



Integrated  
Circuit  
Systems, Inc.

# ICS840031I

## FEMTOCLOCKS™ CRYSTAL-TO-LVCMOS/LVTTL CLOCK GENERATOR

### GENERAL DESCRIPTION



The ICS840031I is an IEEE 1394b Clock Generator and a member of the HiPerClocks™ family of high performance devices from ICS. The ICS840031I uses a 24.576MHz crystal to synthesize 98.304MHz. The ICS840031I has excellent phase jitter performance, from 12KHz – 20MHz integration range. The ICS840031I is packaged in a small 8-pin SOIC, making it ideal for use in systems with limited board space.

### FEATURES

- (1) LVCMOS/LVTTL output
- Crystal oscillator interface designed for a 24.576MHz, 18pF parallel resonant crystal
- Output frequency: 98.304MHz (typical)
- VCO range: 490MHz to 640MHz
- RMS phase jitter @ 98.304MHz, using a 24.576MHz crystal (12KHz - 20MHz): 0.75ps (typical)
- RMS phase noise at 98.304MHz (typical)

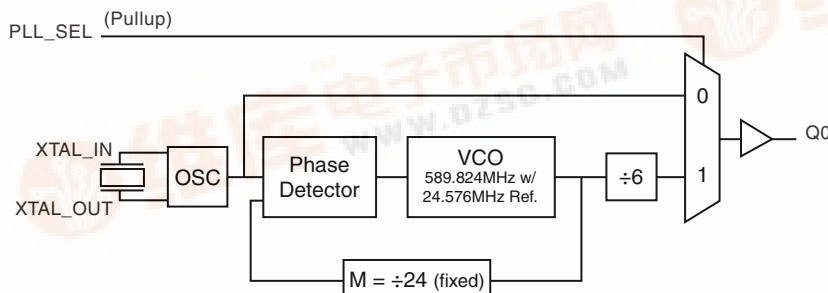
| Offset       | Noise Power   |
|--------------|---------------|
| 100Hz .....  | -103.3 dBc/Hz |
| 1KHz .....   | -126.2 dBc/Hz |
| 10KHz .....  | -134.2 dBc/Hz |
| 100KHz ..... | -132.9 dBc/Hz |

- 3.3V core/1.8V output operating supply
- Lead-Free fully RoHS compliant
- -40°C to 85°C ambient operating temperature

### FREQUENCY TABLE

| Inputs                  | Output Frequency (MHz) |
|-------------------------|------------------------|
| Crystal Frequency (MHz) |                        |
| 24.576                  | 98.304                 |

### BLOCK DIAGRAM



### PIN ASSIGNMENT

|          |   |   |         |
|----------|---|---|---------|
| VDD      | 1 | 8 | VDDO    |
| XTAL_OUT | 2 | 7 | Q0      |
| XTAL_IN  | 3 | 6 | GND     |
| VDDA     | 4 | 5 | PLL_SEL |

### ICS840031I

8-Lead SOIC

3.90mm x 4.90mm x 1.37mm package body

M Package

Top View





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TABLE 1. PIN DESCRIPTIONS

| Number  | Name                 | Type   |        | Description                                                                 |
|---------|----------------------|--------|--------|-----------------------------------------------------------------------------|
| 1       | $V_{DD}$             | Power  |        | Core supply pin.                                                            |
| 2,<br>3 | XTAL_OUT,<br>XTAL_IN | Input  |        | Crystal oscillator interface. XTAL_IN is the input, XTAL_OUT is the output. |
| 4       | $V_{DDA}$            | Power  |        | Analog supply pin.                                                          |
| 5       | PLL_SEL              | Input  | Pullup | PLL select pin. LVCMOS/LVTTL interface levels.                              |
| 6       | GND                  | Power  |        | Power supply ground.                                                        |
| 7       | Q0                   | Output |        | Single-ended clock output. LVCMOS/LVTTL interface levels.                   |
| 8       | $V_{DDO}$            | Power  |        | Output supply pin.                                                          |

NOTE: *Pullup* refers to internal input resistors. See Table 2, Pin Characteristics, for typical values.

