

### General Description

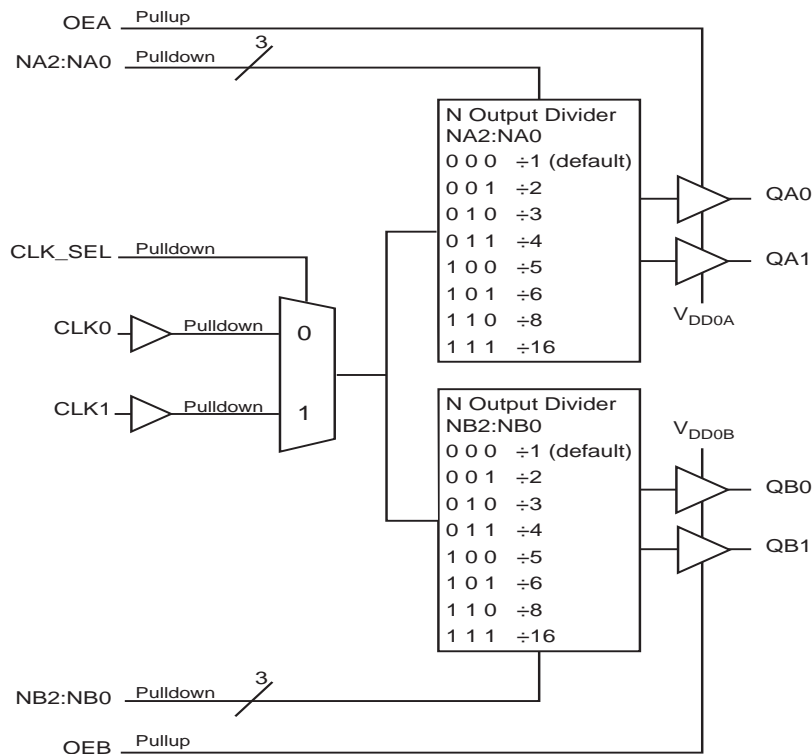
The ICS87004I-03 is a low skew,  $\div 1$ ,  $\div 2$   $\div 3$ ,  $\div 4$   $\div 5$ ,  $\div 6$   $\div 8$ ,  $\div 16$  LVC MOS/LVTTTL Fanout Buffer/Divider. The ICS87004I-03 has selectable clock inputs that accept single ended input levels. Output enable pin controls whether the output is in the active or high impedance state.

The ICS87004I-03 is characterized at 3.3V, 2.5V and mixed 3.3V,2.5V, 3.3V,1.8V, 2.5V,1.8V input/output supply operating modes. Guaranteed bank, output, and part-to-part skew characteristics make the ICS87004I-03 ideal for those applications demanding well defined performance and repeatability.

### Features

- Two banks of two LVC MOS/LVTTTL outputs
- Selectable LVC MOS/LVTTTL clock inputs
- LVC MOS\_CLK supports the following input types: LVC MOS, LVTTTL
- Maximum output frequency: 250MHz
- Output skew: 40ps (typical)
- Bank skew: 20ps (typical)
- Part-to-part skew: 60ps (typical)
- Power supply modes:  
CORE / OUTPUT  
3.3V / 3.3V  
3.3V / 2.5V  
3.3V / 1.8V  
2.5V / 2.5V  
2.5V / 1.8V
- -40°C to 85°C ambient operating temperature
- Available in lead-free (RoHS 6) package

### Block Diagram



### Pin Assignment

V <sub>DD</sub>	1	20	OEA
NA2	2	19	V <sub>DD0A</sub>
NA1	3	18	QA0
NA0	4	17	QA1
CLK0	5	16	GND
CLK_SEL	6	15	QB1
CLK1	7	14	QB0
NB2	8	13	V <sub>DD0B</sub>
NB1	9	12	GND
NB0	10	11	OEB

#### ICS87004I-03

#### 20-Lead TSSOP

6.50mm x 4.40mm x 0.925mm package body

#### G Package

#### Top View

**Table 1. Pin Descriptions**

Number	Name	Type		Description
1	V <sub>DD</sub>	Power		Power supply pin.
2, 3, 4	NA2, NA1, NA0	Input	Pulldown	N divider select pins for Bank A outputs. LVCMOS / LVTTL interface levels.
5, 7	CLK0, CLK1	Input	Pulldown	Single-ended clock inputs. LVCMOS / LVTTL interface levels.
6	CLK_SEL	Input	Pulldown	Input clock selection. LVCMOS / LVTTL interface levels. See Table 6.
8, 9, 10	NB2, NB1, NB0	Input	Pulldown	N divider select pins for Bank B outputs. LVCMOS / LVTTL interface levels.
11	OEB	Input	Pullup	Output enable control input for Bank B outputs. LVCMOS / LVTTL interface levels. See Table 5.
12, 16	GND	Power		Power supply core ground.
13	V <sub>DDOB</sub>	Power		Bank B output supply pin.
14, 15	QB0, QB1	Output		Single-ended Bank B clock outputs. LVCMOS / LVTTL interface levels.
17, 18	QA1, QA0	Output		Single-ended Bank A clock outputs. LVCMOS / LVTTL interface levels.
19	V <sub>DDOA</sub>	Power		Bank A output supply pin.
20	OEA	Input	Pullup	Output enable control input for Bank A outputs. LVCMOS / LVTTL interface levels. See Table 4.

