



Integrated  
Circuit  
Systems, Inc.

# ICS840021I

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

### GENERAL DESCRIPTION



The ICS840021I is a Gigabit Ethernet Clock Generator and a member of the HiPerClockS™ family of high performance devices from ICS. The ICS840021I uses a 25MHz crystal to synthesize 125MHz. The ICS840021I has excellent phase jitter performance, over the 1.875MHz – 20MHz integration range. The ICS840021I is packaged in a small 8-pin TSSOP, making it ideal for use in systems with limited board space.

www.DataSheet4U.com

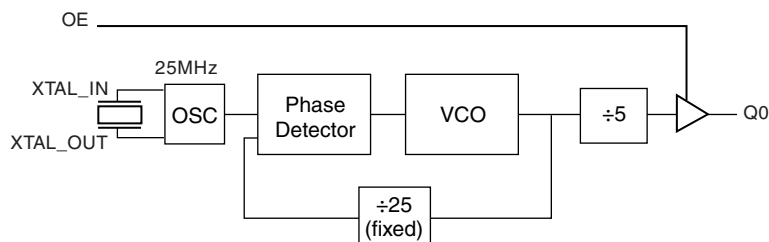
### FEATURES

- 1 LVCMOS/LVTTL output, 15Ω output impedance
- Crystal oscillator interface designed for 25MHz, 18pF parallel resonant crystal
- Output frequency: 125MHz
- VCO range: 560MHz to 680MHz
- RMS phase jitter @ 125MHz, using a 25MHz crystal (1.875MHz - 20MHz): 0.48ps (typical) (3.3V)

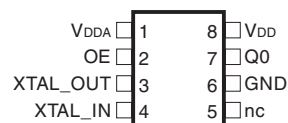
| Offset       | Noise Power   |
|--------------|---------------|
| 100Hz .....  | -97.8 dBc/Hz  |
| 1kHz .....   | -124.6 dBc/Hz |
| 10kHz .....  | -132.5 dBc/Hz |
| 100kHz ..... | -131.1 dBc/Hz |

- Voltage supply modes:  
 $V_{DD}/V_{DDA} = 3.3V$   
 $V_{DD}/V_{DDA} = 2.5V$
- -40°C to 85°C ambient operating temperature
- Lead-Free package fully RoHS compliant

### BLOCK DIAGRAM



### PIN ASSIGNMENT



**ICS840021I**

**8-Lead TSSOP**

4.40mm x 3.0mm x 0.925mm package body

**G Package**

Top View



**TABLE 1. PIN DESCRIPTIONS**

| Number | Name              | Type         | Description                                                                                                          |
|--------|-------------------|--------------|----------------------------------------------------------------------------------------------------------------------|
| 1      | V <sub>DDA</sub>  | Power        | Analog supply pin.                                                                                                   |
| 2      | OE                | Input Pullup | Output enable pin. When HIGH, Q0 output is enabled. When LOW, forces Q0 to HiZ state. LVCMOS/LVTTL interface levels. |
| 3, 4   | XTAL_OUT, XTAL_IN | Input        | Crystal oscillator interface. XTAL_IN is the input, XTAL_OUT is the output.                                          |
| 5      | nc                | Unused       | No connect.                                                                                                          |
| 6      | GND               | Power        | Power supply ground.                                                                                                 |
| 7      | Q0                | Output       | Single-ended clock output. LVCMOS/LVTTL interface levels. 15Ω output impedance.                                      |
| 8      | V <sub>DD</sub>   | Power        | Core 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 <sub>IN</sub>     | Input Capacitance             |                                             |         | 4       |         | pF    |
| C <sub>PD</sub>     | Power Dissipation Capacitance | V <sub>DD</sub> , V <sub>DDA</sub> = 3.465V |         | 7       |         | pF    |
|                     |                               | V <sub>DD</sub> , V <sub>DDA</sub> = 2.625V |         | 7       |         | pF    |
| R <sub>PULLUP</sub> | Input Pullup Resistor         |                                             |         | 51      |         | kΩ    |
| R <sub>OUT</sub>    | Output Impedance              |                                             |         | 15      |         | Ω     |

