Integrated Circuit Systems, Inc.

ICS8752

LOW SKEW, 1-TO-8
LVCMOS CLOCK MULTIPLIER/ZERO DELAY BUFFER

GENERAL DESCRIPTION

The ICS8752 is a low voltage, low skew LVCMOS clock generator and a member of the HiPerClockS™ family of High Performance Clock Solutions from ICS. With output frequencies up to 240MHz, the ICS8752 is targeted for high performance clock applications. Along with a fully integrated PLL, the ICS8752 contains frequency configurable outputs and an external feedback input for regenerating clocks with "zero delay".

Dual clock inputs, CLK0 and CLK1, support redundant clock applications. The CLK_SEL input determines which reference clock is used. The output divider values of Bank A and B are controlled by the DIV_SELA0:1, and DIV_SELB0:1, respectively.

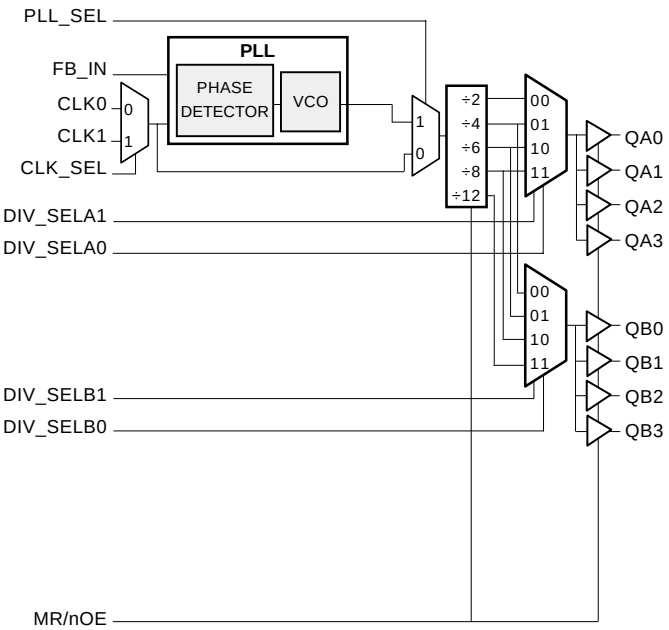
For test and system debug purposes, the PLL_SEL input allows the PLL to be bypassed. When HIGH, the MR/nOE input resets the internal dividers and forces the outputs to the high impedance state.

The low impedance LVCMOS outputs of the ICS8752 are designed to drive terminated transmission lines. The effective fanout of each output can be doubled by utilizing the ability of each output to drive two series terminated transmission lines.

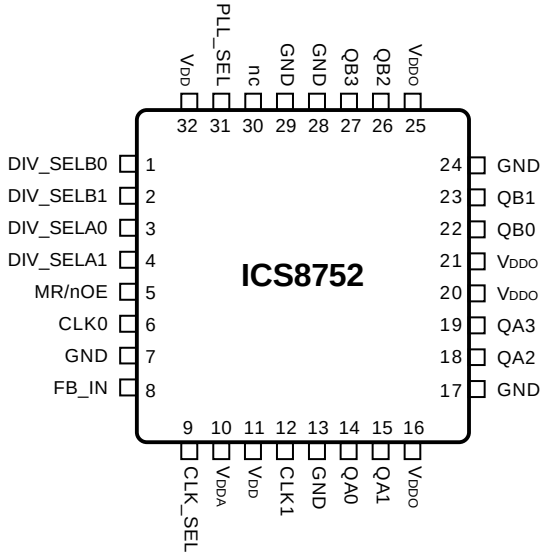
FEATURES

- Fully integrated PLL
- 8 LVCMOS outputs, 7Ω typical output impedance
- Selectable LVCMOS CLK0 or CLK1 inputs for redundant clock applications
- Input/Output frequency range: 18.33MHz to 240MHz at V_{CC} = 3.3V ± 5%
- VCO range: 220MHz to 480MHz
- External feedback for "zero delay" clock regeneration
- Cycle-to-cycle jitter: 75ps (maximum), (all outputs are the same frequency)
- Output skew: 100ps (maximum)
- Bank skew: 55ps (maximum)
- 3.3V or 2.5V supply voltage
- 0°C to 70°C ambient operating temperature
- Industrial temperature information available upon request
- Functionally compatible with MPC952 in some applications

