

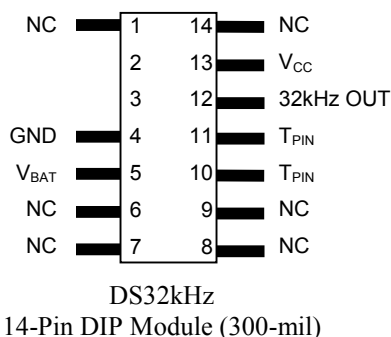
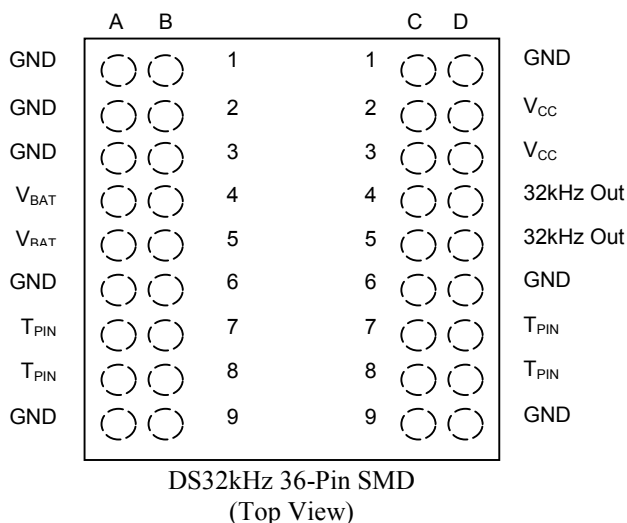
## FEATURES

- Accurate to  $\pm 4$  Min/Yr ( $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ )
- Accurate to  $\pm 1$  Min/Yr ( $0^{\circ}\text{C}$  to  $40^{\circ}\text{C}$ )
- Battery back up for continuous timekeeping
- $V_{\text{BAT}}$  operating voltage: 2.7V to 5.5V with  $V_{\text{CC}}$  grounded
- $V_{\text{CC}}$  operating voltage: 4.5V to 5.5V
- Operating temperature range:
  - $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$  (Commercial)
  - $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  (Industrial)
- No calibration required
- Low-power consumption
- Surface mountable using BGA package
  - $V_{\text{CC}}$ : C2, C3, D2, D3
  - $V_{\text{BAT}}$ : A4, A5, B4, B5
  - 32kHz: C4, C5, D4, D5
  - GND: All Remaining Balls
  - $T_{\text{PIN}}$ : A7, A8, B7, B8, C7, C8, D7, D8

## ORDERING INFORMATION

DS32kHz/BGA	36-Pin BGA	$0^{\circ}\text{C}$ to $+70^{\circ}\text{C}$
DS32kHz-N/BGA	36-Pin BGA	$-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$
DS32kHz/DIP	14-Pin DIP	$0^{\circ}\text{C}$ to $+70^{\circ}\text{C}$
DS32kHz-N/DIP	14-Pin DIP	$-40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$

## PIN ASSIGNMENT



## PIN DESCRIPTION

$V_{\text{CC}}$	- Primary Power Supply
$V_{\text{BAT}}$	- +3V Battery Supply
GND	- Ground
NC	- No Connect
$T_{\text{PIN}}$	- Test Pin (Must Be Grounded)

