CS-3770

High Performance Stepper Motor Driver

Description

The CS-3770 is a bipolar monolithic circuit intended to control and drive the current in one winding of a stepper motor. Special care has been taken to optimize the power handling capability without suffering in reliability.

The circuit consists of a TTL compatible logic input, a current sensor, a monostable multivibrator and a high power H-bridge output stage.

Two CS-3770's and several external components form a complete control and drive unit for TTL or microprocessor controlled stepper motor systems.

Features

Half-Step and Full-Step Modes

Switched Mode Bipolar Constant Current Drive (Chopped Mode)

Wide Range of Current Control 5–1500mA

Wide Voltage Range 10–45V

Designed for Unstabilized Motor Supply Voltage

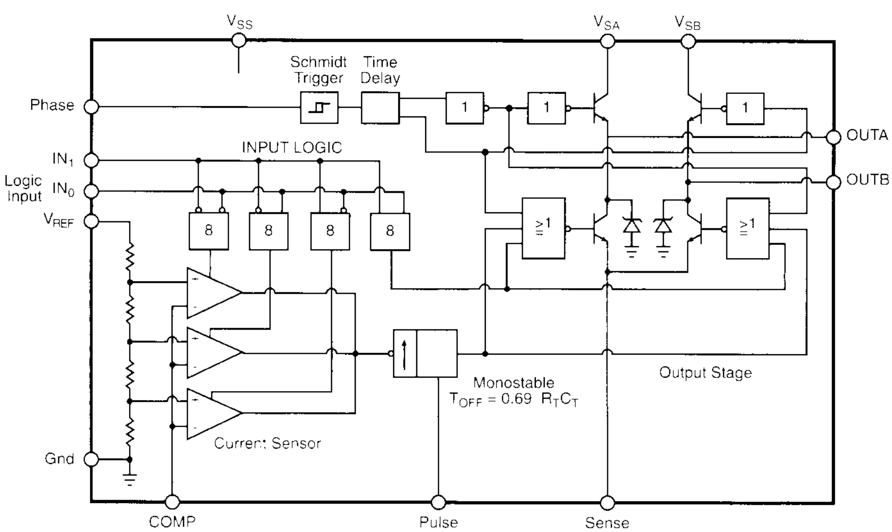
Current Levels Can Be Selected in Steps or Varied Continuously

Thermal Overload Protection

Absolute Maximum Ratings

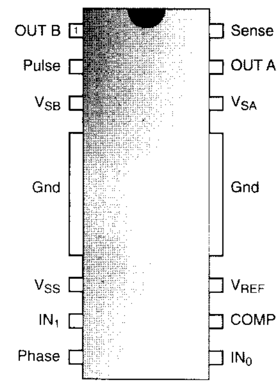
Logic Supply Voltage	7V
Output Supply Voltage	45V
Logic Input Voltage	6V
Comparator Input Voltage	V_{SS}
Reference Input Voltage	15V
Logic Input Currents	-10mA
Comparator Input Current	-10mA
Reference Input Current	-10mA
Output Current	±1.5A
Junction Temperature	-40°C to 150°C
Operating Ambient Temperature	0°C to +70°C
Storage Temperature	-55°C to +150°C