BLOCK DIAGRAM



PIN ASSIGNMENT



32-Lead LQFP
7mm x 7mm x 1.4mm package body
Y package
Top View

TABLE 1. PIN DESCRIPTIONS

Number	Name	Type		Description
1, 2	DIV_SELB0, DIV_SELB1	Input	Pulldown	Determines output divider values for Bank B as described in Table 3. LVCMOS / LVTTL interface levels.
3, 4	DIV_SELA0, DIV_SELA1	Input	Pulldown	Determines output divider values for Bank A as described in Table 3. LVCMOS / LVTTL interface levels.
5	MR/nOE	Input	Pulldown	Active LOW Master Reset and output enable. When logic LOW, the internal dividers are reset. When HIGH, the Master Reset is disabled. LVCMOS / LVTTL interface levels.
6	CLK0	Input	Pulldown	Clock input. LVCMOS / LVTTL interface levels.
7, 13, 17, 24, 28, 29	GND	Power		Power supply ground.
8	FB_IN	Input	Pulldown	Feedback input to phase detector for generating clocks with "zero delay". LVCMOS / LVTTL interface levels.
9	CLK_SEL	Input	Pulldown	Clock select input. Selects between CLK0 or CLK1 as phase detector reference. When LOW, selects CLK0. When HIGH, selects CLK1. LVCMOS / LVTTL interface levels.
10	V_{DDA}	Power		Analog supply pin.
11, 32	V_{DD}	Power		Positive supply pins.
12	CLK1	Input	Pulldown	Clock input. LVCMOS / LVTTL interface levels.
14, 15, 18, 19	QA0, QA1, QA2, QA3	Output		Bank A clock outputs. 7Ω typical output impedance. LVCMOS / LVTTL interface levels.
16, 20, 21, 25	V_{DDO}	Power		Output supply pins.
22, 23, 26, 27	QB0, QB1, QB2, QB3	Output		Bank B clock outputs. 7Ω typical output impedance. LVCMOS / LVTTL interface levels.
30	nc	Unused		No connect.
31	PLL_SEL	Input	Pullup	Selects between the PLL and CLK0 or CLK1 as the input to the dividers. When HIGH selects PLL. When LOW selects CLK0 or CLK1. LVCMOS / LVTTL 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_{DDA}, V_{DD}, V_{DDO} = 3.465V		23		pF
R_{OUT}	Output Impedance			7		Ω

TABLE 3. CONTROL INPUT FUNCTION TABLE

Inputs							Outputs	
MR/nOE	PLL_SEL	CLK_SEL	DIV_ SELA1	DIV_ SELA0	DIV_ SELB1	DIV_ SELB0	QAx	QBx
1	X	X	X	X	X	X	Hi-Z	Hi-Z
0	1	X	0	0	0	0	fVCO/2	fVCO/4
0	1	X	0	1	0	1	fVCO/4	fVCO/6
0	1	X	1	0	1	0	fVCO/6	fVCO/8
0	1	X	1	1	1	1	fVCO/8	fVCO/12
0	0	0	0	0	0	0	fCLK0/2	fCLK0/4
0	0	0	0	1	0	1	fCLK0/4	fCLK0/6
0	0	0	1	0	1	0	fCLK0/6	fCLK0/8
0	0	0	1	1	1	1	fCLK0/8	fCLK0/12
0	0	1	0	0	0	0	fCLK1/2	fCLK1/4
0	0	1	0	1	0	1	fCLK1/4	fCLK1/6
0	0	1	1	0	1	0	fCLK1/6	fCLK1/8
0	0	1	1	1	1	1	fCLK1/8	fCLK1/12

NOTE: For normal operation, MR/nOE is LOW. When MR/nOE is HIGH, all ouputs are disabled.

