Dual H-Bridge Motor Driver

Description

The FS8003E is a dual bridge motor driver which has two H-bridge drivers, and can drive two DC brush motors, a bipolar stepper motor, solenoids, or other inductive loads.

It operates from 2.7V to 15V, and can deliver motor current up to 700mA per channel. Each H-bridge includes circuitry to regulate or limit the winding current.

The internal safety features include sinking and sourcing current limits implemented with external sensors, under-voltage lockout, over current protection and thermal shutdown. An output flag is available to indicate thermal shutdown or over current.

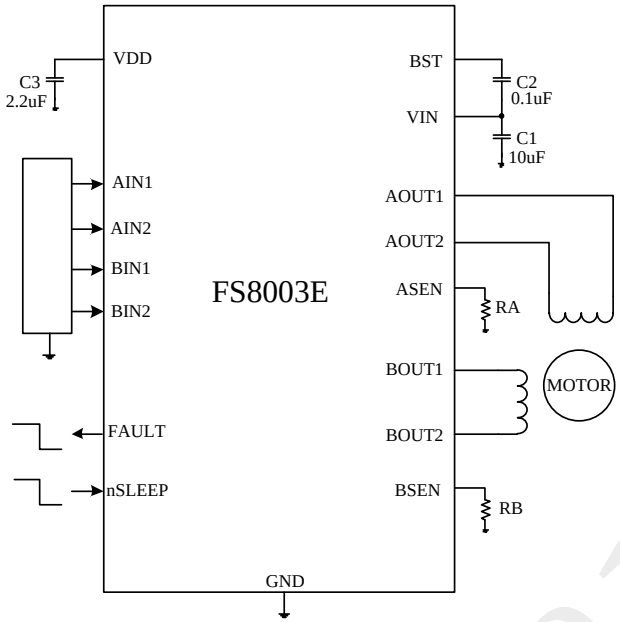
Features

- Wide Input Voltage Range: 2.7V to 15V
- Two Internal Full-bridge Drivers
- Internal Charge Pump for High-side Driver
- Low Quiescent Current: 1.1mA
- Low Sleep Current: 1uA
- Thermal Shutdown
- Under-Voltage Lockout Protection
- Over Current Protection
- Over Temperature Or Over Current Output Flag
- Low MOSFET On Resistance (HS: 500mΩ LS: 450mΩ)
- eTSSOP16L(5mm*4.4mm) Package
- ROHS Compliant and Halogen Free

