



Integrated  
Circuit  
Systems, Inc.

# ICS844022I-02

## FEMTOCLOCKS™ CRYSTAL-TO- LVDS CLOCK GENERATOR

### GENERAL DESCRIPTION



The ICS844022I-02 is an Ethernet Clock Generator and a member of the HiPerClocks™ family of high performance devices from ICS. The ICS844022I-02 uses an 18pF parallel resonant crystal over the range of 24.5MHz - 34MHz. For Ethernet applications, a 25MHz crystal is used and either 62.5MHz or 125MHz may be selected with the FREQ\_SEL pin. The ICS844022I-02 has excellent <1ps phase jitter performance, over the 1.875MHz - 20MHz integration range. The ICS844022I-02 is packaged in a small 8-pin TSSOP, making it ideal for use in systems with limited board space.

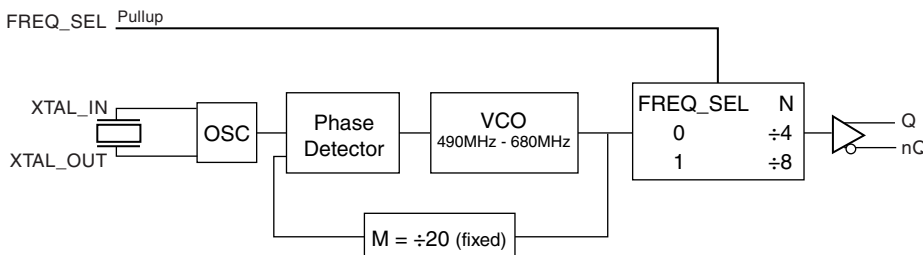
### FEATURES

- (1) Differential LVDS output
- Crystal oscillator interface, 18pF parallel resonant crystal (24.5MHz - 34MHz)
- Output frequency range: 61.25MHz - 170MHz
- VCO range: 490MHz - 680MHz
- RMS phase jitter @ 125MHz, using a 25MHz crystal (1.875MHz - 20MHz): 0.44ps (typical)
- 3.3V or 2.5V operating supply
- -40°C to 85°C ambient operating temperature

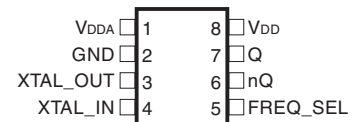
COMMON CONFIGURATION TABLE - Gb ETHERNET

Crystal Frequency (MHz)	Inputs				Output Frequency (MHz)
	FREQ_SEL	M	N	Multiplication Value M/N	
25	0	20	4	5	125
25	1	20	8	2.5	62.5
26.66	0	20	4	5	133.33
26.66	1	20	8	2.5	66.66
33.33	0	20	4	5	166.66
33.33	1	20	8	2.5	83.33

### BLOCK DIAGRAM



### PIN ASSIGNMENT



### ICS844022I-02

8-Lead TSSOP

4.40mm x 3.0mm x 0.925mm

package body

**G Package**

Top View

The Preliminary Information presented herein represents a product in prototyping or pre-production. The noted characteristics are based on initial product characterization. Integrated Circuit Systems, Incorporated (ICS) reserves the right to change any circuitry or specifications without notice.



**TABLE 1. PIN DESCRIPTIONS**

Number	Name	Type		Description
1	V <sub>DDA</sub>	Power		Analog supply pin.
2	GND	Power		Power supply ground.
3, 4	XTAL_OUT, XTAL_IN	Input		Crystal oscillator interface. XTAL_IN is the input, XTAL_OUT is the output.
5	FREQ_SEL	Input	Pullup	Frequency select pin LVCMOS interface levels.
6, 7	nQ, Q	Output		Differential clock outputs. LVDS interface levels.
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
R <sub>PULLUP</sub>	Input Pullup Resistor			51		kΩ



**ABSOLUTE MAXIMUM RATINGS**

Supply Voltage, $V_{DD}$	4.6V
Inputs, $V_I$	-0.5V to $V_{DD} + 0.5V$
Outputs, $I_O$ (LVDS)	
Continuous Current	10mA
Surge Current	15mA
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.