TABLE 2. PIN CHARACTERISTICS

| Symbol       | Parameter                     | Test Conditions                                 | Minimum | Typical | Maximum | Units      |
|--------------|-------------------------------|-------------------------------------------------|---------|---------|---------|------------|
| $C_{IN}$     | Input Capacitance             |                                                 |         | 4       |         | pF         |
| $C_{PD}$     | Power Dissipation Capacitance | $V_{DD} = V_{DDA} = 3.465V$ , $V_{DDO} = 1.89V$ |         | 18      |         | pF         |
| $R_{PULLUP}$ | Input Pullup Resistor         |                                                 |         | 51      |         | k $\Omega$ |
| $R_{OUT}$    | Output Impedance              |                                                 |         | 10      |         | $\Omega$   |



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### ABSOLUTE MAXIMUM RATINGS

|                                          |                           |
|------------------------------------------|---------------------------|
| Supply Voltage, $V_{DD}$                 | 4.6V                      |
| Inputs, $V_I$                            | -0.5V to $V_{DD} + 0.5V$  |
| Outputs, $V_O$                           | -0.5V to $V_{DDO} + 0.5V$ |
| Package Thermal Impedance, $\theta_{JA}$ | 112.7°C/W (0 lfpm)        |
| Storage Temperature, $T_{STG}$           | -65°C to 150°C            |

NOTE: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These ratings are stress specifications only. Functional operation of product at these conditions or any conditions beyond those listed in the *DC Characteristics* or *AC Characteristics* is not implied. Exposure to absolute maximum rating conditions for extended periods may affect product reliability.

**TABLE 3A. POWER SUPPLY DC CHARACTERISTICS,  $V_{DD} = V_{DDA} = 3.3V \pm 5\%$ ,  $V_{DDO} = 1.8V \pm 5\%$ ,  $T_A = -40^\circ\text{C}$  TO  $85^\circ\text{C}$**

| Symbol    | Parameter             | Test Conditions | Minimum | Typical | Maximum | Units |
|-----------|-----------------------|-----------------|---------|---------|---------|-------|
| $V_{DD}$  | Core Supply Voltage   |                 | 3.135   | 3.3     | 3.465   | V     |
| $V_{DDA}$ | Analog Supply Voltage |                 | 3.135   | 3.3     | 3.465   | V     |
| $V_{DDO}$ | Output Supply Voltage |                 | 1.71    | 1.8     | 1.89    | V     |
| $I_{DD}$  | Power Supply Current  |                 |         |         | 55      | mA    |
| $I_{DDA}$ | Analog Supply Current |                 |         |         | 12      | mA    |
| $I_{DDO}$ | Output Supply Current |                 |         |         | 5       | mA    |

**TABLE 3B. LVCMOS/LVTTL DC CHARACTERISTICS,  $V_{DD} = V_{DDA} = 3.3V \pm 5\%$ ,  $V_{DDO} = 1.8V \pm 5\%$ ,  $T_A = -40^\circ\text{C}$  TO  $85^\circ\text{C}$**

| Symbol   | Parameter                   | Test Conditions                              | Minimum | Typical | Maximum        | Units         |
|----------|-----------------------------|----------------------------------------------|---------|---------|----------------|---------------|
| $V_{IH}$ | Input High Voltage          |                                              | 2       |         | $V_{DD} + 0.3$ | V             |
| $V_{IL}$ | Input Low Voltage           |                                              | -0.3    |         | 0.8            | V             |
| $I_{IH}$ | Input High Current          | PLL_SEL<br>$V_{DD} = V_{IN} = 3.465V$        |         |         | 5              | $\mu\text{A}$ |
| $I_{IL}$ | Input Low Current           | PLL_SEL<br>$V_{DD} = 3.465V$ , $V_{IN} = 0V$ | -150    |         |                | $\mu\text{A}$ |
| $V_{OH}$ | Output High Voltage; NOTE 1 |                                              | 1.5     |         |                | V             |
| $V_{OL}$ | Output Low Voltage; NOTE 1  |                                              |         |         | 0.4            | V             |

NOTE 1: Outputs terminated with  $50\Omega$  to  $V_{DD}/2$ . See Parameter Measurement Information Section, "3.3V/1.8V Output Load Test Circuit".