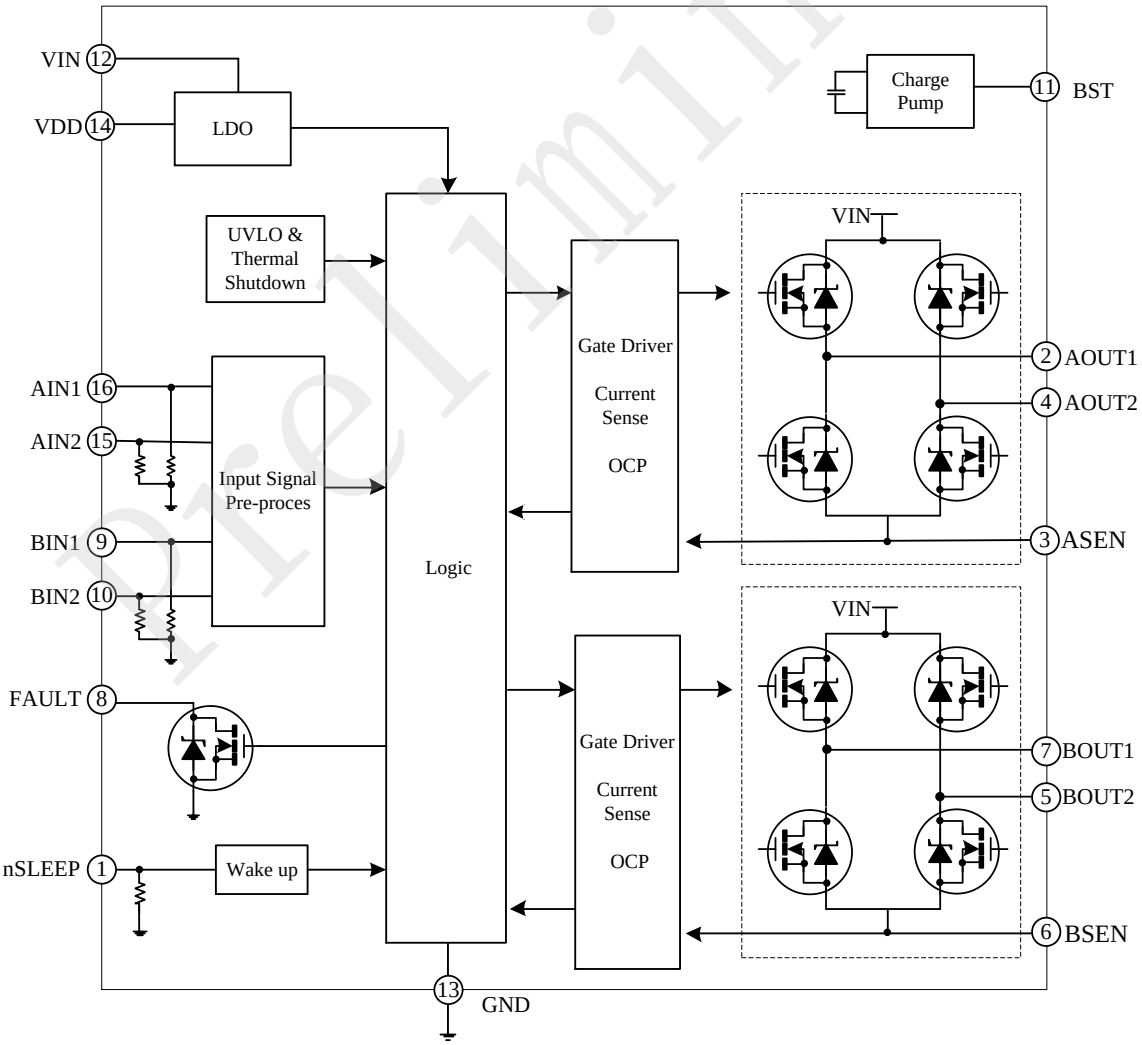
Applications

- Robotics
- POS Printers
- Digital Still Cameras
- Battery Powered Toys
- Video Security Cameras