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 <sub>IN</sub>	Input Capacitance			4		pF
R <sub>PULLDOWN</sub>	Input Pulldown Resistor			51		kΩ
R <sub>PULLUP</sub>	Input Pullup Resistor			51		kΩ
C <sub>PD</sub>	Power Dissipation Capacitance (per output)	V <sub>DDOA</sub> = V <sub>DDOB</sub> = 3.465V		10		pF
		V <sub>DDOA</sub> = V <sub>DDOB</sub> = 2.625V		10		pF
		V <sub>DDOA</sub> = V <sub>DDOB</sub> = 1.95V		10		pF
R <sub>OUT</sub>	Output Impedance	V <sub>DDOA</sub> = V <sub>DDOB</sub> = 3.3V ± 5%		17		Ω
		V <sub>DDOA</sub> = V <sub>DDOB</sub> = 2.5V ± 5%		20		Ω
		V <sub>DDOA</sub> = V <sub>DDOB</sub> = 1.8V ± 0.15V		28		Ω

## Function Table

**Table 3. Programmable Output Divider Function Table**

Inputs			N Divider Value	MAX Output Frequency (MHz)
NX2	NX1	NX0		
0	0	0	÷1 (default)	250
0	0	1	÷2	125
0	1	0	÷3	83.333
0	1	1	÷4	62.5
1	0	0	÷5	50
1	0	1	÷6	41.667
1	1	0	÷8	31.25
1	1	1	÷16	15.625

NOTE: Bank A and Bank B outputs are only synchronous if the same divider value is selected (NA2:0=NB2:0).

**Table 4. OEA Function Table**

OEA	Function
0	Bank A outputs are disabled in high-impedance state.
1 (default)	Bank A outputs are enabled

**Table 5. OEB Function Table**

OEB	Function
0	Bank B outputs are disabled in high-impedance state.
1 (default)	Bank B outputs are enabled

**Table 6. Input Clock Selection**

CLK_SEL	Input Clock
0 (default)	CLK0
1	CLK1

## Absolute Maximum Ratings

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.

Item	Rating
Supply Voltage, $V_{DD}$	4.6V
Inputs, $V_I$	-0.5V to $V_{DD} + 0.5V$
Outputs, $V_O$	-0.5V to $V_{DDOX} + 0.5V$
Package Thermal Impedance, $\theta_{JA}$	91.1°C/W (0 mps)
Storage Temperature, $T_{STG}$	-65°C to 150°C

## DC Electrical Characteristics

**Table 7A. Power Supply DC Characteristics,  $V_{DD} = 3.3V \pm 5\%$ ,  $V_{DDOA} = V_{DDOB} = 3.3V \pm 5\%$  or  $2.5V \pm 5\%$  or  $1.8V \pm 0.15V$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{DD}$	Power Supply Voltage		3.135	3.3	3.465	V
$V_{DDOA}$ , $V_{DDOB}$	Output Supply Voltage		3.135	3.3	3.465	V
			2.375	2.5	2.625	V
$I_{DD}$	Power Supply Current				55	mA
$I_{DDOA}$ , $I_{DDOB}$	Output Supply Current	No input clock or output loading			2	mA

**Table 7B. Power Supply DC Characteristics,  $V_{DD} = 2.5V \pm 5\%$ ,  $V_{DDOA} = V_{DDOB} = 2.5V \pm 5\%$  or  $1.8V \pm 0.15V$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$V_{DD}$	Power Supply Voltage		2.375	2.5	2.625	V
$V_{DDOA}$ , $V_{DDOB}$	Output Supply Current		2.375	2.5	2.625	V
			1.65	1.8	1.95	V
$I_{DD}$	Power Supply Current				55	mA
$I_{DDOA}$ , $I_{DDOB}$	Output Supply Current	No input clock or output loading			2	mA

