

## Overview

Zilog's Z8F1680 MCU-based Microstepper Motor Reference Design is a complete and easy-to-use platform that demonstrates the features set of the Z8F1680 Microcontroller, which is optimized for microstepper motor control. This Microstepper Motor Reference Design drives a unipolar stepper motor using the Z8F1680 MCU's onboard analog comparators for one-shot feedback current limiting. It also uses the Z8F1680 MCU's multi-channel timer as a microstepper sine/cosine current generator. The Microstepper Motor Reference Design, shown in Figure 1, is designed to be operated by either any battery or an external power supply of 5V DC to 12V DC.

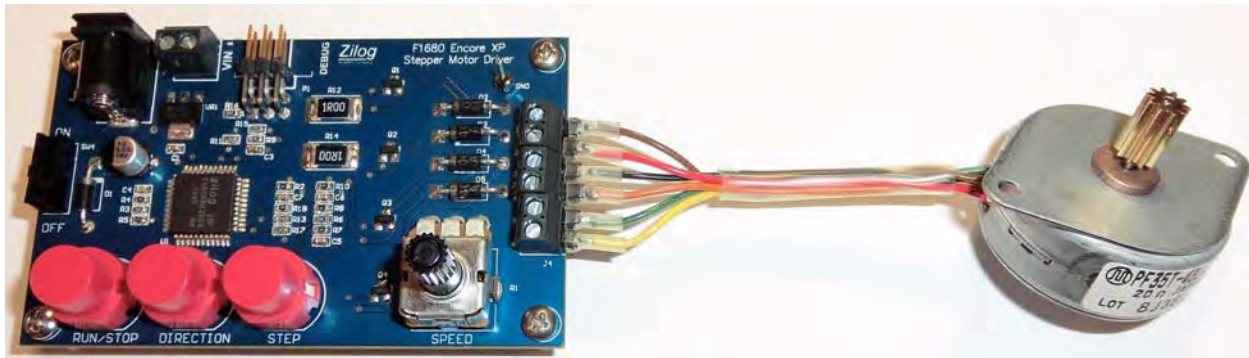


Figure 1. Zilog's Microstepper Motor Reference Design

## Features

The key features of the Microstepper Motor Reference Design are:

- Stepper motor
- Sine/cosine microstepping
- Current limiting
- Speed control
- Directional control of the motor
- One-step advancing of the motor
- Current generator for each coil

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## Potential Applications

The Microstepper Motor Reference Design can be used to develop a number of applications; a number of potential applications are listed below.

- Precision surgical procedures
- Motorized position camera
- HVAC coolant control
- Robotic arms for a factory production line
- Robot controls
- Valve control for a fluid control system
- Motorized curtains or window cover controls
- Laser or optical precision positioning equipment
  - Linear actuators
  - Linear stages
  - Goniometers
  - Mirror mounts
- Packaging machinery
- CD/DVD disk drives
- Flatbed/image scanners
- Computer printers
- Plotters
- Slot machines
- Intelligent lighting
- Retrieval or exploration/drilling machinery

## Discussion

The Microstepper Motor Reference Design employs Zilog's full-featured Z8F1680 MCU to receive user commands to drive a unipolar stepper motor. The Z8F1680 MCU's multi-channel timer is used as a microstepper sine/cosine current generator.

Microstepping, or sine/cosine microstepping, is a stepper motor drive technique in which the current in the motor windings is controlled to approximate a sinusoidal waveform. Microstepping produces a much smoother rotation than that of a full step drive, plus it provides greater resolution and freedom from resonance problems because it involves more steps per revolution.

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In a conventional full step drive, an equal amount of current is applied to each of a motor's stator coils. The magnetic rotor aligns itself in the coil's magnetic field. With each motor step, current is reversed in one of the coils, and the rotor realigns to the new magnetic field to move the rotor one motor step (i.e., 90 degrees).

With microstepping, varying amounts of current are applied to a motor's coils so that the magnetic field smoothly transitions from one polarity to the next. Each full step is divided into several microsteps of varying current to produce a larger number of magnetic fields that the rotor can align with. The result is a smoother motor rotation, quieter operation, and greater motor resolution. This reference design is a physical demonstration of this theory. To learn more, see the [Z8 Encore! XP F1680 Microstepping Controller Application Note \(AN0272\)](#), which is available free for download from the Zilog website.

## Principles of Operation

The Microstepper Motor Reference Design offers the following control switches and buttons, which demonstrate the microstepping functions of a unipolar microstepper motor.

**ON/OFF Switch (SW4).** This switch turns the power to the Microstepper Motor Reference Design Board either ON or OFF.

**SPEED Knob (R1).** Rotate this knob counterclockwise to slow rotation, and clockwise to speed rotation if the motor is operating in Run Mode.