TABLE 4A. QA OUTPUT FREQUENCY W/FB_IN = QB

Inputs									Outputs
FB_IN	DIV_ SELB1	DIV_ SELB0	QB Output Divider Mode (NOTE 2)	CLK0, CLK1 (MHz) (NOTE 1)		DIV_ SELA1	DIV_ SELA0	QA Output Divider Mode	QA Multiplier (NOTE 2)
				Minimum	Maximum				
QB	0	0	÷4	55	120	0	0	÷2	2
						0	1	÷4	1
						1	0	÷6	0.667
						1	1	÷8	0.5
QB	0	1	÷6	36.66	80	0	0	÷2	3
						0	1	÷4	1.5
						1	0	÷6	1
						1	1	÷8	0.75
QB	1	0	÷8	27.5	60	0	0	÷2	4
						0	1	÷4	2
						1	0	÷6	1.33
						1	1	÷8	1
QB	1	1	÷12	18.33	40	0	1	÷2	6
						0	1	÷4	3
						1	0	÷6	2
						1	1	÷8	1.5

NOTE 1: VCO frequency range is 220MHz to 480MHz.
NOTE 2: QA output frequency equal to CLKx frequency times the multiplier;
QB output frequency equal to CLKx.

TABLE 4B. QB OUTPUT FREQUENCY W/FB_IN = QA

Inputs									Outputs
FB_IN	DIV_ SELA1	DIV_ SELA0	QA Output Divider Mode (NOTE 2)	CLK0, CLK1 (MHz) (NOTE 1)		DIV_ SELB1	DIV_ SELB0	QB Output Divider Mode	QB Multiplier (NOTE 2)
				Minimum	Maximum				
QA	0	0	÷2	110	240 (NOTE 3)	0	0	÷4	0.5
						0	1	÷6	0.333
						1	0	÷8	0.25
						1	1	÷12	0.167
QA	0	1	÷4	55	120	0	0	÷4	1
						0	1	÷6	0.667
						1	0	÷8	0.5
						1	1	÷12	0.333
QA	1	0	÷6	36.66	80	0	0	÷4	1.5
						0	1	÷6	1
						1	0	÷8	0.75
						1	1	÷12	0.5
QA	1	1	÷8	27.5	60	0	1	÷4	2
						0	1	÷6	1.333
						1	0	÷8	1
						1	1	÷12	0.667

NOTE 1: VCO frequency range is 220MHz to 480MHz.
NOTE 2: QB output frequency equal to CLKx frequency times the multiplier;
QA output frequency equal to CLKx.
NOTE 3: Maximum frequency of 240MHz valid for V_{CC} = 3.3V ± 5% only.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V_{DDx}	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, 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 5A. POWER SUPPLY DC CHARACTERISTICS, $V_{DD} = V_{DDA} = V_{DDO}$ = 3.3V±5%, T_A = 0°C TO 70°C

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Positive 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}	Positive Supply Current				105	mA
I_{DDA}	Analog Supply Current				15	mA
I_{DDO}	Output Supply Current				20	mA

TABLE 5B. LVCMOS/LVTTL DC CHARACTERISTICS, $V_{DD} = V_{DDA} = V_{DDO}$ = 3.3V±5%, T_A = 0°C TO 70°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	CLK0, CLK1, FB_IN, CLK_SEL, DIV_SELA1, DIV_SELA0, DIV_SELB1, DIV_SELB0, MR/nOE	$V_{DD} = V_{IN}$ = 3.465V			150	µA
		PLL_SEL	$V_{DD} = V_{IN}$ = 3.465V			5	µA
I_{IL}	Input Low Current	CLK0, CLK1, FB_IN, CLK_SEL, DIV_SELA1, DIV_SELA0, DIV_SELB1, DIV_SELB0, MR/nOE	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			2.4			V
V_{OL}	Output Low Voltage; NOTE 1					0.5	V