**Table 7C. LVC MOS/LVTTL DC Characteristics,  $V_{DD} = 3.3V \pm 5\%$ , or  $2.5V \pm 5\%$ ,  $V_{DDOA} = V_{DDOB} = 3.3V \pm 5\%$  or  $2.5V \pm 5\%$  or  $1.8V \pm 0.15V$ ,  $T_A = -40^\circ C$  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	NA[2:0], NB[2:0], CLK[0:1], CLK_SEL $V_{DD} = V_{IN} = 3.465V$ or $2.625V$			150	$\mu A$
		OEA, OEB $V_{DD} = V_{IN} = 3.465V$ or $2.625V$			5	$\mu A$
$I_{IL}$	Input Low Current	NA[2:0], NB[2:0], CLK[0:1], CLK_SEL $V_{DD} = 3.465V$ or $2.625V$ , $V_{IN} = 0V$	-5			$\mu A$
		OEA, OEB $V_{DD} = 3.465V$ or $2.625V$ , $V_{IN} = 0V$	-150			$\mu A$
$V_{OH}$	Output High Voltage; NOTE 1	$V_{DDOA} = V_{DDOB} = 3.3V$	2.6			V
		$V_{DDOA} = V_{DDOB} = 2.5V$	1.8			V
		$V_{DDOA} = V_{DDOB} = 1.8V$	1.25			V
$V_{OL}$	Output Low Voltage; NOTE 1	$V_{DDOA} = V_{DDOB} = 3.3V$ or $2.5V$			0.5	V
		$V_{DDOA} = V_{DDOB} = 1.8V$			0.4	V
$I_{OZL}$	Output Hi-Z Current Low		-5			$\mu A$
$I_{OZH}$	Output Hi-Z Current Low				5	$\mu A$

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

## AC Electrical Characteristics

**Table 8A. AC Characteristics,  $V_{DD} = V_{DDOA} = V_{DDOB} = 3.3V \pm 5\%$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{OUT}$	Output Frequency				250	MHz
$t_{PD}$	Propagation Delay, NOTE 1	$N \leq 2$	3.8	4.8	5.8	ns
		$N > 2$	4.0	5.5	7.0	ns
$t_{sk(o)}$	Output Skew; NOTE 2, 3			40	200	ps
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 3, 4			50	300	ps
$t_{sk(b)}$	Bank Skew; NOTE 3, 5			20	85	ps
$t_R / t_F$	Output Rise/Fall Time	20% to 80%	400	700	900	ps
odc	Output Duty Cycle	$N=1$	35		55	%
		$N>1$	40		60	%
$t_{EN}$	Output Enable Time; NOTE 6				5	ns
$t_{DIS}$	Output Disable Time; NOTE 6				5	ns

NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500lfpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.

All parameters measured at  $f_{in} \leq 250\text{MHz}$ .

NOTE 1: Measured from  $V_{DD}/2$  of the input to  $V_{DDOX}/2$  of the output.

NOTE 2: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at  $V_{DDOX}/2$ .

NOTE 3: This parameter is defined in accordance with JEDEC Standard 65.

NOTE 4: Defined as skew between outputs on different devices operating at the same supply voltage, same frequency, same temperature and with equal load conditions. Using the same type of input on each device, the output is measured at  $V_{DDOX}/2$ .

NOTE 5: Defined as skew within a bank with equal load conditions.

NOTE 6: These parameters are guaranteed by characterization. Not tested in production.

**Table 8B. AC Characteristics,  $V_{DD} = 3.3V \pm 5\%$ ,  $V_{DDOA} = V_{DDOB} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$**

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{OUT}$	Output Frequency				250	MHz
$t_{PD}$	Propagation Delay, NOTE 1	$N \leq 2$	4.0	5.0	6.0	
		$N > 2$	4.5	6.0	7.5	ns
$t_{sk(o)}$	Output Skew; NOTE 2, 3			40	200	ps
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 3, 4			60	550	ps
$t_{sk(b)}$	Bank Skew; NOTE 3, 5			20	85	ps
$t_R / t_F$	Output Rise/Fall Time	20% to 80%	400	800	1200	ps
odc	Output Duty Cycle	$N=1$	35		55	%
		$N>1$	40		60	%
$t_{EN}$	Output Enable Time; NOTE 6				5	ns
$t_{DIS}$	Output Disable Time; NOTE 6				5	ns

NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500lfpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.

All parameters measured at  $f_{in} \leq 250\text{MHz}$ .

NOTE 1: Measured from  $V_{DD}/2$  of the input to  $V_{DDOX}/2$  of the output.

NOTE 2: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at  $V_{DDOX}/2$ .

NOTE 3: This parameter is defined in accordance with JEDEC Standard 65.

NOTE 4: Defined as skew between outputs on different devices operating at the same supply voltage, same frequency, same temperature and with equal load conditions. Using the same type of input on each device, the output is measured at  $V_{DDOX}/2$ .

NOTE 5: Defined as skew within a bank with equal load conditions.

NOTE 6: These parameters are guaranteed by characterization. Not tested in production.

**Table 8C. AC Characteristics,  $V_{DD} = 3.3V \pm 5\%$ ,  $V_{DDOA} = V_{DDOB} = 1.8V \pm 0.15V$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$** 

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{OUT}$	Output Frequency				250	MHz
$t_{PD}$	Propagation Delay, NOTE 1	$N \leq 2$	4.0	5.5	7.0	ns
		$N > 2$	4.8	6.3	7.8	ns
$t_{sk(o)}$	Output Skew; NOTE 2, 3			40	200	ps
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 3, 4			60	600	ps
$t_{sk(b)}$	Bank Skew; NOTE 3, 5			20	85	ps
$t_R / t_F$	Output Rise/Fall Time	20% to 80%	0.4	1	2.5	ns
odc	Output Duty Cycle	$N=1$	35		55	%
		$N>1$	40		60	%
$t_{EN}$	Output Enable Time; NOTE 6				5	ns
$t_{DIS}$	Output Disable Time; NOTE 6				5	ns

NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500lfpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.