**TABLE 4. CRYSTAL CHARACTERISTICS**

| Parameter                          | Test Conditions | Minimum     | Typical | Maximum | Units    |
|------------------------------------|-----------------|-------------|---------|---------|----------|
| Mode of Oscillation                |                 | Fundamental |         |         |          |
| Frequency                          | $F\_SEL = 1$    | 20.417      | 24.576  | 26.667  | MHz      |
| Equivalent Series Resistance (ESR) |                 |             |         | 50      | $\Omega$ |
| Shunt Capacitance                  |                 |             |         | 7       | pF       |

**TABLE 5. AC CHARACTERISTICS,  $V_{DD} = V_{DDA} = 3.3V \pm 5\%$ ,  $V_{DDO} = 1.8V \pm 5\%$ ,  $T_A = -40^\circ\text{C}$  TO  $85^\circ\text{C}$**

| Symbol               | Parameter                         | Test Conditions                                    | Minimum | Typical | Maximum | Units |
|----------------------|-----------------------------------|----------------------------------------------------|---------|---------|---------|-------|
| $f_{OUT}$            | Output Frequency                  |                                                    | 81.67   | 98.304  | 106.67  | MHz   |
| $f_{jit}(\emptyset)$ | RMS Phase Jitter (Random); NOTE 1 | $f_{OUT} = 98.304\text{MHz}$ ,<br>(12KHz to 20MHz) |         | 0.75    |         | ps    |
| $t_R / t_F$          | Output Rise/Fall Time             | 20% to 80%                                         | 0.2     |         | 1       | ns    |
| odc                  | Output Duty Cycle                 |                                                    | 46      |         | 54      | %     |

NOTE 1: Please refer to the Phase Noise Plot.