## DESCRIPTION

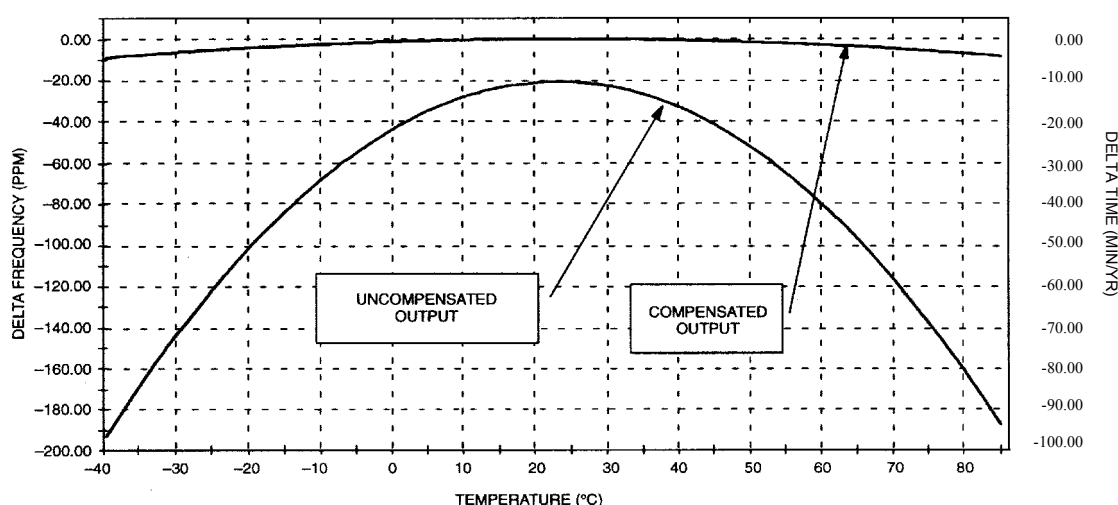
The DS32kHz is a temperature-compensated crystal oscillator (TCXO) with an output frequency of 32.768kHz. This device addresses applications requiring better timekeeping accuracy and may be used to drive the X1 input of most Dallas Semiconductor real-time clocks (RTCs), chipsets, and other ICs containing RTCs. This device is available in commercial and industrial temperature versions, DS32kHz and DS32kHz-N respectively.

The DS32kHz requires four pins for operation: 1)  $V_{CC}$ , 2) GND, 3)  $V_{BAT}$ , and 4) 32kHz OUT. (See Figures 1, 2, and 3 for connection schemes.) Power is applied via  $V_{CC}$  and GND, while  $V_{BAT}$  is used to maintain the 32kHz output in the absence of power. The output is accurate to  $\pm 7.5$  ppm ( $\pm 4$  min/yr) from  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  and  $\pm 2$  ppm ( $\pm 1$  min/yr) from  $0^{\circ}\text{C}$  to  $40^{\circ}\text{C}$ .

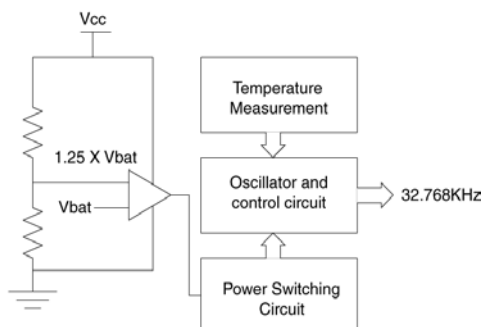
The DS32kHz is packaged in a small, 36-pin SMD using ball grid array (BGA) technology with dimensions 0.400 inches wide, 0.450 inches long, and 0.180 inches high. It also is available in a 14-pin DIP module.

The additional board space required is negligible in most applications and, therefore, the recommended land pattern layout should be implemented on all new designs and future board revisions to satisfy applications requiring better timekeeping accuracy.

## DELTA TIME AND FREQUENCY vs. TEMPERATURE



## DS32kHz BLOCK DIAGRAM



## OPERATION

The DS32kHz module contains a crystal and an IC. While powered, the DS32kHz periodically measures the temperature and adjusts the crystal load to compensate.

The DS32kHz is designed to operate in two modes. In the dual-supply mode, a comparator circuit, powered by  $V_{CC}$ , monitors the relationship between the  $V_{CC}$  and  $V_{BAT}$  input levels. When  $V_{CC}$  drops

below a certain level compared to  $V_{BAT}$ , the device switches over to  $V_{BAT}$ . (See Figure 1.0.) This mode uses  $V_{CC}$  to conserve the battery connected to  $V_{BAT}$  while  $V_{CC}$  is applied.

In the single-supply mode,  $V_{CC}$  is grounded and the unit is powered by  $V_{BAT}$ . Current consumption is less than that of  $V_{CC}$ , because the comparator circuit is unpowered. (See Figure 2.0.)

