Integrated Circuit Systems, Inc.

ICS8705I
ZERO DELAY DIFFERENTIAL-TO-LVCMOS CLOCK GENERATOR

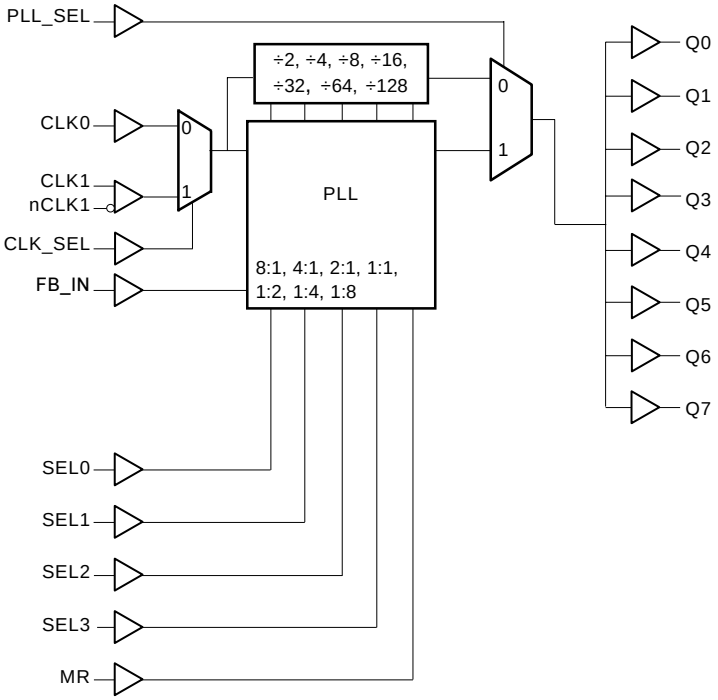
GENERAL DESCRIPTION

The ICS8705I is a highly versatile 1:8 Differential-to-LVCMOS clock generator and a member of the HiPerClockS™ family of High Performance Clock Solutions from ICS. The ICS8705I has two selectable clock inputs. The CLK1, nCLK1 pair can accept most standard differential input levels. The single ended CLK0 input accepts LVCMOS or LVTTL input levels.The ICS8705I has a fully integrated PLL and can be configured as zero delay buffer, multiplier or divider and has an input and output frequency range of 15.625MHz to 250MHz. The reference divider, feedback divider and output divider are each programmable, thereby allowing for the following output-to-input frequency ratios: 8:1, 4:1, 2:1, 1:1, 1:2, 1:4, 1:8. The external feedback allows the device to achieve "zero delay" between the input clock and the output clocks. The PLL_SEL pin can be used to bypass the PLL for system test and debug purposes. In bypass mode, the reference clock is routed around the PLL and into the internal output dividers.

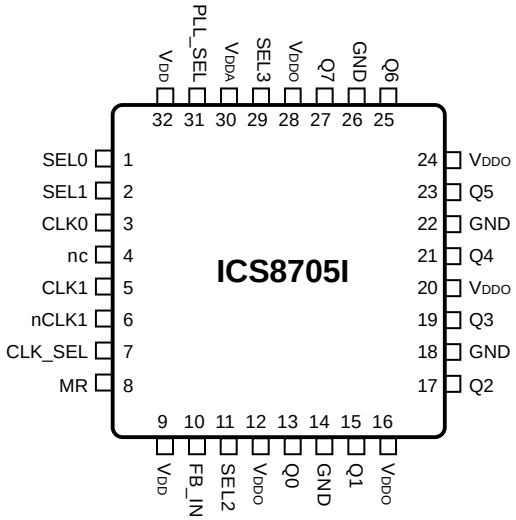
FEATURES

- 8 LVCMOS outputs, 7Ω typical output impedance
- Selectable CLK1, nCLK1 or LVCMOS clock inputs
- CLK1, nCLK1 pair can accept the following differential input levels: LVDS, LVPECL, LVHSTL, SSTL, HCSL
- CLK0 input accepts LVCMOS or LVTTL input levels
- Output frequency range: 15.625MHz to 250MHz
- Input frequency range: 15.625MHz to 250MHz
- VCO range: 250MHz to 500MHz
- External feedback for "zero delay" clock regeneration with configurable frequencies
- Programmable dividers allow for the following output-to-input frequency ratios: 8:1, 4:1, 2:1, 1:1, 1:2, 1:4, 1:8
- Fully integrated PLL
- Cycle-to-cycle jitter: 45ps (maximum)
- Output skew: CLK0, 65ps (maximum)
  CLK1, nCLK1, 55ps (maximum)
- Static Phase Offset: 25 ±125ps (maximum), CLK0
- Full 3.3V or 2.5V operating supply
- -40°C to 85°C ambient operating temperature