**TABLE 3. CONTROL FUNCTION TABLE**

| Control Inputs | Output    |
|----------------|-----------|
| <b>OE</b>      | <b>Q0</b> |
| 0              | Hi-Z      |
| 1              | Active    |



#### 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 $V_{DD} + 0.5V$ |
| Package Thermal Impedance, $\theta_{JA}$ | 101.7°C/W (0 mps)        |
| 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.

www.DataSheet4U.com

**TABLE 4A. POWER SUPPLY DC CHARACTERISTICS,  $V_{DD} = V_{DDA} = 3.3V \pm 5\%$ ,  $T_A = -40^\circ\text{C}$  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     |
| $I_{DD}$  | Power Supply Current  |                 |         |         | 65      | mA    |
| $I_{DDA}$ | Analog Supply Current |                 |         |         | 10      | mA    |

**TABLE 4B. POWER SUPPLY DC CHARACTERISTICS,  $V_{DD} = V_{DDA} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ\text{C}$  TO  $85^\circ\text{C}$**

| Symbol    | Parameter             | Test Conditions | Minimum | Typical | Maximum | Units |
|-----------|-----------------------|-----------------|---------|---------|---------|-------|
| $V_{DD}$  | Core Supply Voltage   |                 | 2.375   | 2.5     | 2.625   | V     |
| $V_{DDA}$ | Analog Supply Voltage |                 | 2.375   | 2.5     | 2.625   | V     |
| $I_{DD}$  | Power Supply Current  |                 |         |         | 60      | mA    |
| $I_{DDA}$ | Analog Supply Current |                 |         |         | 10      | mA    |

**TABLE 4C. LVCMOS/LVTTL DC CHARACTERISTICS,  $V_{DD} = V_{DDA} = 3.3V \pm 5\%$  OR  $2.5V \pm 5\%$ ,  $T_A = -40^\circ\text{C}$  TO  $85^\circ\text{C}$**

| Symbol   | Parameter                   | Test Conditions                                     | Minimum | Typical | Maximum        | Units         |
|----------|-----------------------------|-----------------------------------------------------|---------|---------|----------------|---------------|
| $V_{IH}$ | Input High Voltage          | $V_{DD} = 3.3V$                                     | 2       |         | $V_{DD} + 0.3$ | V             |
|          |                             | $V_{DD} = 2.5V$                                     | 1.7     |         | $V_{DD} + 0.3$ | V             |
| $V_{IL}$ | Input Low Voltage           | $V_{DD} = 3.3V$                                     | -0.3    |         | 0.8            | V             |
|          |                             | $V_{DD} = 2.5V$                                     | -0.3    |         | 0.7            | V             |
| $I_{IH}$ | Input High Current          | OE<br>$V_{DD} = V_{IN} = 3.465V$ or $2.625V$        |         |         | 5              | $\mu\text{A}$ |
| $I_{IL}$ | Input Low Current           | OE<br>$V_{DD} = 3.465V$ or $2.625V$ , $V_{IN} = 0V$ | -150    |         |                | $\mu\text{A}$ |
| $V_{OH}$ | Output High Voltage; NOTE 1 | $V_{DD} = 3.465V$                                   | 2.6     |         |                | V             |
|          |                             | $V_{DD} = 2.625V$                                   | 1.8     |         |                | V             |
| $V_{OL}$ | Output Low Voltage; NOTE 1  | $V_{DD} = 3.465V$ or $2.625V$                       |         |         | 0.5            | V             |

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



**TABLE 5. CRYSTAL CHARACTERISTICS**

| Parameter                          | Test Conditions | Minimum     | Typical | Maximum | Units    |
|------------------------------------|-----------------|-------------|---------|---------|----------|
| Mode of Oscillation                |                 | Fundamental |         |         |          |
| Frequency                          |                 |             | 25      |         | MHz      |
| Equivalent Series Resistance (ESR) |                 |             |         | 50      | $\Omega$ |
| Shunt Capacitance                  |                 |             |         | 7       | pF       |
| Drive Level                        |                 |             |         | 1       | mW       |

www.DataSheet4U.com

**TABLE 6A. AC CHARACTERISTICS,  $V_{DD} = V_{DDA} = 3.3V \pm 5\%$ ,  $T_A = -40^\circ\text{C}$  TO  $85^\circ\text{C}$**