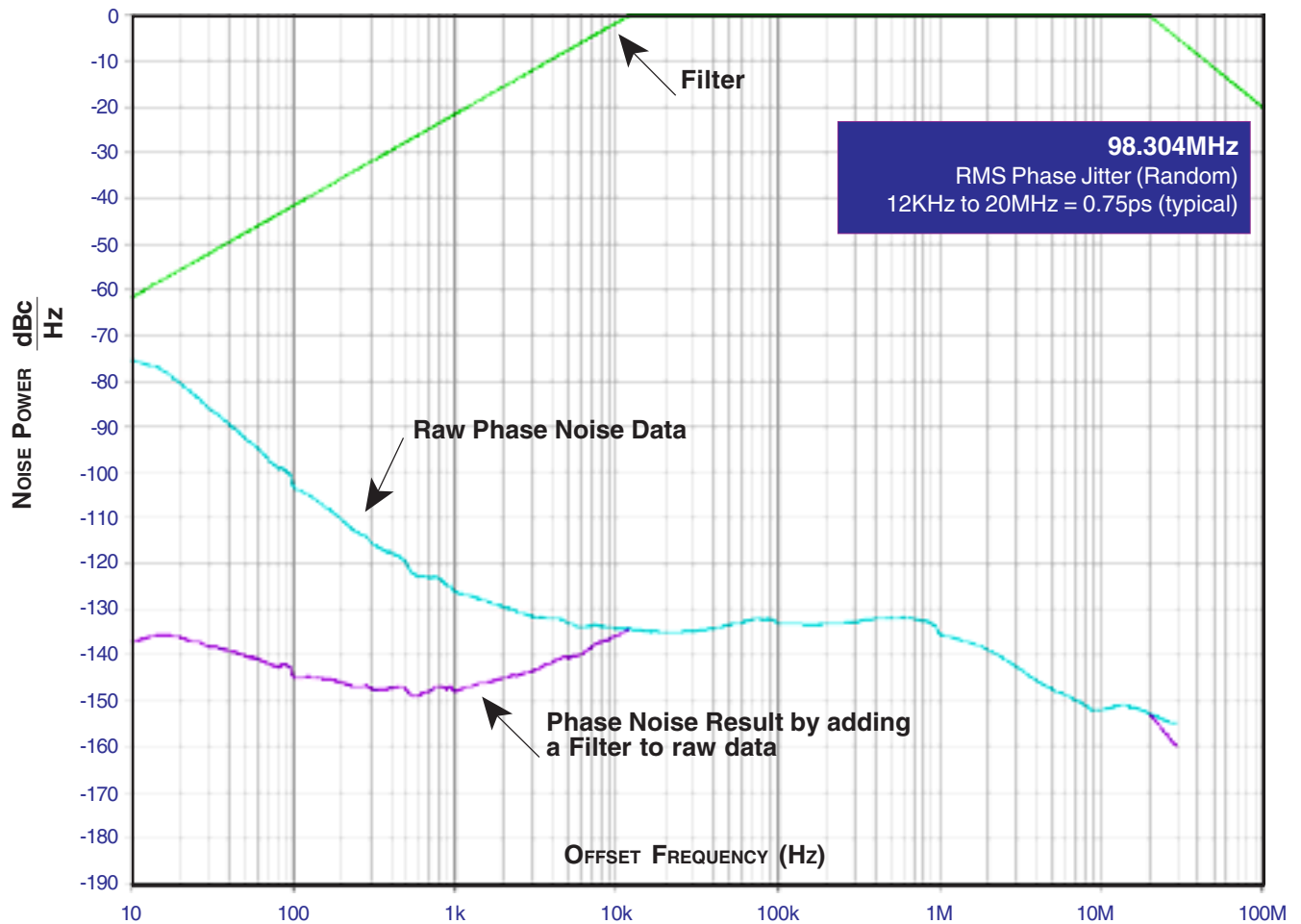


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## TYPICAL PHASE NOISE AT 98.304MHz



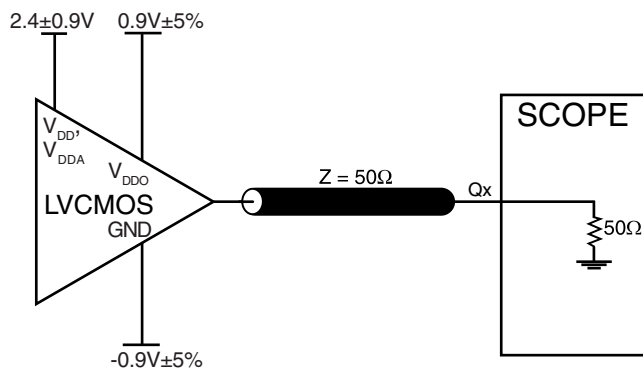


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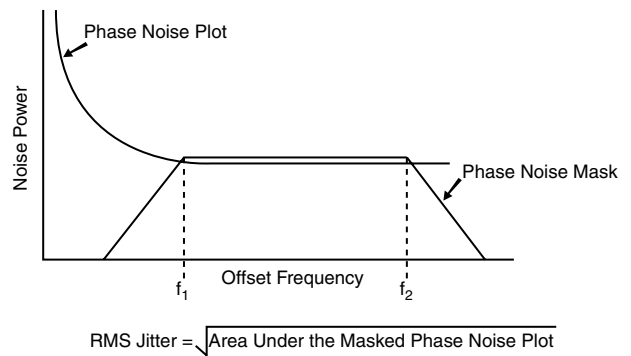
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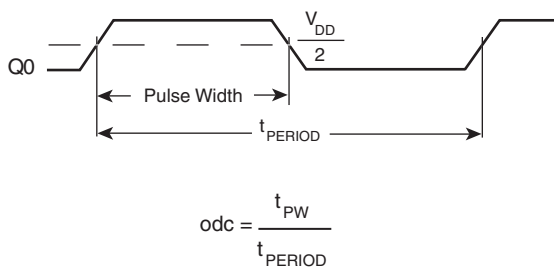
### PARAMETER MEASUREMENT INFORMATION