**RUN/STOP Button (SW1).** A pushbutton toggle switch to allow a motor to run or to stop a motor from running.

**DIRECTION Button (SW2).** A pushbutton toggle switch that allows a motor to rotate clockwise or counterclockwise if the motor is operating in Run Mode.

**STEP Button (SW3).** A single push and release of this pushbutton switch allows the motor, when in Stop Mode, to take a single step in whichever direction the motor is currently rotating.



**Caution:** The motor must first be stopped prior to using the STEP button; otherwise, damage may occur to the motor.

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**Power Connector Jack (J5).** A single 5VDC to 12VDC power supply can be connected to this jack to power the Microstepper Motor Reference Design.

**Power Terminal Block Connector (J1).** An external 5VDC to 12VDC power supply can be connected to this terminal block to power the Microstepper Motor Reference Design.

**Terminal Block Connectors (J2, J3, J4).** The microstepper motor's wires are connected to the Microstepper Motor Reference Design through these terminal block connectors, as follows:

- Connect the brown wire to J2-1
- Connect the green wire to J2-2

- Connect the black wire to J3-1
- Connect the orange wire to J3-2
- Connect the red wire to J4-1
- Connect the yellow wire to J4-2

## Testing Procedure

Observe the following procedure to become familiar with the features of the Microstepper Motor Reference Design.

1. Switch ON/OFF SW4 to the OFF position.
2. Connect the 5V DC to 12V DC power supply to either Power Jack J5 or to Terminal Block J1. Ensure that the positive and negative connections from the power supply are connected to their corresponding terminal block connectors , both positive and negative.
3. Switch ON/OFF SW4 to the ON position.
4. Push the RUN/STOP button once. The microstepper motor will start to rotate.
5. Rotate the SPEED knob counterclockwise to slow the motor's rotation.
6. Rotate the SPEED knob clockwise to accelerate the motor's rotation.
7. Push the DIRECTION button once. The microstepper motor will immediately change the direction of its rotation.
8. Push the RUN/STOP button once. The microstepper motor will stop its rotation.
9. Push the STEP button once. The microstepper motor will advance one microstep in the direction in which it last rotated. Repeat this step a few times to observe this microstepping function.
10. Push the DIRECTION button once. The microstepper motor will change the direction of its rotation.
11. Push the STEP button once. The microstepper motor will advance one microstep in the new direction. Repeat this step a few times to observe this microstepping function.
12. Switch ON/OFF SW4 to the OFF position to conclude this test procedure.

## Electrical Specifications

Table 1 presents the electrical specifications for the Microstepper Motor Reference Design. These specifications reflect all available data as a result of testing prior to qualification and characterization. Therefore, the data presented in this table are subject to change.

Stresses greater than those listed in Table 1 may cause permanent damage to the device. These ratings are stress ratings only. Operation of the device at any condition outside

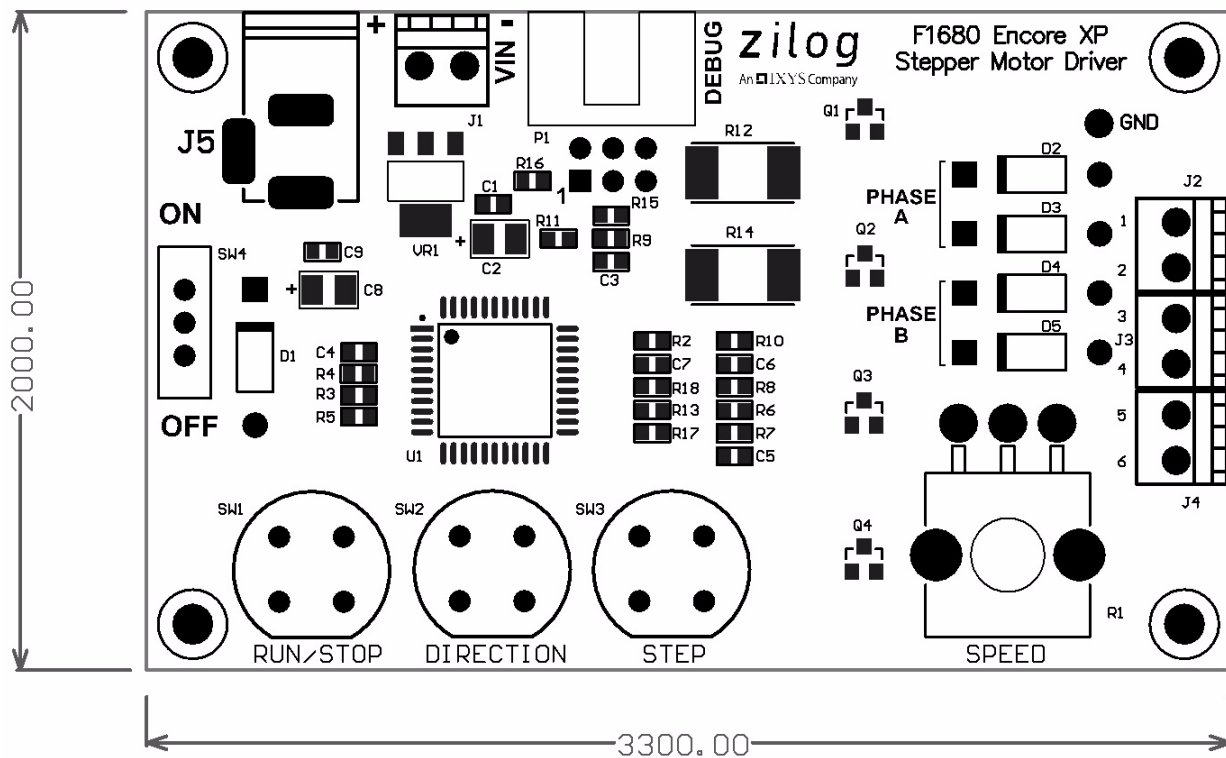
those indicated in the operational sections of these specifications is not implied. Exposure to absolute maximum rating conditions for extended periods affects device reliability. For improved reliability, unused inputs must be tied to one of the supply voltages ( $V_{DD}$  or  $V_{SS}$ ).