| Symbol               | Parameter                         | Test Conditions                      | Minimum | Typical | Maximum | Units |
|----------------------|-----------------------------------|--------------------------------------|---------|---------|---------|-------|
| $f_{OUT}$            | Output Frequency                  |                                      |         | 125     |         | MHz   |
| $f_{jit}(\emptyset)$ | RMS Phase Jitter (Random); NOTE 1 | Integration Range: 1.875MHz to 20MHz |         | 0.48    |         | ps    |
| $t_R / t_F$          | Output Rise/Fall Time             | 20% to 80%                           | 200     |         | 500     | ps    |
| odc                  | Output Duty Cycle                 |                                      | 48      |         | 52      | %     |

NOTE 1: Please refer to the Phase Noise Plot.

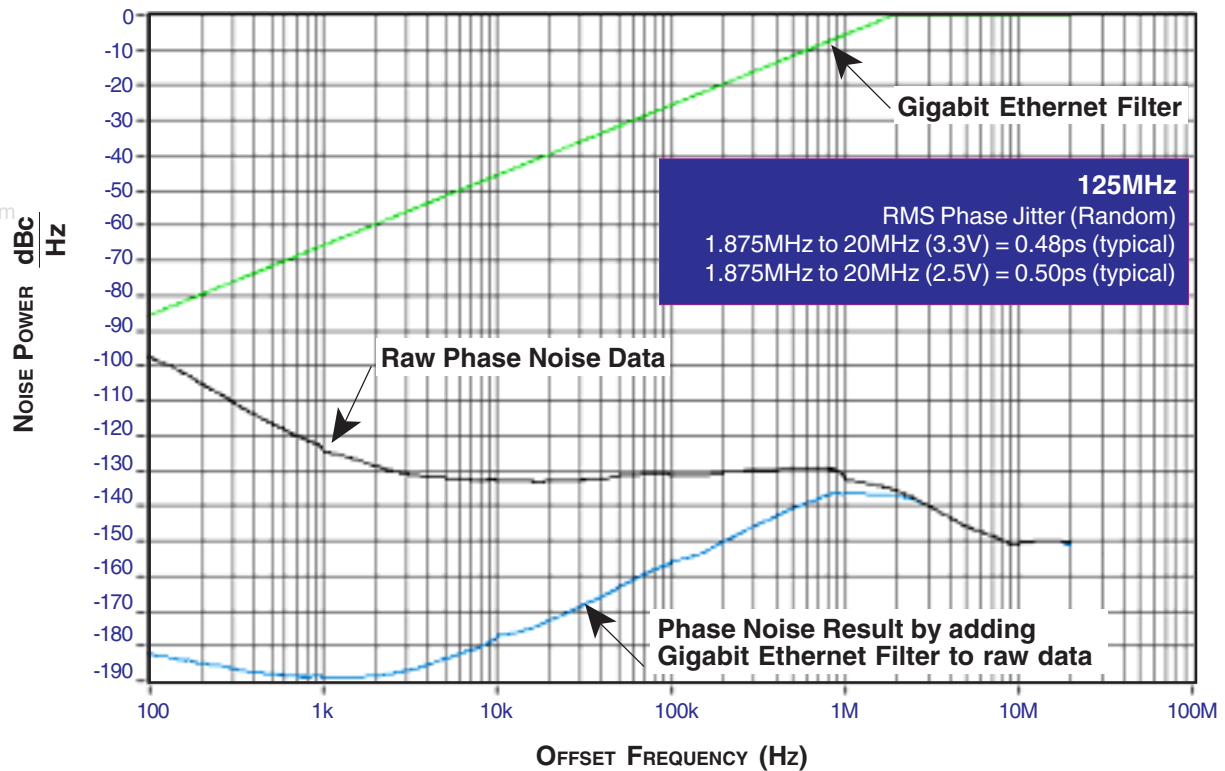
**TABLE 6A. AC CHARACTERISTICS,  $V_{DD} = V_{DDA} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ\text{C}$  TO  $85^\circ\text{C}$**

| Symbol               | Parameter                         | Test Conditions                      | Minimum | Typical | Maximum | Units |
|----------------------|-----------------------------------|--------------------------------------|---------|---------|---------|-------|
| $f_{OUT}$            | Output Frequency                  |                                      |         | 125     |         | MHz   |
| $f_{jit}(\emptyset)$ | RMS Phase Jitter (Random); NOTE 1 | Integration Range: 1.875MHz to 20MHz |         | 0.50    |         | ps    |
| $t_R / t_F$          | Output Rise/Fall Time             | 20% to 80%                           | 250     |         | 550     | ps    |
| odc                  | Output Duty Cycle                 |                                      | 48      |         | 52      | %     |

NOTE 1: Please refer to the Phase Noise Plot.

