



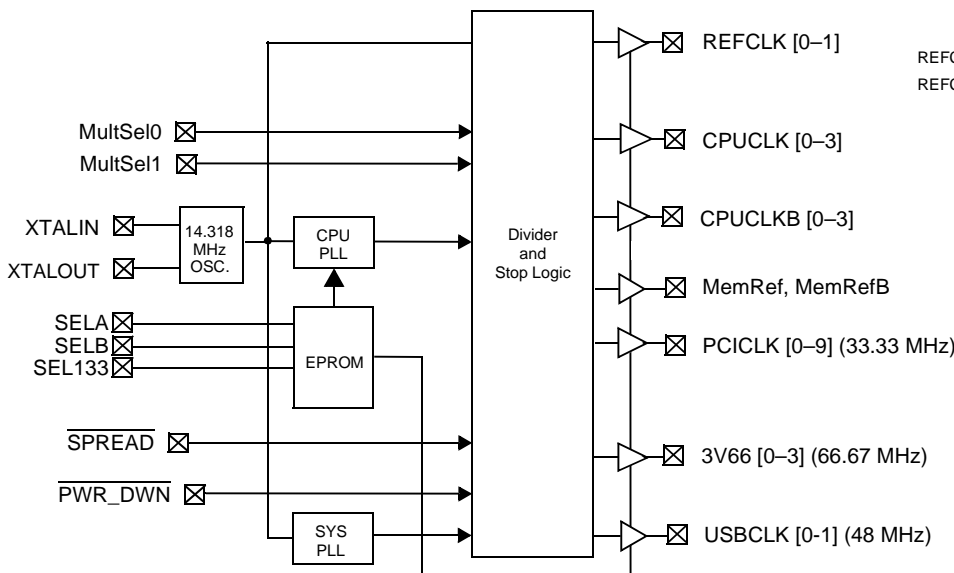
CYPRESS

CY2220

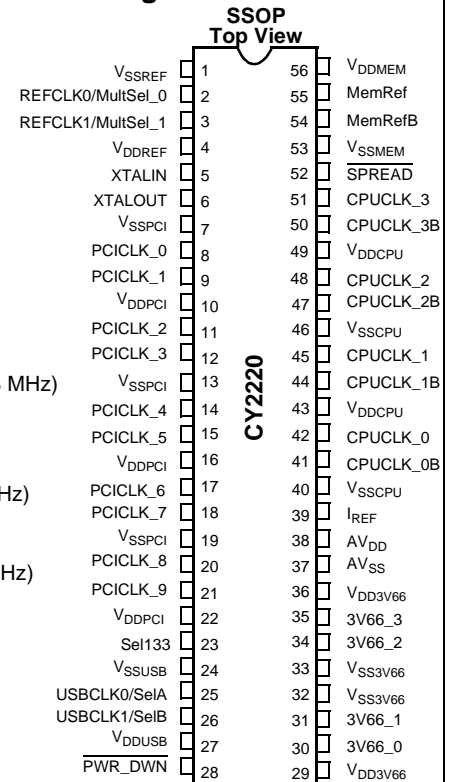
# 133-MHz Spread Spectrum Clock Synthesizer/Driver with Differential CPU Outputs

Features	Benefits
<ul style="list-style-type: none"> <li>Compliant to Intel® CK00 Clock Synthesizer/Driver Specifications</li> </ul>	Supports next generation Pentium® processors using differential clock drivers
<ul style="list-style-type: none"> <li>Multiple output clocks at different frequencies               <ul style="list-style-type: none"> <li>Four pairs of differential CPU outputs, up to 133 MHz</li> <li>Ten synchronous PCI clocks</li> <li>Two Memory Reference clocks, 180 degrees out of phase</li> <li>Four AGP and Hub Link clocks at 66 MHz</li> <li>Two 48-MHz clocks</li> <li>Two reference clocks at 14.318 MHz</li> </ul> </li> </ul>	Motherboard clock generator <ul style="list-style-type: none"> <li>Support Multiple CPUs and a chipset</li> <li>Support for PCI slots and chipset</li> <li>Drives up to two Direct Rambus™ Clock Generators (DRCG)</li> <li>Supports USB host controller and SuperI/O chip</li> <li>Supports ISA slots and I/O chip</li> </ul>
<ul style="list-style-type: none"> <li>Spread Spectrum clocking               <ul style="list-style-type: none"> <li>31 kHz modulation frequency</li> <li>Default is -0.6%, which is recommended by Intel</li> </ul> </li> </ul>	Enables reduction of EMI and overall system cost
<ul style="list-style-type: none"> <li>Power-down features</li> </ul>	Enables ACPI compliant designs
<ul style="list-style-type: none"> <li>Three Select inputs</li> </ul>	Supports up to eight CPU clock frequencies
<ul style="list-style-type: none"> <li>Low-skew and low-jitter outputs</li> </ul>	Meets tight system timing requirements at high frequency
<ul style="list-style-type: none"> <li>OE and Test Mode support</li> </ul>	Enables ATE and “bed of nails” testing
<ul style="list-style-type: none"> <li>56-pin SSOP package</li> </ul>	Widely available, standard package enables lower cost