BLOCK DIAGRAM



PIN ASSIGNMENT



32-Lead LQFP
7mm x 7mm x 1.4 mm
Y Package
Top View

TABLE 1. PIN DESCRIPTIONS

Number	Name	Type		Description
1, 2	SEL0, SEL1	Input	Pulldown	Determines output divider values in Table 3. LVCMOS interface levels.
3	CLK0	Input	Pulldown	Non-inverting LVCMOS clock input.
4	nc			No connect.
5	CLK1	Input	Pulldown	Non-inverting differential clock input.
6	nCLK1	Input	Pullup	Inverting differential clock input.
7	CLK_SEL	Input	Pulldown	Clock select input. When HIGH, selects differential CLK1, nCLK1. When LOW, selects LVCMOS CLK0. LVCMOS interface levels.
8	MR	Input	Pulldown	Master reset. Resets the output dividers. LVCMOS interface levels.
9, 32	V_{DD}	Power		Positive supply pins.
10	FB_IN	Input	Pulldown	LVCMOS feedback input to phase detector for regenerating clocks with "zero delay". LVCMOS interface levels.
11	SEL2	Input	Pulldown	Determines output divider values in Table 3. LVCMOS interface levels.
12, 16, 20, 24, 28	V_{DDO}	Power		Output supply pins.
13, 15, 17, 19, 21, 23, 25, 27	Q0, Q1, Q2, Q3, Q4, Q5, Q6, Q7	Output		Clock output. 7Ω typical output impedance. LVCMOS interface levels.
14, 18, 22, 26	GND	Power		Power supply ground.
29	SEL3	Input	Pulldown	Determines output divider values in Table 3. LVCMOS interface levels
30	V_{DDA}	Power		Analog supply pin.
31	PLL_SEL	Input	Pullup	Selects between the PLL and reference clock as input to the dividers. When LOW, selects the reference clock (PLL Bypass). When HIGH, selects PLL (PLL Enabled). LVCMOS interface levels.

NOTE: *Pullup* and *Pulldown* refer 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
R_{PULLUP}	Input Pullup Resistor			51		KΩ
$R_{PULLDOWN}$	Input Pulldown Resistor			51		KΩ
C_{PD}	Power Dissipation Capacitance (per output)	V_{DD}, V_{DDO}, V_{DDA} = 3.465V				pF
R_{OUT}	Output Impedance			7		Ω

TABLE 3A. PLL ENABLE FUNCTION TABLE

Inputs					Outputs PLL_SEL = 1 PLL Enable Mode
SEL3	**SEL2**	**SEL1**	**SEL0**	**Reference Frequency Range (MHz)**	**Q0:Q7**
0	0	0	0	125 - 250	÷ 1
0	0	0	1	62.5 - 125	÷ 1
0	0	1	0	31.25 - 62.5	÷ 1
0	0	1	1	15.625 -31.25	÷ 1
0	1	0	0	125 - 250	÷ 2
0	1	0	1	62.5 - 125	÷ 2
0	1	1	0	31.25 - 62.5	÷ 2
0	1	1	1	125 - 250	÷ 4
1	0	0	0	62.5 - 125	÷ 4
1	0	0	1	125 - 250	÷ 8
1	0	1	0	62.5 - 125	x 2
1	0	1	1	31.25 - 62.5	x 2
1	1	0	0	15.625 - 31.25	x 2
1	1	0	1	31.25 - 62.5	x 4
1	1	1	0	15.625 - 31.25	x 4
1	1	1	1	15.625 - 31.25	x 8

TABLE 3B. PLL BYPASS FUNCTION TABLE

Inputs				Outputs PLL_SEL = 0 PLL Bypass Mode
SEL3	**SEL2**	**SEL1**	**SEL0**	**Q0:Q7**
0	0	0	0	÷ 8
0	0	0	1	÷ 8
0	0	1	0	÷ 8
0	0	1	1	÷ 16
0	1	0	0	÷ 16
0	1	0	1	÷ 16
0	1	1	0	÷ 32
0	1	1	1	÷ 32
1	0	0	0	÷ 64
1	0	0	1	÷ 128
1	0	1	0	÷ 4
1	0	1	1	÷ 4
1	1	0	0	÷ 8
1	1	0	1	÷ 2
1	1	1	0	÷ 4
1	1	1	1	÷ 2

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V_{DDx}	4.6V
Inputs, V_I	-0.5V to V_{DD}+0.5 V
Outputs, V_O	-0.5V to V_{DDO}+0.5V
Package Thermal Impedance, θ_{JA}	47.9°C/W (0 lfpm)
Storage Temperature, T_{STG}	-65°C to 150°C

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 4A. POWER SUPPLY DC CHARACTERISTICS, $V_{DD} = V_{DDA} = V_{DDO}$ = 3.3V±5%, TA = -40°C TO 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Input 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		3.135	3.3	3.465	V
I_{DD}	Input Supply Current				90	mA
I_{DDA}	Analog Supply Current				15	mA
I_{DDO}	Output Supply Current				20	mA