Block Diagram

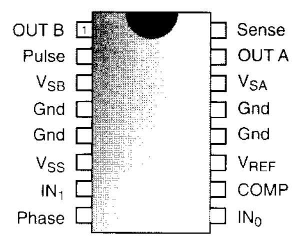


Package Options

20L SO Batwing



16L PDIP Batwing



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Electrical Characteristics: Electrical characteristics over recommended operating conditions 0°C≤T_A≤70°C					
PARAMETER	**TEST CONDITIONS**	**MIN**	**TYP**	**MAX**	**UNIT**
■ General					
Supply Current, I_{CC}	20V≤V_S≤40V				
	$IN_1 = IN_0 = 1$		20	30	mA
	$IN_1 = IN_0 = 0$		65	145	mA
Output Supply Voltage		10		40	V
Output Current		20		1200	mA
■ Logic					
High-level Logic Input Voltages			2.0		V
Low-level Logic Input Voltages				0.8	V
High-level Logic Input Currents	V_{IN_1}=2.4V			20	µA
Low-level Logic Input Currents	V_{IN_1} = 0.4V	-0.4			mA
Logic Supply Voltage		4.75	5	5.25	V
Rise Time Logic Inputs				2	µs
Fall Time Logic Inputs				2	µs
Comparator Threshold Voltage	$IN_0 = 0$ V_{REF} - 5.0V $IN_1 = 0$	390	420	440	mV
	$IN_0 = 1$ V_{REF} = 5.0V $IN_1 = 0$	230	250	270	mV
	$IN_0 = 0$ V_{REF} = 5.0V $IN_1 = 1$	65	80	90	mV
Comparator Input Current		-20		20	µA
Output Leakage Current	$IN_0 = IN_1$; T_A = 25°C			100	µA
Total Saturation Voltage Drop (Source + Sink)	I_S = 800mA			2.0	V
Total Power Dissipation	I_S = 800mA fs = 30kHz		1.8	*	W
Cut Off Time, T_{OFF}	R_{Pulse} = 56kΩ, C_{Pulse} = 1nF V_S = 10V; T_{ON} ≥ 5µs	35	40	45	µs
Turn Off Delay, T_D	TA = +25°C dVc/dt ≥ 50mV/µs		1.6	3.0	µs
Thermal Shutdown Junction Temperature			+170		°C

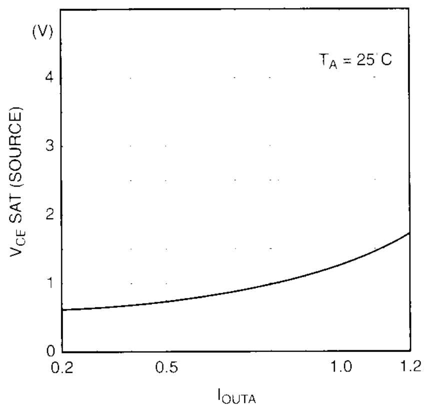
*Depends upon heat sink

Package Pin Description

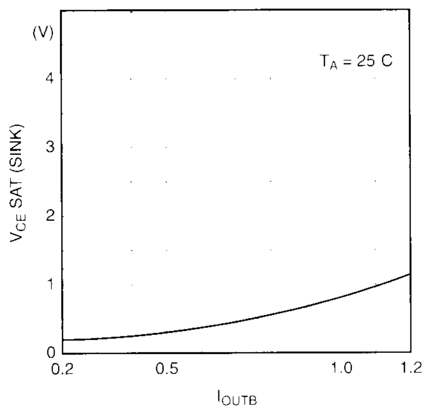
PACKAGE PIN #		PIN SYMBOL	FUNCTION
16L PDIP BW	20L SO BW		
1	1	OUT B	Output connection with OUT A. The output stage is an H-bridge formed by four transistors and four diodes suitable for switching applications.
2	2	Pulse	A parallel RC network connected to this pin sets the OFF time of the lower power transistors. The pulse generator is a monostable triggered by the rising edge of the output of the comparators (t_{OFF}=0.69 $R_T C_T$).
3	3	V_{SB}	Supply voltage input for half output stage.
4, 5, 12, 13	4, 5, 6, 7, 14, 15, 16, 17	Gnd	Ground connection. Also conducts heat from die to printed circuit copper.
6	8	V_{SS}	Supply voltage input for logic circuitry
7	9	IN_1	This pin and (IN0) are logic inputs which select the outputs of the three comparators to set the current level. Current also depends on the sensing resistor and reference voltage. See truth table.
8	10	Phase	Phase input determines current polarity in motor windings.
9	11	IN_0	See IN1.
10	12	COMP	Input connected to the three comparators. The voltage across the sense resistor is fed back to this input through the low pass filter $R_C C_C$. 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 $R_T C_T$, tOFF=0.69 $R_T C_T$.
11	13	V_{REF}	A voltage applied to this pin sets the reference voltage of the three comparators, thus determining the output current (also dependent on R_{Sense} and the two inputs IN0 and IN1).
14	18	V_{SA}	Supply voltage input for half output stage.
15	19	OUT A	See OUT B.
16	20	Sense	Connection to lower emitters of output stage for insertion of current sense resistor.