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

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			TBD		mA
$I_{DDA}$	Analog Supply Current			TBD		mA

**TABLE 3B. POWER SUPPLY DC CHARACTERISTICS,  $V_{DD} = V_{DDA} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ C$  TO  $85^\circ C$**

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			TBD		mA
$I_{DDA}$	Analog Supply Current			TBD		mA

**TABLE 3C. LVCMOS/LVTTL DC CHARACTERISTICS,  $V_{DD} = V_{DDA} = 3.3V \pm 5\%$  OR  $2.5V \pm 5\%$ ,  $T_A = -40^\circ C$  TO  $85^\circ C$**

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	FREQ_SEL $V_{DD} = V_{IN} = 3.465V$ or $2.625V$			5	$\mu A$
$I_{IL}$	Input Low Current	FREQ_SEL $V_{DD} = 3.465V$ or $2.625V$ , $V_{IN} = 0V$	-150			$\mu A$

**TABLE 3D. LVDS DC CHARACTERISTICS,  $V_{DD} = V_{DDA} = 3.3V \pm 5\%$ ,  $T_A = -40^\circ C$  TO  $85^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{OD}$	Differential Output Voltage			350		mV
$\Delta V_{OD}$	$V_{OD}$ Magnitude Change			40		mV
$V_{OS}$	Offset Voltage			1.25		V
$\Delta V_{OS}$	$V_{OS}$ Magnitude Change			50		mV

NOTE: Please refer to Parameter Measurement Information for output information.



**TABLE 3E. LVDS DC CHARACTERISTICS,  $V_{DD} = V_{DDA} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ C$  TO  $85^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{OD}$	Differential Output Voltage			350		mV
$\Delta V_{OD}$	$V_{OD}$ Magnitude Change			50		mV
$V_{OS}$	Offset Voltage			1.2		V
$\Delta V_{OS}$	$V_{OS}$ Magnitude Change			40		mV

NOTE: Please refer to Parameter Measurement Information for output information.

**TABLE 4. CRYSTAL CHARACTERISTICS**

Parameter	Test Conditions	Minimum	Typical	Maximum	Units
Mode of Oscillation		Fundamental			
Frequency		24.5		34	MHz
Equivalent Series Resistance (ESR)				50	$\Omega$
Shunt Capacitance				7	pF
Drive Level				1	mW

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

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{OUT}$	Output Frequency		61.25		170	MHz
$f_{jit}(\emptyset)$	RMS Phase Jitter ( Random); NOTE 1	125MHz @ Integration Range: 1.875MHz - 20MHz		0.44		ps
$t_R / t_F$	Output Rise/Fall Time	20% to 80%		260		ps
odc	Output Duty Cycle			50		%

NOTE 1: Please refer to the Phase Noise Plots following this section.

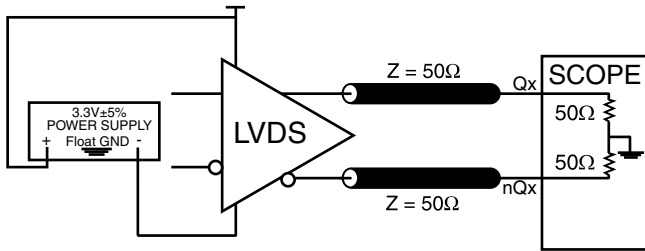
**TABLE 5B. AC CHARACTERISTICS,  $V_{DD} = V_{DDA} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ C$  TO  $85^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{OUT}$	Output Frequency		61.25		170	MHz
$f_{jit}(\emptyset)$	RMS Phase Jitter ( Random); NOTE 1	125MHz @ Integration Range: 1.875MHz - 20MHz		0.45		ps
$t_R / t_F$	Output Rise/Fall Time	20% to 80%		270		ps
odc	Output Duty Cycle			50		%

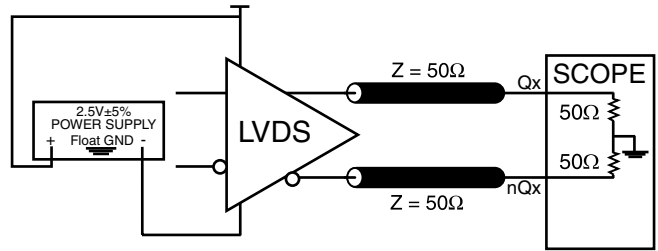
NOTE 1: Please refer to the Phase Noise Plots following this section.



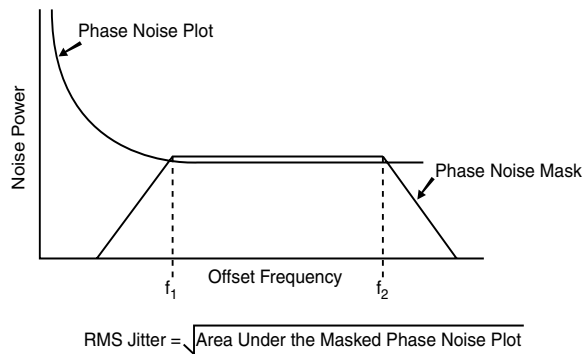
**PARAMETER MEASUREMENT INFORMATION**



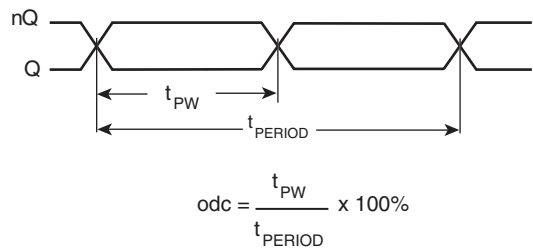
**LVDS 3.3V OUTPUT LOAD AC TEST CIRCUIT**



