

0.5A Fully Protected Dual H-Bridge Driver

Description

The CS-3710 is a smart dual 0.5A H-bridge driver used in microprocessor controlled stepper motor systems. The CS-3710 provides bidirectional current using two independent 0.5A H-bridge drivers. On chip commutation diodes protect the output drivers by suppressing flyback voltage transients generated by inductive loads. The system microprocessor can control stepper motor direction and drive using the CS-3710's two independent pairs of direction (DIR1, DIR2) and ENABLE (ENABLE1, ENABLE2) logic control functions.

Each output stage consists of four NPN power transistors arranged in an H-bridge configuration. The geometry of each power transistor is designed for a very low total V_{sat} (2.5V (typ) @ $I_{OUT} = 500mA$).

The output stage is fully protected. Overvoltage protection prevents the output stage and its attendant circuitry

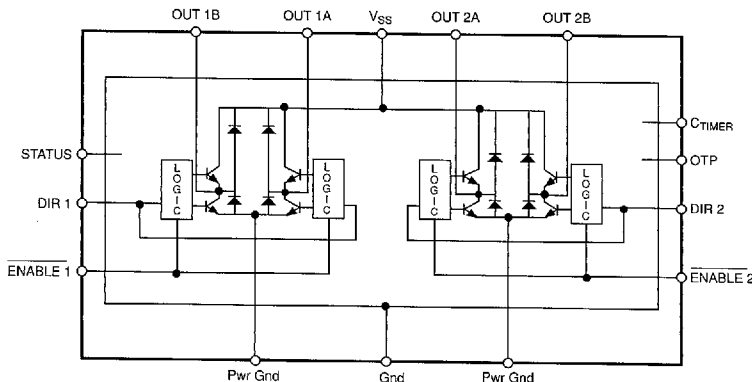
from by shutting the outputs down whenever the supply voltage (V_{SS}) extends 19.5V (typ). Short circuit protection shuts off the output current at 0.85A (typ) regardless of the load impedance. Thermal shutdown is initiated whenever the output transistor junction temperature extends 165°C (typ). The open collector STATUS output goes low while the H-bridge outputs are turned off by these protection circuits.

The microprocessor compatible logic control functions ENABLE and DIR control current flow through the H-bridge output stage. ENABLE is used to switch the output stage on and off. DIR controls which pairs of power transistors in the H-bridge are active at any one time. If the output load is a stepper motor, DIR is used to control the direction of motion of the stepper motor.

Features

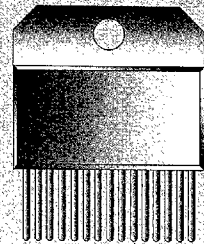
- 2 Independent 0.5A H-bridge Drivers
- On-Chip Commutation Diodes
- Logic Control Functions ENABLE DIRECTION
- Low V_{sat} (2.5V @ $I_{OUT} = 500mA$, typ)
- Full Output Protection Overvoltage Short Circuit Thermal Shutdown

Block Diagram



Package Options

15 Lead Power SIP



- | | |
|-----------|------------|
| 1 C_TIMER | 9 OUT2A |
| 2 Gnd | 10 OUT2B |
| 3 ENABLE1 | 11 Pwr Gnd |
| 4 DIR1 | 12 DIR2 |
| 5 Pwr Gnd | 13 ENABLE2 |
| 6 OUT1B | 14 OTP |
| 7 OUT1A | 15 STATUS |
| 8 VSS | |

Absolute Maximum Ratings

Supply Voltage Operating Range (V_{SS})	-0.5V to 30V
Overvoltage Protection	.60V
DIRECTION and ENABLE Voltage Range	-0.3V to 7V
Peak Output Current (each channel) (I_{OUT})	
Nonrepetitive ($t=20\mu s$)	2.00A
Repetitive ($T_{ON}=10ms$; 80% duty cycle)	0.75A
Constant on	0.50A
Total Power Dissipation ($T_{case}=75^{\circ}C$)	10W
Electrostatic Discharge (Human Body Model)	4kV
Operating Temperature Range	-40°C to 105°C
Junction Temperature Range	-40°C to 150°C
Storage Temperature Range	-40°C to 150°C
Lead Temperature Soldering Wave Solder(through hole styles only)	10 sec. max, 260°C peak

Electrical Characteristics: $6V < V_{CC} <= 16V$; $-40^{\circ}C <= T_A <= +105^{\circ}C$ unless otherwise specified.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
■ General Characteristics					
Supply Voltage (V_{CC})	$V_{ENABLE1,2} >= 2.0V$	6		16	V
Quiescent Current (I_{CC})	$V_{ENABLE1,2} >= 2.0V$		7	15	mA
	$V_{ENABLE1,2} <= 0.8V$		40	80	mA
Clamp Diode Forward Voltage	$I_{Diode} = 200mA$		1.2	2.0	V
	$I_{Diode} = 500mA$		1.5	2.4	V
Output Stage: OUT1A,B; OUT2A,B					
Total V_{sat}	$V_{ENABLE}, 0.8V; I_{load} = 200mA$		1.65	2.0	V
	$I_{load} = 500mA$		2.50	3.0	V
Load Current					
Turnoff delay			3	6	μs
Turnon delay			3	10	μs
Output Leakage Current	$V_{ENABLE} >= 2.0V$			10	μA
Crossover Current	$V_{DIRECTION}$ HIGH to LOW			100	mA
	LOW to HIGH			100	mA