Typical Performance Characteristics

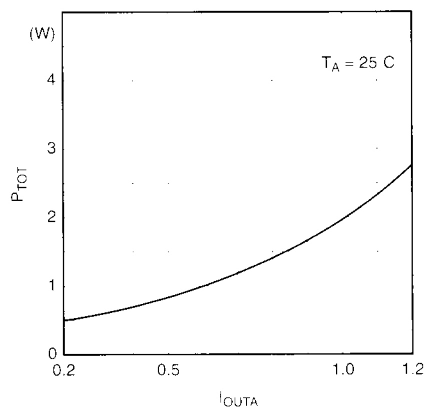
Source Saturation Voltage vs. Output Current



Sink Saturation Voltage vs. Output Current



Power Losses vs. Output Current



Functional Description

Current Level Selection

The status of IN_0 and IN_1 input pins in conjunction with the reference voltage V_{REF} determines the output current (Figure 1). If V_{REF} is fixed four current levels can be selected:

Table 1: Logic Control of Output Current

LOGIC IN_0	INPUT IN_1	CURRENT LEVEL I_{motor}
H	H	No Current
L	H	Low (20%) Current
H	L	Medium (60%) Current
L	L	High (100%) Current

Sense Resistor

The voltage drop across the current sensing resistor, R_{Sense} is compared with the voltage drop across reference resistor chain (using V_{REF}). When the two values are equal the monostable is triggered which in turn sets the output in tristate for a fixed time T_{OFF} (T_{OFF} = 0.69 x R_{Pulse} x C_{Pulse}). The R-C network is a filter for the sensing resistor R_{Sense}.

Output Stage

The output contains four power transistors connected in an H-bridge. The lower two sink transistors have diodes across them. It is recommended to use two external diodes across the two upper source transistors when driving inductive load.

Reference Voltage

Variation of V_{REF} can give wide control of motor current. A modulated V_{REF} provides continuously adjusted motor current (for example, when microstepping the motor).

