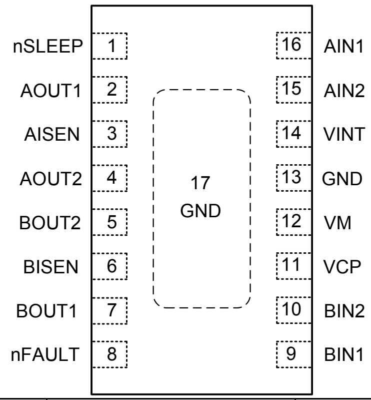
Application Note: SY6703

Low Voltage H-Bridge IC
Preliminary Specification

Pinout (top view)



Part Number	Package type	Top Mark①
SY6703HFC	TSSOP-16E	**AZR*xyz***

Note①： x=year code, y=week code, z= lot number code.

Name	Number	Description
nSLEEP	1	Sleep mode pin. Logic low puts device in low-power sleep mode, this pin has a internal pull-down resistor
AOUT1	2	Bridge A output 1 pin. Connect this pin to motor winding.
AISEN	3	Bridge A current sense pin. Connect a resistor between this pin and GND for current control, or connect to GND is current control is not needed.
AOUT2	4	Bridge A output 2 pin. Connect this pin to motor winding.
BOUT2	5	Bridge B output 2 pin. Connect this pin to motor winding.
BISEN	6	Bridge B current sense pin. Connect a resistor between this pin and GND for current control, or connect to GND is current control is not needed
BOUT1	7	Bridge B output 1 pin. Connect this pin to motor winding.
nFAULT	8	Fault state output pin. Logic low if fault is detected.
BIN1	9	Bridge B input 1 pin. Control the state of bridge B, this pin has a internal pull-down resistor.
BIN2	10	Bridge B input 2 pin. Control the state of bridge B, this pin has a internal pull-down resistor
VCP	11	Internal charge pump voltage for high side gate driver. Connect a ceramic capacitor to VM.
VM	12	Motor power supply pin. Decouple this pin to GND pin with 0.1uF ceramic cap.
GND	13	Device ground pin.
VINT	14	Internal logic and driver supply. Connect this pin with a ceramic capacitor to GND.
AIN2	15	Bridge A input 2 pin. Control the state of bridge A, this pin has a internal pull-down resistor.
AIN1	16	Bridge A input 1 pin. Control the state of bridge A, this pin has a internal pull-down resistor.
GND	17	Ground pin for thermal dissipation.

Electrical Characteristics

(T_A = 25°C, VM=5V, unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Power Supplies						
VM Operating Supply Current	I_{VM}	VM=5V, xIN=0V, xIN2=0V		1	2	mA
VM Sleep Mode Current	I_{VMS}	nSLEEP=0V, VM=5V		1.8	2.5	µA
VM Undervoltage Lockout Voltage	V_{UVLO_RISE}	VM Rising		2.2		V
	V_{UVLO_FALL}	VM Falling		2.1		V
Logic Level Input						
Input Low Voltage	V_{IL}	nSLEEP			0.5	V
		All other pins			0.7	
Input High Voltage	V_{IH}	nSLEEP	2.5			V
		All other pins	2			
Input Hysteresis	V_{IHYS}			0.4		V
Input Low Current	I_{IL}	V_{IN}=0V			1	µA
Input High Current	I_{IH}	V_{IN}=3.3V, nSLEEP		6.6	13	µA
		V_{IN}=3.3V, all except nSLEEP		16.5	33	
Pulldown Resistance	R_{PD}	nSLEEP		600		kΩ
		All other pins		150		
Input Deglitch Time	t_{DEG}			450		ns
nFAULT Output (Open-Drain Output)						
Output Low Voltage	V_{OL}	I_O=5mA			0.5	V
Output High Leakage Current	I_{OH}	V_O=3.3V			1	µA
H-Bridge MOSFETs						
High Side MOSFETs On Resistance	R_{dson}	V_M=5V, I_O=500mA, T_J=25℃		310		mΩ
		V_M=5V, I_O=500mA, T_J=85℃			400	
		V_M=2.7V, I_O=500mA, T_J=25℃		330		
		V_M=2.7V, I_O=500mA, T_J=85℃			410	
Low Side MOSFETs On Resistance		V_M=5V, I_O=500mA, T_J=25℃		260		
		V_M=5V, I_O=500mA, T_J=85℃			310	
		V_M=2.7V, I_O=500mA, T_J=25℃		270		
		V_M=2.7V, I_O=500mA, T_J=85℃			330	
Off-State Leakage Current	I_{OFF}	V_M=5V, VOUT=0V, TJ=25℃			±1	µA
Motor Driver						
Current Control PWM Frequency	f_{PWM}	Internal PWM Frequency		50		kHz
Rise Time	t_R	V_M=5V,16Ω to GND, 10% to 90% V_M		50		ns
Fall Time	t_F			50		ns
Propagation Delay INx to OUTx	t_{PROP}	V_M=5V		1.1		µs
Dead Time	t_{DEAD}	V_M=5V		50		ns
Protection						
Output Over Current Limit	I_{OCP}		2	2.5		A
Over Current Retry Time	t_{OCPR}			1.2		ms
OCP Deglitch Time	t_{DEG}			180		ns
Thermal Shutdown Temperature	T_{SD}		150	160	180	℃
Thermal Shutdown hysteresis	T_{HYS}			20		℃
Current Control						
xISEN Trip Voltage	V_{TRIP}		160	200	240	mV
Current Sense Blanking Time	t_{BLANK}			3.75		µs
Sleep Mode						
Startup Time	t_{WAKE}	nSLEEP Inactive high to H-bridge On			1	ms

