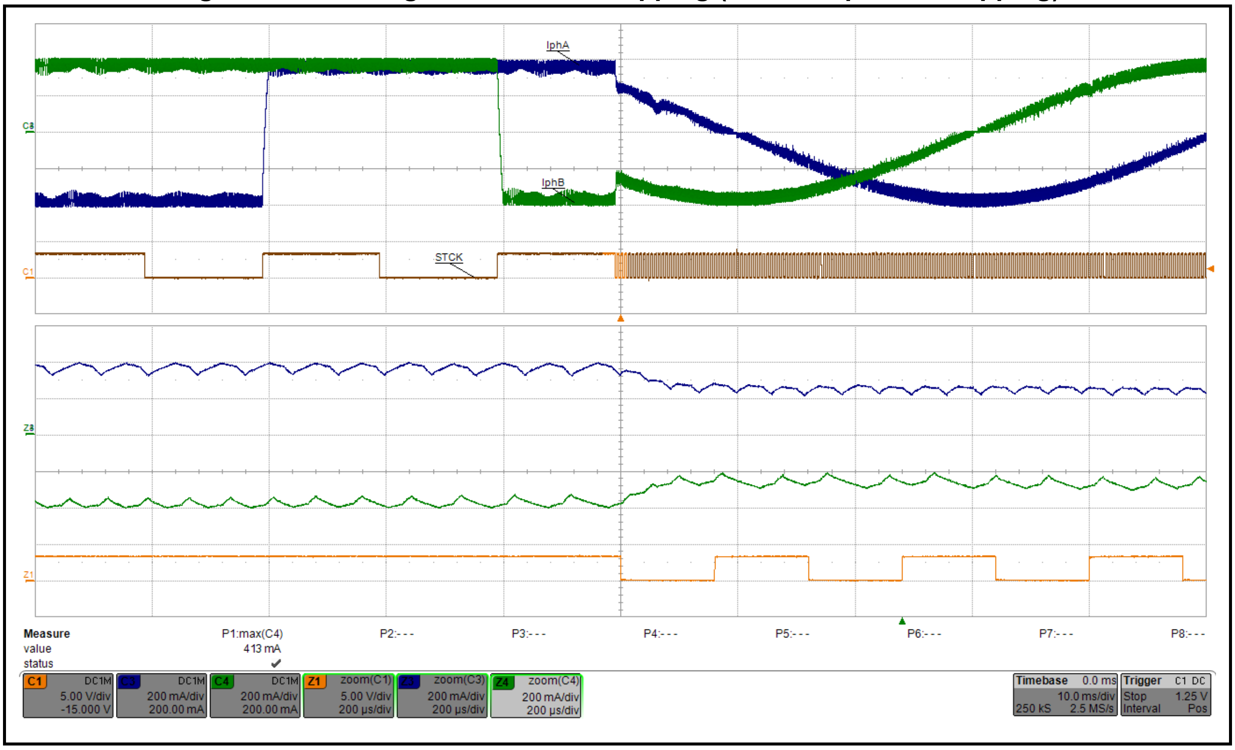


Figure 8. Switching back to microstepping (1/64th step microstepping)



4 Revision history

Table 3. Document revision history

Date	Revision	Changes
18-Oct-2016	1	Initial release.