**Table 1. Electrical Specifications for the Microstepper Motor Reference Design**

Parameter	Min	Max	Units	Notes
Input power supply	5	12	Volts	Applied on J1 or J5 connector
Max voltage range, all other pins	-0.3	5.5	Volts	For Z8F1680: GPIO I/O pins and Reset. External Pull-ups are not enabled.
Storage temperature	20	30	Degrees Celsius	
Ambient temperature	20	30	Degrees Celsius	

## Packaging

Figure 2 shows an assembly diagram of the Microstepper Motor Reference Design Board.



**Figure 2. Microstepper Motor Reference Design Board Assembly Diagram**

## Mechanical Profile

Figure 3 shows top- and side-view dimensions of the Microstepper Motor Reference Design Board.

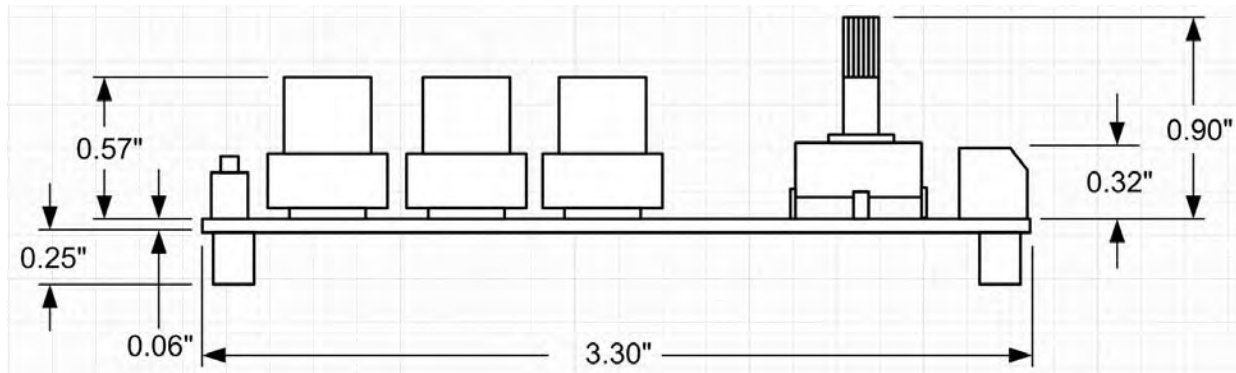


Figure 3. Microstepper Motor Reference Design Board Dimensions

## Ordering Information

The Microstepper Motor Reference Design is available as an individual board and as part of a kit, as shown in the Kit Contents section that follows. Both products can be ordered from the [Zilog Store](#) using the part numbers listed in Table 2.

Table 2. Microstepper Motor Reference Design Ordering Information

Part Number	Description	Store Product ID
Z8F1680MM00MODG	Microstepper Motor Design Board	<a href="#">RD10031</a>
Z8F1680MM00KITG	Microstepper Motor Design Kit	<a href="#">RD10032</a>

## Kit Contents

The Microstepper Motor Reference Design Kit contains the following items:

- Microstepper Motor Reference Design Board
- Stepper Motor PF35T-48L4
- AC-5VDC Power Adapter

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## Related Documentation

The documents associated with the Microstepper Motor Reference Design are listed in Table 3. Each of these documents can be obtained from the Zilog website by clicking the link associated with its document number.