Note 1: Stresses beyond the "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Note 2: θ_{JA} is measured in the natural convection at TA = 25°C on a low effective single layer thermal conductivity test board of JEDEC 51-3 thermal measurement standard.

Note 3: Power dissipation and thermal limits must be observed.

Functional Description

PWM Motor Drivers

SY6703 contains two identical H-bridge motor drivers with current-control PWM circuitry. A block diagram of the circuitry is shown below:

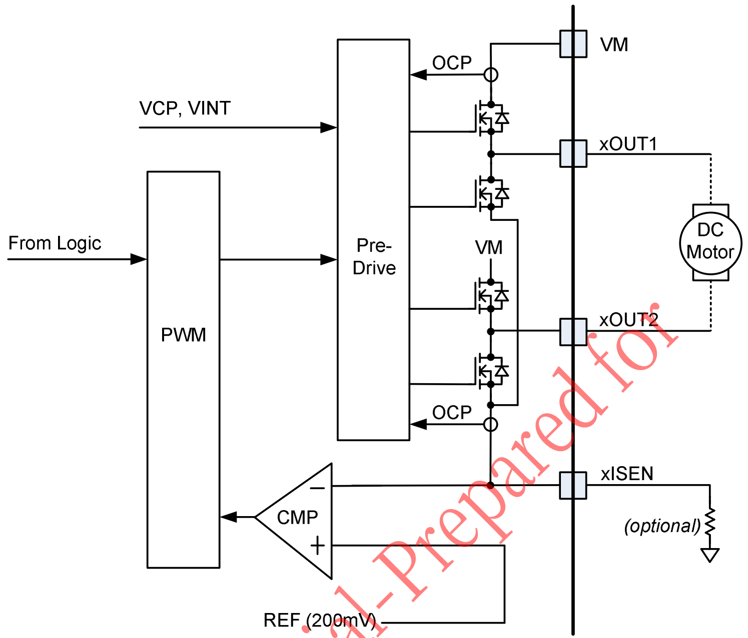


Figure3. Motor Control Circuitry

H-Bridge Driving Control

The Bridge is controlled by a PWM input interface, also called IN/IN interface. The following table shows the control logic of the device:

Table 1 H-Bridge Logic

xIN1	xIN2	xOUT1	xOUT2	Function
0	0	Z	Z	Coast/Fast Decay
0	1	L	H	Reverse
1	0	H	L	Forward
1	1	L	L	Brake/Slow Decay

The inputs can also be used for PWM control of the motor speed. When controlling a winding with PWM, when the drive current is interrupted, the inductive nature of the motor requires that the current must continue to flow. This is called recirculation current. To handle this recirculation current, the H-bridge can operate in two different states, fast decay or slow decay. In fast decay mode, the H-bridge is disabled and recirculation current flows through the body diodes; in slow decay, the motor winding is shorted.

To PWM using fast decay, the PWM signal is applied to one xIN pin while the other is held low; to use slow decay, one xIN pin is held high.

Table 2 PWM Control of Motor Speed

xIN1	xIN2	Function
PWM	0	Forward PWM, Fast Decay
1	PWM	Forward PWM, Slow Decay
0	PWM	Reverse PWM, Fast Decay
PWM	1	Reverse PWM, Slow Decay

Figure 4 shows the current paths in different drive and decay modes.

