EDITED BY BRAD THOMPSON
AND FRAN GRANVILLE

designideas

READERS SOLVE DESIGN PROBLEMS

Two-channel audio amplifier drives stepper motor

Phill Leyva and Bill Quach, Maxim Integrated Products, Sunnyvale, CA

Although relatively expensive, monofilar-wound, bipolar stepper motors provide strong torque for a given physical size. However, each of the motor's two windings requires eight driving transistors connected in groups of four in an H-bridge configuration. Each transistor must withstand and quickly recover from overloads and short-circuit conditions, and a driver must consequently include complex and large discrete-component protective circuitry.

As an alternative, **Figure 1** shows a motor-driver circuit based on Maxim's (www.maxim-ic.com) MAX9715, a tiny, surface-mount, 2.8W Class D audio amplifier, which typically drives 4 or 8Ω speakers. Each of IC_1's two outputs consists of a MOSFET H-bridge that drives a pair of output lines, OUTR+ and OUTR− and OUTL+ and OUTL−, that connect to the stepper motor's A and B windings, respectively. Each pair delivers a differential-pulse-width-modulated signal with a nominal switching frequency of 1.22 MHz. The circuit's low-interference design eliminates the requirement for output-line filters.

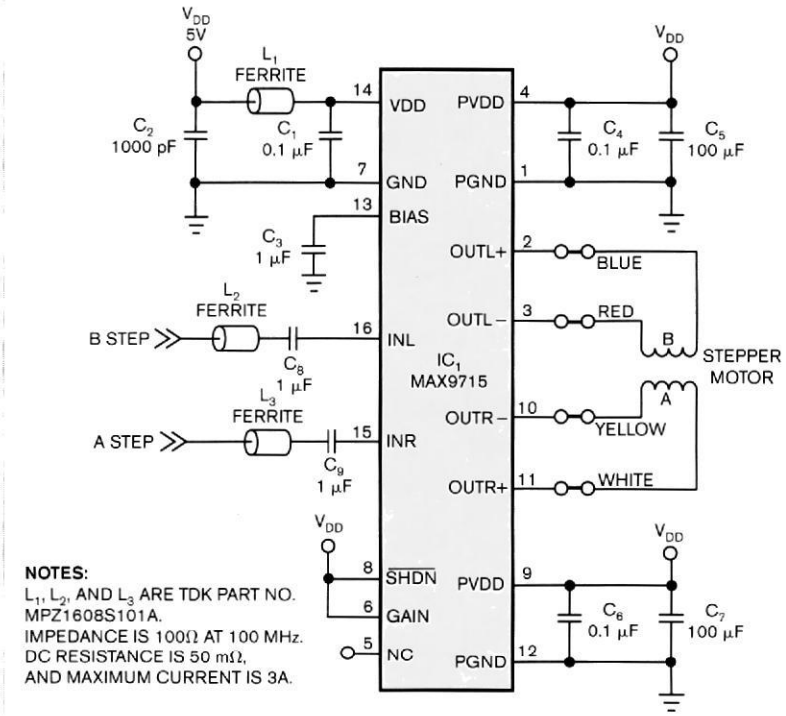

Figure 1 A single surface-mount circuit and a few passive components can drive a bipolar, monofilar-wound stepper motor.

Capacitors C_1, C_3, C_4, and C_6 provide bypassing for IC_1's power input and bias pins, and C_5 and C_7 provide bulk-holdup capacitance for the Class D power amplifiers' outputs. Capacitors C_8 and C_9 limit the amplifiers' input bandwidth to 16 Hz, and L_2 and L_3 suppress electrical-noise pickup by the long input cables. Comprising C_1, C_2, and ferrite bead L_1, a pi-section noise filter suppresses noise on IC_1's power-sup-

TABLE 1 A_STEP AND B_STEP PULSE SEQUENCE

Step	A_Step	B_Step
0	H	L
1	L	L
2	L	H
3	H	H
4	H	L

DIs Inside

▶What are your design problems and solutions? Publish them here and receive $150! Send your Design Ideas to edndesignideas@reedbusiness.com.

ply input. A suitable controller feeds digital pulses to IC_1's A_Step and B_Step inputs, which respectively drive the motor's right and left channels. Internal short-circuit and thermal protection guards the amplifier against overcurrent and short circuits caused by the stepper motor or its connecting leads.

Table 1 illustrates the A_Step and B_Step pulse sequence that rotates a typical stepper motor in one direction by continuous application of steps 0 through 4. Step 4 returns the motor's shaft to its starting position and completes its 360° rotation. To reverse the motor, begin at the bottom of the **table** to reverse the pulse pattern and work upward. You can disable both of the amplifier's channels by applying a logic-low signal to Pin 8, IC_1's active-low $\overline{SHDN}$ input. **Figure 2** illustrates the circuit's input and output waveforms. EDN

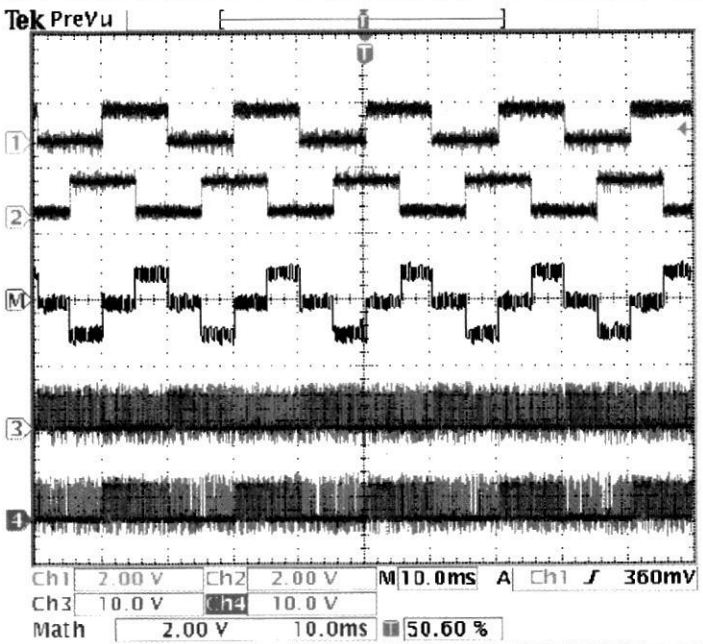

Figure 2 Waveforms from the circuit in Figure 1 include the A_Step input (Channel 1), B_Step input (Channel 2), outputs OUTR+ (Channel 3) and OUTR− (Channel 4), and the signal that arrives at the motor's windings (OUTR+ minus OUTR−, middle trace), which the oscilloscope's math function computes.