



Integrated  
Circuit  
Systems, Inc.

**ICS844071I**  
FEMTOCLOCKS™ CRYSTAL-TO- LVDS  
CLOCK GENERATOR

**GENERAL DESCRIPTION**



The ICS844071I is a Serial ATA (SATA)/Serial Attached SCSI (SAS) Clock Generator and a member of the HiPerClocks™ family of high performance devices from ICS. The ICS844071I uses an 18pF parallel resonant crystal over the range of 20.833MHz - 28.3MHz. For SATA/SAS applications, a 25MHz crystal is used and either 75MHz or 150MHz may be selected with the FREQ\_SEL pin. The ICS844071I has excellent <1ps phase jitter performance, over the 12kHz - 20MHz integration range. The ICS844071I is packaged in a small 8-pin TSSOP, making it ideal for use in systems with limited board space.

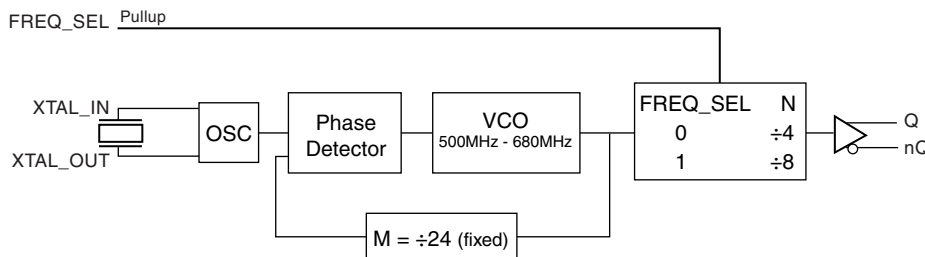
**FEATURES**

- (1) Differential LVDS output
- Crystal oscillator interface, 18pF parallel resonant crystal (20.833MHz - 28.3MHz)
- Output frequency range: 62.5MHz - 170MHz
- VCO range: 500MHz - 680MHz
- RMS phase jitter @ 150MHz, using a 25MHz crystal (12kHz - 20MHz): 0.75ps (typical)
- 3.3V or 2.5V operating supply
- -40°C to 85°C ambient operating temperature
- Replaces ICS844051-11

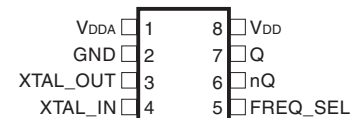
**COMMON CONFIGURATION TABLE**

Inputs					Output Frequency (MHz)
Crystal Frequency (MHz)	FREQ_SEL	M	N	Multiplication Value M/N	
25	0	24	4	6	150
25	1	24	8	3	75
26.041666	0	24	4	6	156.25
26.041666	1	24	8	3	78.125
26.5625	0	24	4	6	159.375
26.5625	1	24	8	3	79.675

**BLOCK DIAGRAM**



**PIN ASSIGNMENT**



**ICS844071I**

**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/LVTTL interface levels.
6, 7	nQ, Q	Output		Differential clock outputs. HSTL 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			$\mu A$

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



**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

**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

**TABLE 4. CRYSTAL CHARACTERISTICS**

Parameter	Test Conditions	Minimum	Typical	Maximum	Units
Mode of Oscillation		Fundamental			
Frequency		20.833		28.3	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		62.5		170	MHz
$f_{jit}(\emptyset)$	RMS Phase Jitter ( Random); NOTE 1	150MHz @ Integration Range: 12kHz - 20MHz		0.75		ps
		75MHz @ Integration Range: 12kHz - 20MHz		0.68		ps
$t_R / t_F$	Output Rise/Fall Time	20% to 80%		300		ps
odc	Output Duty Cycle			50		%