## Logic Block Diagram



## Pin Configuration



Intel and Pentium are registered trademarks of Intel Corporation.  
Direct Rambus is a trademark of Rambus, Inc.

**Pin Summary**

Name	Pins	Description
V <sub>SSREF</sub>	1	3.3V Reference ground
V <sub>DDREF</sub>	4	3.3V Reference voltage supply
V <sub>SSPCI</sub>	7, 13, 19	3.3V PCI ground
V <sub>DDPCI</sub>	10, 16, 22	3.3V PCI voltage supply
V <sub>SS3V66</sub>	32, 33	3.3V AGP and Hub Link ground
V <sub>DD3V66</sub>	29, 36	3.3V AGP and Hub Link voltage supply
V <sub>SSUSB</sub>	24	3.3V USB ground
V <sub>DDUSB</sub>	27	3.3V USB voltage supply
V <sub>SSCPU</sub>	40, 46	3.3V CPU ground
V <sub>DDCPU</sub>	43, 49	3.3V CPU voltage supply
V <sub>SSMEM</sub>	53	3.3V Memory ground
V <sub>DDMEM</sub>	56	3.3V Memory voltage supply
AV <sub>SS</sub>	37	Analog ground for PLL and Core
AV <sub>DD</sub>	38	Analog voltage supply to PLL and Core
I <sub>REF</sub>	39	Reference current for external biasing
XTALIN <sup>[1]</sup>	5	Reference crystal input
XTALOUT <sup>[1]</sup>	6	Reference crystal feedback
CPUCLK [0–3]	42, 45, 48, 51	CPU clock outputs
CPUCLK [0–3]B	41, 44, 47, 50	Inverse CPU clock outputs
PCICLK [0–9]	8, 9, 11, 12, 14, 15, 17, 18, 20, 21	PCI clock outputs, synchronously running at 33.33 MHz
MemRef	55	MemRef clock output, drives memory clock generator
MemRefB	54	MemRefB clock output 180 degrees out of phase with MemRef
3V66_ [0–3]	30, 31, 34, 35	AGP and Hub Link clock outputs, running at 66 MHz
USBCLK [0–1]/Sel[A–B]	25, 26	Sel [A–B] inputs are sensed then internally latched on power-up before the pins are used for 48-MHz USB clock outputs
REFCLK[0–1]/MultSel[0–1]	2, 3	MultSel[0–1] inputs are sensed then internally latched on power-up before the pins are Reference clock outputs, 14.318 MHz
PWR_DWN	28	Active LOW input, powers down part when asserted
SPREAD <sup>[2]</sup>	52	Active LOW input, enables spread spectrum when asserted
SEL133	23	CPU frequency select input (See Function Table)

**Notes:**

- For best accuracy, use a parallel-resonant crystal, C<sub>LOAD</sub> = 18 pF. For crystals with different C<sub>LOAD</sub>, please refer to the application note, "Crystal Oscillator Topics."
- Input is static HIGH or LOW. Frequency of toggling cannot exceed 30 MHz.