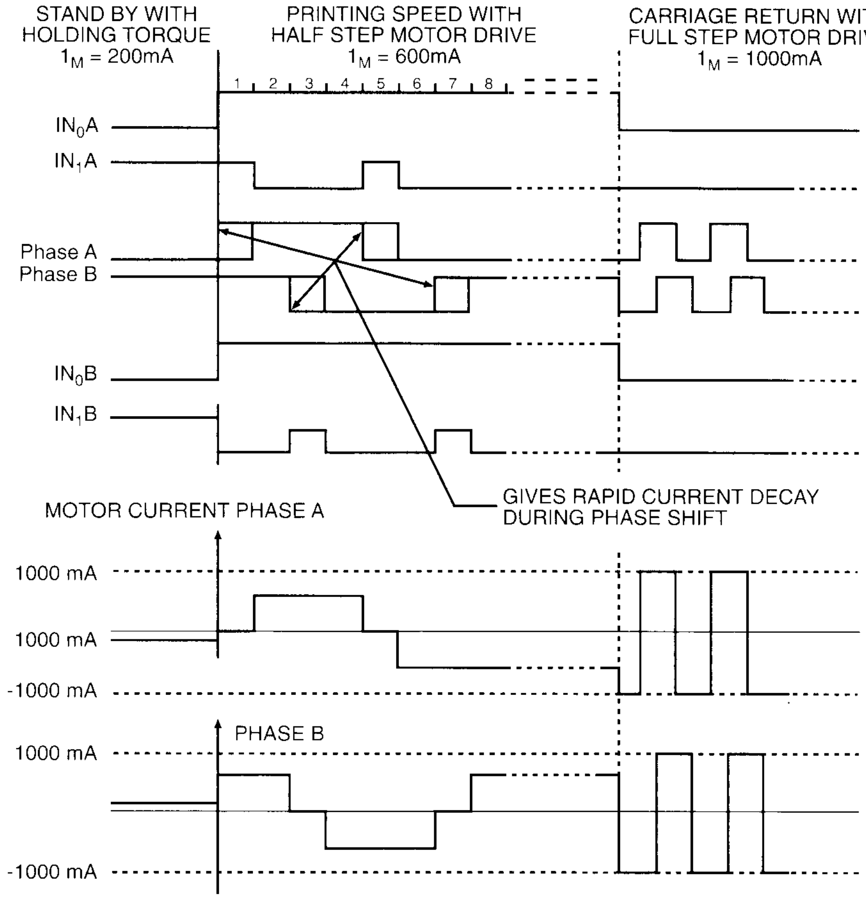
Phase Input

At Phase input pin a logic signal determines the direction of current in the motor winding. When Phase is H_1, current flows from M_A to M_B and when Phase is LOW, current flows in the opposite direction, from M_B to M_A. A Schmitt trigger provides noise immunity and a delay circuit eliminates the possibility of output short circuit during a phase shift.

Thermal Protection

A thermal shutdown is provided which limits the junction temperature. However, there is no short circuit protection.

Figure 1. Operating Sequence



Heatsinking

The junction temperature of the chip highly affects the lifetime of the driver circuit. Thus in high current applications the heatsinking must be carefully considered.

The $R\Theta_{JA}$ of the CS-3770 can be reduced by soldering the ground pins to a suitable copper area on the printed circuit board or by applying an external heatsink Staver type V7 or V8 (see fig. 4). The diagram in Figure 2 shows the maximum permissible power dissipation versus the ambient temperature in °C, for heatsinkers of the type V7, V8 or Figure 3 for a 20 cm^2 copper area respectively. Any external heatsink or printed circuit board copper area must be connected to electrical ground. For motor currents higher than 1A, heatsinking is recommended to assure optimal reliability.

The diagrams in Figure 1 and the Power Losses vs. Output Current can be used to determine the required heatsinking of the circuit. In some systems forced air cooling may be available to reduce the temperature rise of the circuit.