TABLE 4B. LVCMOS / LVTTLE DC CHARACTERISTICS, $V_{DD} = V_{DDA} = V_{DDO}$ = 3.3V±5%, TA = -40°C TO 85°C

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
V_{IH}	Input High Voltage	PLL_SEL, CLK_SEL, SEL0, SEL1, SEL2, SEL3, FB_IN, MR		2		V_{DD} + 0.3	V
		CLK0		2		V_{DD} + 0.3	V
V_{IL}	Input Low Voltage	PLL_SEL, CLK_SEL, SEL0, SEL1, SEL2, SEL3, FB_IN, MR		-0.3		0.8	V
		CLK0		-0.3		1.3	V
I_{IH}	Input High Current	CLK0, CLK_SEL MR, FB_IN, SEL0, SEL1, SEL2, SEL3	$V_{DD} = V_{IN}$ = 3.465V			150	µA
		PLL_SEL	$V_{DD} = V_{IN}$ = 3.465V			5	µA
I_{IL}	Input Low Current	CLK0, CLK_SEL MR, FB_IN, SEL0, SEL1, SEL2, SEL3	V_{DD} = 3.465V, V_{IN} = 0V	-5			µA
		PLL_SEL	V_{DD} = 3.465V, V_{IN} = 0V	-150			µA
V_{OH}	Output High Voltage; NOTE 1			2.6			V
V_{OL}	Output Low Voltage; NOTE 1					0.5	V

NOTE 1: Outputs terminated with 50Ω to V_{DDO}/2. In the Parameter Measurement Information section, see 3.3V Output Load Test Circuit figure.

TABLE 4C. DIFFERENTIAL DC CHARACTERISTICS, $V_{DD} = V_{DDA} = V_{DDO}$ = 3.3V±5%, TA = -40°C TO 85°C

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
I_{IH}	Input High Current	CLK1	$V_{DD} = V_{IN}$ = 3.465V			150	µA
		nCLK1	$V_{DD} = V_{IN}$ = 3.465V			5	µA
I_{IL}	Input Low Current	CLK1	V_{DD} = 3.465V, V_{IN} = 0V	-5			µA
		nCLK1	V_{DD} = 3.465V, V_{IN} = 0V	-150			µA
V_{PP}	Peak-to-Peak Input Voltage			0.15		1.3	V
V_{CMR}	Common Mode Input Voltage; NOTE 1, 2			GND + 0.5		V_{DD} - 0.85	V

NOTE 1: Common mode voltage is defined as V_{IH}.
NOTE 2: For single ended applications, the maximum input voltage for CLK1, nCLK1 is V_{DD} + 0.3V.

TABLE 5A. AC CHARACTERISTICS, $V_{DD} = V_{DDA} = V_{DDO}$ = 3.3V±5%, TA = -40°C TO 85°C

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
f_{MAX}	Output Frequency			15.625		250	MHz
tp_{LH}	Propagation Delay, Low-to-High; NOTE 1	CLK0	PLL_SEL = 0V, f ≤ 250MHz, Qx ÷ 2	5		7	ns
		CLK1, nCLK1	PLL_SEL = 0V, f ≤ 250MHz, Qx ÷ 2	5		7.3	ns
t(Ø)	Static Phase Offset; NOTE 2, 4	CLK0	PLL_SEL = 3.3V, fREF ≤ 200MHz, Qx ÷ 1	-100	25	150	ps
		CLK1, nCLK1	PLL_SEL = 3.3V, fREF ≤ 167MHz, Qx ÷ 1	-15	+135	285	ps
			PLL_SEL = 3.3V, fREF = 200MHz, Qx ÷ 1	-250	-100	50	ps
*t*sk(o)	Output Skew; NOTE 3, 4	CLK0	PLL_SEL = 0V			65	ps
		CLK1, nCLK1	PLL_SEL = 0V			55	ps
*t*jit(cc)	Cycle-to-Cycle Jitter; NOTE 4		f_{OUT} > 40MHz			45	ps
t_L	PLL Lock Time					1	mS
t_R	Output Rise Time			400		950	ps
t_F	Output Fall Time			400		950	ps
odc	Output Duty Cycle			43		57	%

All parameters measured at f_{MAX} unless noted otherwise.
NOTE 1: Measured from the differential input crossing point to the output at V_{DDO}/2.
NOTE 2: Defined as the time difference between the input reference clock and the average feedback input signal when the PLL is locked and the input reference frequency is stable.
NOTE 3: Defined as skew between outputs at the same supply voltages and with equal load conditions. Measured at V_{DDO}/2.
NOTE 4: This parameter is defined in accordance with JEDEC Standard 65.

TABLE 4D. POWER SUPPLY DC CHARACTERISTICS, $V_{DD} = V_{DDA} = V_{DDO}$ = 2.5V±5%, TA = -40°C TO 85°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Input Supply Voltage		2.375	2.5	2.625	V
V_{DDA}	Analog Supply Voltage		2.375	2.5	2.625	V
V_{DDO}	Output Supply Voltage		2.375	2.5	2.625	V
I_{DD}	Input Supply Current				90	mA
I_{DDA}	Analog Supply Current				15	mA
I_{DDO}	Output Supply Current				20	mA