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

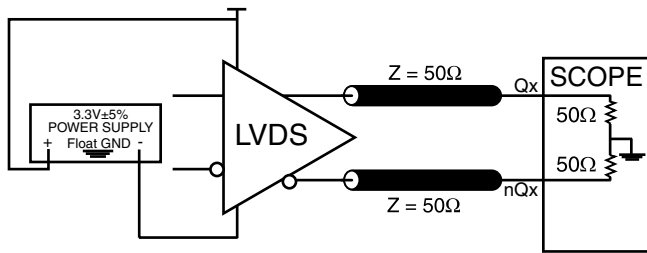
**TABLE 5B. AC CHARACTERISTICS,  $V_{DD} = V_{DDA} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ C$  TO  $85^\circ C$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{OUT}$	Output Frequency		62.5		170	MHz
$f_{jit}(\emptyset)$	RMS Phase Jitter ( Random); NOTE 1	150MHz @ Integration Range: 12kHz - 20MHz		0.96		ps
		75MHz @ Integration Range: 12kHz - 20MHz		0.98		ps
$t_R / t_F$	Output Rise/Fall Time	20% to 80%		300		ps
odc	Output Duty Cycle			50		%

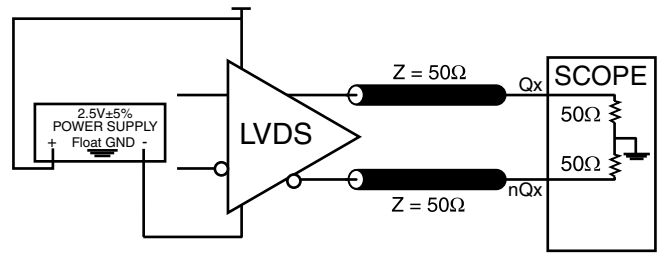
NOTE 1: Please refer to the Phase Noise Plots following this section.



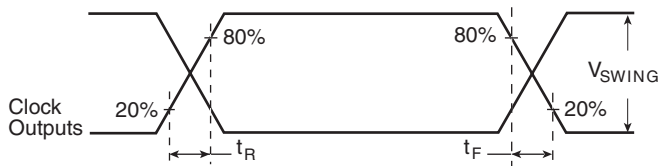
**PARAMETER MEASUREMENT INFORMATION**



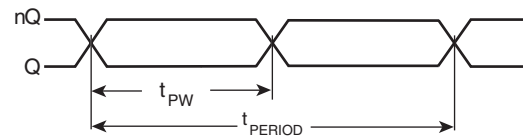
**LVDS 3.3V OUTPUT LOAD AC TEST CIRCUIT**



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

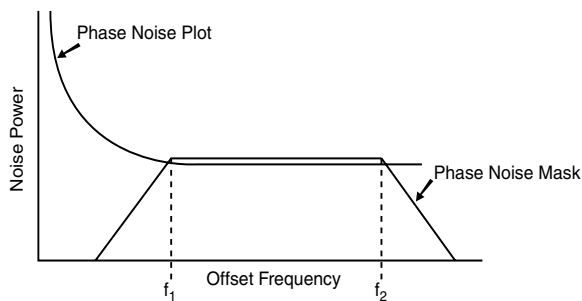


**OUTPUT RISE/FALL TIME**



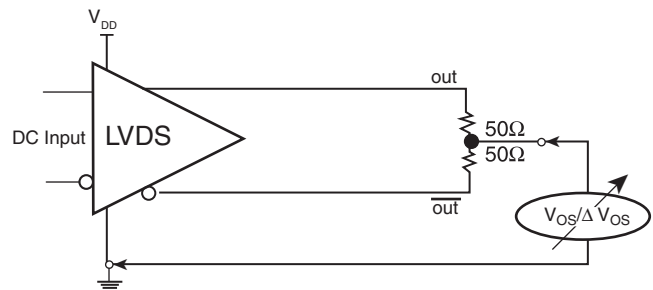
$$odc = \frac{t_{PW}}{t_{PERIOD}} \times 100\%$$

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

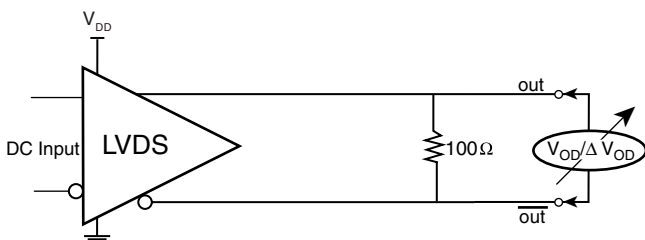


$$RMS\ Jitter = \sqrt{\text{Area Under the Masked Phase Noise Plot}}$$

**RMS PHASE JITTER**



**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 ICS844071I 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 10Ω resistor along with a 10μF and a .01μF bypass capacitor should be connected to each  $V_{DDA}$  pin.

