Multiple Stepper-Motors Control with Two-Pins
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Introduction
Cost of microcontroller is a significant cost in the bill of material (BOM) of any system solution board and reducing the cost of microcontroller by decreasing the number of peripherals is an important aspect of the system design. This article presents an application of the TI's next generation stepper motor driver (DRV8847S) for reducing the microcontroller's GPIOs by communicating with the driver over I2C line.

DRV8847 Family
DRV8847 family is a dual full-bridge driver with in-built current regulation and integrated protection features as shown in Figure 1. This device family is designed to operate from 2.7-V to 18-V with current carrying ability upto 1-A (rms) depending upon the package selection. This device family can be used for driving two DC motors, a bipolar stepper motor, or other loads such as relays with different modes as explained in Small Motors in Large Appliances.

DRV8847S Device
The DRV8847S consists of I2C communication which can be used to control the device with detailed diagnostics. This device is capable of controlling the stepper motor (or other loads such as brushed DC motor or solenoids) by controlling the bits of the I2C registers to completely eliminate input GPIO’s. Moreover, DRV8847S gives flexibility in configuration and diagnostics of motor and driver via multiple control and status registers.

The advantages of DRV8847S over DRV8847 are as follows:
• Individual fault diagnostics such as open load, over-current, under-voltage and over-temperature for quick trouble shooting
• Half-bridge open load detection and over-current status for individual half-bridge health check
• Open load on demand feature enables user to detect any OLD scenario during driver operation
• Choice of bridge operation during open load detect
• Programmability of disabling the nFAULT pin for open load detect event
• Option of nFAULT pin disable for all faults
• 100% slow decay mode for reduced ripple current
• Driver programmability for latching during over-current protection
• Choice of higher and slower slew rates for EMI vs performance trade-offs

A brief comparison of DRV8847 (Hardware Device) and DRV8847S (I2C Device) is shown in Table 1.

Table 1. Comparison of DRV8847 and DRV8847S

<table>
<thead>
<tr>
<th>Parameter</th>
<th>DRV8847</th>
<th>DRV8847S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Fault Diagnostics</td>
<td>NO</td>
<td>YES</td>
</tr>
<tr>
<td>Bridge Operation at OLD</td>
<td>Operating</td>
<td>Operating / Hi-Z</td>
</tr>
<tr>
<td>Fault Signaling at OLD</td>
<td>ON</td>
<td>ON / OFF</td>
</tr>
<tr>
<td>OLD on Demand</td>
<td>Not Available</td>
<td>Available</td>
</tr>
<tr>
<td>Bridge Operation in OCP</td>
<td>Retry</td>
<td>Retry / Latch</td>
</tr>
<tr>
<td>Decay Options</td>
<td>25% Fast</td>
<td>25% Fast / 100% Slow</td>
</tr>
<tr>
<td>nFAULT Pin Flag</td>
<td>ON</td>
<td>ON / OFF</td>
</tr>
<tr>
<td>Slew Rate Control</td>
<td>100ns</td>
<td>100ns / 200ns</td>
</tr>
</tbody>
</table>

Multiple Stepper Motor Control using Multi-Slave Operation
Multiple stepper motors can be controlled over a single I2C line by using the multi-slave operation of DRV8847S. Figure 2 shows the connection of microcontroller to multiple DRV8847S devices via a single I2C communication line. The address of each connected device has to be reprogrammed before starting the multi-slave operation.
Following are the steps to reprogram the address of multiple DRV8847S connected for achieving a multi-slave operation.

- The DRV8847S device default address is 0x60 (7-bit address). For achieving a multi-slave operation, this address has to be changed.
- The DRV8847S device releases the I\(^{2}\)C bus as soon as the nFAULT pin is pulled-low externally (from micro-controller). The device has to disable the nFAULT pin before releasing the I2C buses by setting the DISFLT bit in IC2_CON register.
- To re-program the slave address of the device (1), the remaining devices’ nFAULT pin is pulled-low. Similarly the slave address of other connected DRV8847S devices are re-programmed.
- Once all device addresses are reprogrammed, the nFAULT line is enabled again by clearing the DISFLT bit in IC2_CON register.

Figure 3 shows the sequence waveform for programming the address of the multiple DRV8847S device.

**Micro-controller Resources Comparison**

Take an example of a refrigerator main motor control board which can be used to control various motors and solenoid loads. Considering this board is controlling a damper stepper motor, ice-maker high current brushed DC motor and 4-relays for controlling high voltage fans and heaters. In DRV8847 (hardware variant), the stepper motor can be driven in full-step mode which requires at least 2-input pins from the controller (2-pin interface) and high-current brushed DC motor can be controlled by using parallel interface of the DRV8847 which also requires 2-pins for input. Moreover, for controlling the 4-relays, independent half-bridge operation of DRV8847 is required which need atleast 4-input pins. However, in DRV8847S, the number of GPIO pins is significantly reduced by using the multi-slave operation of DRV8847S as shown in Table 2.
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