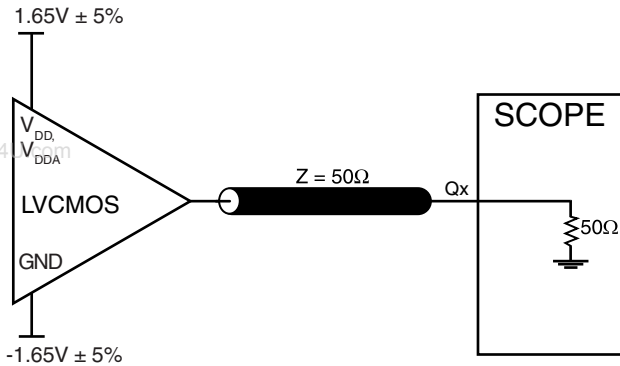


**TYPICAL PHASE NOISE AT 125MHz (3.3V OR 2.5V)**

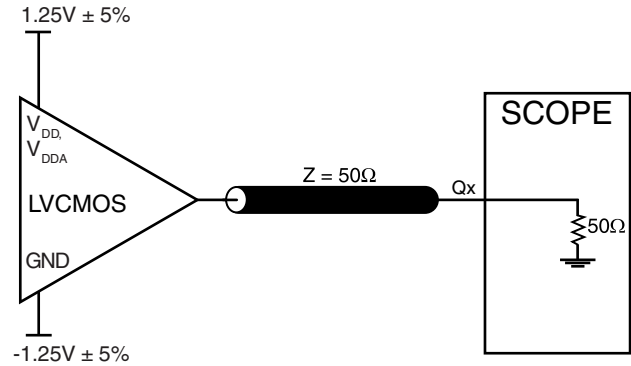




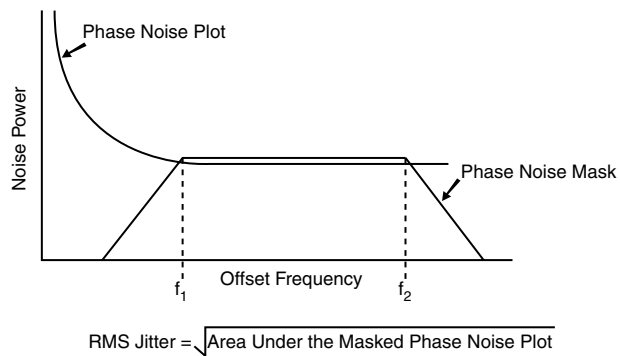
## PARAMETER MEASUREMENT INFORMATION



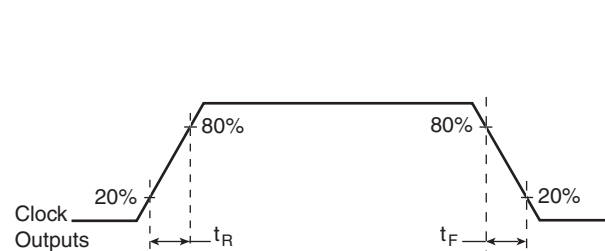
**3.3V OUTPUT LOAD AC TEST CIRCUIT**



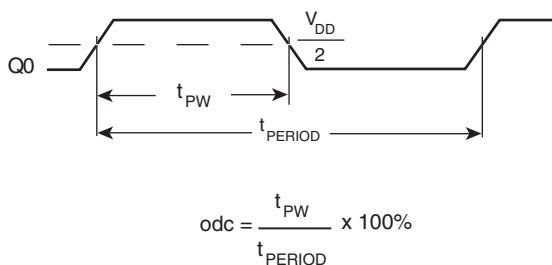
**2.5V OUTPUT LOAD AC TEST CIRCUIT**



**RMS PHASE JITTER**



**OUTPUT RISE/FALL TIME**



**OUTPUT DUTY CYCLE/PULSE WIDTH/PERIOD**



## APPLICATION INFORMATION

### POWER SUPPLY FILTERING TECHNIQUES

As in any high speed analog circuitry, the power supply pins are vulnerable to random noise. The ICS840021I provides separate power supplies to isolate any high switching noise from the outputs to the internal PLL.  $V_{DD}$  and  $V_{DDA}$  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.