All parameters measured at  $f_{in} \leq 250\text{MHz}$

NOTE 1: Measured from  $V_{DD}/2$  of the input to  $V_{DDOX}/2$  of the output.

NOTE 2: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at  $V_{DDOX}/2$ .

NOTE 3: This parameter is defined in accordance with JEDEC Standard 65.

NOTE 4: Defined as skew between outputs on different devices operating at the same supply voltage, same frequency, same temperature and with equal load conditions. Using the same type of input on each device, the output is measured at  $V_{DDOX}/2$ .

NOTE 5: Defined as skew within a bank with equal load conditions.

NOTE 6: These parameters are guaranteed by characterization. Not tested in production.

**Table 8D. AC Characteristics,  $V_{DD} = V_{DDOA} = V_{DDOB} = 2.5V \pm 5\%$ ,  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$** 

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{OUT}$	Output Frequency				250	MHz
$t_{PD}$	Propagation Delay, NOTE 1	$N \leq 2$	4.0	5.0	6.0	ns
		$N > 2$	4.5	6.0	7.5	ns
$t_{sk(o)}$	Output Skew; NOTE 2, 3			40	200	ps
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 3, 4			50	350	ps
$t_{sk(b)}$	Bank Skew; NOTE 3, 5			20	85	ps
$t_R / t_F$	Output Rise/Fall Time; NOTE 6	20% to 80%	400	900	1200	ps
odc	Output Duty Cycle	$N=1$	35		55	%
		$N>1$	40		60	%
$t_{EN}$	Output Enable Time; NOTE 6				5	ns
$t_{DIS}$	Output Disable Time; NOTE 6				5	ns

NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500lfpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.

All parameters measured at  $f_{in} \leq 250\text{MHz}$  unless noted otherwise.

NOTE 1: Measured from  $V_{DD}/2$  of the input to  $V_{DDOX}/2$  of the output.

NOTE 2: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at  $V_{DDOX}/2$ .

NOTE 3: This parameter is defined in accordance with JEDEC Standard 65.

NOTE 4: Defined as skew between outputs on different devices operating at the same supply voltage, same frequency, same temperature and with equal load conditions. Using the same type of input on each device, the output is measured at  $V_{DDOX}/2$ .

NOTE 5: Defined as skew within a bank with equal load conditions.

NOTE 6: These parameters are guaranteed by characterization. Not tested in production.

**Table 8E. AC Characteristics,  $V_{DD} = 2.5V \pm 5\%$ ,  $V_{DDOA} = V_{DDOB} = 1.8V \pm 0.15V$ ,  $T_A = -40^\circ C$  to  $85^\circ C$** 

Symbol	Parameter	Test Conditions	Minimum	Typical	Maximum	Units
$f_{OUT}$	Output Frequency				250	MHz
$t_{PD}$	Propagation Delay, NOTE 1	$N \leq 2$	4.0	5.5	7.0	ns
		$N > 2$	4.8	6.3	7.8	ns
$t_{sk(o)}$	Output Skew; NOTE 2, 3			40	200	ps
$t_{sk(pp)}$	Part-to-Part Skew; NOTE 3, 4			50	600	ps
$t_{sk(b)}$	Bank Skew; NOTE 3, 5			20	85	ps
$t_R / t_F$	Output Rise/Fall Time; NOTE 6	20% to 80%	0.4	1.1	2.5	ns
odc	Output Duty Cycle	$N=1$	35		55	%
		$N>1$	40		60	
$t_{EN}$	Output Enable Time; NOTE 6				5	ns
$t_{DIS}$	Output Disable Time; NOTE 6				5	ns

NOTE: Electrical parameters are guaranteed over the specified ambient operating temperature range, which is established when the device is mounted in a test socket with maintained transverse airflow greater than 500 lfpm. The device will meet specifications after thermal equilibrium has been reached under these conditions.

All parameters measured at  $f_{in} \leq 250\text{MHz}$  unless noted otherwise.

NOTE 1: Measured from  $V_{DD}/2$  of the input to  $V_{DDOX}/2$  of the output.

NOTE 2: Defined as skew between outputs at the same supply voltage and with equal load conditions. Measured at  $V_{DDOX}/2$ .

NOTE 3: This parameter is defined in accordance with JEDEC Standard 65.

