

# CS8441

## Stepper Motor Driver with Divide by Select

The CS8441 is a Stepper Motor Driver that implements an H-Bridge design in order to drive two coils in an eight step sequence per revolution in the divide by 1 mode; 16 step sequence in the divide by 2 mode. The H-Bridge is capable of delivering 85 mA to the load.

The sequencer insures that the odometer is monotonic. This sequencer is configured such that simultaneous conduction does not occur. Before each successive output sequence the part is taken through a state where both outputs are turned off individually. This tends to minimize the inductive kick back energy that the part must absorb. On-chip clamp diodes are across each output to protect the part from the kick back energy that it must absorb.

Additional part protection is provided by two functions. The first being "short circuit protection." This function will protect the part in the case of a shorted or partially shorted load. The second protection function is the "overvoltage function." This function monitors the level of the supply voltage. In transient conditions such as load dump, the part will shut down, protecting itself.

### Features

- No Cross-Conduction in Either H-Bridge
- Divide by 1 and Divide by 2 Modes
- Guaranteed Monotonic
- On-Chip Flyback Diodes
- Fault Protection
  - Overvoltage
  - Load Dump Protection to 60 V

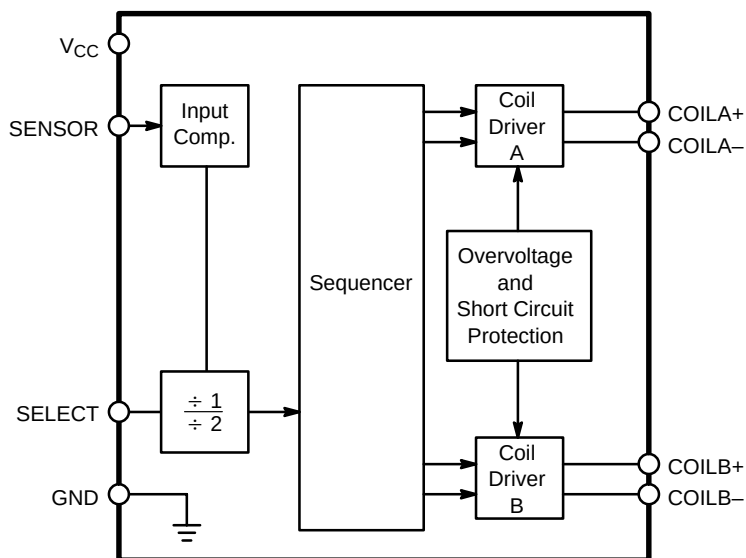
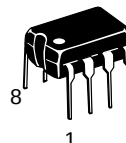


Figure 1. Block Diagram



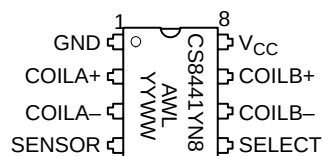
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DIP-8  
N SUFFIX  
CASE 626

### PIN CONNECTIONS AND MARKING DIAGRAM



A = Assembly Location  
WL, L = Wafer Lot  
YY, Y = Year  
WW, W = Work Week

### ORDERING INFORMATION

| Device    | Package | Shipping      |
|-----------|---------|---------------|
| CS8441YN8 | DIP-8   | 50 Units/Rail |

**ABSOLUTE MAXIMUM RATINGS\***

| Rating                                                                         | Value                    | Unit   |
|--------------------------------------------------------------------------------|--------------------------|--------|
| Supply Voltage ( $V_{CC}$ ) (Note 1.):<br>Continuous<br>100 ms Pulse Transient | –0.5 to 24<br>–0.5 to 60 | V<br>V |
| Input Voltage ( $V_{IN}$ )                                                     | –0.3 to $V_{CC} + 0.3$   | V      |
| Storage Temperature Range ( $T_{STG}$ )                                        | –65 to 150               | °C     |
| Junction Temperature Range                                                     | –40 to 150               | °C     |
| ESD (Human Body Model)                                                         | 2.0                      | kV     |
| Lead Temperature Soldering: Wave Solder: (through hole styles only) (Note 2.)  | 260 peak                 | °C     |

1. –40°C to +125°C.

2. 10 second maximum.

\*The maximum package power dissipation must be observed.