TABLE 4E. LVCMOS / LVTTLE DC CHARACTERISTICS, $V_{DD} = V_{DDA} = V_{DDO}$ = 2.5V±5%, TA = -40°C TO 85°C

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
V_{IH}	Input High Voltage	PLL_SEL, CLK_SEL, SEL0, SEL1, SEL2, SEL3, FB_IN, MR		2		V_{DD} + 0.3	V
		CLK0		2		V_{DD} + 0.3	V
V_{IL}	Input Low Voltage	PLL_SEL, CLK_SEL, SEL0, SEL1, SEL2, SEL3, FB_IN, MR		-0.3		0.8	V
		CLK0		-0.3		1.3	V
I_{IH}	Input High Current	CLK0, CLK_SEL MR, FB_IN, SEL0, SEL1, SEL2, SEL3	$V_{DD} = V_{IN}$ = 2.625V			150	µA
		PLL_SEL	$V_{DD} = V_{IN}$ = 2.625V			5	µA
I_{IL}	Input Low Current	CLK0, CLK_SEL MR, FB_IN, SEL0, SEL1, SEL2, SEL3	V_{DD} = 2.625V, V_{IN} = 0V	-5			µA
		PLL_SEL	V_{DD} = 2.625V, V_{IN} = 0V	-150			µA
V_{OH}	Output High Voltage; NOTE 1			1.8			V
V_{OL}	Output Low Voltage; NOTE 1					0.5	V

NOTE 1: Outputs terminated with 50Ω to V_{DDO}/2. In the Parameter Measurement Information section, see 2.5V Output Load Test Circuit figure.

TABLE 4F. DIFFERENTIAL DC CHARACTERISTICS, $V_{DD} = V_{DDA} = V_{DDO}$ = 2.5V±5%, TA = -40°C TO 85°C

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
I_{IH}	Input High Current	CLK1	$V_{DD} = V_{IN}$ = 2.625V			150	µA
		nCLK1	$V_{DD} = V_{IN}$ = 2.625V			5	µA
I_{IL}	Input Low Current	CLK1	V_{DD} = 2.625V, V_{IN} = 0V	-5			µA
		nCLK1	V_{DD} = 2.625V, V_{IN} = 0V	-150			µA
V_{PP}	Peak-to-Peak Input Voltage			0.15		1.3	V
V_{CMR}	Common Mode Input Voltage; NOTE 1, 2			GND + 0.5		V_{DD} - 0.85	V

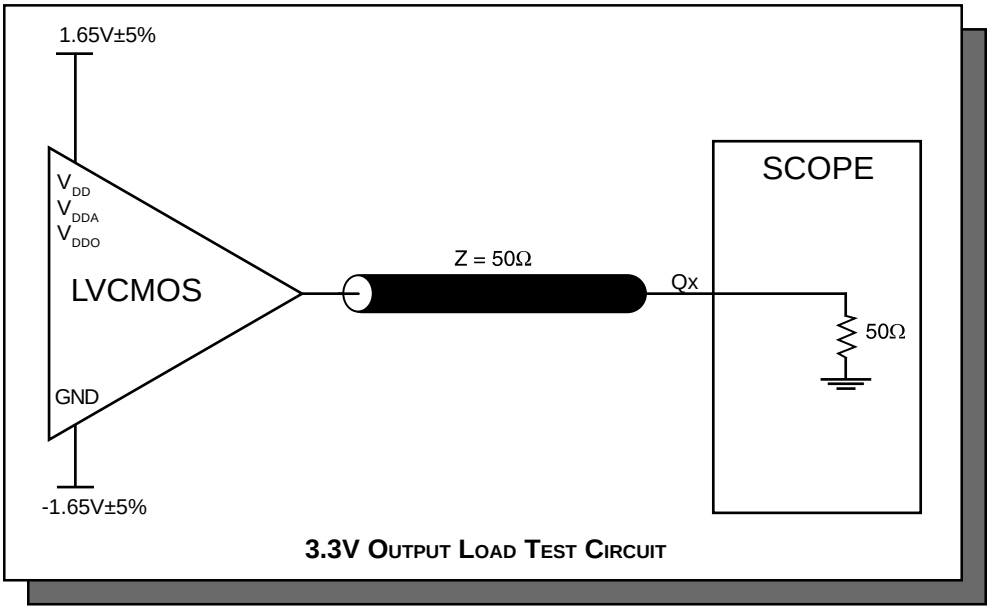
NOTE 1: Common mode voltage is defined as V_{IH}.
NOTE 2: For single ended applications, the maximum input voltage for CLK1, nCLK1 is V_{DD} + 0.3V.