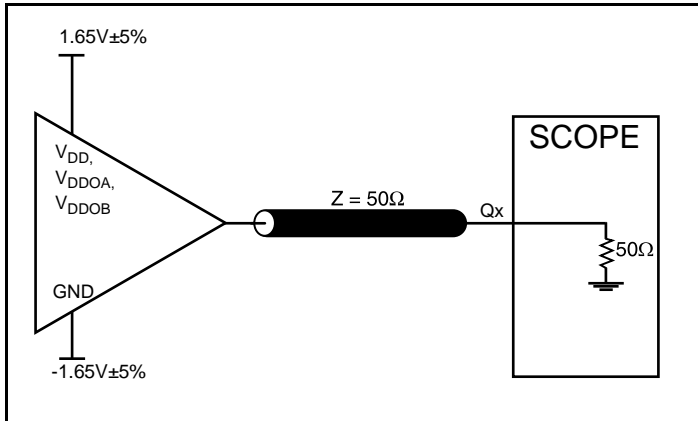
NOTE 4: Defined as skew between outputs on different devices operating at the same supply voltage, same frequency, same temperature and with equal load conditions. Using the same type of input on each device, the output is measured at  $V_{DDOX}/2$ .

NOTE 5: Defined as skew within a bank with equal load conditions.

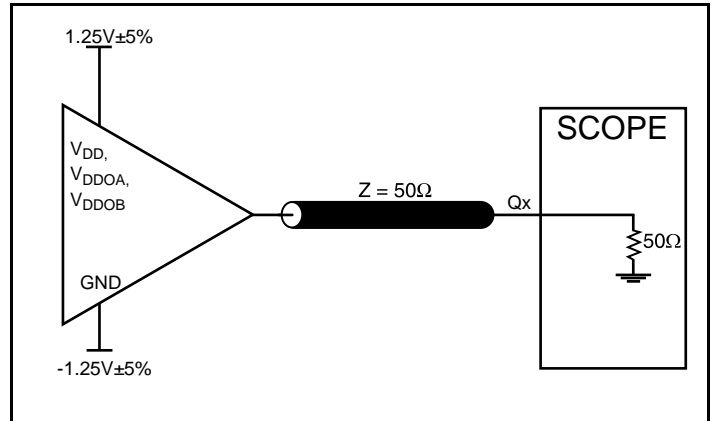
NOTE 6: These parameters are guaranteed by characterization. Not tested in production.



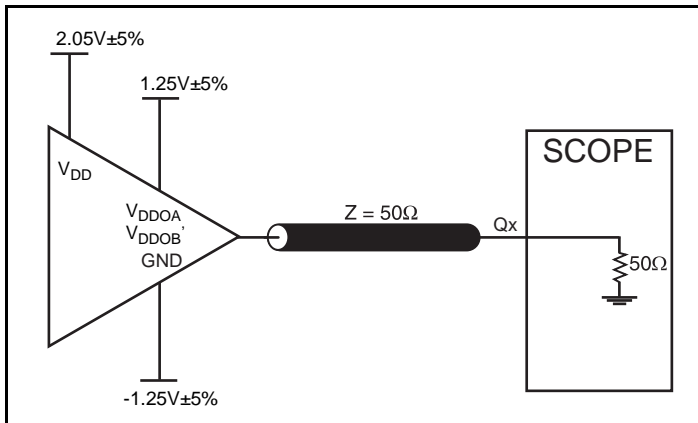
## Parameter Measurement Information



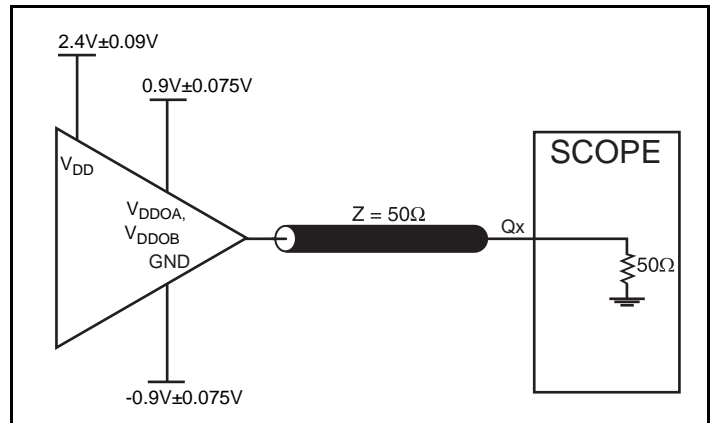
3.3V Core/3.3V Output Load AC Test Circuit



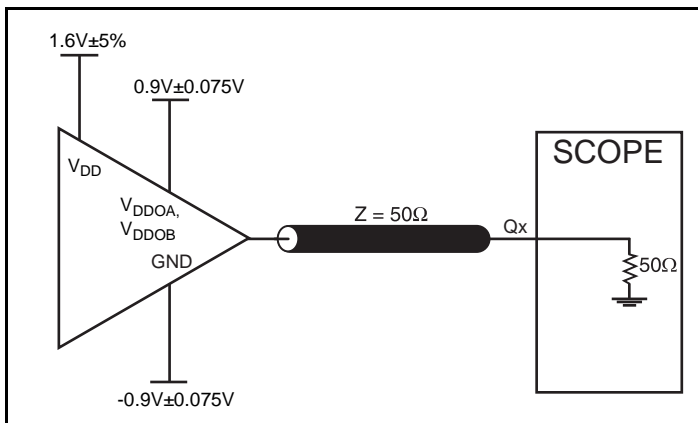
2.5V Core/2.5V Output Load AC Test Circuit



