CS-3717A

1A H-bridge Stepper Motor Driver

Description

The CS-3717A controls and drives one phase of a bipolar stepper motor with chopper control of the phase current. Current levels may be selected in three steps by means of two logic inputs which select one of three current comparators. When both of these inputs are high the device is disabled. A separate logic input controls the direction of current flow. A monostable, programmed by an external RC network, sets the current decay time.

The power section is a full H-bridge driver with four internal clamp diodes for current recirculation. An external connection to the lower emitters is available for the insertion of a sensing resistor. Two CS-3717A's and several external components form a complete stepper motor drive subsystem.

The recommended operating ambient temperature range is from 0 to 70°C.

The CS-3717A is supplied in a 16 lead PDIP.

Features

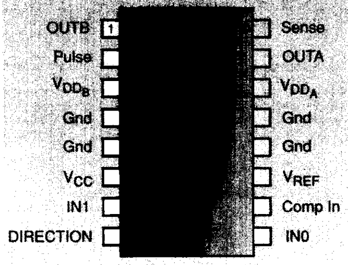
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- [illegible]
- Thermal Overload Protection
- Minimum External Components

Absolute Maximum Ratings

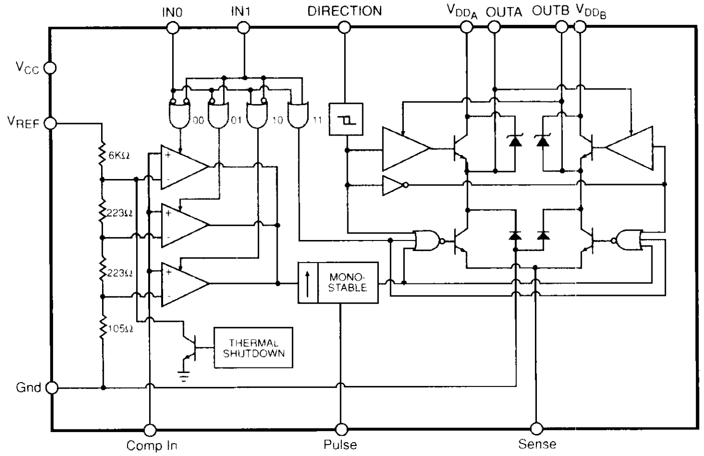
Power Supply Voltage	50V
Logic Supply Voltage	7V
Logic Input Voltage	6V
Comparator Input	V_{SS}
Reference Input Voltage	15V
Output Current (DC Operation)	1.2A
Storage Temperature	–55°C to +150°C
Operating Junction Temperature	–40°C to +150°C
Lead Temperature Soldering	
Wave Solder(through hole styles only)	10 sec. max, 260°C peak

Package Options

16L PDIP



Block Diagram



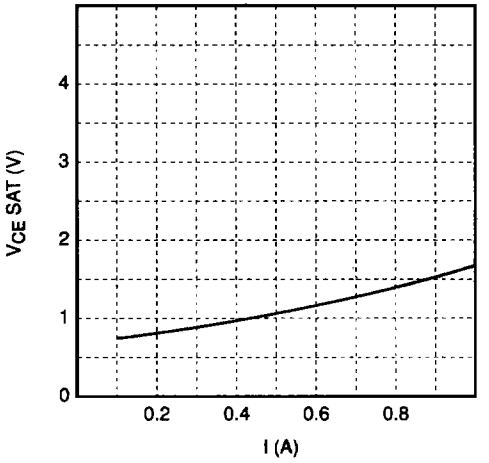
Cherry Semiconductor

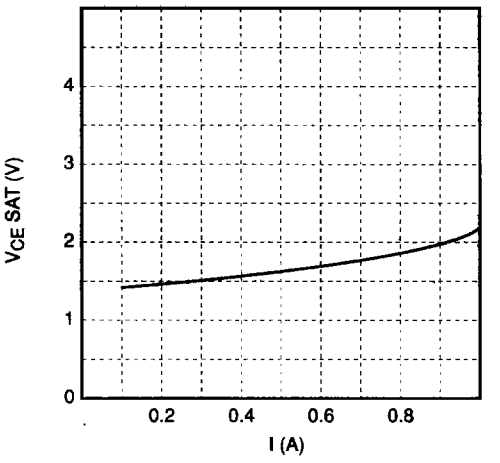
Cherry Semiconductor Corporation
2000 South County Trail
East Greenwich, Rhode Island 02818-1530
Tel: (401)885-3600 Fax (401)885-5786
email: info@cherry-semi.com