TABLE 5B. AC CHARACTERISTICS, $V_{DD} = V_{DDA} = V_{DDO}$ = 2.5V±5%, TA = -40°C TO 85°C

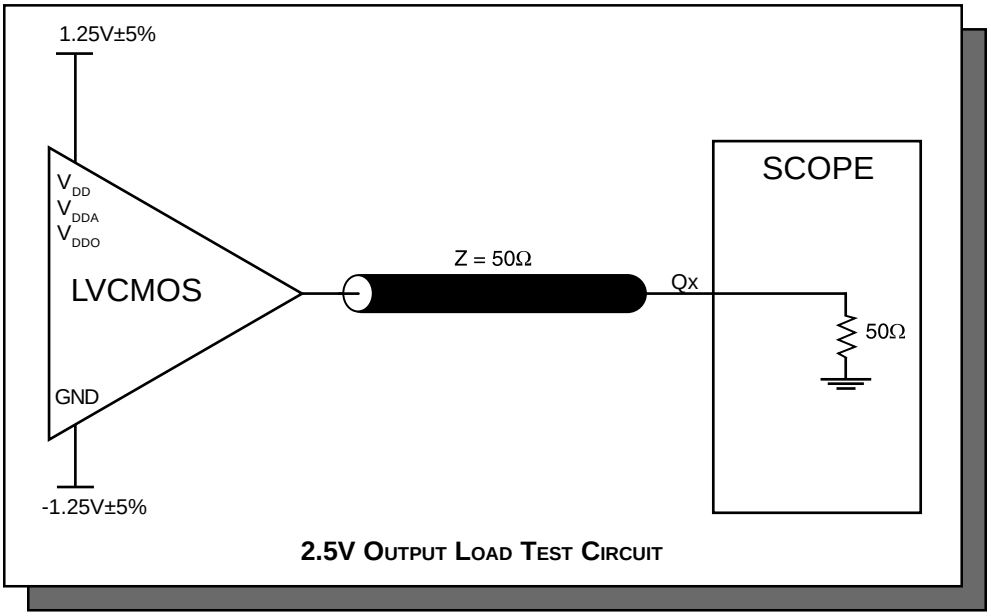
Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
f_{MAX}	Output Frequency			15.625		250	MHz
tp_{LH}	Propagation Delay, Low-to-High; NOTE 1	CLK0	PLL_SEL = 0V, f ≤ 250MHz, Qx ÷ 2	5		7	ns
		CLK1, nCLK1	PLL_SEL = 0V, f ≤ 250MHz, Qx ÷ 2	5		7.3	ns
t(Ø)	Static Phase Offset; NOTE 2, 4	CLK0	PLL_SEL = 2.5V, fREF ≤ 200MHz, Qx ÷ 1	-250	25	200	ps
		CLK1, nCLK1	PLL_SEL = 2.5V, fREF = 133MHz, Qx ÷ 1	-50	100	250	ps
			PLL_SEL = 2.5V, fREF = 200MHz, Qx ÷ 1	-300	-100	100	ps
*t*sk(o)	Output Skew; NOTE 3, 4	CLK0	PLL_SEL = 0V			65	ps
		CLK1, nCLK1	PLL_SEL = 0V			55	ps
*t*jit(cc)	Cycle-to-Cycle Jitter; NOTE 4		f_{OUT} > 40MHz			45	ps
t_L	PLL Lock Time					1	mS
t_R	Output Rise Time			400		950	ps
t_F	Output Fall Time			400		950	ps
odc	Output Duty Cycle			43		57	%

All parameters measured at f_{MAX} unless noted otherwise.
NOTE 1: Measured from the differential input crossing point to the output at $V_{DDO}/2$.
NOTE 2: Defined as the time difference between the input reference clock and the average feedback input signal when the PLL is locked and the input reference frequency is stable.
NOTE 3: Defined as skew between outputs at the same supply voltages and with equal load conditions. Measured at $V_{DDO}/2$.
NOTE 4: This parameter is defined in accordance with JEDEC Standard 65.