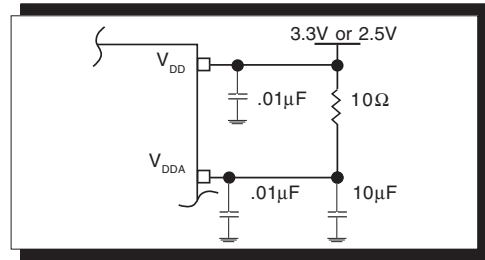


FIGURE 1. POWER SUPPLY FILTERING

### RECOMMENDATIONS FOR UNUSED INPUT AND OUTPUT PINS

#### INPUTS:

##### CRYSTAL INPUT:

For applications not requiring the use of the crystal oscillator input, both XTAL\_IN and XTAL\_OUT can be left floating. Though not required, but for additional protection, a 1kΩ resistor can be tied from XTAL\_IN to ground.

##### CLK INPUT:

For applications not requiring the use of the test clock, it can be left floating. Though not required, but for additional protection, a 1kΩ resistor can be tied from the CLK input to ground.

##### TEST\_CLK INPUT:

For applications not requiring the use of the test clock, it can be left floating. Though not required, but for additional protection, a 1kΩ resistor can be tied from the TEST\_CLK to ground.

##### CLK/nCLK INPUT:

For applications not requiring the use of the differential input, both CLK and nCLK can be left floating. Though not required, but for additional protection, a 1kΩ resistor can be tied from CLK to ground.

##### PCLK/nPCLK INPUT:

For applications not requiring the use of a differential input, both the PCLK and nPCLK pins can be left floating. Though not required, but for additional protection, a 1kΩ resistor can be tied from PCLK to ground.

#### SELECT PINS:

All select pins have internal pull-ups and pull-downs; additional resistance is not required but can be added for additional protection. A 1kΩ resistor can be used.

#### OUTPUTS:

##### LVC MOS OUTPUT:

All unused LVC MOS output can be left floating. We recommend that there is no trace attached.

##### LVPECL OUTPUT

All unused LVPECL outputs can be left floating. We recommend that there is no trace attached. Both sides of the differential output pair should either be left floating or terminated.

##### L VHSTL OUTPUT

All unused LVHSTL outputs can be left floating. We recommend that there is no trace attached. Both sides of the differential output pair should either be left floating or terminated.

##### LVDS OUTPUT

All unused LVDS outputs should be terminated with 100Ω resistor between the differential pair.

##### LVDS – Like OUTPUT

All unused LVDS outputs can be left floating. We recommend that there is no trace attached. Both sides of the differential output pair should either be left floating or terminated.

##### HCSL OUTPUT

All unused HCSL outputs can be left floating. We recommend that there is no trace attached. Both sides of the differential output pair should either be left floating or terminated.

##### SSTL OUTPUT

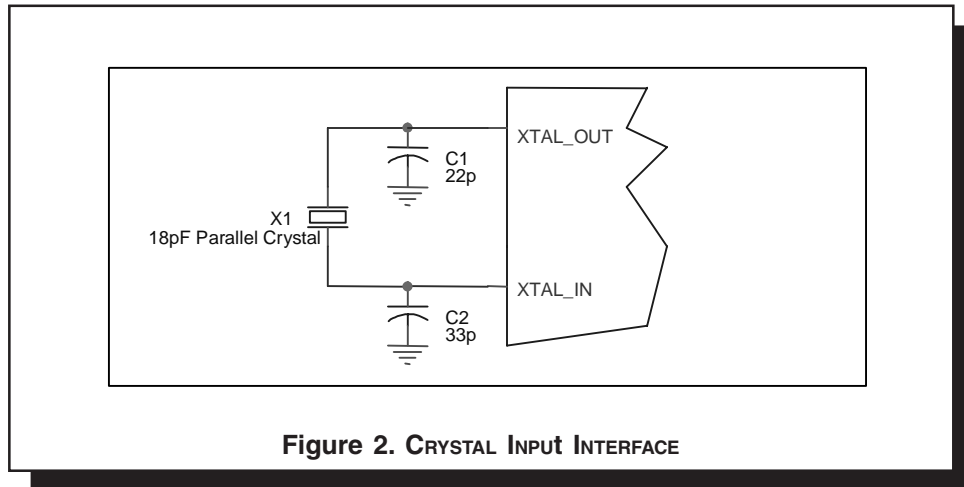
All unused SSTL outputs can be left floating. We recommend that there is no trace attached. Both sides of the differential output pair should either be left floating or terminated.