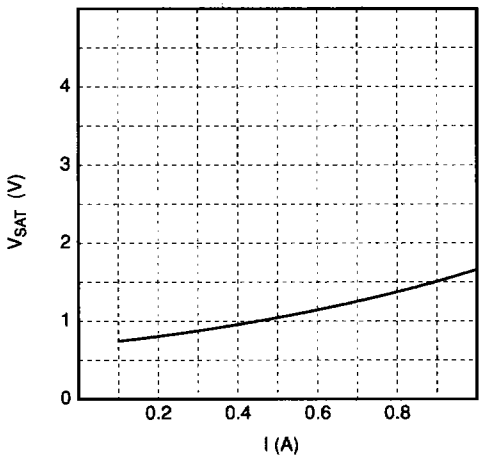
Supply Voltage			10		46	V
Logic Supply Current				7	15	mA
■ Logic Inputs						
Input Low Voltage					0.8	V
Low Voltage Input Current	V_{IN} = 0.4V	(Phase)			-100	µA
		(IN0, IN1)			-400	µA
■ Comparators						
Comparator Low Threshold Voltage	V_{REF} = 5V	IN0 = Low IN1 = High	66	80	94	mV
Comparator High Threshold Voltage	V_{REF} = 5V	IN0 = Low IN1 = Low	396	416	436	mV
Cutoff Time	R_T = 56kΩ	C_T = 820pF	27		37	µs
Output Leakage Current	IN0 =IN1 = High				100	µA
■ Source Diode-Transistor Pair						
Saturation Voltage	I_{MOTOR} = -0.5A	conduction period		1.7	2.1	V
		recirculation period		1.10	1.35	V
Leakage Current	V_S = 46V				300	µA
■ Sink Diode-Transistor Pair						
Saturation Voltage	I_{MOTOR} = 0.5A			1.20	1.45	V
	I_{MOTOR} = 1A			1.75	2.30	V
Diode Forward Voltage	I_{MOTOR} = 0.5A			1.1	1.5	V
	I_{MOTOR} = 1A			1.4	2.0	V

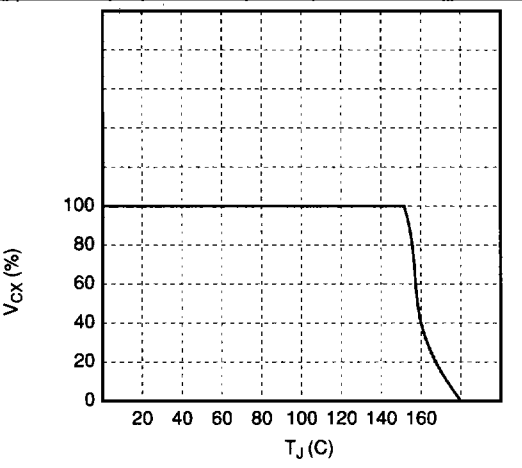
H	H	No Current
[illegible]	[illegible]	[illegible]
H	L	Medium Current
[illegible]	[illegible]	[illegible]