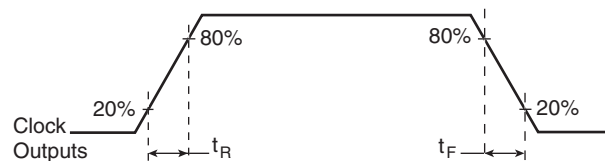
3.3V/1.8V OUTPUT LOAD AC TEST CIRCUIT



RMS PHASE JITTER



OUTPUT DUTY CYCLE/PULSE WIDTH/PERIOD



OUTPUT RISE/FALL TIME



## APPLICATION INFORMATION

### POWER SUPPLY FILTERING TECHNIQUES

As in any high speed analog circuitry, the power supply pins are vulnerable to random noise. The ICS840031I provides separate power supplies to isolate any high switching noise from the outputs to the internal PLL.  $V_{DD}$ ,  $V_{DDA}$ , and  $V_{DDO}$  should be individually connected to the power supply plane through vias, and bypass capacitors should be used for each pin. To achieve optimum jitter performance, power supply isolation is required. *Figure 1* illustrates how a  $10\Omega$  resistor along with a  $10\mu F$  and a  $.01\mu F$  bypass capacitor should be connected to each  $V_{DDA}$  pin.

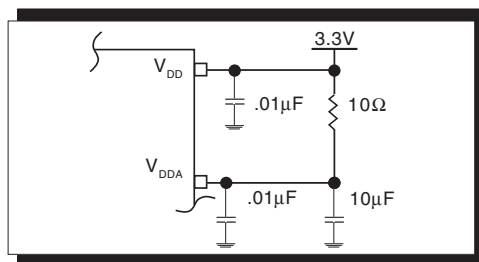


FIGURE 1. POWER SUPPLY FILTERING

### CRYSTAL INPUT INTERFACE

The ICS840031I has been characterized with 18pF parallel resonant crystals. The capacitor values, C1 and C2, shown in *Figure 2* below were determined using a 24.576MHz, 18pF

parallel resonant crystal and were chosen to minimize the ppm error. The optimum C1 and C2 values can be slightly adjusted for different board layouts.