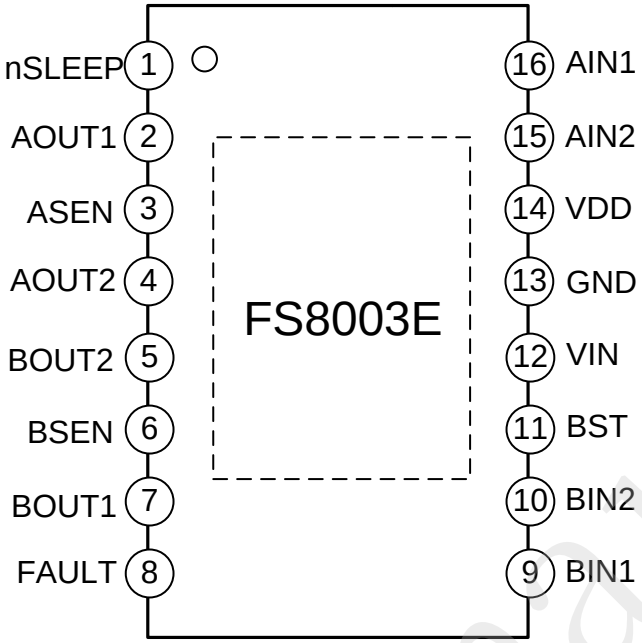
Typical Application Circuit



Functional Block Diagram



Pin Configuration



Pin Description

Pin	Name	Description
1	nSLEEP	Sleep mode input. Logic high to enable device, logic low for sleep mode.
2	AOUT1	Connecting to motor winding A.
3	ASEN	Bridge A current sense. Connect to current sensor resistor for bridge A.
4	AOUT2	Connecting to motor winding A.
5	BOUT2	Connecting to motor winding B.
6	BSEN	Bridge B current sense. Connect to current sensor resistor for bridge B.
7	BOUT1	Connecting to motor winding B.
8	FAULT	Fault output. Logic low when in over temperature or over current fault condition.
9	BIN1	Bridge B input signal to control BOUT1.
10	BIN2	Bridge B input signal to control BOUT2.
11	BST	Charge pump output. Connect a 10nF to 100nF ceramic capacitor to VIN.
12	VIN	Power supply input. Connect a 10uF ceramic bypass capacitor to GND.
13	GND	Device ground. Both the GND pin and device PowerPAD must be connected to GND.
14	VDD	Internal control and logic supply voltage. Connect a 2.2uF capacitor from VDD to GND.
15	AIN2	Bridge A input signal to Control AOUT2.
16	AIN1	Bridge A input signal to Control AOUT1.

Absolute Maximum Ratings

Exceeding the Absolute Maximum ratings may damage to the device.

Symbol	Description	Min	Max	Unit
V_{IN}	Supply voltage	-0.3	18	V
$V_{AOUT1,2}$	$AOUT_{1,2}$ voltage	-0.3	V_{IN}+0.7	V
$V_{BOUT1,2}$	$BOUT_{1,2}$ voltage	-0.3	V_{IN}+0.7	V
V_{BST}	BST voltage	-0.3	V_{IN}+7	V
$V_{SEN1,2}$	Sense voltage	-0.3	0.5	V
V_{FAULT}	FAULT voltage	-0.3	20	V
$V_{INx/nSLEEP}$	Logic input voltage	-0.3	6.5	V
T_J	Maximum operating junction temperature	---	150	°C
T_L	Lead temperature (soldering 30 seconds)	---	260	°C
T_S	Storage temperature range	-40	150	°C
P_D	Power dissipation @TA≤25°C	---	3	W
$R_{th(J-A)}$	Thermal resistance, junction to ambient	---	42	℃/W

Note1: In any case, power dissipation should not exceed P_D.

Note2: Voltages above the absolute maximum ratings may damage the chip.

Note3: Measured on JESD51-7, 4-layer PCB

Recommended Operating Conditions

The device is not guaranteed to operate beyond the Maximum Recommended Operating Conditions.

Symbol	Description	Min	Typ	Max	Units
V_{IN}	Supply voltage	2.7	---	15	V
I_{OUT}	Output current	---	700	---	mA
T_A	Operating Junction temperature	-40	---	125	°C

Static Electrical Characteristics

V_{IN}=5V, T_A=25℃, unless otherwise specified.