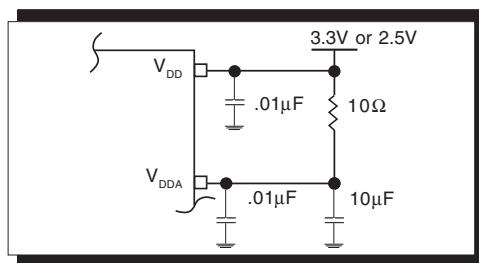


FIGURE 1. POWER SUPPLY FILTERING

### CRYSTAL INPUT INTERFACE

The ICS840021I has been characterized with 18pF parallel resonant crystals. The capacitor values, C1 and C2, shown in *Figure 2* below were determined using a 25MHz, 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.

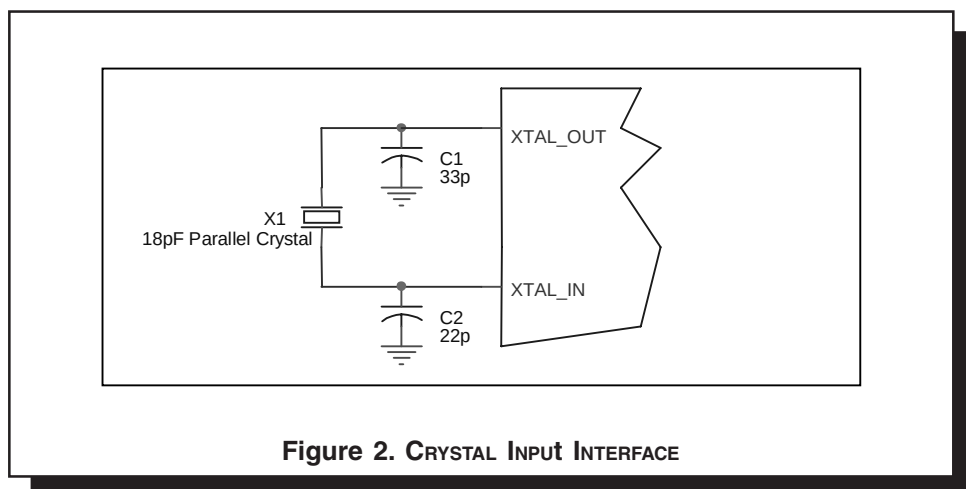


Figure 2. CRYSTAL INPUT INTERFACE



### APPLICATION SCHEMATIC

Figure 3A shows a schematic example of the ICS840021I. An example of LVCMOS termination is shown in this schematic. Additional LVCMOS termination approaches are shown in the LVCMOS Termination Application Note. In this example, an 18pF parallel resonant 25MHz crystal is used for generating 125MHz

output frequency. The C1 = 22pF and C2 = 33pF are recommended for frequency accuracy. For different board layout, the C1 and C2 values may be slightly adjusted for optimizing frequency accuracy.