**Function Table<sup>[3]</sup>**

SEL133	SELA	SELB	CPUCLK (MHz)	MemRef (MHz)	3V66CLK (MHz)	PCICLK (MHz)	USBCLK (MHz)	REFCLK (MHz)
0	0	0	100	50	66	33	48	14.318
0	0	1	N/A	N/A	N/A	N/A	N/A	N/A
0	1	0	N/A	N/A	N/A	N/A	N/A	N/A
0	1	1	Hi-Z	Hi-Z	Hi-Z	Hi-Z	Hi-Z	Hi-Z
1	0	0	133	66	66	33	48	14.318
1	0	1	N/A	N/A	N/A	N/A	N/A	N/A
1	1	0	N/A	N/A	N/A	N/A	N/A	N/A
1	1	1	TCLK/2	TCLK/4	TCLK/4	TCLK/8	TCLK/2	TCLK

**Actual Clock Frequency Values**

Clock Output	Target Frequency (MHz)	CY2220-1		CY2220-2	
		Actual Frequency (MHz)	PPM	Actual Frequency (MHz)	PPM
CPUCLK	100	99.126	-8741	100.227	+2270
CPUCLK	133	132.769	-1740	133.269	+2022
USBCLK	48	48.008	167	48.008	167

**Swing Select Functions**

MultSel0	MultSel1	Board Target	Reference R, I <sub>REF</sub> =	Output Current	V <sub>OH</sub> @ Z, I <sub>ref</sub> = 2.32 mA
0	0	60Ω	R <sub>r</sub> = 475 ± 1%, I <sub>ref</sub> = 2.32 mA	I <sub>OH</sub> = 5*I <sub>ref</sub>	0.71 @ 60
0	0	50Ω	R <sub>r</sub> = 475 ± 1%, I <sub>ref</sub> = 2.32 mA	I <sub>OH</sub> = 5*I <sub>ref</sub>	0.59 @ 50
0	1	60Ω	R <sub>r</sub> = 475 ± 1%, I <sub>ref</sub> = 2.32 mA	I <sub>OH</sub> = 6*I <sub>ref</sub>	0.85 @ 60
0	1	50Ω	R <sub>r</sub> = 475 ± 1%, I <sub>ref</sub> = 2.32 mA	I <sub>OH</sub> = 6*I <sub>ref</sub>	0.71 @ 50
1	0	60Ω	R <sub>r</sub> = 475 ± 1%, I <sub>ref</sub> = 2.32 mA	I <sub>OH</sub> = 4*I <sub>ref</sub>	0.56 @ 60
1	0	50Ω	R <sub>r</sub> = 475 ± 1%, I <sub>ref</sub> = 2.32 mA	I <sub>OH</sub> = 4*I <sub>ref</sub>	0.47 @ 50
1	1	60Ω	R <sub>r</sub> = 475 ± 1%, I <sub>ref</sub> = 2.32 mA	I <sub>OH</sub> = 7*I <sub>ref</sub>	0.99 @ 60
1	1	50Ω	R <sub>r</sub> = 475 ± 1%, I <sub>ref</sub> = 2.32 mA	I <sub>OH</sub> = 7*I <sub>ref</sub>	0.82 @ 50

**Clock Driver Impedances**

Buffer Name	V <sub>DD</sub> Range	Buffer Type	Impedance		
			Minimum Ω	Typical Ω	Maximum Ω
CPUCLK, CPUCLKB		Type X1			
USB, REF	3.135–3.465	Type 3	20	40	60
PCI, 3V66	3.135–3.465	Type 5	12	30	55
MemRef, MemRefB	3.135–3.465	Type 5	12	30	55

**Note:**

3. TCLK is a test clock driven in on the XTALIN input in test mode.

**Maximum Ratings**

(Above which the useful life may be impaired. For user guidelines, not tested.)