PACKAGE PIN #	PIN SYMBOL	FUNCTION
16L		
1	OUT B	Output connection with OUTA. The output stage is a "H" bridge formed by four transistors and four diodes suitable for switching applications.
[illegible]	[illegible]	[illegible]
3	V_{DDB}	Supply voltage input for half output stage.
[illegible]	[illegible]	[illegible]
6	V_{CC}	Supply voltage input for logic circuitry.
[illegible]	[illegible]	[illegible]
8	DIRECTION	This TTL-compatible logic input sets the direction of current flow through the load. A high level causes current to flow from OUTA (source) to OUTB (sink). A Schmitt trigger on this input provides good noise immunity and a delay circuit prevents output stage short circuits during switching.
[illegible]	[illegible]	[illegible]
10	Comp In	Input connected to the three comparators. The voltage across the sense resistor is fed back to this input through the low pass filter R_CC_C. The lower power transistors are disabled when the sense voltage exceeds the reference voltage of the selected comparator. When this occurs the current decays for a time set by R_TC_T, $t_{OFF} = 0.69\ R_TC_T$.
[illegible]	[illegible]	[illegible]
14	V_{DDA}	Supply voltage input for half output stage.
[illegible]	[illegible]	[illegible]
16	Sense	Connection to lower emitters of output stage for insertion of current sense resistor.









The application diagram shows a typical application in which two CS-3717A's control a two phase bipolar stepper motor.

Programming

The logic inputs IN0 and IN1 set at three different levels the amplitude of the current flowing in the motor winding according to the truth table. A high level on the "Direction" logic input sets the direction of that current from OUTA to OUTB; a low level from OUTB to OUTA.

It is recommended that unused inputs are tied to V_{CC} or (Gnd) as appropriate to avoid noise problems.

The current levels can be varied continuously by changing V_{REF}.

Control of the motor

The stepper motor can rotate in either direction according to the sequence of the input signals. It is possible to obtain a full step, a half step and quarter step operation.

Full step operation

Both windings of the stepper motor are energized all the time with the same current $I_{MA} = I_{MB}$.

IN0 and IN1 remain fixed at whatever torque value is required.

Calling $\overline{A}$ the condition with winding A energized in one direction and A in the other direction, the sequence for full step rotation is:

$$AB \rightarrow \overline{A}B \rightarrow \overline{A}\,\overline{B} \rightarrow A\overline{B} \text{ etc.}$$

For rotation in the other direction the sequence must be reversed.

In full step operation the torque is constant each step.

Half step operation

Power is applied alternately to one winding then both according to the sequence:

$$AB \rightarrow B \rightarrow \bar{A}B \rightarrow \bar{A} \rightarrow \bar{A}\bar{B} \rightarrow \bar{B} \rightarrow A\bar{B} \rightarrow A \text{ etc.}$$

Like full step this can be done at any current level; the torque is not constant but is lower when only one winding is energized.

A coil is turned off by setting IN0 and IN1 both high.

Quarter step operation

It is preferable to realize the quarter step operation at full power otherwise the steps will be of very irregular size.

The extra quarter steps are added to the half step sequence by putting one coil on half current according to the sequence.

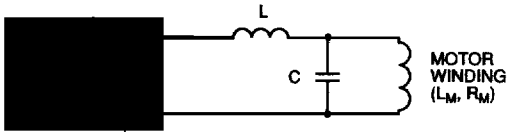
$$AB \rightarrow \frac{A}{2}B \rightarrow B \rightarrow \frac{\bar{A}}{2}B \rightarrow \bar{A}B \rightarrow \bar{A}\frac{B}{2} \rightarrow \bar{A} \text{ etc.}$$

Motor selection

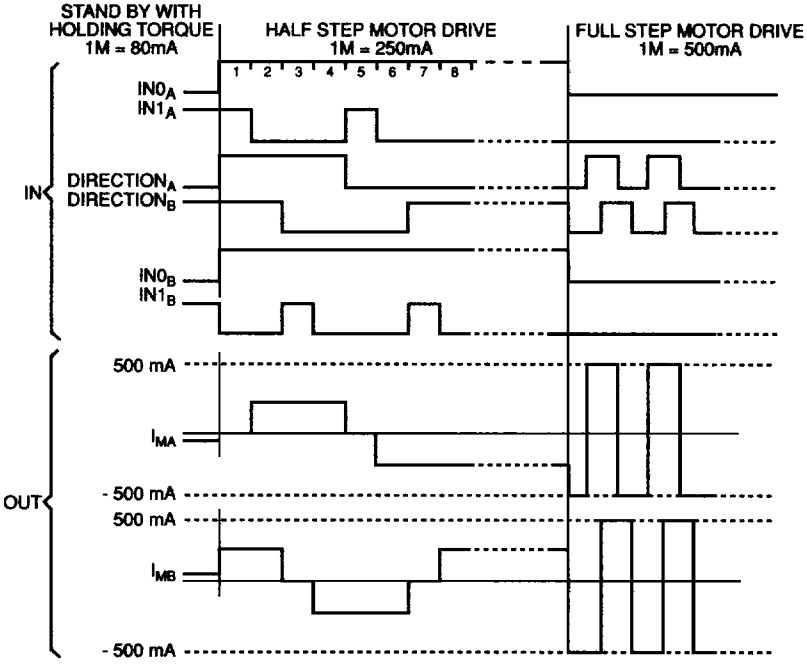
As the CS-3717A provides constant current drive with a switching operation, care must be taken to select stepper motors with low hysteresis losses to prevent motor overheating.