■ LOGIC Functions: ENABLE, DIRECTION, STATUS

ENABLE Input Voltage					
LOW State		-0.3		0.8	V
HIGH State		2.0		7.0	V
ENABLE Input Current					
LOW State	$-0.3V, V_{ENABLE} <= 0.8V$		-15	-100	μA
HIGH State	$2.0V, V_{ENABLE} <= 7.0V$	-10		10	μA
DIRECTION Input Voltage					
LOW State			-0.3	0.8	V
HIGH State			2.0	7.0	V
DIRECTION Input Current					
LOW State	$-0.3V, V_{DIRECTION} <= 0.8$		-15	-100	μA
HIGH State	$2.0V <= V_{DIRECTION} <= 7.0V$	-10		10	μA
STATUS Voltage					
LOW State	$R_{STATUS} = 1.2k\Omega$ to 5V Supply	4.990	4.999		V
HIGH State	$I_{STATUS} = 4mA$			0.400	V

2067556 0003588 090

Electrical Characteristics: continued

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
■ Protection Circuitry: Over Voltage, Short Circuit, Thermal Shutdown.					
Over Voltage Shutdown		17.25	19.50	21.00	V
Over Voltage Shutdown Hysteresis		0.25		0.60	V
Short Circuit Trip Point		0.525	0.85	1.250	A
Short Circuit Current Delay	$C_{\text{TIMER}} = 360\text{pF}$	15	25	33	μs
Short Circuit Current Duty Cycle	$\frac{I_{\text{OUT}} I_{\text{Short Circuit}}}{I_{\text{OUT OFF}}}$	3.0	4.75	6.0	%
Thermal Shutdown		150	165	190	$^{\circ}\text{C}$

Package Pin Description

PACKAGE PIN #	PIN SYMBOL	FUNCTION
15 Lead Power SIP		
1	C_{TIMER}	C_{TIMER} sets the time delay to shut off both H-bridges after onset of overcurrent condition.
2	Gnd	Analog ground.
3	ENABLE1	Microprocessor compatible input signal which controls OUT1. When ENABLE1 is LOW, OUT1 is active.
4	DIR 1	Microprocessor compatible input signal which controls which pair of power transistors are activated when OUT1 is active.
5	Pwr Gnd	Power ground for OUT1.
6	OUT1A	One of two output pins for drive current from OUT1.
7	OUT1B	One of two output pins for drive current from OUT1.
8	V_{SS}	Supply voltage; usually connected directly to the battery.
9	OUT2A	One of two output pins for drive current from OUT2.
10	OUT2B	One of two output pins for drive current from OUT2.
11	Pwr Gnd	Power ground for OUT2.
12	DIR 2	Microprocessor compatible input signal which controls which pair of power transistors are activated when OUT2 is active.
13	ENABLE2	Microprocessor compatible input signal which controls OUT2. When ENABLE2 is LOW, OUT2 is active.
14	OTP	Test pin for thermal shutdown; normally left unconnected
15	STATUS	Microprocessor compatible open collector output that goes low during a fault condition.

Truth Table

ENABLE	DIRECTION	OUTA	OUTB
LOW	LOW	LOW	HIGH
LOW	HIGH	HIGH	LOW
HIGH	X	HI Z	HI Z

Truth Table

STATUS	CONDITIONS
HIGH	Normal Operation
LOW	High Voltage Shutdown
LOW	Thermal Shutdown
LOW	Over Current Shutdown

Output Stage

Two identical half-H-bridges make up the output stage. Each half-H bridge is composed of a totem pole of 2 NPN power transistors that supply 500mA (typ) at a total V_{sat} of 2.5V (typ).

Current flow through the drive transistors is controlled by the DIRECTION input signal.

The output power transistors can be disabled in two ways: 1) by using the TTL compatible ENABLE input, and 2) by the on chip protection circuitry during a fault condition.

The four output pins are protected by on chip flyback diodes. They protect against negative transients between output and ground and between battery and output.

Protection Circuitry

Thermal Shutdown

Thermal shutdown disables the output drive transistors and forces the STATUS signal low when the die's temperature exceeds 165°C (typ). Built in hysteresis prevents oscillations and requires that the cools down 15°C (typ) before the outputs are re-enabled.

The OTP Test pin can be used to disable thermal shutdown, by placing a 2kΩ resistor between OTP and Gnd.

The driver outputs can be controlled through this pin. Forcing a voltage in excess of 1.75V on the pin, disables the output drivers.

Overvoltage shutdown

Two types of overvoltage shutdown protection are present in this circuit: a "slow" and a "fast" shutdown function.