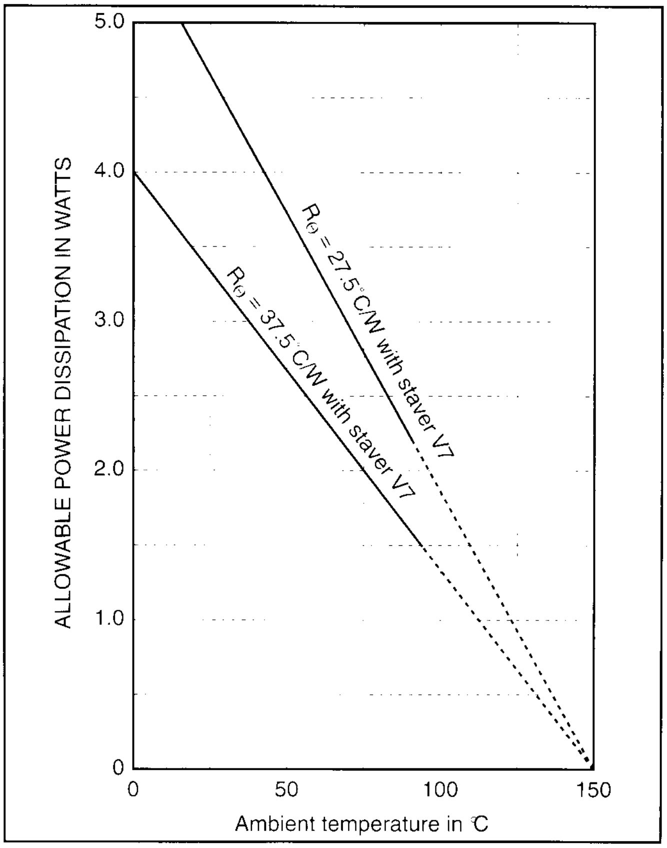
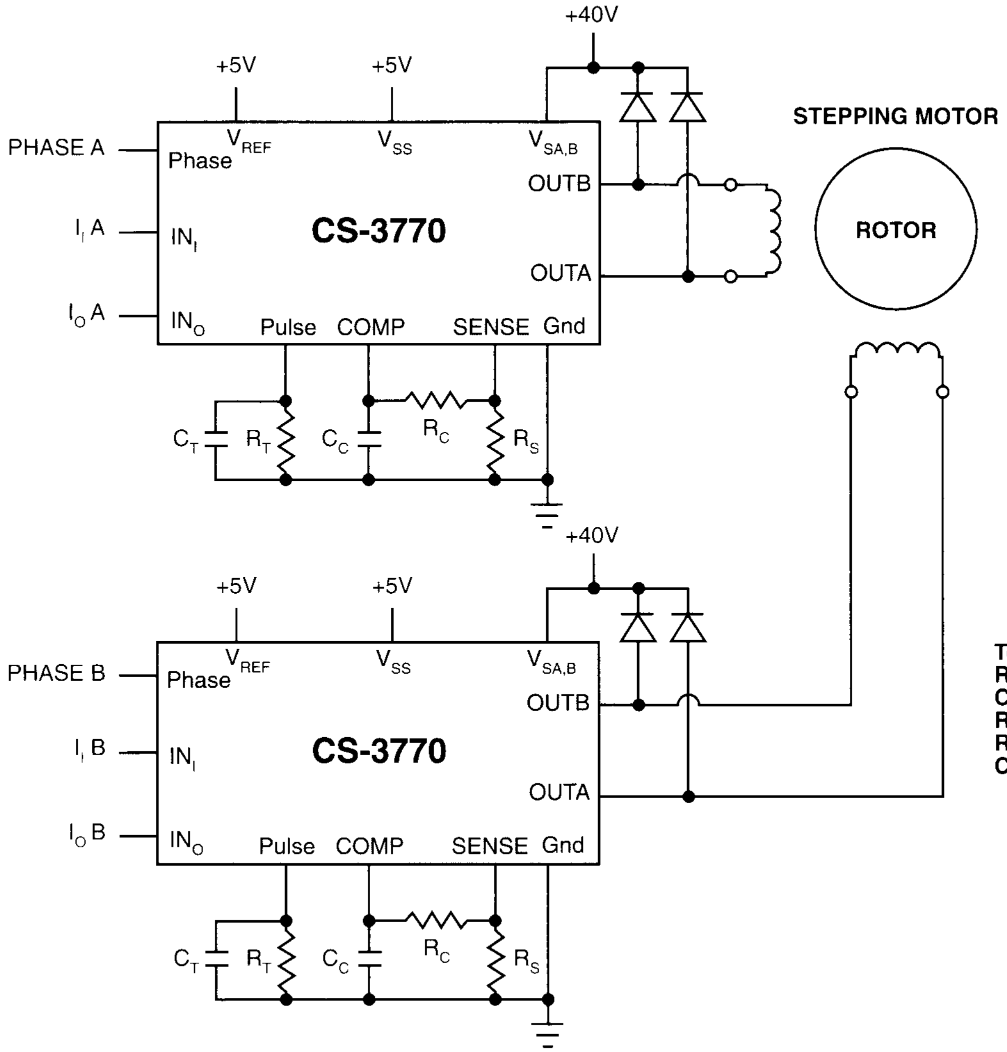


Figure 2.