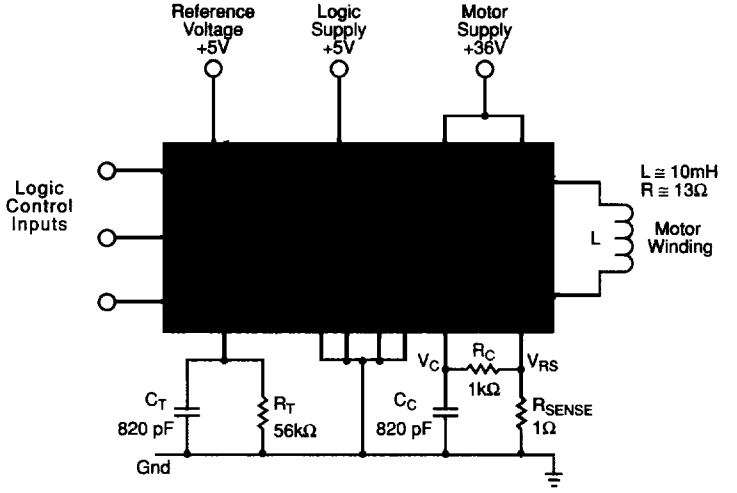
L-C filter

To reduce EMI and chopping losses in the motor, a low pass L-C filter can be inserted across the outputs of the CS-3717A as shown in the following diagram.