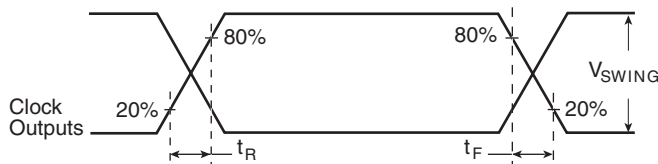
**LVDS 2.5V OUTPUT LOAD AC TEST CIRCUIT**



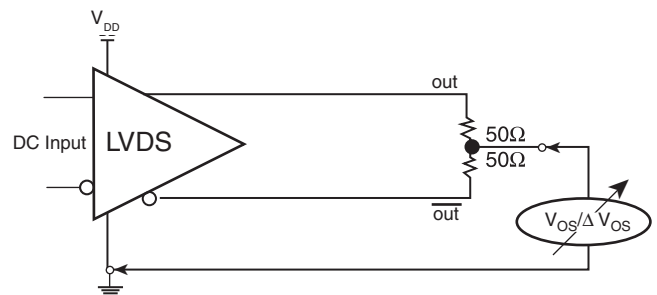
**RMS PHASE JITTER**



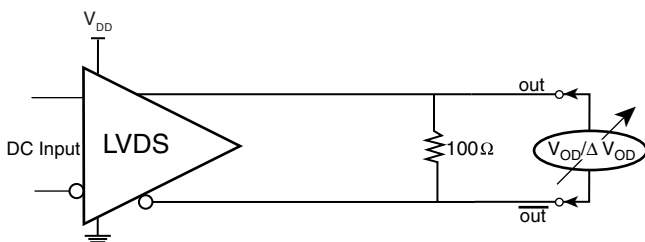
**OUTPUT DUTY CYCLE/PULSE WIDTH/PERIOD**



**OUTPUT RISE/FALL TIME**



**OFFSET VOLTAGE SETUP**



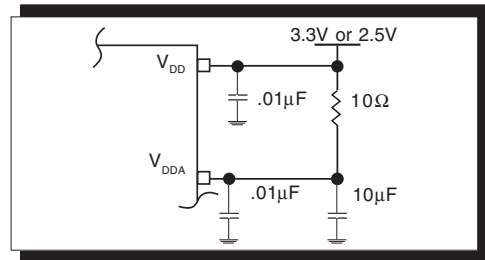
**DIFFERENTIAL OUTPUT VOLTAGE SETUP**



## APPLICATION INFORMATION

### POWER SUPPLY FILTERING TECHNIQUES

As in any high speed analog circuitry, the power supply pins are vulnerable to random noise. The ICS844022I-02 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  $10\mu\text{F}$  and a  $.01\mu\text{F}$  bypass capacitor should be connected to each  $V_{DDA}$  pin.

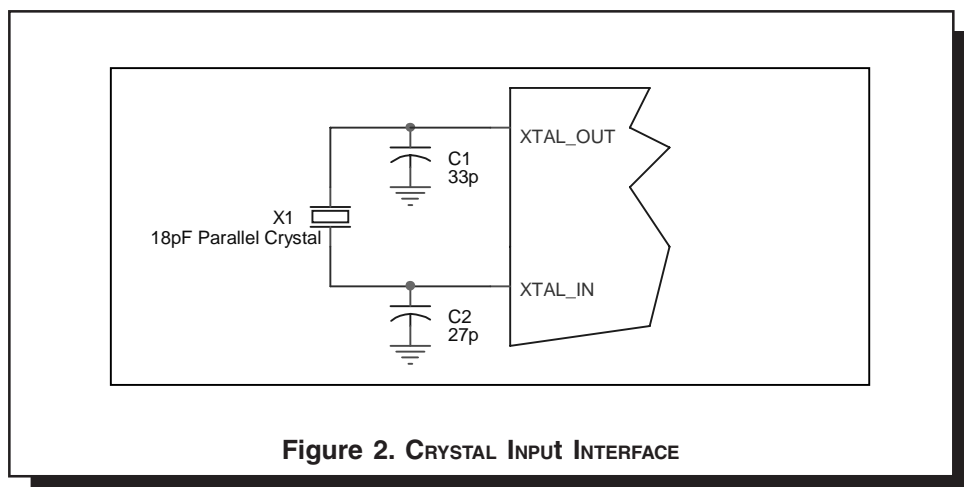


**FIGURE 1. POWER SUPPLY FILTERING**

### CRYSTAL INPUT INTERFACE

The ICS844022I-02 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.