Application Diagram



Test Circuit
R_T = 56kΩ
C_T = 820pF
R_S = 0.5Ω±1%
R_C = 1kΩ
C_C = 820pF

Figure 3. Example of P.C. Board Copper Area Which is Used As Heatsink

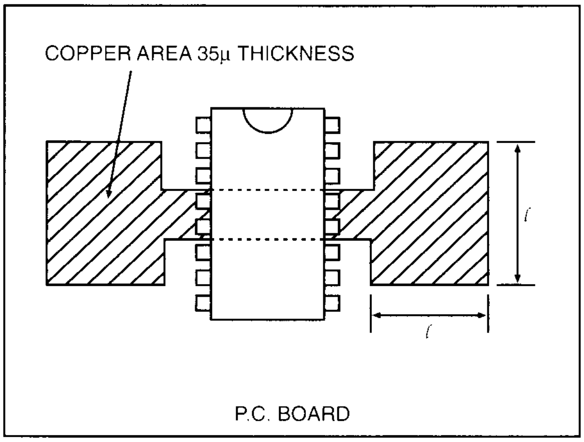
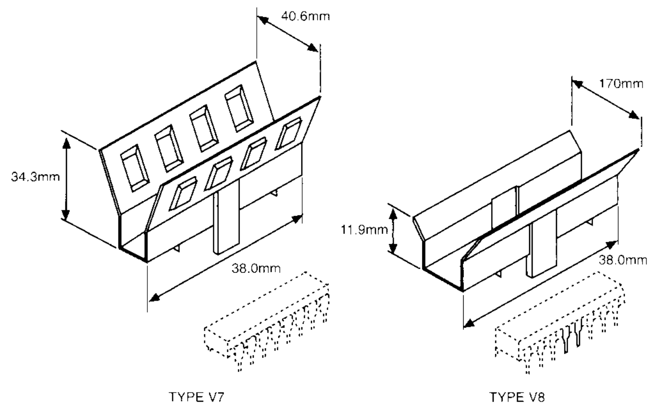


Figure 4. External Heatsink Mounting Example (R_Θ = 27.5°C/W) (Type V7) (R_Θ = 37.5°C/W) (Type V8)



Mounting Instructions

The $R_{\Theta JA}$ of the CS-3770 can be reduced by soldering the ground pins to a suitable copper area of the printed circuit board or to an external heatsink.

The diagram of Figure 5 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. 3). In addition, it is possible to use an external heatsink (see fig. 4). During soldering the pins temperature must not exceed 260°C for longer than 12 seconds.

The printed circuit copper area is connected to electrical ground.

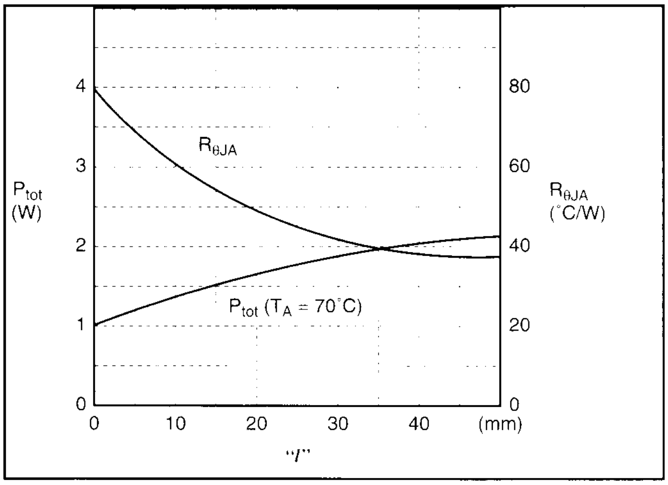


Figure 5. Max. Power Dissipation And Junction To Ambient Thermal Resistance vs. Size "ℓ" for 16L PDIP batwing.