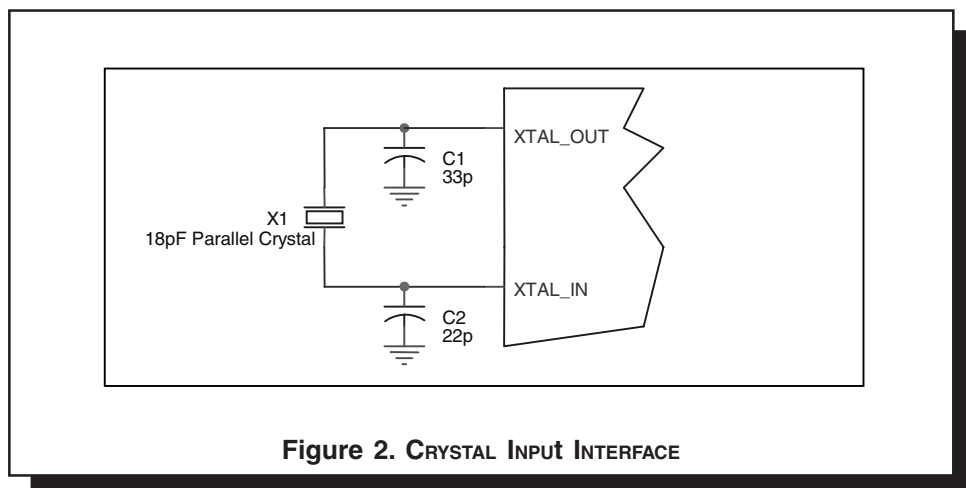


Figure 2. CRYSTAL INPUT INTERFACE



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### APPLICATION SCHEMATIC EXAMPLE

Figure 3 shows a schematic example of the ICS840031I. In this example, a series termination, one of LVCMOS termination approaches, is shown. Additional LVCMOS termination approaches are shown in the LVCMOS Termination Application Note. In this

example, an 18pF parallel resonant crystal is used. The C1=22pF and C2=33pF are approximate values for frequency accuracy. The C1 and C2 may be slightly adjusted for optimizing frequency accuracy.

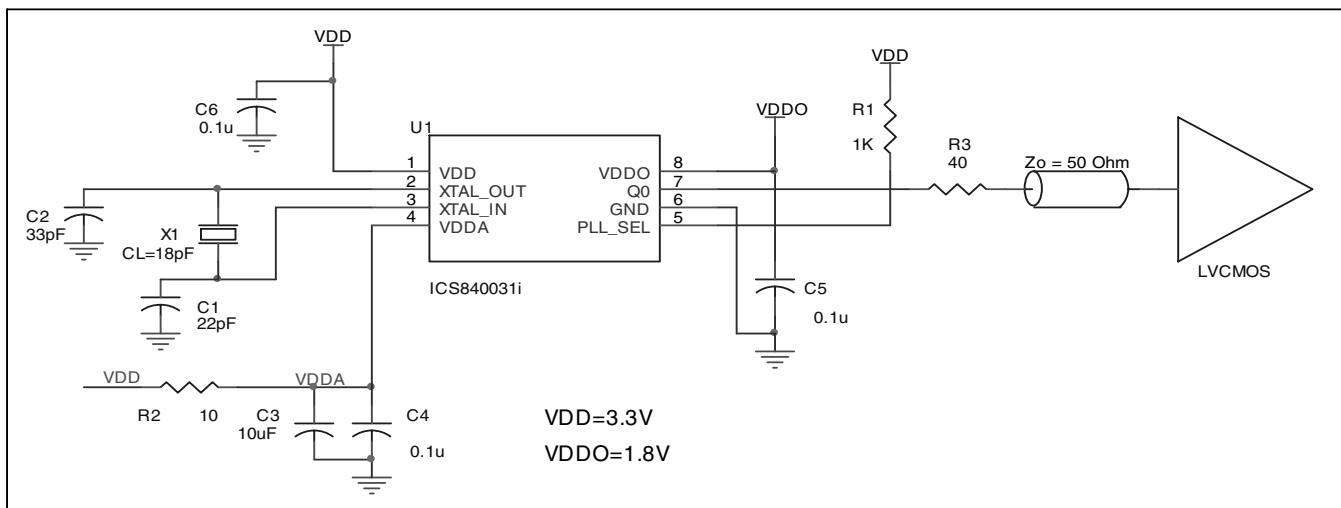


FIGURE 3. ICS840031I APPLICATION SCHEMATIC EXAMPLE

## RELIABILITY INFORMATION

TABLE 6.  $\theta_{JA}$  vs. AIR FLOW TABLE FOR 8 LEAD SOIC

| $\theta_{JA}$ by Velocity (Linear Feet per Minute) |           |           |           |
|----------------------------------------------------|-----------|-----------|-----------|
|                                                    | 0         | 200       | 500       |
| Single-Layer PCB, JEDEC Standard Test Boards       | 153.3°C/W | 128.5°C/W | 115.5°C/W |
| Multi-Layer PCB, JEDEC Standard Test Boards        | 112.7°C/W | 103.3°C/W | 97.1°C/W  |