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

TABLE 6A. PLL INPUT REFERENCE CHARACTERISTICS, $V_{DD} = V_{DDA} = V_{DDO} = 3.3V \pm 5\%$, $T_A = 0°C$ TO $70°C$

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
f_{REF}	Input Reference Frequency NOTE: Input reference frequency is limited by the divider selection and the VCO lock range.		20		240	MHz

TABLE 7A. AC CHARACTERISTICS, $V_{DD} = V_{DDA} = V_{DDO} = 3.3V \pm 5\%$, $T_A = 0°C$ TO $70°C$

Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
f_{OUT}	Output Frequency (PLL Mode)		÷2	110		240	MHz
			÷4	55		120	MHz
			÷6	36.67		80	MHz
			÷8	27.5		60	MHz
			÷12	18.33		40	MHz
f_{VCO}	PLL VCO Lock Range			220		480	MHz
t(Ø)	Static Phase Offset; NOTE 1		fVCO = 400MHz, Feedback ÷ 8	-30	70	170	ps
*t*sk(b)	Bank Skew; NOTE 2, 4		Measured on rising edge at $V_{DDO}/2$			55	ps
*t*sk(o)	Output Skew; NOTE 3, 4		Measured on rising edge at $V_{DDO}/2$			100	ps
*t*jit(cc)	Cycle-to-Cycle Jitter; NOTE 4	Different Frequencies on Different Banks				400	ps
		All Outputs at Same Frequency				75	ps
t_L	PLL Lock Time					1	mS
t_R	Output Rise Time		20% to 80%	400		950	ps
t_F	Output Fall Time		20% to 80%	400		950	ps
odc	Output Duty Cycle			47	50	53	%

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

TABLE 5C. POWER SUPPLY DC CHARACTERISTICS, $V_{DD} = V_{DDA} = V_{DDO} = 2.5V±5\%$, $T_A = 0°C$ TO $70°C$

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
V_{DD}	Positive 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}	Positive Supply Current				100	mA
I_{DDA}	Analog Supply Current				15	mA
I_{DDO}	Output Supply Current				20	mA

TABLE 5D. LVCMOS/LVTTL DC CHARACTERISTICS, $V_{DD} = V_{DDA} = V_{DDO} = 2.5V±5\%$, $T_A = 0°C$ TO $70°C$

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	CLK0, CLK1, FB_IN, CLK_SEL, DIV_SELA1, DIV_SELA0, DIV_SELB1, DIV_SELB0, MR/nOE	$V_{DD} = V_{IN} = 2.625V$			150	µA
		PLL_SEL	$V_{DD} = V_{IN} = 2.625V$			5	µA
I_{IL}	Input Low Current	CLK0, CLK1, FB_IN, CLK_SEL, DIV_SELA1, DIV_SELA0, DIV_SELB1, DIV_SELB0, MR/nOE	$V_{DD} = 2.625V$, $V_{IN} = 0V$	-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 $V_{DDO}/2$. See Parameter Measurement Information Section, "2.5 Output Load Test Circuit".