The "slow" shutdown function prevents IC damage in cases where double battery conditions occur. When the voltage on V_{cc} exceeds 19.3V (typ) the output drivers are disabled and the STATUS output signal goes low. Built in hysteresis prevents oscillations. The "fast" shutdown function prevents IC damage in cases where a high voltage transient (> 22.5V, typ) occurs. The output stage is shutdown more quickly.

Logic control Signals

Status

The status section of the IC generates a logic output that reflects the operating status of the IC. When a fault condition occurs: e.g. overvoltage, short circuit, over temperature, the output voltage on the STATUS pin goes low. No effort is made to indicate the nature of the fault, only that a fault condition exists.

Table 1. STATUS States

STATUS	Condition
High	Normal Operation
Low	Overvoltage Shutdown
Low	Thermal Shutdown
Low	Short Circuit

ENABLE and DIRECTION Inputs

The two H-bridge outputs are independently controlled by separate ENABLE and direction input signals. The ENABLE input signal is TTL compatible. When the ENABLE signal is low (<0.8V) the output drivers are on. When the input exceeds 2V, the output drivers are off. Hysteresis in the ENABLE function gives improved noise immunity.

The logic state of the DIRECTION input determines the direction of current flow in the output load. When the input on DIR 1 is high, output current flows from OUT1B to OUT1A. When input on DIR 1 is low, output current flows from OUT1A to OUT1B.

A deadband in the H-bridge configuration insures that both halves of the bridge will not be active simultaneously.

Short Circuit Protection

When an overcurrent condition exists, the protection circuitry disables the output drivers and forces the STATUS signal low, indicating a fault condition. The delay time between detection of the fault and output disable is set by the charge time on C_{TIMER} :

$$t_{delay} = 3V \times C_{TIMER} / 56\mu A.$$

The off time for the H-bridge is determined by the discharge rate of the same capacitor, C_{TIMER} . During a continuous over current condition the STATUS signal and the output drivers have a 4.0% duty cycle (typ): i.e. the drivers are off 96% of the cycle. If the over current condition persists when the outputs are re-enabled, they are disabled again and the cycle repeats itself.

Table 2. ENABLE and DIRECTION States

ENABLE	DIRECTION	OUTxA	OUTxB
Low	Low	Low	High
Low	High	High	Low
High	X	High Z	High Z

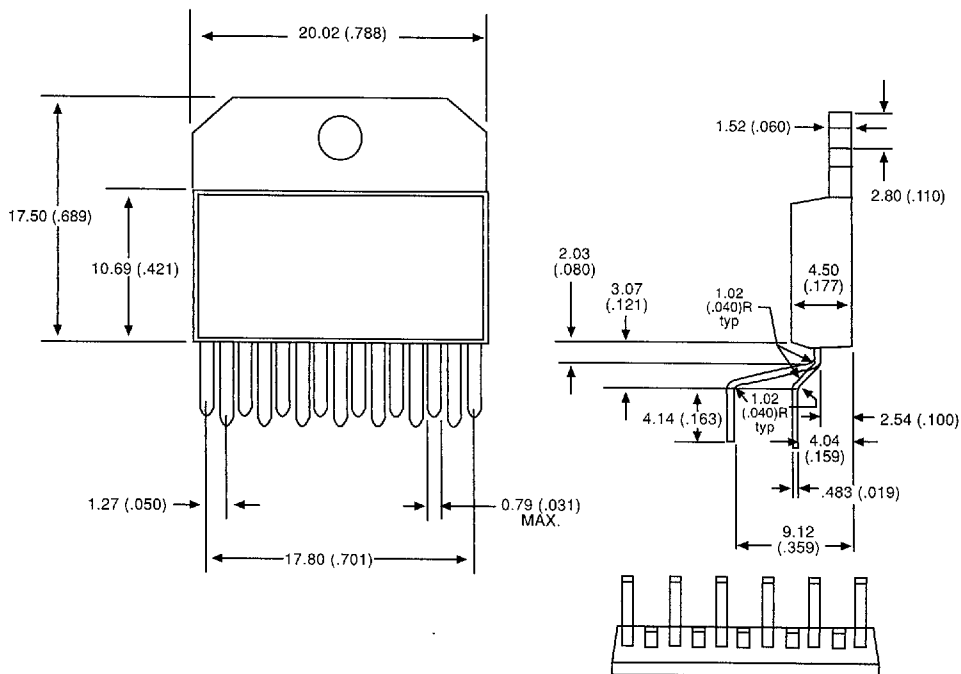
Package Specification

PACKAGE DIMENSIONS IN mm (INCHES)

PACKAGE THERMAL DATA

Thermal Data		15 Lead Power SIP	
$R_{\theta JC}$	typ	3	$^{\circ}\text{C/W}$
$R_{\theta JA}$	typ	35	$^{\circ}\text{C/W}$

15 Lead Power SIP (straight)



Ordering Information

Part Number	Description
CS-3710M15	Power SIP Straight