## POWER SUPPLY CONNECTIONS Figures 1.0 and 2.0

Figure 1.0

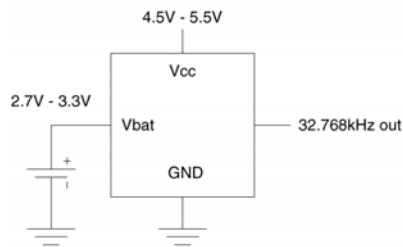


Figure 2.0

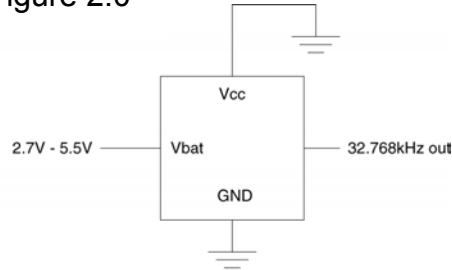


Figure 1.0 shows how the DS32kHz should be connected when using two power supplies.  $V_{CC}$  should be between 4.5V and 5.5V and  $V_{BAT}$  should be between 2.7V and 3.3V. Figure 2.0 shows how the DS32kHz can be used when only a single-supply system is available.  $V_{CC}$  should be grounded and  $V_{BAT}$  should then be held between 2.7V and 5.5V. The  $V_{BAT}$  pin should be connected directly to a battery using no external components.

## DS32kHz CONNECTIONS Figures 3.0 and 4.0

Figure 3.0

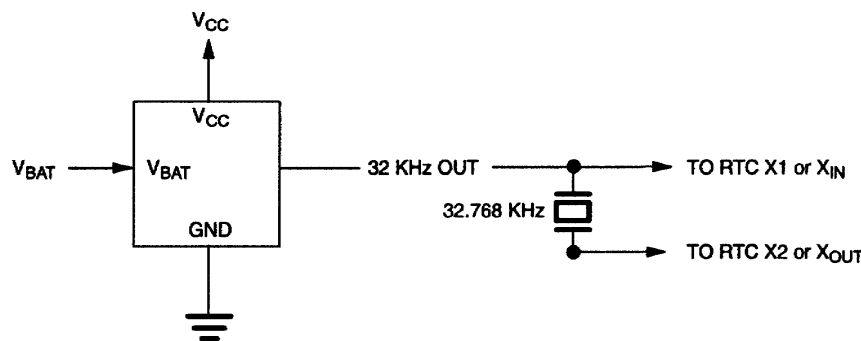


Figure 4.0

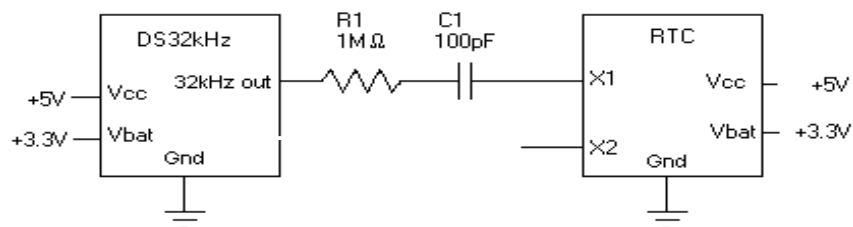


Figure 3.0 illustrates how a standard 32.768kHz crystal and the DS32kHz should be connected to address the interchangeable option. Using this connection scheme and the recommended layout provides a solution, which requires no hardware modifications. Only one device should be used at a time, and both layouts should be located very close together if the recommended layout is not used.

The DS32kHz  $I_{CC}$  and  $I_{BAT}$  currents are specified with no output loads. Many RTC oscillator circuits use a quartz crystal or resonator. Driving the oscillator circuit with the rail-to-rail output of the DS32kHz may increase the  $I_{CC}$  and  $I_{BAT}$  currents significantly and increase the current consumption of the RTC as well. Figure 4 shows one recommended circuit that can be used to reduce the current consumption of a DS32kHz and an RTC. The values of R1 and C1 will vary depending on the RTC used. However, values of 1.0M $\Omega$  and 100pF are recommended as a starting point.