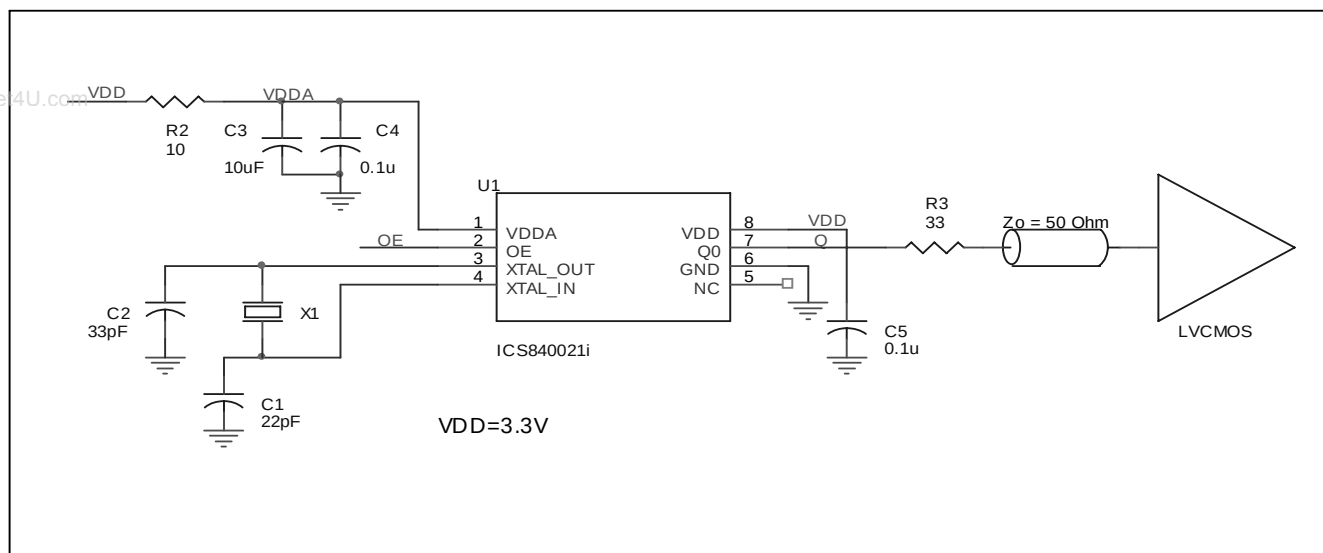


FIGURE 3A. ICS840021I SCHEMATIC EXAMPLE

### PC BOARD LAYOUT EXAMPLE

Figure 3B shows an example of ICS840021I P.C. board layout. The crystal X1 footprint shown in this example allows installation of either surface mount HC49S or through-hole HC49 package. The footprints of other components in this example are listed

in the Table 7. There should be at least one decoupling capacitor per power pin. The decoupling capacitors should be located as close as possible to the power pins. The layout assumes that the board has clean analog power ground plane.

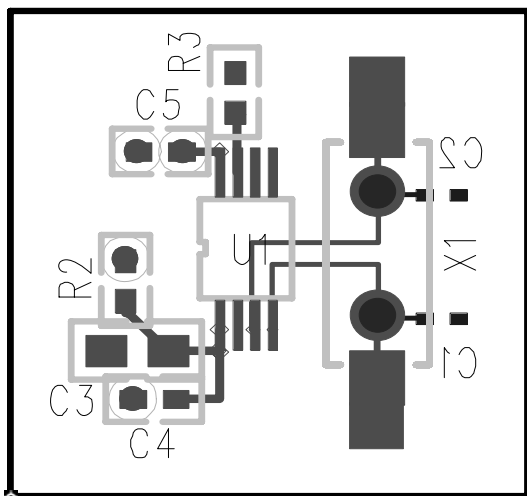


FIGURE 3B. ICS840021I PC BOARD LAYOUT EXAMPLE

TABLE 7. FOOTPRINT TABLE

| Reference | Size |
|-----------|------|
| C1, C2    | 0402 |
| C3        | 0805 |
| C4, C5    | 0603 |
| R2, R3    | 0603 |

NOTE: Table 7, lists component sizes shown in this layout example.





## RELIABILITY INFORMATION

TABLE 8.  $\theta_{JA}$  VS. AIR FLOW TABLE FOR 8 LEAD TSSOP

www.DataSheet4U.com

| $\theta_{JA}$ by Velocity (Meters per Second) |           |          |          |
|-----------------------------------------------|-----------|----------|----------|
|                                               | 0         | 1        | 2.5      |
| Multi-Layer PCB, JEDEC Standard Test Boards   | 101.7°C/W | 90.5°C/W | 89.8°C/W |

### TRANSISTOR COUNT

The transistor count for ICS840021I is: 1961



Integrated  
Circuit  
Systems, Inc.