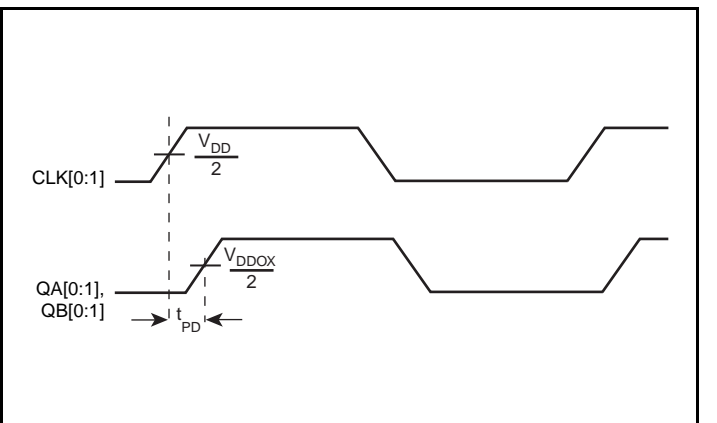
3.3V Core/2.5V Output Load AC Test Circuit



3.3V Core/1.8V Output Load AC Test Circuit

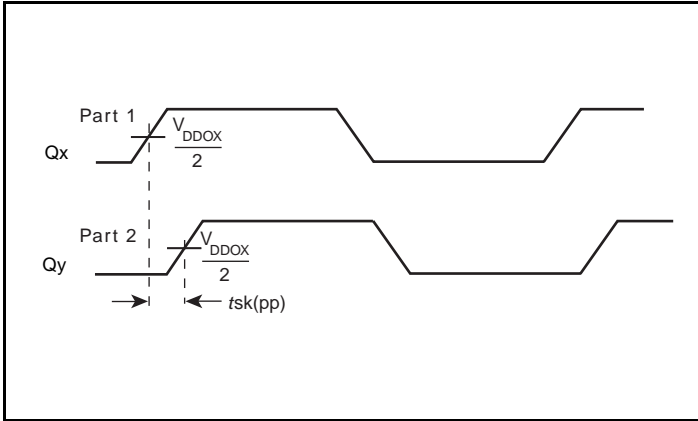


2.5V Core/1.8V Output Load AC Test Circuit

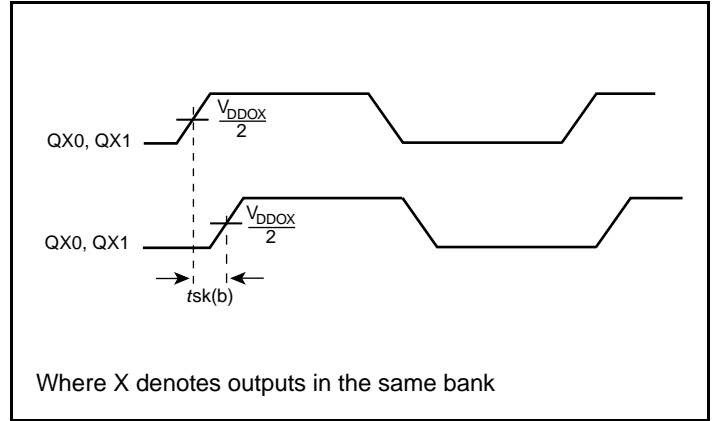


Propagation Delay

### Parameter Measurement Information, continued

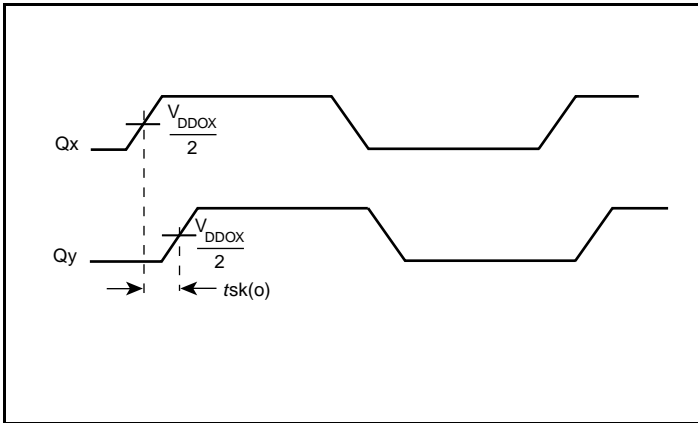


**Part-to-Part Skew**

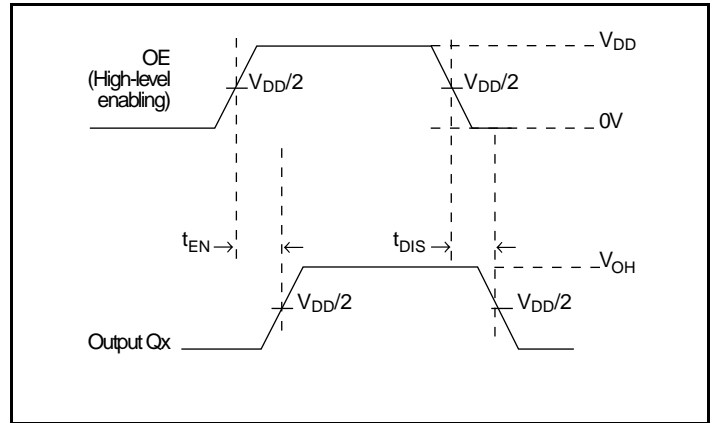


Where X denotes outputs in the same bank

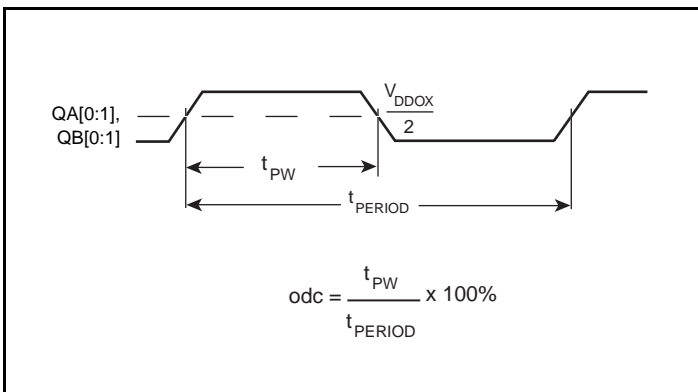
**Bank Skew**



**Output Skew**

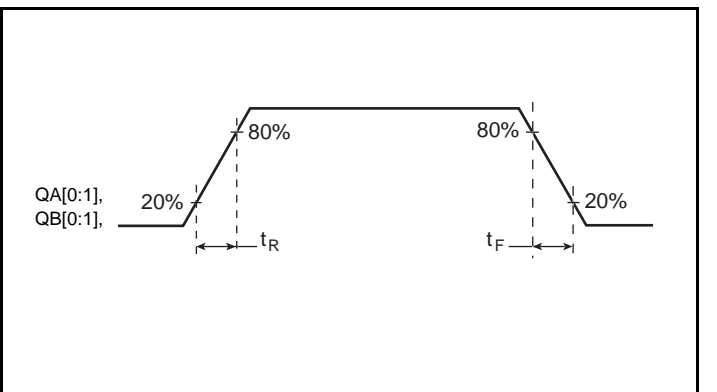


**Output Enable/Disable**



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

**Output Duty Cycle/Pulse Width/Period**



**Output Rise/Fall Time**

## Applications Information

### Recommendations for Unused Input and Output Pins

#### Inputs:

##### CLK Inputs

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

##### LVCMOS Control Pins

All control pins have internal pullups or pulldowns; additional resistance is not required but can be added for additional protection. A 1k $\Omega$  resistor can be used.