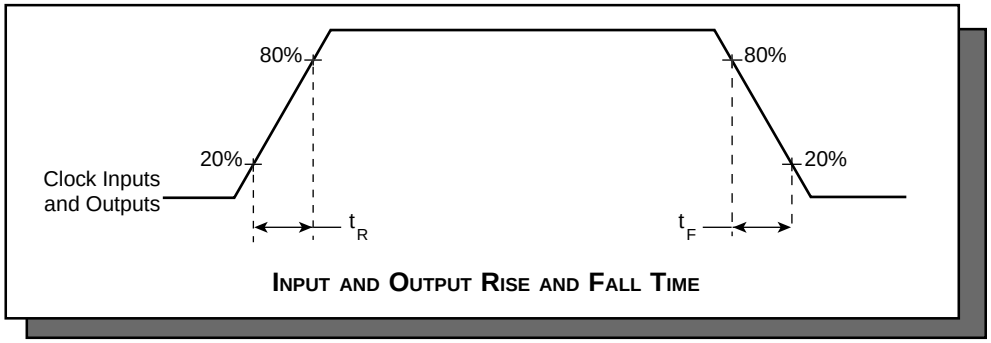
PARAMETER MEASUREMENT INFORMATION



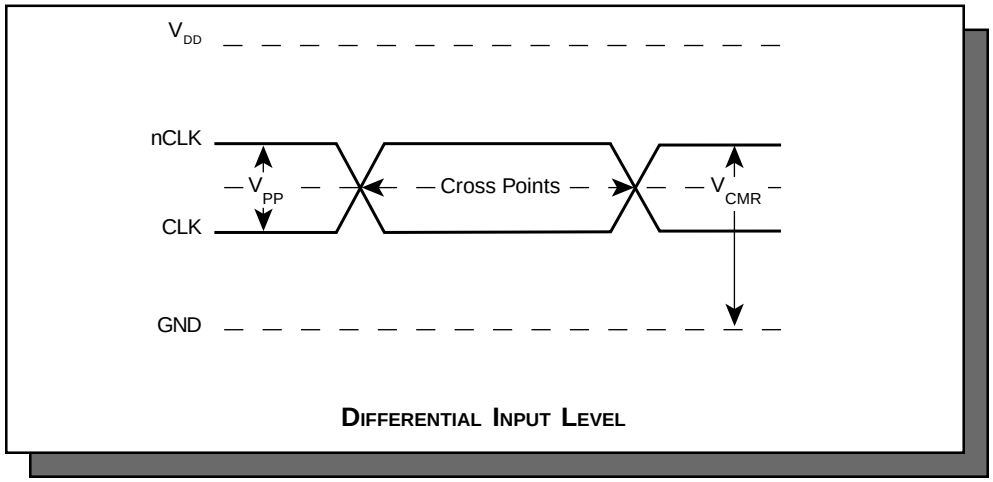
3.3V OUTPUT LOAD TEST CIRCUIT



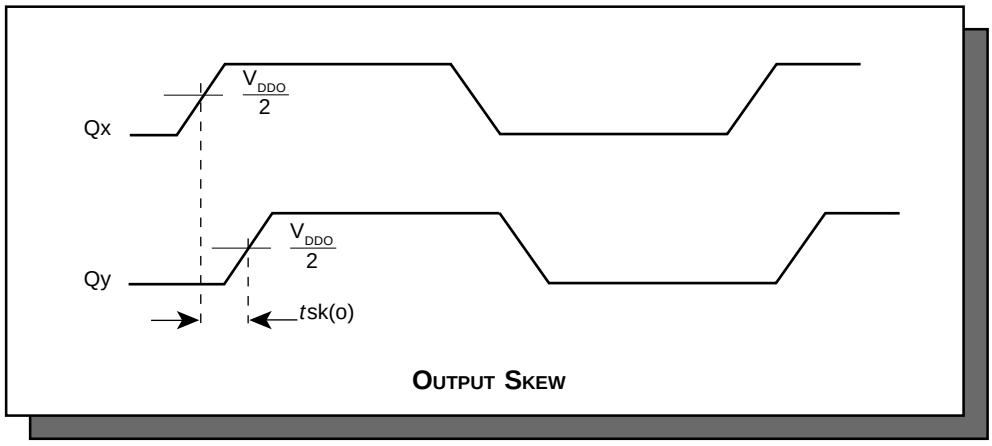
2.5V OUTPUT LOAD TEST CIRCUIT



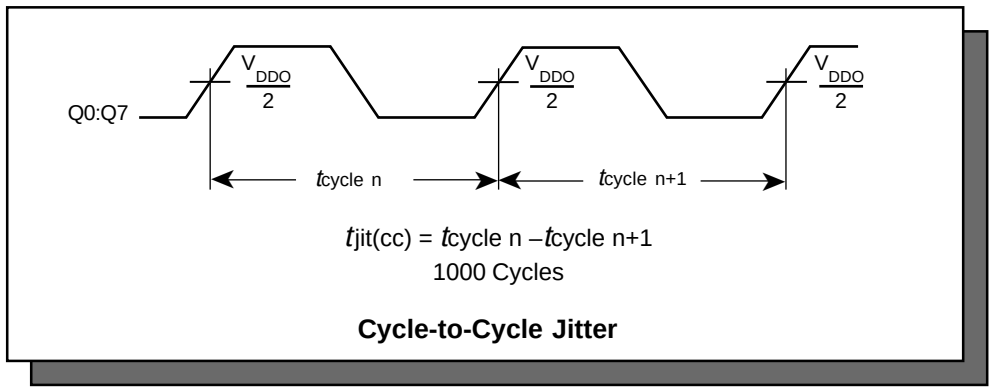
INPUT AND OUTPUT RISE AND FALL TIME



DIFFERENTIAL INPUT LEVEL

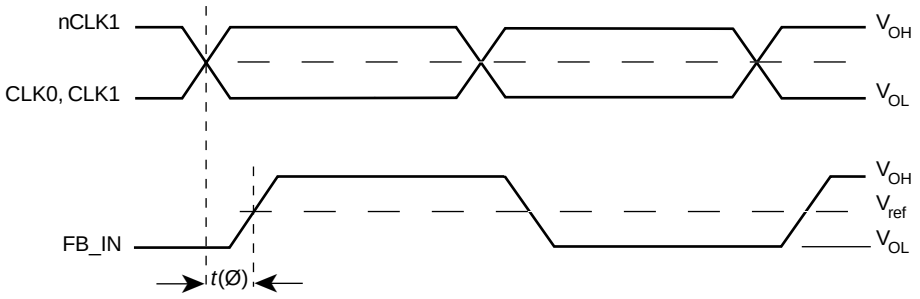


OUTPUT SKEW



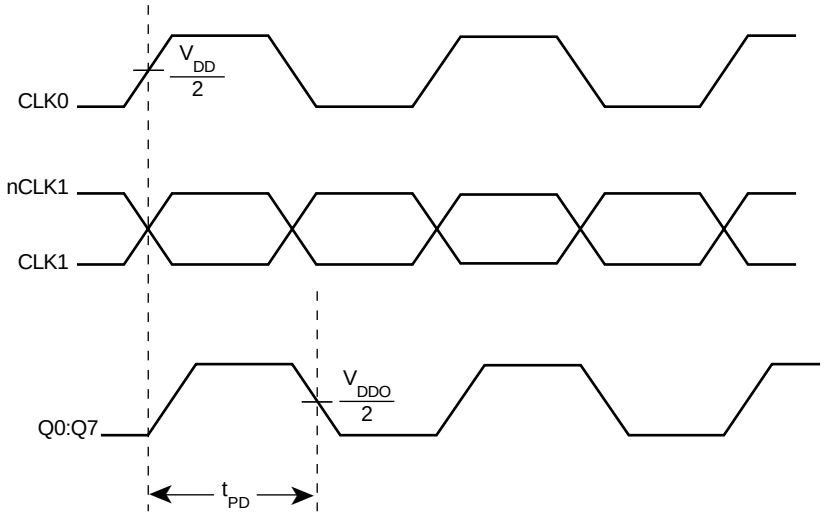
$t_{jit(cc)} = t_{cycle\ n} - t_{cycle\ n+1}$
1000 Cycles

Cycle-to-Cycle Jitter

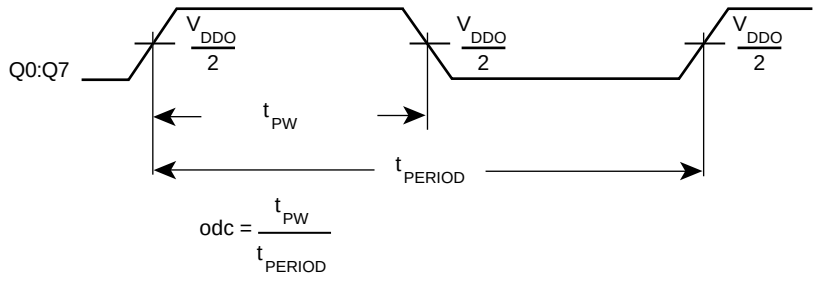


$t(Ø)_{mean}$ = Static Phase Offset
(where $t(Ø)$ is any random sample, and $t(Ø)_{mean}$ is the average of the sampled cycles measured on controlled edges)

STATIC PHASE OFFSET



PROPAGATION DELAY



t_{PW}, odc AND t_{PERIOD}

APPLICATION INFORMATION

POWER SUPPLY FILTERING TECHNIQUES

As in any high speed analog circuitry, the power supply pins are vulnerable to random noise. The ICS8705I 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 10Ω resistor along with a 10µF and a .01µF bypass capacitor should be connected to each V_{DDA}.

