Multiple Stepper-Motors Control with Two-Pins

Vashist Bist, Analog Motor Drives

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 microcontoller's GPIOs by communicating with the driver over I^2C 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 I^2C 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

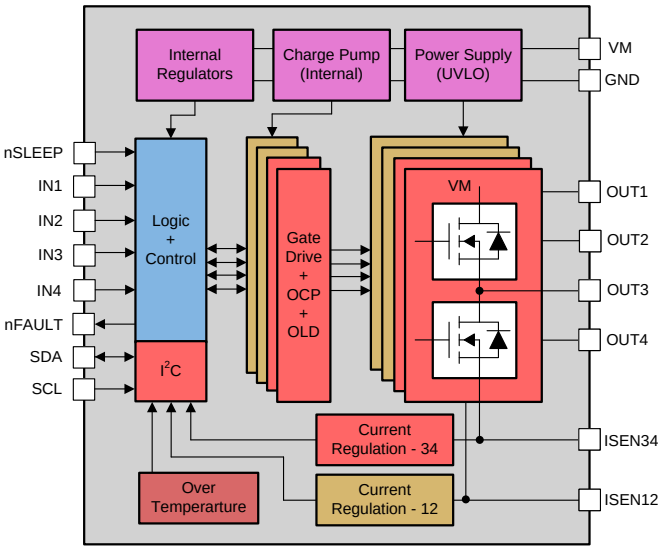

Figure 1. DRV8847S Device

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

Table 1. Comparison of DRV8847 and DRV8847S

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

Multiple Stepper Motor Control using Multi-Slave Operation

Multiple stepper motors can be controlled over a single I^2C line by using the multi-slave operation of DRV8847S. Figure 2 shows the connection of micro-controller to multiple DRV8847S devices via a single I^2C communication line. The address of each connected device has to be reprogrammed before starting the multi-slave operation.

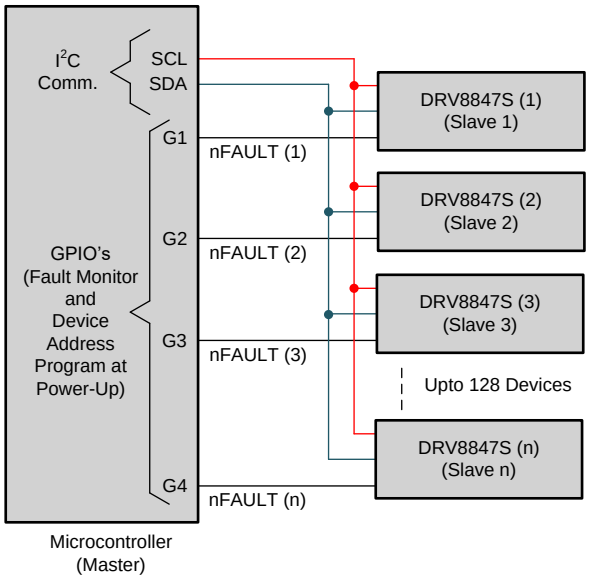

Figure 2. Multi-Slave Operation of DRV8847S

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 I²C 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.

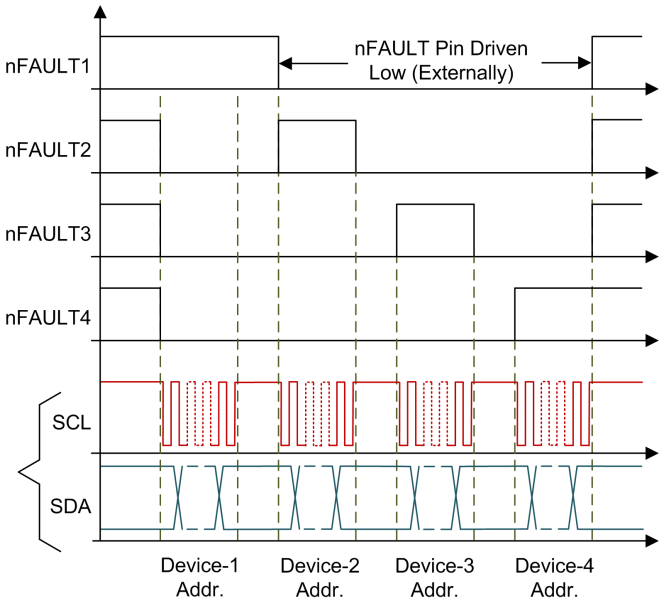

Figure 3. Multi-Slave Operation Waveforms

Table 2. GPIO's Requirement Comparison

Pin Description	DRV8847	DRV8847S
GPIO's for Stepper Motor Control	IN1, IN2, nSLEEP, nFAULT	SDA, SCL, nSLEEP, nFAULT
GPIO's for Brushed DC Motor Control	IN1, IN2, nSLEEP, nFAULT	**SDA, SCL,** nSLEEP, nFAULT
GPIO's for Solenoids	IN1, IN2, IN3, IN4, nSLEEP, nFAULT	**SDA, SCL,**nSLEEP, nFAULT
Total	14 GPIO's	8 GPIO's

Table 3. Alternative Device Recommendations

Device	Optimized Parameters	Performance Trade-Off
DRV8846	Supports 1/32 Microstepping for Stepper Motor Supports Adaptive Current Decay (AutoTune) for Lower Current Ripple	Brushed-DC motors and Solenoid Loads are Not Supported Detailed Diagnostics not Supported

Table 4. Adjacent Tech Notes

SLVA977	Small Motors in Large Appliances
TIDA-00297	Refrigerator Damper and Fan Motor Control Solutions

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265