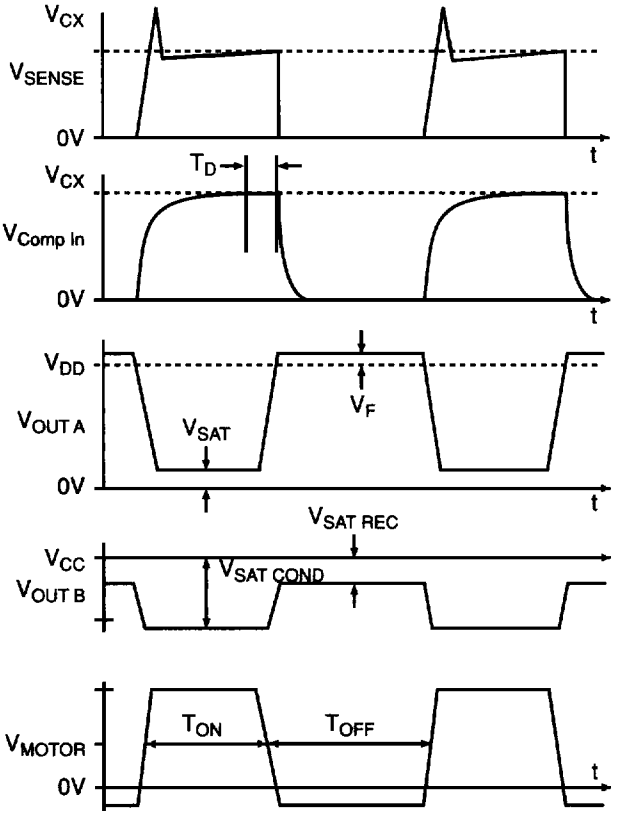


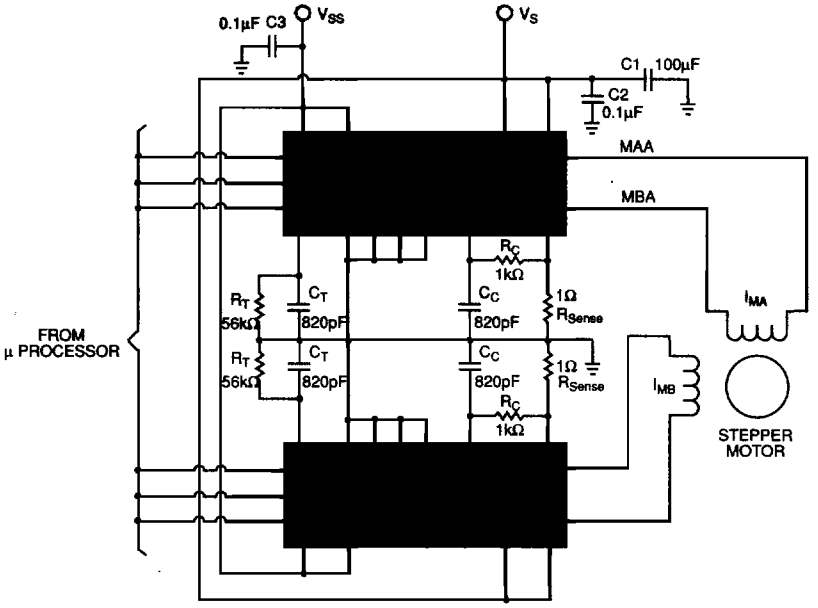
$L \cong \frac{1}{10} L_M$ $\quad C \cong \frac{4 \cdot 10^{10}}{L}$




Reference Voltage +5V
Logic Supply +5V
Motor Supply +36V
Logic Control Inputs
L ≅ 10mH
R ≅ 13Ω
L
Motor Winding
V_C
R_C
1kΩ
V_{RS}
C_T
820 pF
R_T
56kΩ
C_C
820 pF
R_{SENSE}
1Ω
Gnd

[illegible]


V_{CX}
V_{SENSE}
0V
t
T_D
V_{CX}
$V_{Comp\ In}$
0V
t
V_{DD}
$V_{OUT\ A}$
V_{SAT}
V_F
0V
t
$V_{SAT\ REC}$
V_{CC}
$V_{OUT\ B}$
$V_{SAT\ COND}$
V_{MOTOR}
T_{ON}
T_{OFF}
0V
t



Important Information

The $R_{\Theta JA}$ of the CS-3717A can be reduced by soldering the Gnd pins to a suitable copper area of the printed circuit board or to an external heatsink.

The diagram of fig. 2 shows the maximum dissipated power P_{tot} and the $R_{\Theta JA}$ as a function of the side "ℓ" of two equal square copper areas having a thickness of 35µ (see fig. 1). In addition, it is possible to use an external heatsink (see fig. 3). During soldering the pins temperature must not exceed 260°C and the soldering time must not be longer than 12 seconds.

The external heatsink or printed circuit copper area must be connected to electrical ground.

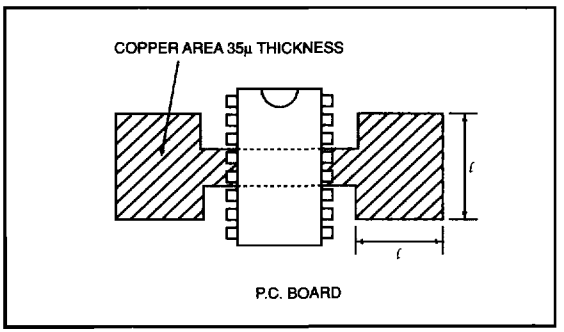


Figure 1 - Example of P.C. Board Copper Area Which is Used as Heatsink with 16 lead batwing package.