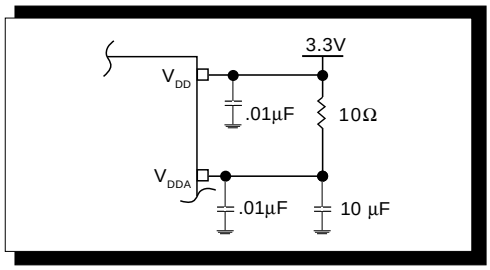


FIGURE 1 - POWER SUPPLY FILTERING

WIRING THE DIFFERENTIAL INPUT TO ACCEPT SINGLE ENDED LEVELS

Figure 2 shows how the differential input can be wired to accept single ended levels. The reference voltage V_REF = V_{DD}/2 is generated by the bias resistors R1, R2 and C1. This bias circuit should be located as close as possible to the input pin. The ratio of R1 and R2 might need to be adjusted to position the V_REF in the center of the input voltage swing. For example, if the input clock swing is only 2.5V and V_{DD} = 3.3V, V_REF should be 1.25V and R2/R1 = 0.609.

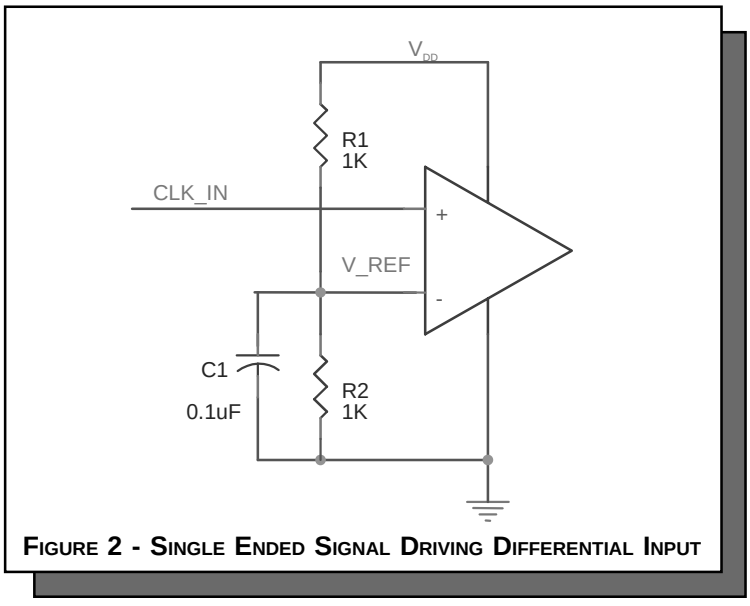


FIGURE 2 - SINGLE ENDED SIGNAL DRIVING DIFFERENTIAL INPUT

RELIABILITY INFORMATION

TABLE 6. θ_{JA} VS. AIR FLOW TABLE

θ_{JA} by Velocity (Linear Feet per Minute)			
	0	**200**	**500**
Single-Layer PCB, JEDEC Standard Test Boards	67.8°C/W	55.9°C/W	50.1°C/W
Multi-Layer PCB, JEDEC Standard Test Boards	47.9°C/W	42.1°C/W	39.4°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 ICS8705I is: 3126