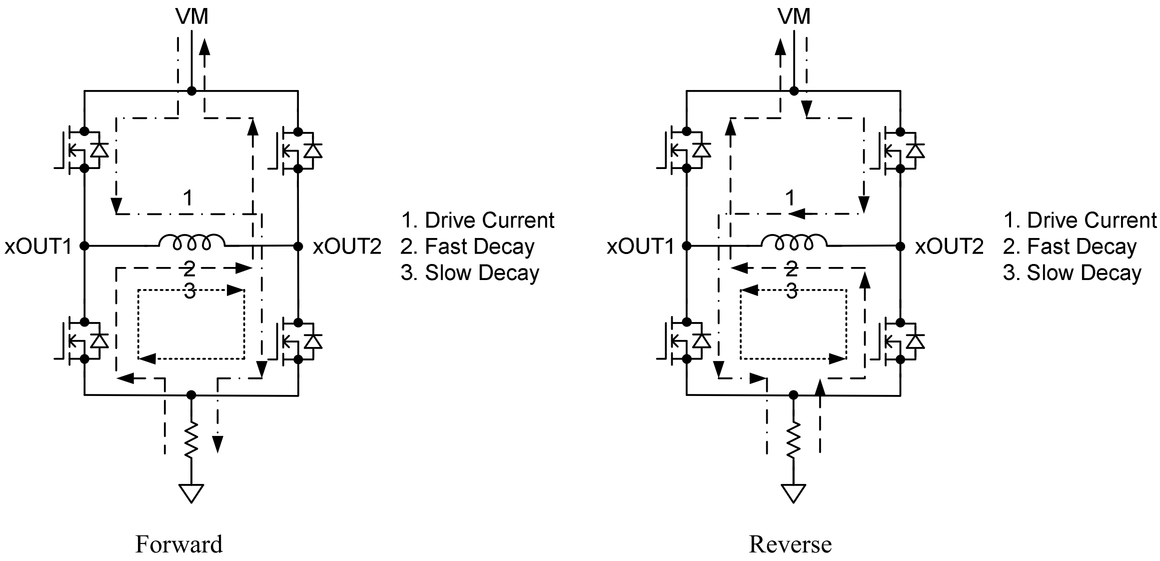


Figure4. Decay Mode

Current Control

The current through the motor windings may be limited, or controlled, by a fixed-frequency PWM current regulation, or current chopping. For DC motors, current control is used to limit the start-up and stall current of the motor. For stepper motors, current control is often used at all times.

When an H-bridge is enabled, current rises through the winding at a rate dependent on the DC voltage and inductance of the winding. If the current reaches the current chopping threshold, the bridge disables the current until the beginning of the next PWM cycle. Note that immediately after the current is enabled, the voltage on the xISEN pin is ignored for a fixed period of time before en

If a 1-Ω sense resistor is used, the chopping current will be 200 mV/1 Ω = 200 mA.

Once the chopping current threshold is reached, the H-bridge switches to slow decay mode. Winding current is re-circulated by enabling both of the low-side FETs in the bridge. This state is held until the beginning of the next fixed-frequency PWM cycle.

Note that if current control is not needed, the xISEN 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 H-bridges are disabled, the gate drive charge pump is stopped, all internal logic is reset, and all internal clocks are stopped. All inputs are ignored until nSLEEP returns inactive high. When returning from sleep mode, some time (up to 1 ms) needs to pass before the motor driver becomes fully operational. To make the board design simple, the nSLEEP can be pulled up to the supply (VM). It is recommended to use a pullup resistor when this is done. This resistor limits the current to the input in case VM is higher than 6.5 V. Internally, the nSLEEP pin has a 500-kΩ resistor to GND. It also has a clamping zener diode that clamps the voltage at the pin at 6.5 V. Currents greater than 250 µA can cause damage to the input structure. Hence the recommended pullup resistor would be between 20 kΩ and 75 kΩ.

Protection Circuits

The device is fully protected against undervoltage, overcurrent, and overtemperature.

Overcurrent Protection (OCP)

An analog current limit circuit on each FET limits the current through the FET by limiting the gate drive. If this analog current limit persists for longer than the OCP deglitch time, all FETs in the H-bridge will be disabled and the nFAULT pin will be driven low. The driver will be re-enabled after the OCP retry period (t_{OCP}) has passed. nFAULT becomes high again at this time. If the fault condition is still present, the cycle repeats. If the fault is no longer present, normal operation resumes and nFAULT remains deasserted. Please note that only the H-bridge in which the OCP is detected will be disabled while the other bridge will function normally.

Overcurrent conditions are detected independently on both high and low side devices; i.e., a short to ground, supply, or across the motor winding will all result in an overcurrent shutdown. Note that overcurrent protection does not use the current sense circuitry used for PWM current control, so functions even without presence of the xISEN resistors.

Thermal Shutdown (TSD)

If the die temperature exceeds safe limits, all MOSFETs in the H-bridge are disabled. Once the die temperature has fallen to a safe level, operation automatically resumes.