**ELECTRICAL CHARACTERISTICS** (–40°C ≤  $T_A$  ≤ 125°C, 6.5 V ≤  $V_{CC}$  ≤ 15.5 V; unless otherwise stated. All voltage shall be referenced to GND unless otherwise noted. Overvoltage shutdown of coils occurs when  $V_{CC} > 16$  V.)

| Characteristic | Test Conditions | Min | Typ | Max | Unit |
|----------------|-----------------|-----|-----|-----|------|
|----------------|-----------------|-----|-----|-----|------|

**Supply,  $V_{CC}$** 

|                      |                                                                          |                 |             |                  |                                  |
|----------------------|--------------------------------------------------------------------------|-----------------|-------------|------------------|----------------------------------|
| Supply Voltage Range | –40°C ≤ $T_A$ ≤ 125°C<br>–40°C ≤ $T_A$ ≤ 25°C<br>Transient Pulse, 100 ms | 6.5<br>6.5<br>– | –<br>–<br>– | 15.5<br>24<br>35 | $V_{DC}$<br>$V_{DC}$<br>$V_{DC}$ |
| Supply Current       | $V_{CC} = 15.5 V_{DC}$ , Outputs not loaded.                             | –               | 24          | 35               | mA                               |
| Overvoltage Shutdown | –                                                                        | 16              | –           | 23               | V                                |

**Speed Sensor Input, SENSOR**

|                         |                                      |     |      |                 |             |
|-------------------------|--------------------------------------|-----|------|-----------------|-------------|
| Input Frequency Range   | –                                    | –   | 0.2  | 1.0             | kHz         |
| Switching Threshold     | –                                    | 1.2 | –    | 2.4             | $V_{DC}$    |
| Hysteresis              | –                                    | 300 | 500  | –               | mV $V_{DC}$ |
| Input Bias Current      | $0.8 V_{DC} \leq V_{IN} \leq V_{CC}$ | –   | 0.1  | ±1.0            | μA          |
| Input Voltage Range     | –                                    | 0   | –    | $V_{CC}$        | $V_{DC}$    |
| Operating Input Voltage | 10 kΩ Resistor in Series             | –   | –    | –15 to $V_{CC}$ | $V_{DC}$    |
| Input Clamp Current     | I Clamp at $V_{IN} = 0 V_{DC}$       | –   | –0.4 | –5.0            | mA          |

**Divider Select Input, SELECT**

|                       |                                      |     |      |          |             |
|-----------------------|--------------------------------------|-----|------|----------|-------------|
| Logic 0 Input Voltage | –                                    | –   | –    | 100      | mV $V_{DC}$ |
| Logic 1 Input Voltage | –                                    | 3.0 | –    | $V_{CC}$ | $V_{DC}$    |
| Logic 0 Input Current | $0 V \leq V_{IN} \leq 100$ mV        | –   | –1.0 | –100     | μA          |
| Logic 1 Input Current | $3.0 V \leq V_{IN} \leq 15.5 V_{DC}$ | –   | 0.75 | 2.0      | mA          |

**Coil Output Drivers**

|                                                               |                                                                                                                                                   |                                                                               |                                                                              |                  |                                              |
|---------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|------------------------------------------------------------------------------|------------------|----------------------------------------------|
| Coil Load                                                     | +25°C                                                                                                                                             | 198                                                                           | 210                                                                          | 222              | Ω                                            |
| Coil Inductance                                               | –                                                                                                                                                 | –                                                                             | 80                                                                           | –                | mH                                           |
| Coil Resistance Temperature                                   | Coefficient                                                                                                                                       | –                                                                             | –                                                                            | 0.35             | %/°C                                         |
| Energized Coil Voltage (Note 3.)<br>(Both Polarities) A and B | $V_{CC} = 6.5 V_{DC}$<br>$V_{CC} = 10 V_{DC}$<br>$V_{CC} = 15.5 V_{DC}$ , –20°C ≤ $T_A$ ≤ 125°C<br>$V_{CC} = 15.5 V_{DC}$ , –40°C ≤ $T_A$ ≤ –20°C | $V_{CC} - 1.5$ V<br>$V_{CC} - 1.6$ V<br>$V_{CC} - 1.75$ V<br>$V_{CC} - 2.0$ V | $V_{CC} - 0.9$ V<br>$V_{CC} - 1.0$ V<br>$V_{CC} - 1.1$ V<br>$V_{CC} - 1.2$ V | –<br>–<br>–<br>– | $V_{DC}$<br>$V_{DC}$<br>$V_{DC}$<br>$V_{DC}$ |
| De-energized Coil Leakage Current                             | –                                                                                                                                                 | –                                                                             | –                                                                            | ±100             | μA                                           |

3. Voltage across the coils shall be measured at the specific voltages, but shall also be within linearly interpolated limits.