TABLE 6B. PLL INPUT REFERENCE CHARACTERISTICS, $V_{DD} = V_{DDA} = V_{DDO} = 2.5V±5\%$, $T_A = 0°C$ TO $70°C$

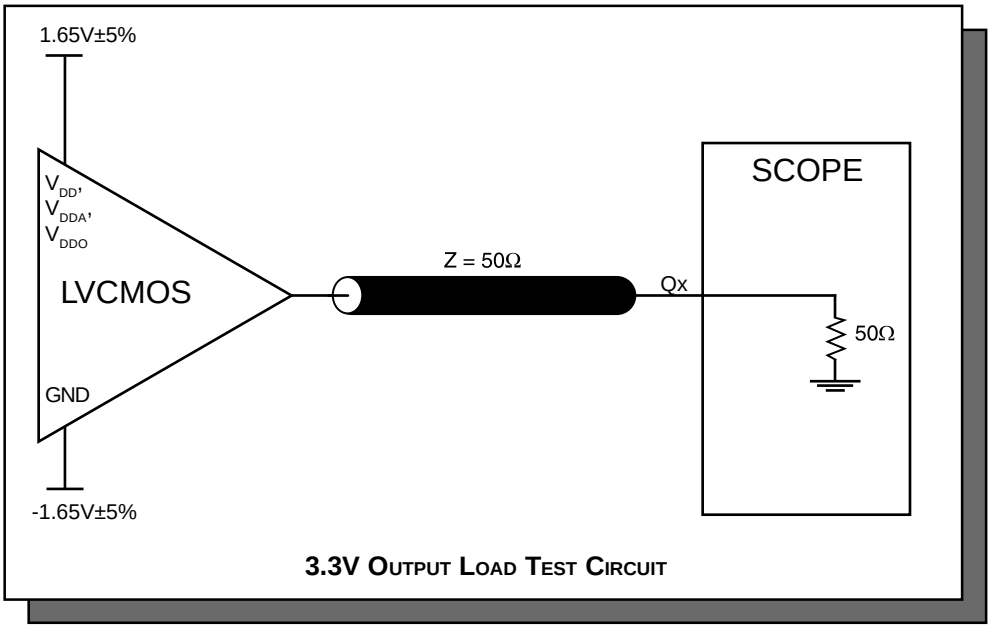
Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
f_{REF}	Input Reference Frequency NOTE: Input reference frequency is limited by the divider selection and the VCO lock range.		20		120	MHz

TABLE 7B. AC CHARACTERISTICS, $V_{DD} = V_{DDA} = V_{DDO} = 2.5V \pm 5\%$, $T_A = 0°C$ TO $70°C$

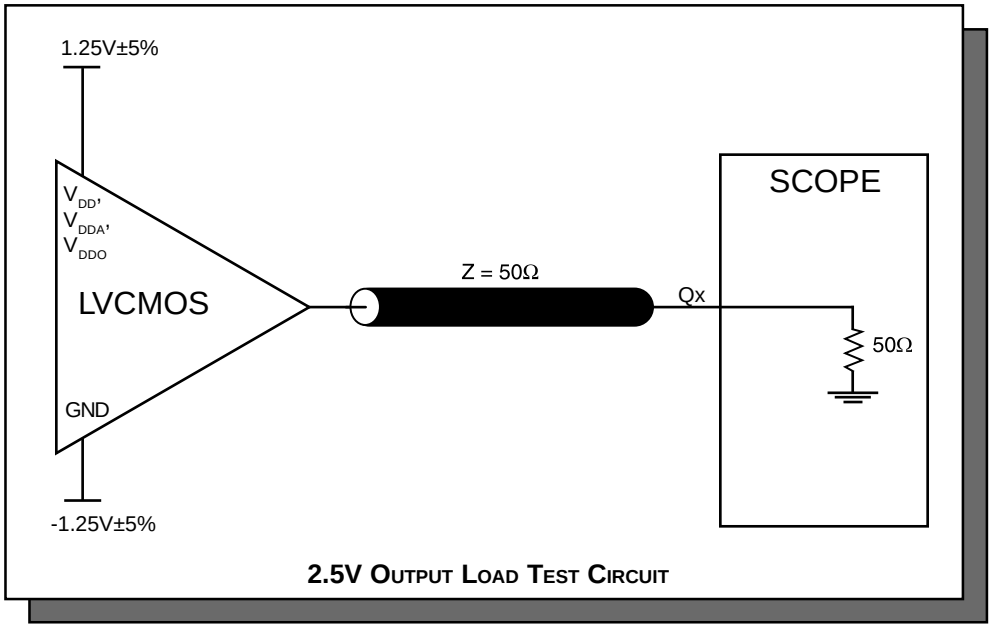
Symbol	Parameter		Test Conditions	Minimum	Typical	Maximum	Units
f_{OUT}	Output Frequency (PLL Mode)		÷2	110		240	MHz
			÷4	55		120	MHz
			÷6	36.67		80	MHz
			÷8	27.5		60	MHz
			÷12	18.33		40	MHz
f_{VCO}	PLL VCO Lock Range			220		480	MHz
t(Ø)	Static Phase Offset; NOTE 1		fVCO = 400MHz Feedback ÷ 8	-90	50	190	ps
*t*sk(b)	Bank Skew; NOTE 2, 4		Measured on rising edge at $V_{DDO}/2$			55	ps
*t*sk(o)	Output Skew; NOTE 3, 4		Measured on rising edge at $V_{DDO}/2$			90	ps
*t*jit(cc)	Cycle-to-Cycle Jitter; NOTE 4	Different Frequencies on Different Banks				400	ps
		All Outputs at Same Frequency				75	ps
t_L	PLL Lock Time					1	mS
t_R	Output Rise Time		20% to 80%	400		950	ps
t_F	Output Fall Time		20% to 80%	400		950	ps
odc	Output Duty Cycle			45	50	55	%