Undervoltage Lockout(UVLO)

If at any time the voltage on the VM pin falls below the undervoltage lockout threshold voltage, all circuitry in the device will be disabled, and all internal logic will be reset. Operation will resume when VM rises above the UVLO threshold. nFAULT is driven low in the event of an undervoltage condition.

THERMAL INFORMATION

Thermal Protection

The device has thermal shutdown (TSD) as described in the Protection Circuits section. If the die temperature exceeds approximately 160°C, the device is disabled until the temperature drops to a safe level.

Any tendency of the device to enter thermal shutdown is an indication of either excessive power dissipation, insufficient heatsinking, or too high an ambient temperature.

Maximum Output Current

In actual operation, the maximum output current achievable with a motor driver is a function of die temperature. This in turn is greatly affected by ambient temperature and PCB design. Basically, the maximum motor current will be the amount of current that results in a power dissipation level that, along with the thermal resistance of the package and PCB, keeps the die at a low enough temperature to stay out of thermal shutdown.

The dissipation ratings given in the datasheet can be used as a guide to calculate the approximate maximum power dissipation that can be expected to be possible without entering thermal shutdown for several different PCB constructions. However, for accurate data, the actual PCB design must be analyzed via measurement or thermal simulation.

Power Dissipation

Power dissipation in the device is dominated by the power dissipated in the output MOSFET resistance, or R_{DSON}. A H-bridge Average power dissipation can be roughly estimated by:

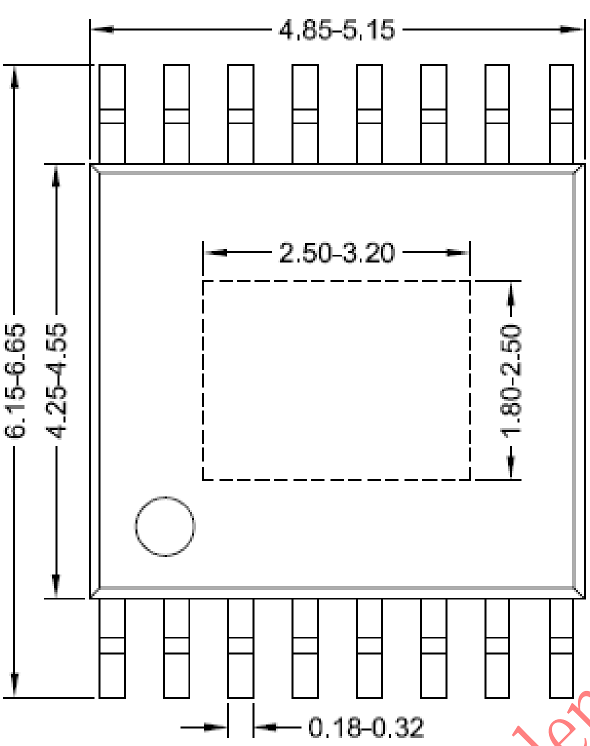
$$P_{TOT} = R_{DSON} \times I_{OUT(RMS)}{}^{2} \quad (2)$$

where P_{TOT} is the total power dissipation, R_{DSON} is the resistance of the HS plus LS MOSFETs, and $I_{OUT(RMS)}$ is the RMS or DC output current being supplied to the load.

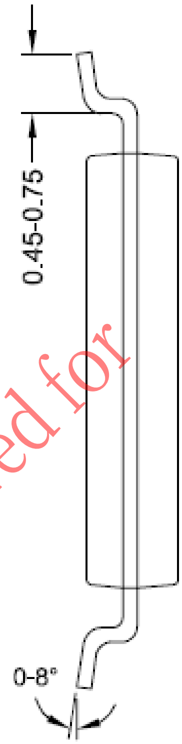
The maximum amount of power that can be dissipated in the device is dependent on ambient temperature and heatsinking.

Note that R_{DSON} increases with temperature, so as the device heats, the power dissipation increases.

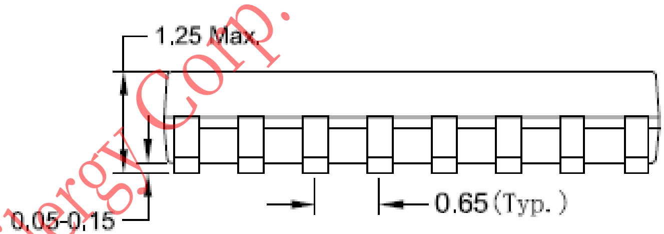
TSSOP16E Package Outline Drawing



Top view



Side view A



Side view B

Notes: **All dimension in MM and exclude mold flash & metal burr.**