**Table 3. Microstepper Motor Reference Design Documentation**

Document Number	Description
<a href="#">RD0004</a>	This Microstepper Motor Reference Design document
<a href="#">PS0250</a>	Z8F1680 Series Product Specification
<a href="#">UM0188</a>	eZ8 CPU Core User Manual
<a href="#">UM0181</a>	USB SmartCable User Manual
<a href="#">AN0272</a>	Z8 Encore! XP F1680 Microstepping Controller Application Note
<a href="#">AN0272-SC01</a>	Source code for Z8 Encore! XP Z8F1680 Microstepping Controller Application Note

## Appendix A. Schematic Diagrams

Figure 4 presents a schematic diagram of the Microstepper Motor Reference Design.

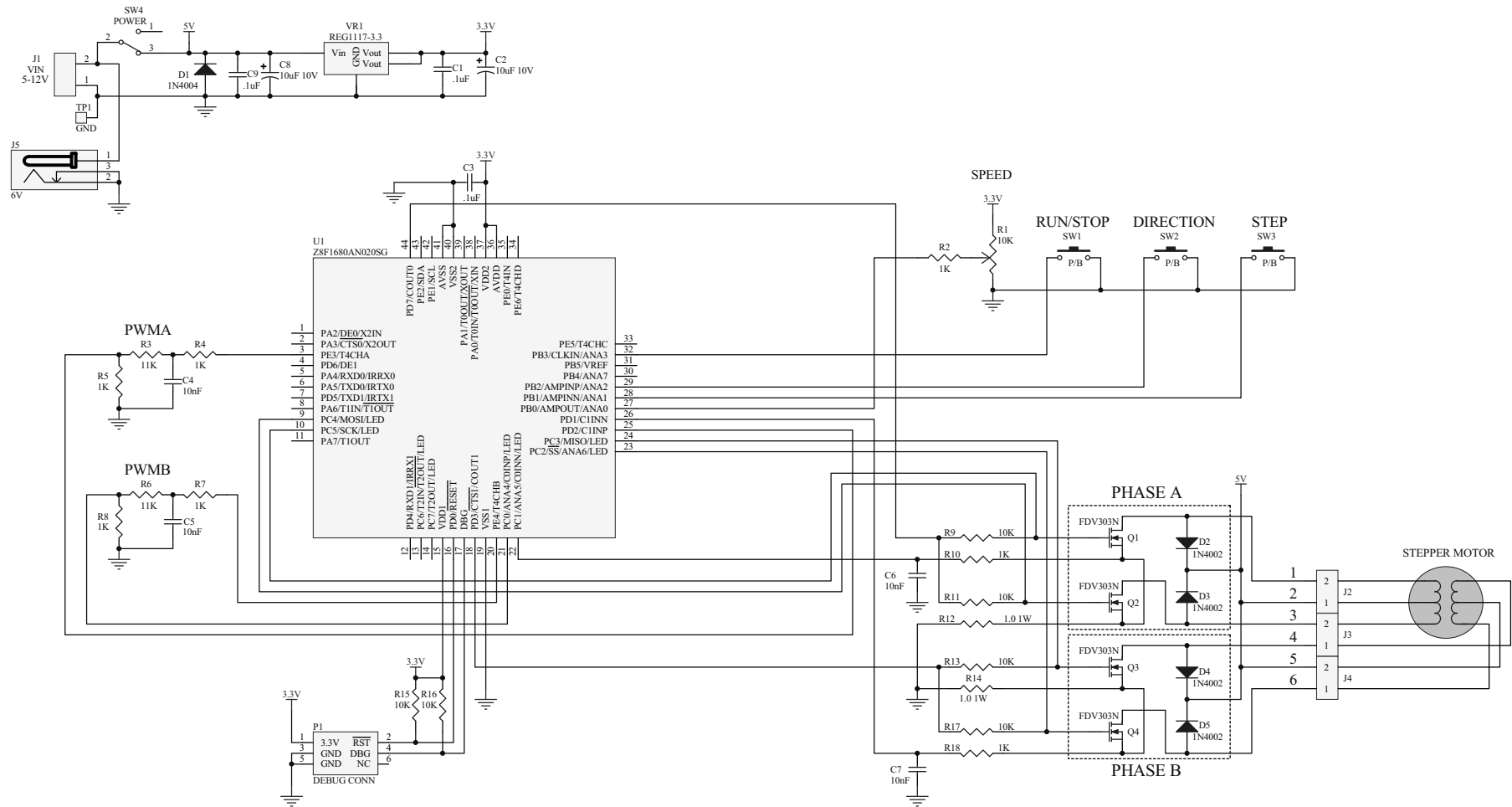


Figure 4. A Schematic Diagram of the Microstepper Motor Reference Design



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**Warning:** DO NOT USE THIS PRODUCT IN LIFE SUPPORT SYSTEMS.

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