**ELECTRICAL CHARACTERISTICS (continued)** ( $-40^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$ ,  $6.5\text{ V} \leq V_{CC} \leq 15.5\text{ V}$ ; unless otherwise stated. All voltage shall be referenced to GND unless otherwise noted. Overvoltage shutdown of coils occurs when  $V_{CC} > 16\text{ V}$ .)

| Characteristic                                 | Test Conditions | Min | Typ | Max | Unit          |
|------------------------------------------------|-----------------|-----|-----|-----|---------------|
| <b>Short Circuit Protection</b>                |                 |     |     |     |               |
| Short Circuit Threshold<br>I Coil A + I Coil B | –               | –   | 275 | 400 | mA            |
| Short Circuit Turn–Off Delay                   | –               | –   | 5.0 | –   | $\mu\text{s}$ |

#### PACKAGE PIN DESCRIPTION

| PACKAGE PIN # | PIN SYMBOL | FUNCTION                                                        |
|---------------|------------|-----------------------------------------------------------------|
| DIP–8         |            |                                                                 |
| 1             | GND        | Ground connection.                                              |
| 2             | COILA+     | Output stage, when active, this pin supplies current to COIL A. |
| 3             | COILA–     | Output stage, when active, this pin supplies current to COIL A. |
| 4             | SENSOR     | Input signal from wheel speed or engine rpm.                    |
| 5             | SELECT     | Selects divide by 1 or divide by 2 mode.                        |
| 6             | COILB–     | Output stage, when active, this pin supplies current to COIL B. |
| 7             | COILB+     | Output stage, when active, this pin supplies current to COIL B. |
| 8             | $V_{CC}$   | Supply voltage.                                                 |

#### CIRCUIT OPERATION

##### SPEED SENSOR INPUT

SENSOR is a PNP comparator input which accepts a sine wave or a square wave input. This input is protected from excursions above  $V_{CC}$  as well as any below ground, as long as the current is limited to 1.5 mA. It has an active clamp set to zero volts to prevent negative input voltages from disrupting normal operation. The sensor input can withstand  $150\text{ V}_{DC}$  as long as the input current is limited to 1.5 mA max. using a series resistor of 100 k $\Omega$ .

##### COIL DRIVER OUTPUTS

Simultaneously energizing the source and sink on either leg is not permitted, i.e. Q1 & Q2 or Q3 & Q4 cannot be energized simultaneously.

Circuit function is not affected by inductive transients due to coil loads as specified in the Transition States section.

The transition states occur as indicated in Table 1 without any intermediate states permitted.

**Table 1. Transition States**

| State | Coil A | Coil B |
|-------|--------|--------|
| 0     | +      | +      |
| 1     | OFF    | +      |
| 2     | –      | +      |
| 3     | –      | OFF    |
| 4     | –      | –      |
| 5     | OFF    | –      |
| 6     | +      | –      |
| 7     | +      | OFF    |

The polarity definition for the coil driver outputs is as follows:

| Polarity     | Connect Coil + | Connect Coil – |
|--------------|----------------|----------------|
| Positive (+) | $V_{CC}$       | GND            |
| Negative (–) | GND            | $V_{CC}$       |

##### DIVIDER SELECT INPUT

The speed sensor input frequency is divided by one or divided by two by connecting the divider select input, (Pin 5) as follows:

Logic 0 = divide by 2.

Logic 1 = divide by 1.