**CRYSTAL INPUT INTERFACE**

The ICS844071I 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

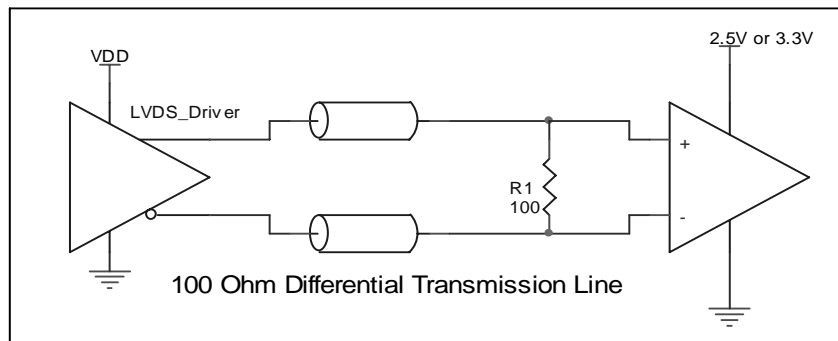
resonant crystal and were chosen to minimize the ppm error. The optimum C1 and C2 values can be slightly adjusted for different board layouts.



**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.





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**PRELIMINARY**

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**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>1</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 ICS844071I is: 2533





PACKAGE OUTLINE - G SUFFIX FOR 8 LEAD TSSOP

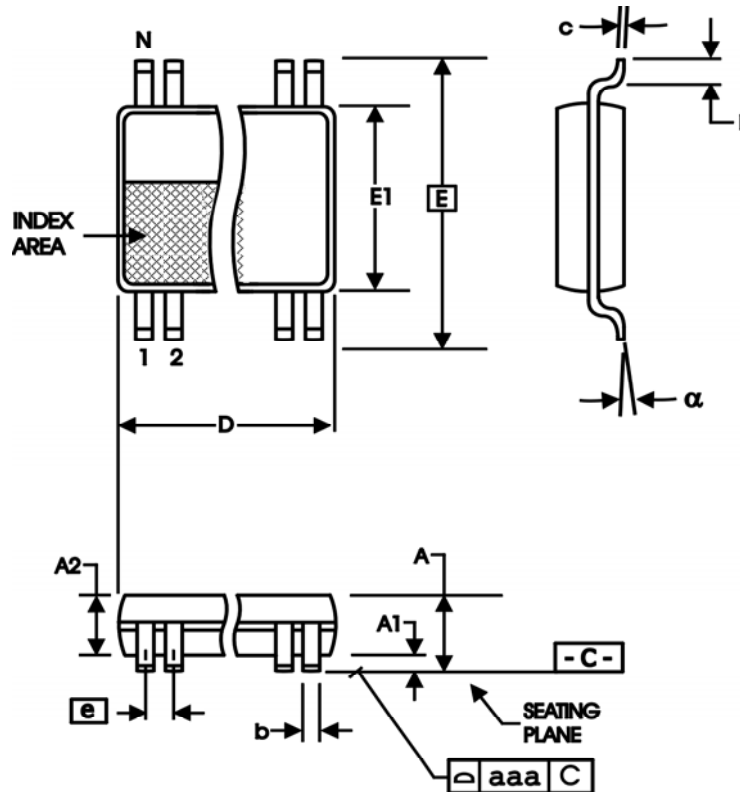


TABLE 7. PACKAGE DIMENSIONS

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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**TABLE 8. ORDERING INFORMATION**

Part/Order Number	Marking	Package	Shipping Packaging	Temperature
ICS844071AGI	4071A	8 Lead TSSOP	tube	-40°C to 85°C
ICS844071AGIT	4071A	8 Lead TSSOP	2500 tape & reel	-40°C to 85°C

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