## RELATED APPLICATION NOTES

Application Note 58 – Crystal Considerations with Dallas Real-Time Clocks

Application Note 701 – Using the DS32kHz with Dallas RTCs

## RECOMMENDED DC OPERATING CONDITIONS (-40°C to +85°C)

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	NOTES
Power Supply Voltage	$V_{CC}$	4.5	5.0	5.5	V	
Battery Voltage	$V_{BAT}$	2.7	3.0	3.3, 5.5	V	1

## DC ELECTRICAL CHARACTERISTICS (Over the operating range\*)

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	NOTES
Active Supply Current	$I_{CC}$		150	180	$\mu$ A	2,5
Active Battery Current ( $V_{CC} = 0V$ , $V_{BAT} = 3.3V$ )	$I_{BAT}$		1	4	$\mu$ A	2,3,5
High Output Voltage ( $V_{CC}$ ) ( $I_{OH} = -1.0mA$ )	$V_{OH}$	2.4			V	
Low Output Voltage ( $I_{OL} = 2.1mA$ )	$V_{OL}$			0.4	V	
Battery Switch Voltage	$V_{SW}$		$V_{BAT}$		V	
High Output Voltage ( $V_{BAT}$ ) ( $I_{OH} = -0.1mA$ )	$V_{OH}$	2.4			V	

\*Unless otherwise specified.

**ABSOLUTE MAXIMUM RATINGS\***

Voltage on Any Pin Relative to Ground	-3.0V to +7.0V
Operating Temperature	0°C to 70°C (Commercial) -40°C to +85°C (Industrial)
Storage Temperature	-40°C to +85°C
Soldering Temperature	See J-STD-020A specification. (Two times max.)

\* This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operation sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

**AC TIMING CHARACTERISTICS**

(Over the operating range\*)

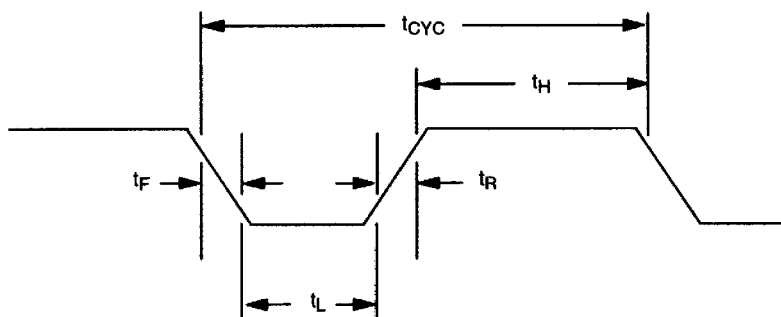
PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	NOTES
Output Frequency	$f_{OUT}$		32.768		kHz	
Frequency Stability vs Temp (0°C to 40°C)	$\Delta f/f_O$	-3.0	+1	+2.0	ppm	
(-40°C to +85°C)		-7.5		+7.5		
Duty Cycle	$T_W/T$	45	50	55	%	
Cycle Time	$t_{CYC}$		30.518		$\mu s$	4
High/Low Time	$t_H/t_L$		15.06		$\mu s$	4
Rise Time	$t_R$		200		ns	4
Fall Time	$t_F$		60		ns	4
Oscillator Start-Up Time	$t_{OSC}$		1		sec	4
Frequency Stability vs Operating Voltage (3.3V Nom)	$\Delta f/V$		$\pm 1.0$		ppm/V	
Crystal Aging	$\Delta f/f_O$		$\pm 1.0$		ppm/yr	6

\*Unless otherwise specified.

**NOTES:**

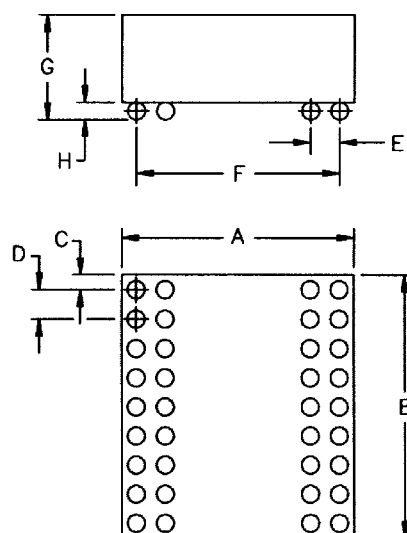
1.  $V_{BAT}$  must be no greater than 3.3V when the device is used in the dual-supply operating modes.
2. Typical values are at +25°C and 5.0V  $V_{CC}$  unless otherwise indicated.
3. This current is the active mode current sourced from the backup supply/battery.
4. These parameters are measured using a 15pF load.
5. These parameters are measured under no load conditions.
6. After reflow.