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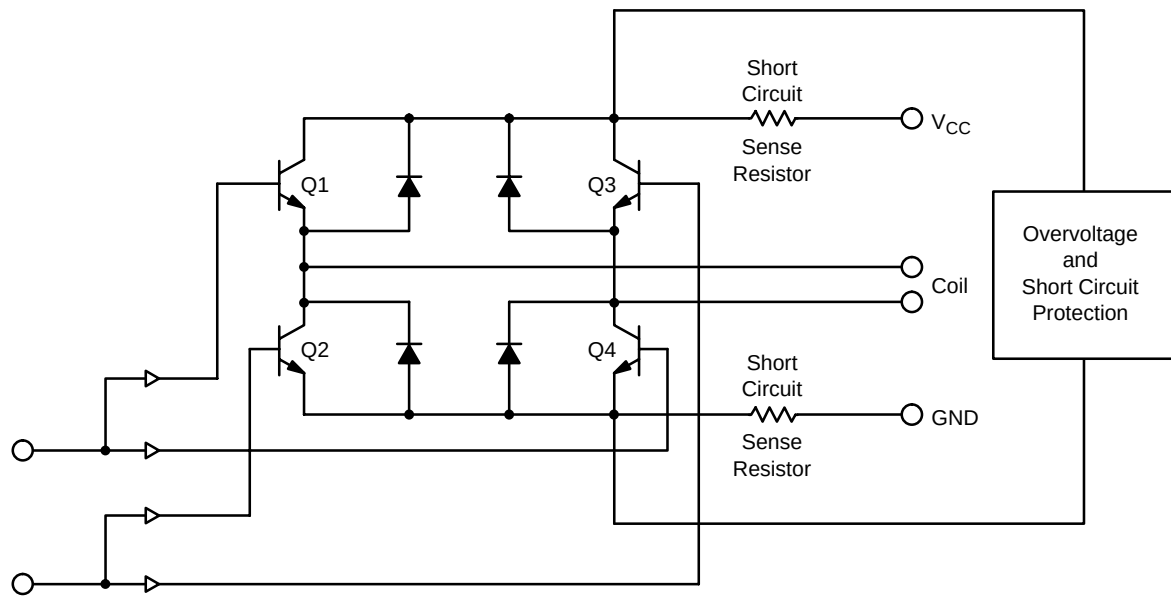