Symbol	Description	Min	Typ	Max	Units	Conditions
Power Supply						
V_{IN}	Input supply voltage	2.7	---	15	V	
I_{IN}	Quiescent current	---	1.1	1.6	mA	nSLEEP=1, I_{OUT}=0
I_{INQ}		---	---	1	uA	nSLEEP=0
Integrated MOSFETs						
V_F	Body diode forward voltage	---	0.95	1.4	V	I_{OUT}=500mA
R_{HS}	Output on resistance	---	500	---	mΩ	I_{OUT}=500mA
R_{LS}		---	450	---	mΩ	I_{OUT}=500mA
Control Logic						
V_{ON}	UVLO rising edge threshold	---	2.3	2.7	V	
V_{HYS}	UVLO hysteresis	---	90	---	mV	
V_{IH}	Input logic high voltage	2	---	---	V	xINx, nSLEEP
V_{IL}	Input logic high voltage	---	---	0.6	V	xINx, nSLEEP
R_{PD}	Input pulldown resistance	---	110	---	kΩ	xINx
		---	200	---	kΩ	nSLEEP
FAULT Output						
V_{OL}	Fault output low level voltage	---	---	120	mV	I_O=1mA
I_{LEAK}	Fault output leakage current	---	---	1	uA	V_{FAULT}=20V
Motor Driver						
t_{ON}	Turn on propagation delay time	50	120	200	ns	
t_{OFF}	Turn off propagation delay time	300	450	600	ns	
t_R	Rise time	---	20	---	ns	100Ω to GND
t_F	Fall time	---	20	---	ns	100Ω to VIN
t_{DT}	Deadtime, HS off to LS on or LS off to HS on for one bridge arm	250	380	550	ns	
t_{WAKE}	Sleep mode wakeup time	---	1	1.5	ms	
Protection Circuitry						
V_{TRIP}	Current limit sense trip voltage	---	165	---	mV	
t_{BLANK}	Minimum on time in current control	2.5	3.2	4.0	us	
t_{OFF}	Current control constant off time	---	29	---	us	
I_{OCP}	Over current protection trip level	---	1.5	---	A	
t_{DEG}	OCP deglitch time	---	3.2	---	us	
t_{OCP}	Over current protection period	---	1.6	---	ms	
T_{TSD}	Thermal shutdown temperature	---	170	---	℃	
T_{TSDH}	Thermal shutdown hysteresis	---	35	---	℃	

Note: All voltages are specified with respect to the corresponding GND

Operation Description

The FS8003E is an integrated motor driver using for brushed DC or bipolar stepper motors. The device integrates two NMOS H-bridges and current regulation circuitry. It can be powered with a supply voltage from 2.7V to 15V and can provide an output current up to 700mA.

The motor output current can be either controlled by an external pulse width modular or internal PWM current controller. The current regulation is a fixed off time PWM slow decay.

The FS8003E provides a low-power sleep mode that enables the system to save power when not driving the motor. It also includes under-voltage lockout, temperature shutdown and over current protection.

External PWM Control

The motor current can be regulated by applying external PWM signals on the input pins. The AIN1 and AIN2 input pins control the state of the AOUT1 and AOUT2; similarly, the BIN1 and BIN2 input pins control the state of the BOUT1 and BOUT2. Table 1 shows the logic.

Table 1 H-bridge logic

A/BIN1	A/BIN2	A/BOUT1	A/BOUT2
L	L	High impedance	High impedance
L	H	GND	VIN
H	L	VIN	GND
H	H	GND	GND

Internal PWM current control

An internal constant off time PWM current circuit will regulate the motor current as the following: when an H-bridge is enabled, the current increases in the motor winding, which is sensed by an external sense resistor. During the initial blanking time, the high-side MOSFET always turns on in spite of current limit detection. The blanking time also sets the minimum on time of the PWM when operating in current chopping mode.

After the blanking time, if the voltage across R_{SEN} reaches the internal reference voltage threshold $V_{TRIP,}$ the bridge disables the current by shutting off the high-side MOSFET. Then the H-bridge switches to slow decay mode. In the slow decay mode, the current freewheels through one low-side MOSFET and the body diode of the other low-side MOSFET to short the winding.

The slow decay mode is held until the internal clock reaches its' constant off time. After the time, the high-side MOSFET is enabled to increase the wheel current again. The cycle then repeats.

Calculate the current limit as: $I_{LIMIT}=V_{TRIP}/R_{SEN}$

If current mode is not needed, the SEN pins should be connected directly to ground.

Sleep mode

Driving nSLEEP low will put the device into a low-power sleep state. In this state, the two H-bridges are disabled, the charge pump is stopped, all internal logic is reset, and all internal clocks are stopped. When returning from sleep mode, a wakeup time is needed before the motor driver becomes fully operational.

Over current protection

A current monitor circuit on each MOSFET limits the current through the MOSFETs by limiting the gate drive. If the current limit persists for longer than the OCP deglitch time, all MOSFETs in the H-bridge will be disabled and the FAULT pin will be driven low. The driver will be re-enabled after the OCP retry period，and FAULT becomes high again at the same time. If the fault condition is still present, the cycle repeats. Only the H-bridge in which the OCP is detected will be disabled while the other H-bridge will work normally.