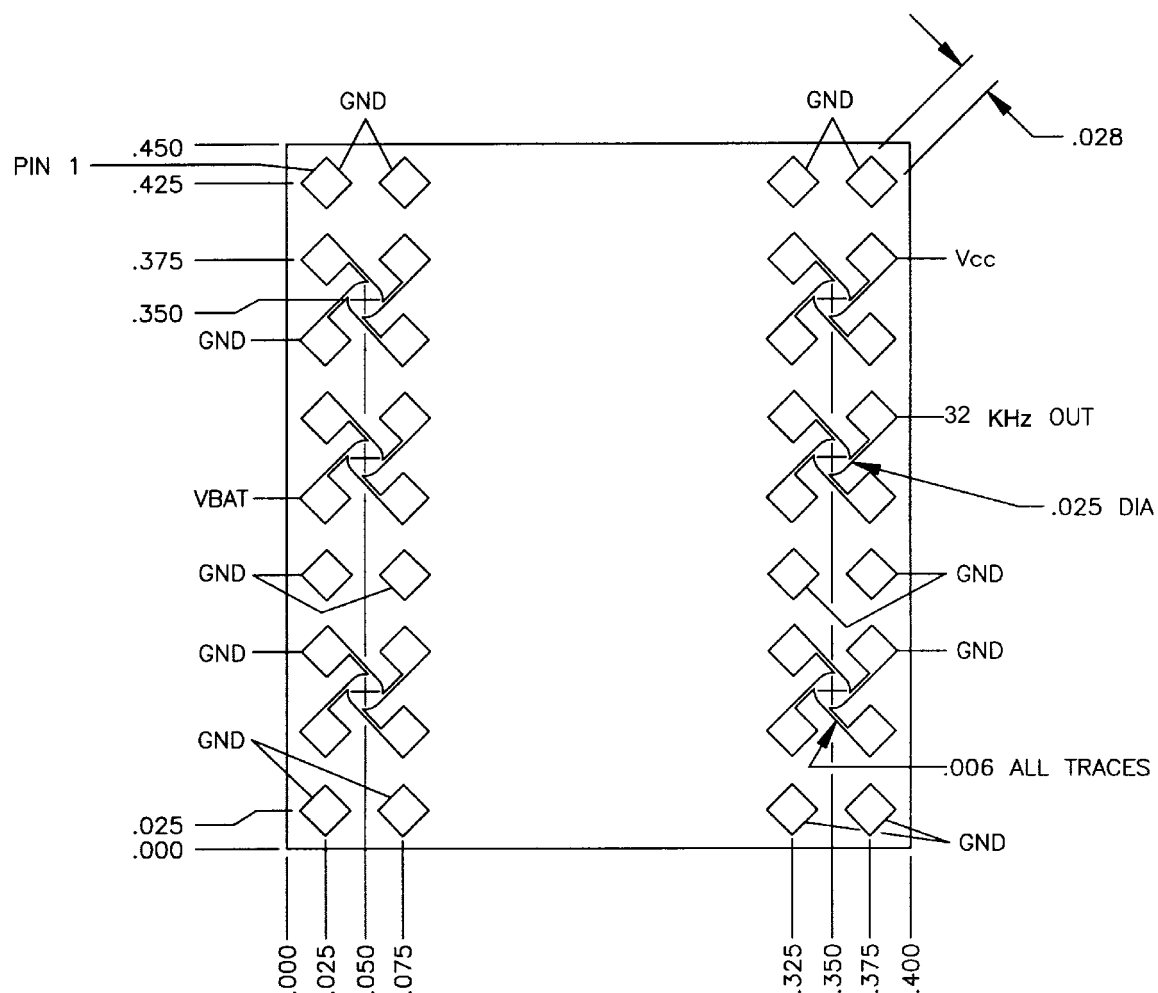
## DS32kHz OUTPUT WAVEFORM



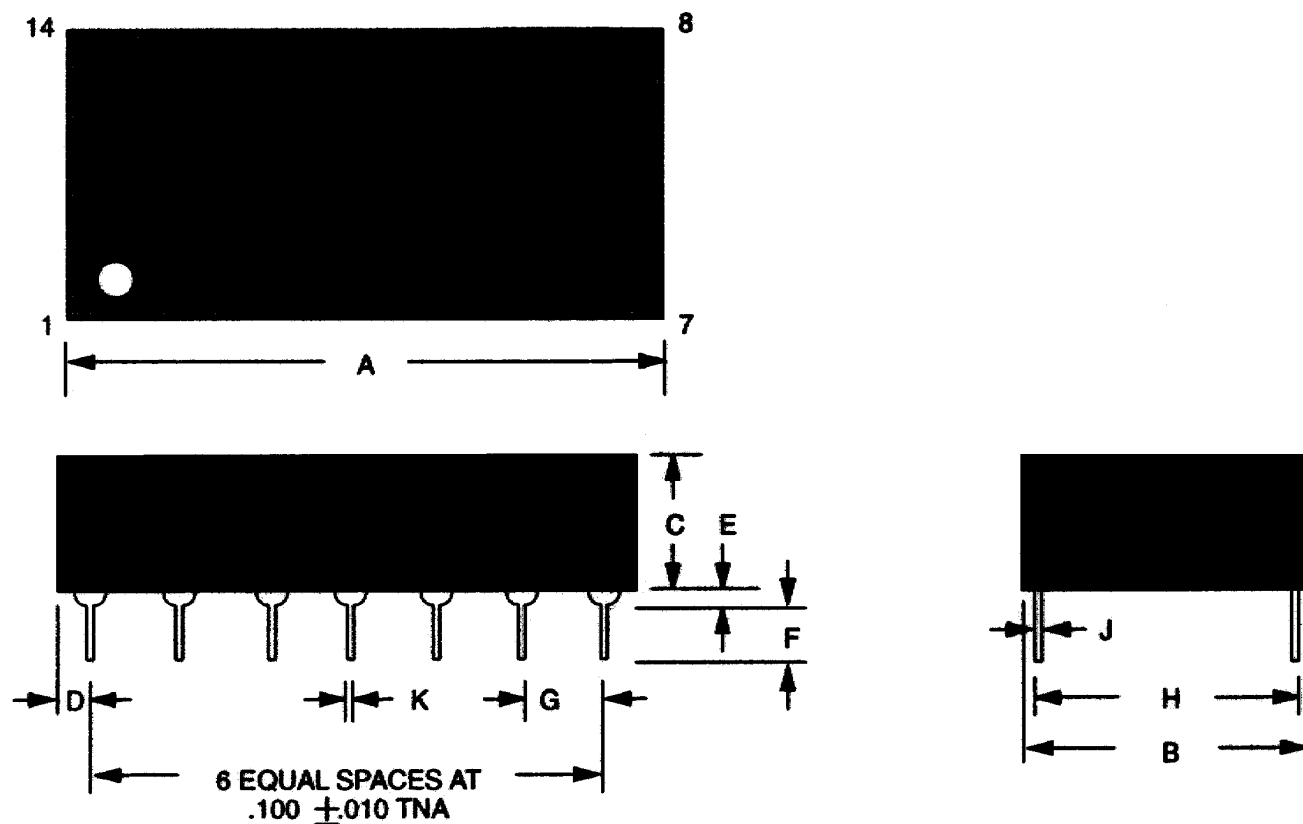
## MECHANICAL DIMENSIONS

PKG	36-PIN BALL GRID	
DIM	MIN	MAX
A (in)	.395	.405
B (in)	.445	.455
C (in)	.022	.028
D (in)	.047	.053
E (in)	.047	.053
F (in)	.347	.353
G (in)	.170	.190
H (in)	.020	.030



**RECOMMENDED LAND PATTERN LAYOUT (36-Pin BGA)**

## DS32kHz 14-PIN DIP MODULE



PKG DIM	14-PIN DIP	
	MIN	MAX
A IN.	0.825	0.840
B IN.	0.420	0.440
C IN.	0.235	0.260
D IN.	0.100	0.130
E IN.	0.015	0.030
F IN.	0.110	0.140
G IN.	0.090	0.110
H IN.	0.290	0.330
J IN.	0.008	0.012
K IN.	0.015	0.021

**Note:** Pins 2, 3 are missing by design.