Figure 2. Coil Driver Output

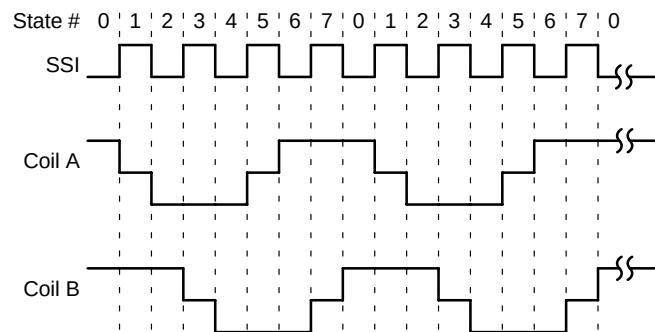


Figure 3. Divide by 1 (8 Step Mode), SELECT = 1

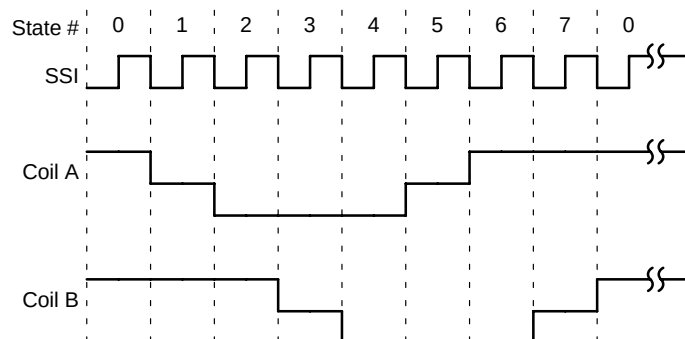


Figure 4. Divide by 2 (16 Step Mode), SELECT = 0

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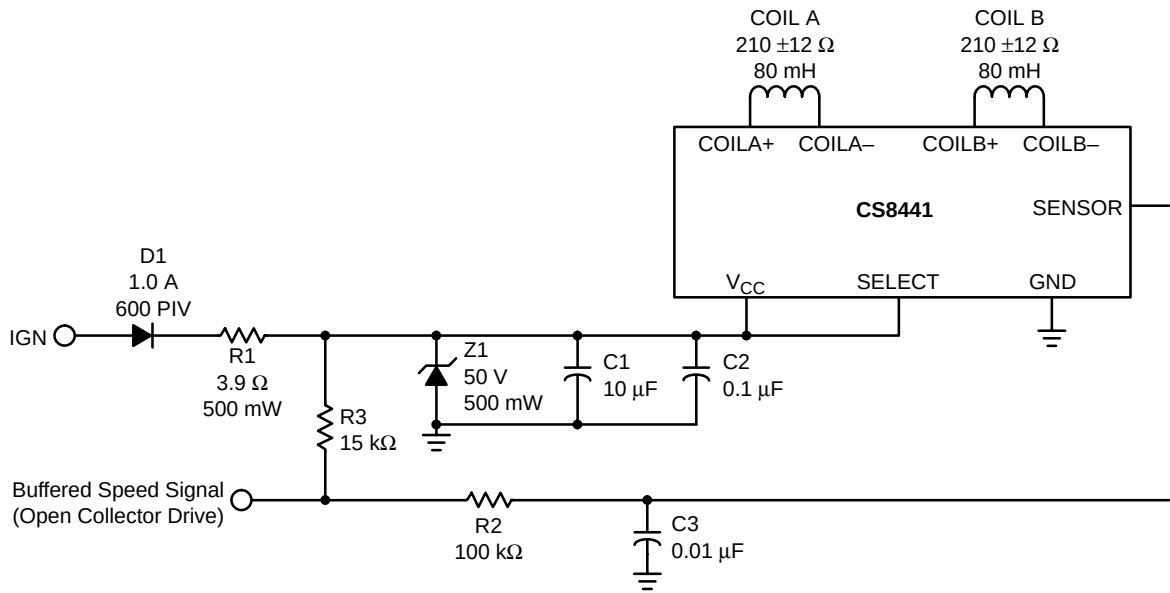
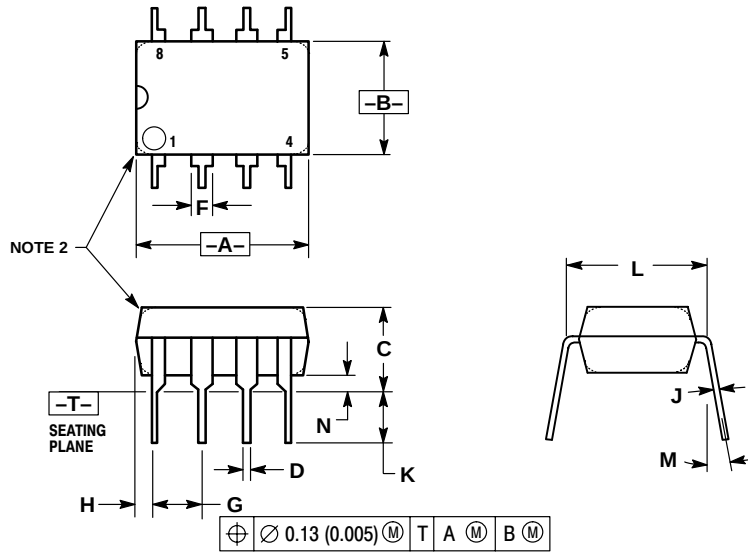


Figure 5. Odometer Application Diagram

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## PACKAGE DIMENSIONS

DIP-8  
N SUFFIX  
CASE 626-05  
ISSUE L



- NOTES:
1. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
  2. PACKAGE CONTOUR OPTIONAL (ROUND OR SQUARE CORNERS).
  3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

| DIM | MILLIMETERS |       | INCHES    |       |
|-----|-------------|-------|-----------|-------|
|     | MIN         | MAX   | MIN       | MAX   |
| A   | 9.40        | 10.16 | 0.370     | 0.400 |
| B   | 6.10        | 6.60  | 0.240     | 0.260 |
| C   | 3.94        | 4.45  | 0.155     | 0.175 |
| D   | 0.38        | 0.51  | 0.015     | 0.020 |
| F   | 1.02        | 1.78  | 0.040     | 0.070 |
| G   | 2.54 BSC    |       | 0.100 BSC |       |
| H   | 0.76        | 1.27  | 0.030     | 0.050 |
| J   | 0.20        | 0.30  | 0.008     | 0.012 |
| K   | 2.92        | 3.43  | 0.115     | 0.135 |
| L   | 7.62 BSC    |       | 0.300 BSC |       |
| M   | ---         | 10°   | ---       | 10°   |
| N   | 0.76        | 1.01  | 0.030     | 0.040 |

## PACKAGE THERMAL DATA

| Parameter        |         | DIP-8 | Unit |
|------------------|---------|-------|------|
| R <sub>θJC</sub> | Typical | 52    | °C/W |
| R <sub>θJA</sub> | Typical | 100   | °C/W |

## Notes

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