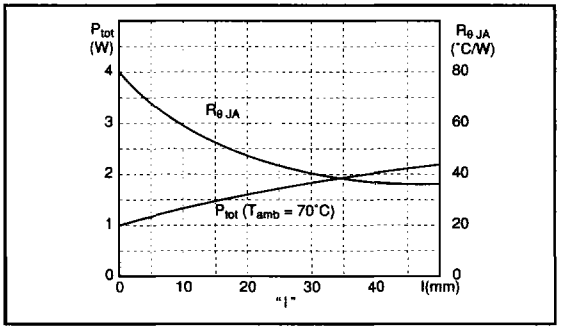


Figure 2 - Max. Power Dissipation And Junction To Ambient Thermal Resistance vs. Size "l" for 16 lead batwing package.

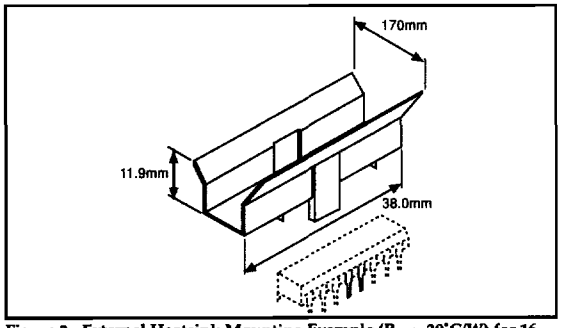


Figure 3 - External Heatsink Mounting Example (R_{th} = 30°C/W) for 16 lead batwing package.

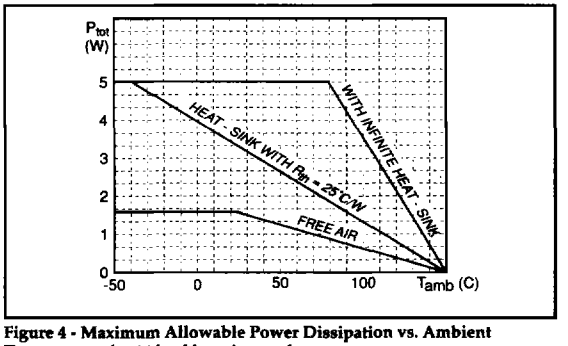
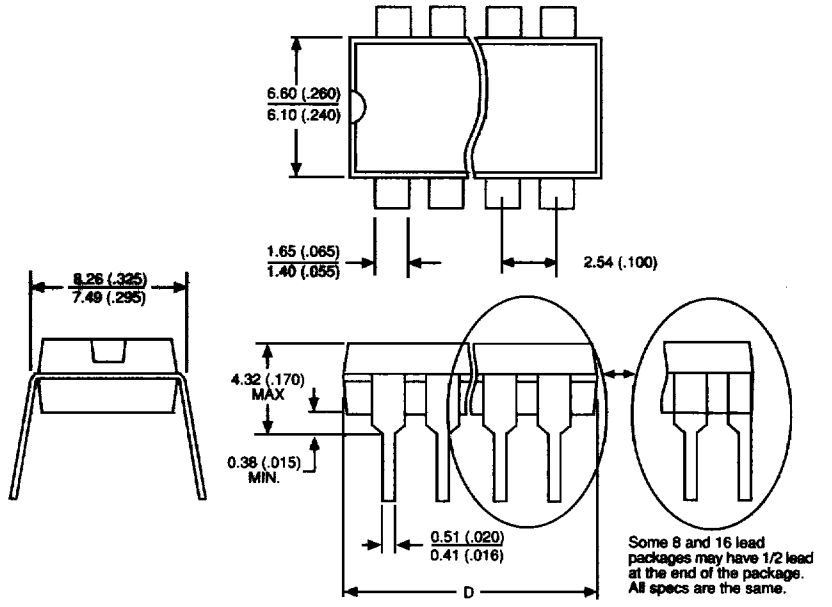


Figure 4 - Maximum Allowable Power Dissipation vs. Ambient Temperature for 16 lead batwing package.

Lead Count	D			
	Metric		English	
	Max	Min	Max	Min
16L PDIP	19.18	18.92	.755	.745

Thermal Data		16 Lead PDIP	
$R_{\Theta JC}$	typ	15	°C/W
$R_{\Theta JA}$	typ	50	°C/W



Part Number	Description
CS-3717AN16	16 Lead PDIP