**NOTE:** Most modern PCB designs use multi-layered boards. The data in the second row pertains to most designs.

### TRANSISTOR COUNT

The transistor count for ICS840031I is: 1787



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## PACKAGE OUTLINE - M SUFFIX FOR 8 LEAD SOIC

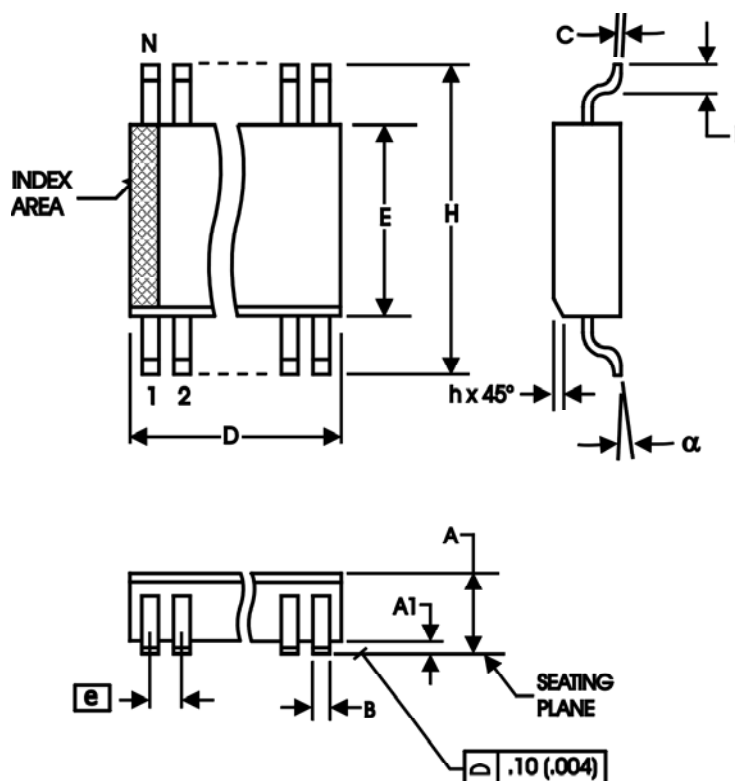


TABLE 7. PACKAGE DIMENSIONS

| SYMBOL | Millimeters |         |
|--------|-------------|---------|
|        | MINIMUM     | MAXIMUM |
| N      | 8           |         |
| A      | 1.35        | 1.75    |
| A1     | 0.10        | 0.25    |
| B      | 0.33        | 0.51    |
| C      | 0.19        | 0.25    |
| D      | 4.80        | 5.00    |
| E      | 3.80        | 4.00    |
| e      | 1.27 BASIC  |         |
| H      | 5.80        | 6.20    |
| h      | 0.25        | 0.50    |
| L      | 0.40        | 1.27    |
| α      | 0°          | 8°      |

Reference Document: JEDEC Publication 95, MS-012



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## FEMTOCLOCKS™ CRYSTAL-TO- LVCMOS/LVTTL CLOCK GENERATOR

TABLE 8. ORDERING INFORMATION

| Part/Order Number | Marking  | Package                 | Count            | Temperature   |
|-------------------|----------|-------------------------|------------------|---------------|
| ICS840031AMI      | 840031AI | 8 lead SOIC             | tube             | -40°C to 85°C |
| ICS840031AMIT     | 840031AI | 8 lead SOIC             | 2500 tape & reel | -40°C to 85°C |
| ICS840031AMILF    | 40031AIL | 8 lead "Lead-Free" SOIC | tube             | -40°C to 85°C |
| ICS840031AMILFT   | 40031AIL | 8 lead "Lead-Free" SOIC | 2500 tape & reel | -40°C to 85°C |