Package Specification

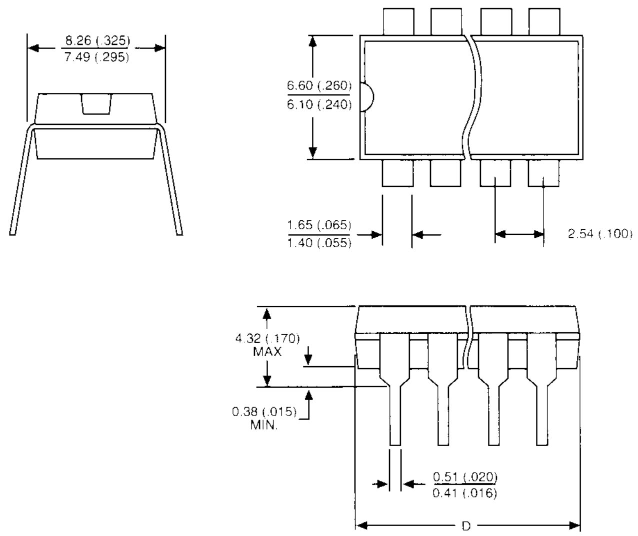
PACKAGE DIMENSIONS IN mm (INCHES)

Lead Count	D Metric Max	D Metric Min	D English Max	D English Min
16L PDIP Batwing	19.18	18.92	.755	.745
20L SO Batwing	12.95	12.70	.510	.500

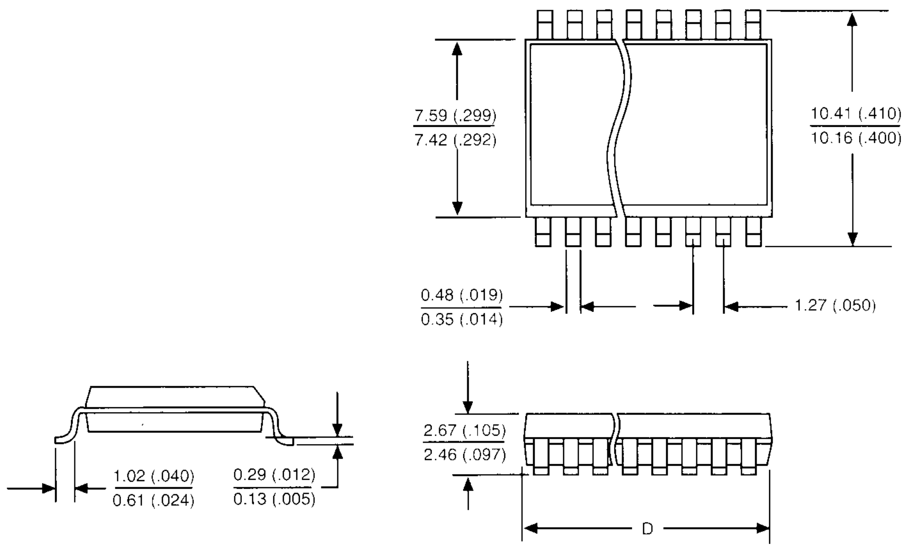
PACKAGE THERMAL DATA

Thermal Data		16L PDIP Batwing	20 Lead SO Batwing	
$R\Theta_{JC}$	typ	15	9	°C/W
$R\Theta_{JA}$	typ	50	55	°C/W

16 Lead PDIP Batwing



20 Lead SO Batwing



Ordering Information

Part Number	Description
CS-3770DW20BW	20 Lead SO Wide Batwing
CS-3770N16BW	16 Lead PDIP Batwing

Preliminary

This product is in the preproduction stages of the design process. The data sheet contains preliminary data. CSC reserves the right to make changes to the specifications without notice. Please contact CSC for the latest available information.

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