PACKAGE OUTLINE - Y SUFFIX

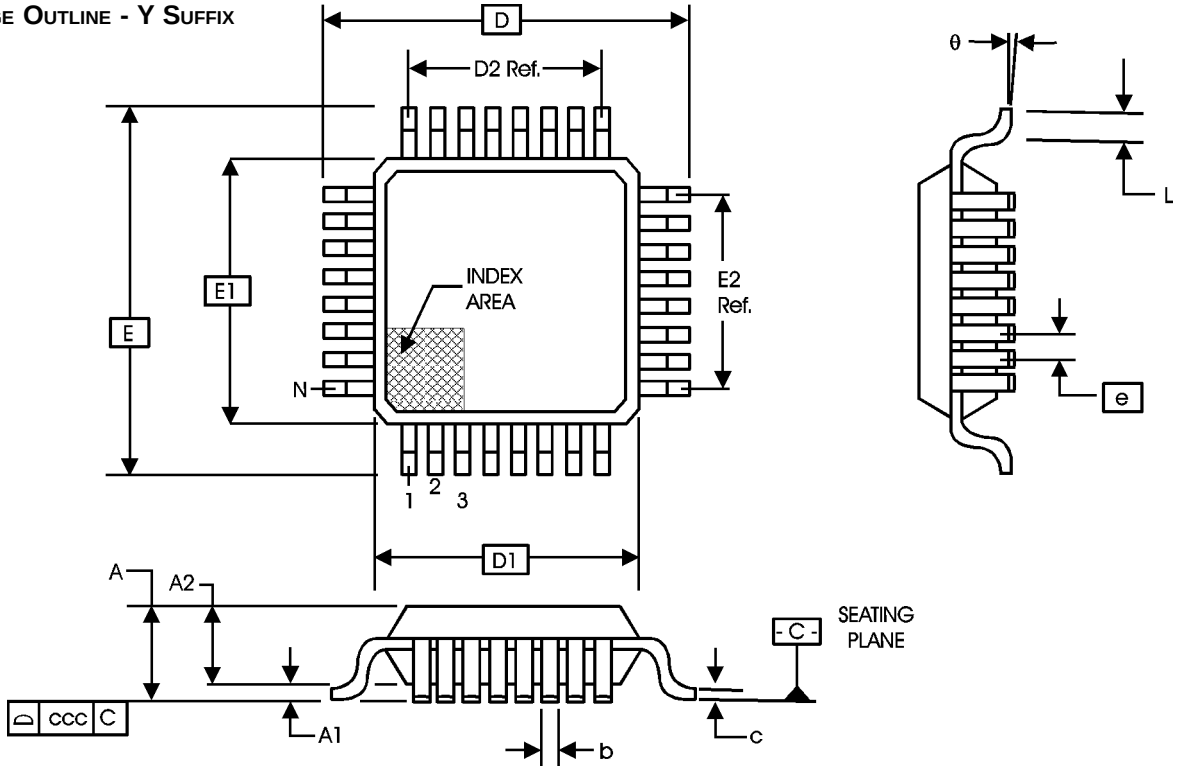


TABLE 7. PACKAGE DIMENSIONS

JEDEC VARIATION ALL DIMENSIONS IN MILLIMETERS			
SYMBOL	BBA		
	MINIMUM	NOMINAL	MAXIMUM
N		32	
A	--	--	1.60
A1	0.05	--	0.15
A2	1.35	1.40	1.45
b	0.30	0.37	0.45
c	0.09	--	0.20
D		9.00 BASIC	
D1		7.00 BASIC	
D2		5.60 Ref.	
E		9.00 BASIC	
E1		7.00 BASIC	
E2		5.60 Ref.	
e		0.80 BASIC	
L	0.45	0.60	0.75
θ	0°	--	7°
ccc	--	--	0.10

Reference Document: JEDEC Publication 95, MS-026

TABLE 8. ORDERING INFORMATION

Part/Order Number	Marking	Package	Count	Temperature
ICS8705BYI	ICS8705BYI	32 Lead LQFP	250 per tray	-40°C to 85°C
ICS8705BYIT	ICS8705BYI	32 Lead LQFP on Tape and Reel	1000	-40°C to 85°C

REVISION HISTORY SHEET				
Rev	**Table**	**Page**	**Description of Change**	**Date**
B	3A 5A 5B	3 5 7	PLL Enable Function Table - revised the Reference Frequency Range column 3.3V AC Characteristics Table - updated the Output Frequency row from 275MHz Max. to 250MHz Max. 2.5V AC Characteristics Table - updated the Output Frequency row from 275MHz Max. to 250MHz Max.	4/5/02
B	1	2	Pin Description Table - revised power pin descriptions.	4/10/02