Over current conditions are detected independently on both high-side and low-side devices, so a short to ground, supply or output short will all result in an over current shutdown.

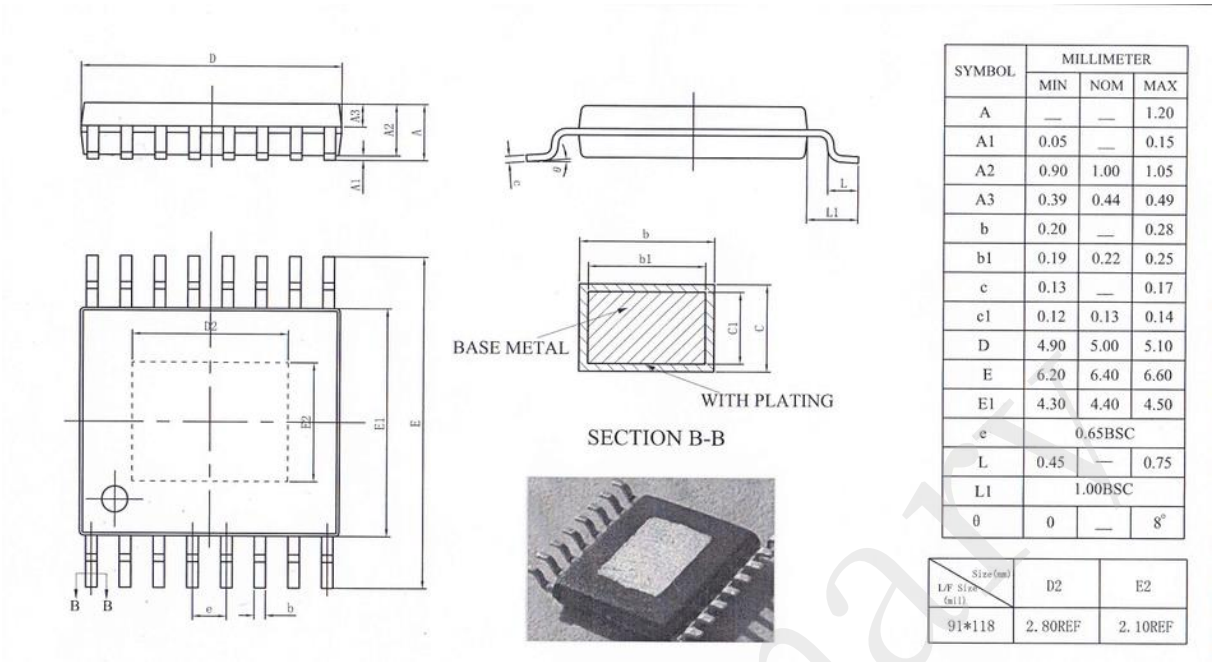
Thermal shutdown

If the junction temperature exceeds the threshold voltage, all MOSFETs in the two H-bridge will be shut down and the FUALT pin will be driven low. Once the temperature has fallen to a safe level, operation will automatically resume.

Under-voltage lockout

If the supply voltage falls below the UVLO falling threshold voltage, the die shuts down. Operation will resume when the supply voltage rises above the UVLO rising threshold voltage.

Package size（eTSSOP16L-5*4.4)



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	—	—	1.20
A1	0.05	—	0.15
A2	0.90	1.00	1.05
A3	0.39	0.44	0.49
b	0.20	—	0.28
b1	0.19	0.22	0.25
c	0.13	—	0.17
c1	0.12	0.13	0.14
D	4.90	5.00	5.10
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	0.65BSC		
L	0.45	—	0.75
L1	1.00BSC		
θ	0	—	8°

Size(mm) / L/F Size (mil)	D2	E2
91*118	2.80REF	2.10REF

Part Number	Package Type	Marking ID	Package Method	Quantity
FS8003E	eTSSOP16-5*4.4	FS8003E	Tape&Reel	3000

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