#### Outputs:

##### LVCMOS Outputs

All unused LVCMOS outputs can be left floating. We recommend that there is no trace attached.

## Power Considerations

This section provides information on power dissipation and junction temperature for the ICS87004I-03.

### 1. Power Dissipation.

The total power dissipation for the ICS87004I-03 is the sum of the core power plus the analog power plus the power dissipated in the load(s). The following is the power dissipation for  $V_{DD} = 3.3V + 5\% = 3.465V$ , which gives worst case results.

- Power (core)<sub>MAX</sub> =  $V_{DD\_MAX} * (I_{DD} + I_{DDOX}) = 3.465V * (55mA + 2mA) = \mathbf{197.51mW}$
- Output Impedance  $R_{OUT}$  Power Dissipation due to Loading  $50\Omega$  to  $V_{DD}/2$   
Output Current  $I_{OUT} = V_{DD\_MAX} / [2 * (50\Omega + R_{OUT})] = 3.465V / [2 * (50\Omega + 15\Omega)] = \mathbf{26.7mA}$
- Power Dissipation on the  $R_{OUT}$  per LVCMOS output  
Power ( $R_{OUT}$ ) =  $R_{OUT} * (I_{OUT})^2 = 15\Omega * (26.7mA)^2 = \mathbf{10.7mW}$  per output
- Total Power ( $R_{OUT}$ ) =  $10.7mW * 4 = \mathbf{42.6mW}$