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

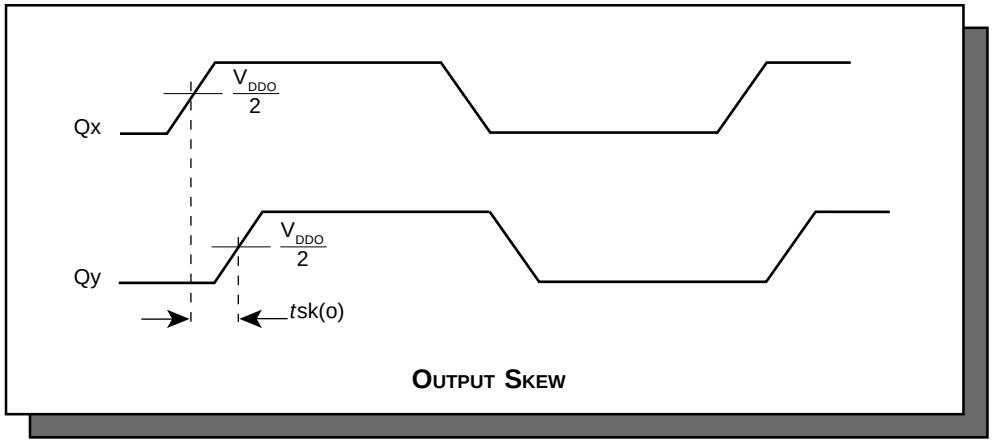
PARAMETER MEASUREMENT INFORMATION



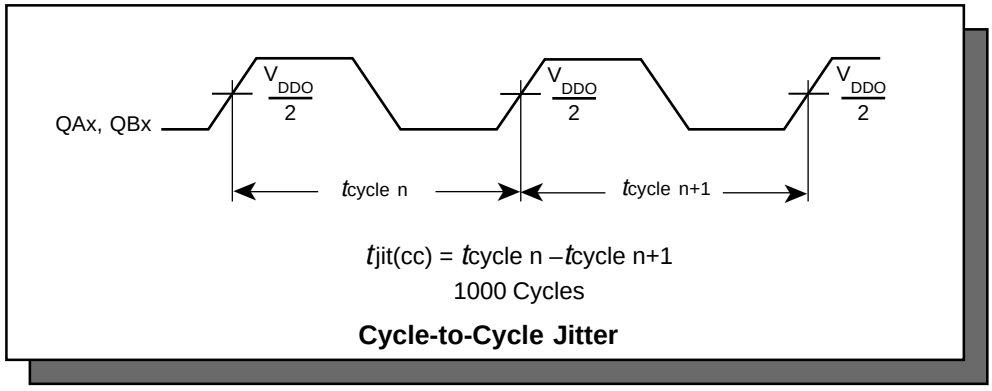
3.3V OUTPUT LOAD TEST CIRCUIT



2.5V OUTPUT LOAD TEST CIRCUIT



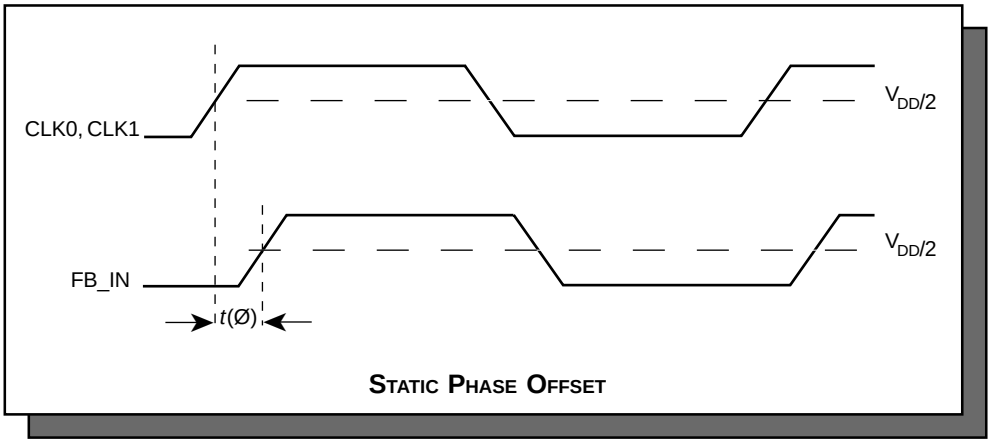
OUTPUT SKEW



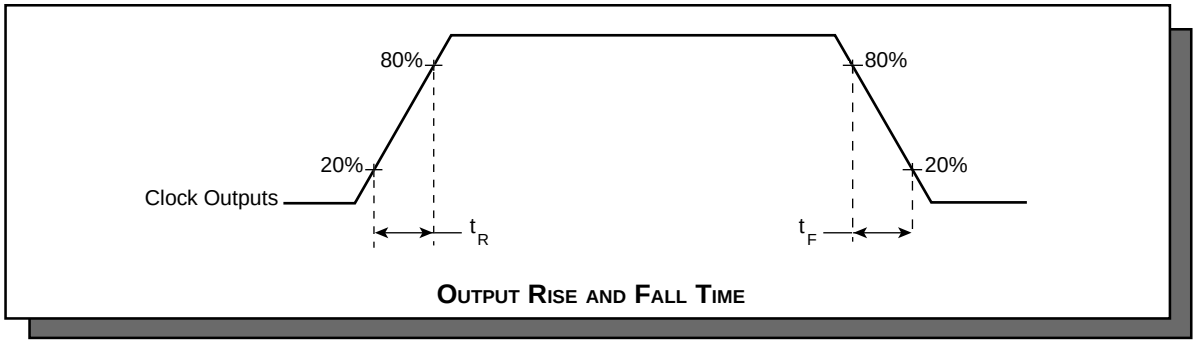
$t_{jit(cc)} = t_{cycle\ n} - t_{cycle\ n+1}$