# ICS840021I

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

### PACKAGE OUTLINE - G SUFFIX FOR 8 LEAD TSSOP

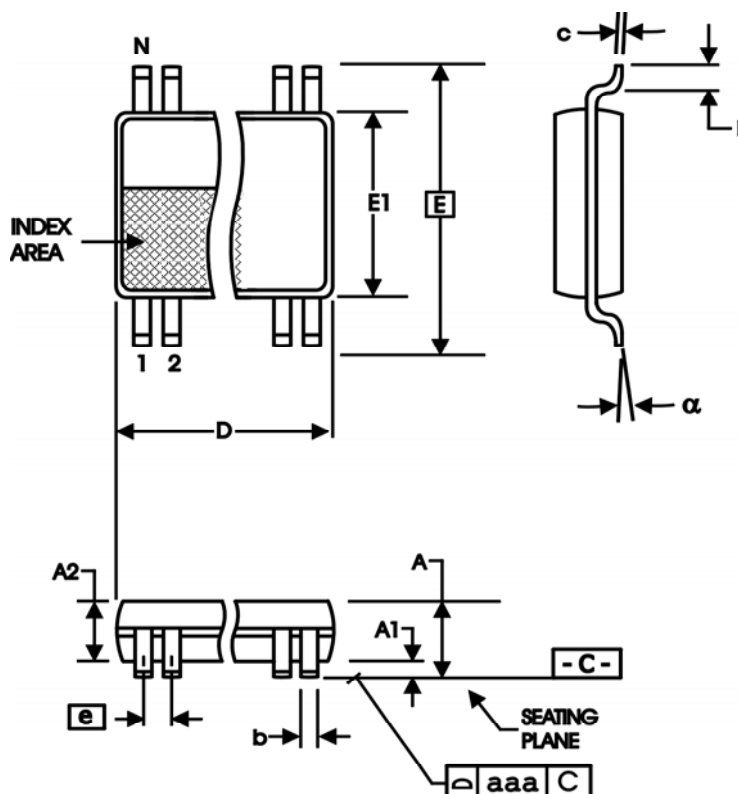


TABLE 9. PACKAGE DIMENSIONS

| SYMBOL   | Millimeters |         |
|----------|-------------|---------|
|          | Minimum     | Maximum |
| N        | 8           |         |
| A        | --          | 1.20    |
| A1       | 0.05        | 0.15    |
| A2       | 0.80        | 1.05    |
| b        | 0.19        | 0.30    |
| c        | 0.09        | 0.20    |
| D        | 2.90        | 3.10    |
| E        | 6.40 BASIC  |         |
| E1       | 4.30        | 4.50    |
| e        | 0.65 BASIC  |         |
| L        | 0.45        | 0.75    |
| $\alpha$ | 0°          | 8°      |
| aaa      | --          | 0.10    |

Reference Document: JEDEC Publication 95, MO-153



Integrated  
Circuit  
Systems, Inc.

# ICS840021I

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

**TABLE 10. ORDERING INFORMATION**

| Part/Order Number | Marking | Package                  | Shipping Packaging | Temperature   |
|-------------------|---------|--------------------------|--------------------|---------------|
| ICS840021AGI      | 021AI   | 8 lead TSSOP             | tube               | -40°C to 85°C |
| ICS840021AGIT     | 021AI   | 8 lead TSSOP             | 2500 tape & reel   | -40°C to 85°C |
| ICS840021AGILF    | TBD     | 8 lead "Lead-Free" TSSOP | tube               | -40°C to 85°C |
| ICS840021AGILFT   | TBD     | 8 lead "Lead-Free" TSSOP | 2500 tape & reel   | -40°C to 85°C |

NOTE: Parts that are ordered with an "LF" suffix to the part number are the Pb-Free configuration and are RoHS compliant.

www.DataSheet4U.com

The aforementioned trademarks, HiPerClockS™ and FemtoClocks™ are a trademark of Integrated Circuit Systems, Inc. or its subsidiaries in the United States and/or other countries. While the information presented herein has been checked for both accuracy and reliability, Integrated Circuit Systems, Incorporated (ICS) assumes no responsibility for either its use or for infringement of any patents or other rights of third parties, which would result from its use. No other circuits, patents, or licenses are implied. This product is intended for use in normal commercial and industrial applications. Any other applications such as those requiring high reliability or other extraordinary environmental requirements are not recommended without additional processing by ICS. ICS reserves the right to change any circuitry or specifications without notice. ICS does not authorize or warrant any ICS product for use in life support devices or critical medical instruments.