### Dynamic Power Dissipation at 250MHz

$$\text{Power (250MHz)} = (C_{PD} + C_L) * \text{Frequency} * (V_{DD})^2 = 15pF * 250MHz * (3.465V)^2 = \mathbf{45.02mW}$$
 per output

$$\text{Total Power (250MHz)} = 45.02mW * 4 = \mathbf{180.09mW}$$

### Total Power Dissipation

- **Total Power**  
= Power (core)<sub>MAX</sub> + Power ( $R_{OUT}$ ) + Power (250MHz)  
=  $197.51mW + 42.6mW + 180.90mW$   
=  $\mathbf{420.22mW}$

### 2. Junction Temperature.

Junction temperature,  $T_j$ , is the temperature at the junction of the bond wire and bond pad directly affects the reliability of the device. The maximum recommended junction temperature is  $125^\circ\text{C}$ . Limiting the internal transistor junction temperature,  $T_j$ , to  $125^\circ\text{C}$  ensures that the bond wire and bond pad temperature remains below  $125^\circ\text{C}$ .

The equation for  $T_j$  is as follows:  $T_j = \theta_{JA} * Pd_{total} + T_A$

$T_j$  = Junction Temperature

$\theta_{JA}$  = Junction-to-Ambient Thermal Resistance

$Pd_{total}$  = Total Device Power Dissipation (example calculation is in section 1 above)

$T_A$  = Ambient Temperature

In order to calculate junction temperature, the appropriate junction-to-ambient thermal resistance  $\theta_{JA}$  must be used. Assuming no air flow and a multi-layer board, the appropriate value is  $91.1^\circ\text{C/W}$  per Table 5 below.

Therefore,  $T_j$  for an ambient temperature of  $85^\circ\text{C}$  with all outputs switching is:

$$85^\circ\text{C} + 0.420W * 91.1^\circ\text{C/W} = 123.3^\circ\text{C}. \text{ This is below the limit of } 125^\circ\text{C}.$$

This calculation is only an example.  $T_j$  will obviously vary depending on the number of loaded outputs, supply voltage, air flow and the type of board (multi-layer).

**Table 9. Thermal Resistance  $\theta_{JA}$  for 20 Lead TSSOP, Forced Convection**

$\theta_{JA}$ by Velocity			
Meters per Second	0	1	2.5
Multi-Layer PCB, JEDEC Standard Test Boards	$91.1^\circ\text{C/W}$	$86.7^\circ\text{C/W}$	$84.6^\circ\text{C/W}$

## Reliability Information

Table 10.  $\theta_{JA}$  vs. Air Flow Table for a 20 Lead TSSOP

$\theta_{JA}$ vs. Air Flow			
Meters per Second	0	1	2.5
Multi-Layer PCB, JEDEC Standard Test Boards	91.1°C/W	86.7°C/W	84.6°C/W

## Transistor Count

The transistor count for ICS87004I-03 is: 2769

## Package Outline and Package Dimensions

Package Outline - G Suffix for 20 Lead TSSOP

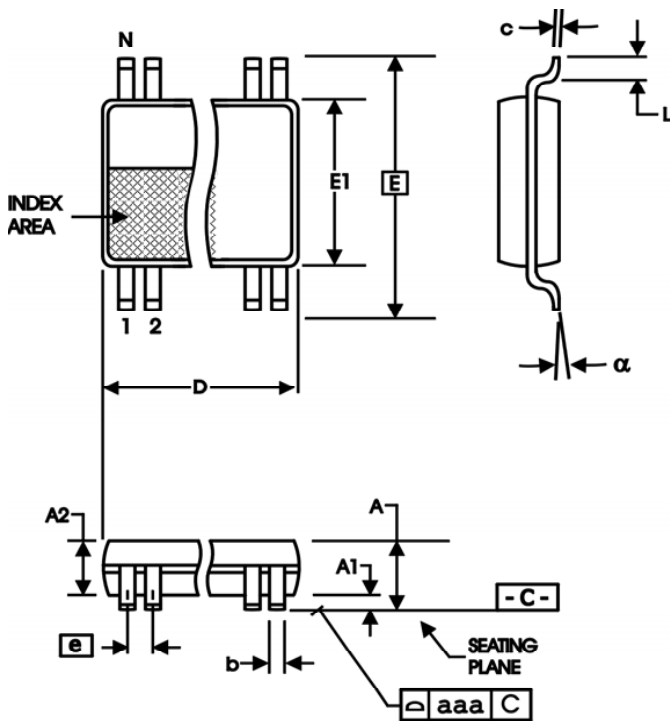


Table 7. Package Dimensions

All Dimensions in Millimeters		
Symbol	Minimum	Maximum
N	20	
A		1.20
A1	0.05	0.15
A2	0.80	1.05
b	0.19	0.30
c	0.09	0.20
D	6.40	6.60
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

## Ordering Information

Table 11. Ordering Information

Part/Order Number	Marking	Package	Shipping Packaging	Temperature
87004BGI-03LF	ICS7004BI03L	"Lead-Free" 20 Lead TSSOP	Tube	-40°C to 85°C
87004BGI-03LFT	ICS7004BI03L	"Lead-Free" 20 Lead 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.

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