1000 Cycles

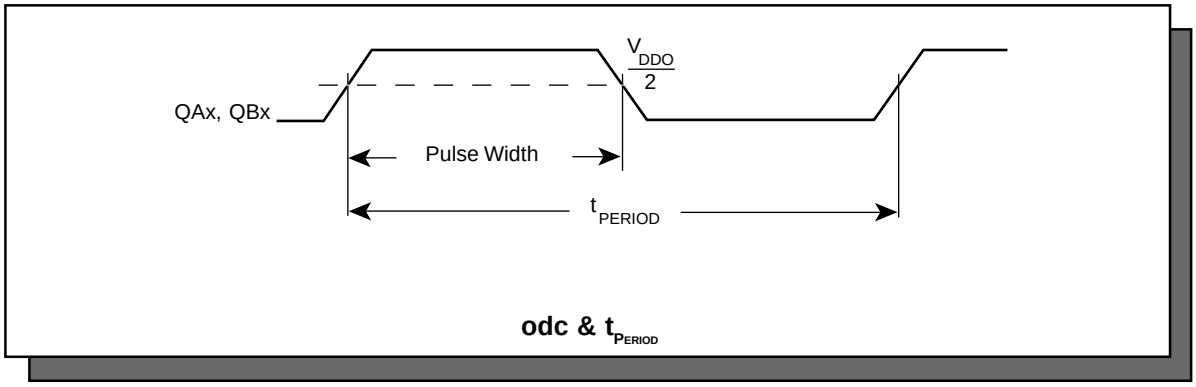
Cycle-to-Cycle Jitter



STATIC PHASE OFFSET



OUTPUT RISE AND FALL TIME



odc & t_{PERIOD}

RELIABILITY INFORMATION

TABLE 7. 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 ICS8752 is: 1546

PACKAGE OUTLINE - Y SUFFIX

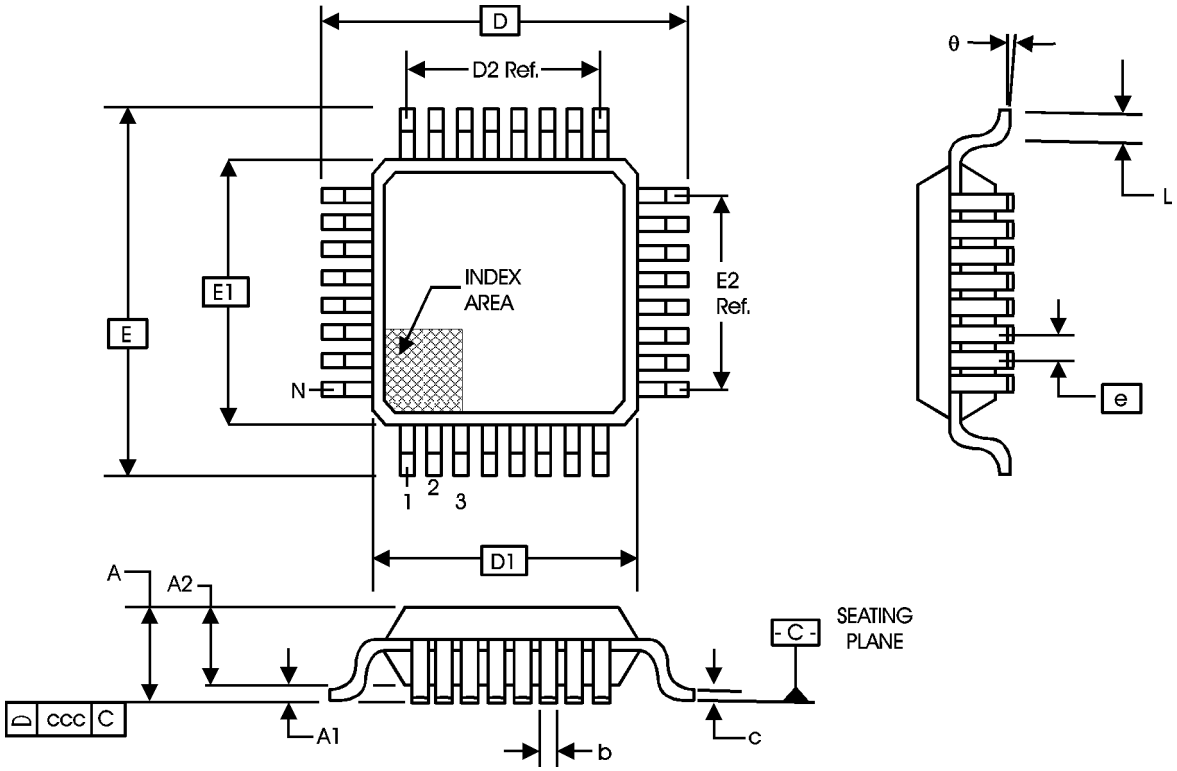


TABLE 8. PACKAGE DIMENSIONS

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 9. ORDERING INFORMATION

Part/Order Number	Marking	Package	Count	Temperature
ICS8752CY	ICS8752CY	32 Lead LQFP	250 per tray	0°C to 70°C
ICS8752CYT	ICS8752CY	32 Lead LQFP on Tape and Reel	1000	0°C to 70°C

REVISION HISTORY SHEET				
Rev	**Table**	**Page**	**Description of Change**	**Date**
A	T1	2	Pin Descriptions Table. Revised MR/nOE description.	8/19/02