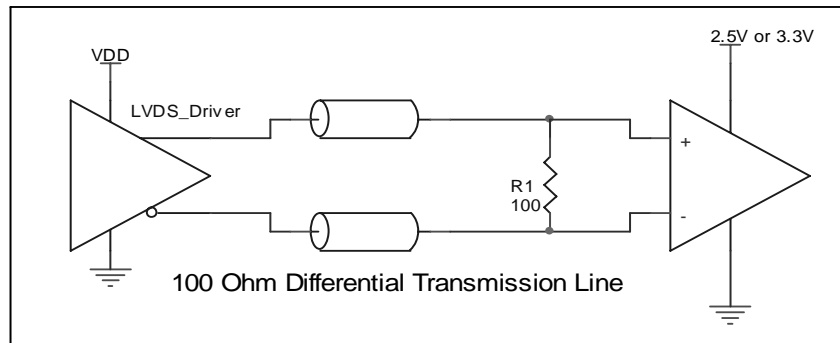
**Figure 2. CRYSTAL INPUT INTERFACE**



### 3.3V, 2.5V LVDS DRIVER TERMINATION

A general LVDS interface is shown in *Figure 3*. In a 100Ω differential transmission line environment, LVDS drivers require a matched load termination of 100Ω across near

the receiver input. For a multiple LVDS outputs buffer, if only partial outputs are used, it is recommended to terminate the un-used outputs.



**FIGURE 3. TYPICAL LVDS DRIVER TERMINATION**



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**PRELIMINARY**

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FEMTOCLOCKS™ CRYSTAL-TO- LVDS  
CLOCK GENERATOR

**RELIABILITY INFORMATION**

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

$\theta_{JA}$ by Velocity (Meters per Second)			
	<b>0</b>	<b>2</b>	<b>2.5</b>
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 ICS844022I-02 is: 2533





PACKAGE OUTLINE - G SUFFIX FOR 8 LEAD TSSOP

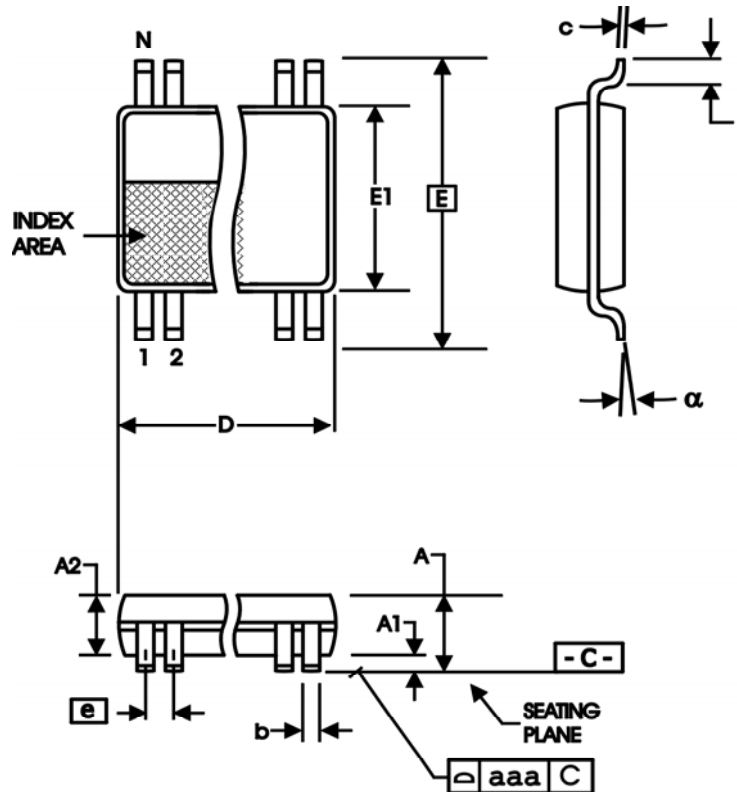


TABLE 7. PACKAGE DIMENSIONS

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



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**PRELIMINARY**

**ICS844022I-02**  
FEMTOCLOCKS™ CRYSTAL-TO- LVDS  
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**TABLE 8. ORDERING INFORMATION**

Part/Order Number	Marking	Package	Shipping Packaging	Temperature
ICS844022AGI-02	TBD	8 lead TSSOP	tube	-40°C to 85°C
ICS844022AGI-02T	TBD	8 lead TSSOP	2500 tape & reel	-40°C to 85°C

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