Supply Voltage.....-0.5 to +7.0V  
 Input Voltage.....-0.5V to  $V_{DD} + 0.5$

Storage Temperature (Non-Condensing).....-65°C to +150°C  
 Junction Temperature.....  
 +150°C  
 Package Power Dissipation.....1W  
 Static Discharge Voltage  
 (per JEDEC EIA/JESD22-A114-A).....2000V

**Operating Conditions** Over which Electrical Parameters are Guaranteed

Parameter	Description	Min.	Max.	Unit
$V_{DDREF}$ , $V_{DDPCI}$ , $AV_{DD}$ , $V_{DD3V66}$ , $V_{DDUSB}$ , $V_{DDCPU}$ , $V_{DDMEM}$	3.3V Supply Voltages	3.135	3.465	V
$T_A$	Operating Temperature, Ambient	0	70	°C
$C_{in}$	Input Pin Capacitance Nominal Value	18 pF	18 pF	pF
$C_{XTAL}$	XTAL Pin Capacitance		22.5	pF
$C_L$	Max. Capacitive Load on MemRef, USBCLK, REF PCICLK, 3V66		20 30	pF
$f_{(REF)}$	Reference Frequency, Oscillator Nominal Value	14.318	14.318	MHz
$t_{PU}$	Power-up time for all VDD's to reach minimum specified voltage (power ramps must be monotonic)	0.05	50	ms

**Electrical Characteristics** Over the Operating Range

Parameter	Description	Test Conditions	Min.	Max.	Unit	
$V_{IH}$	High-level Input Voltage	Except Crystal Pads. Threshold voltage for crystal pads = $V_{DD}/2$	2.0		V	
$V_{IL}$	Low-level Input Voltage	Except Crystal Pads		0.8	V	
$V_{OH}$	High-level Output Voltage	MemRef, USB, REF, 3V66	$I_{OH} = -1$ mA	2.4	V	
		PCI	$I_{OH} = -1$ mA	2.4	V	
$V_{OL}$	Low-level Output Voltage	MemRef, USB, REF, 3V66	$I_{OL} = 1$ mA	0.4	V	
		PCI	$I_{OL} = 1$ mA	0.55	V	
$I_{IH}$	Input High Current	$0 \leq V_{IN} \leq V_{DD}$	-5	5	μA	
$I_{IL}$	Input Low Current	$0 \leq V_{IN} \leq V_{DD}$	-5	5	μA	
$I_{OH}$	High-level Output Current	CPU For $I_{OH} = 6 \cdot I_{Ref}$ Configuration	Type X1, $V_{OH} = 0.65V$	-12.9	-14.9	mA
		USB, REF	Type 3, $V_{OH} = 2.4V$	-15	-51	
		3V66, PCI, MemRef, MemRefB	Type 5, $V_{OH} = 2.4V$	-30	-100	
$I_{OL}$	Low-level Output Current	USB, REF	Type 3, $V_{OL} = 0.4V$	10	24	mA
		3V66, PCI, MemRef, MemRefB	Type 5, $V_{OL} = 0.4V$	20	49	
$I_{OZ}$	Output Leakage Current	Three-state		10	μA	
$I_{DD3}$	3.3V Power Supply Current	$AV_{DD}/V_{DD33} = 3.465V$ , $F_{CPU} = 133$ MHz		250	mA	
$I_{DDP3}$	3.3V Shutdown Current	$AV_{DD}/V_{DDQ3} = 3.465V$		60	mA	

**Switching Characteristics<sup>[4]</sup> Over the Operating Range**

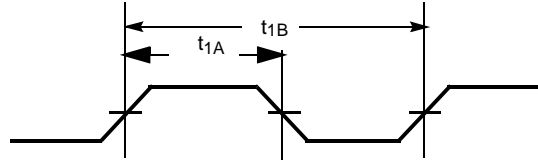
Parameter	Output	Description	Test Conditions	Min.	Max.	Unit
t <sub>1</sub>	All	Output Duty Cycle <sup>[5]</sup>	t <sub>1A</sub> /(t <sub>1B</sub> )	45	55	%
t <sub>2</sub>	CPU	Rise Time	Measured at 20% to 80% of V <sub>OH</sub>	175	700	ps
t <sub>2</sub>	USB, REF	Rising Edge Rate	Between 0.4V and 2.4V	0.5	2.0	V/ns
t <sub>2</sub>	PCI, 3V66, MemRef	Rising Edge Rate	Between 0.4V and 2.4V	1.0	4.0	V/ns
t <sub>3</sub>	CPU	Fall Time	Measured at 80% to 20% of V <sub>OH</sub>	175	700	ps
t <sub>3</sub>	USB, REF	Falling Edge Rate	Between 2.4V and 0.4V	0.5	2.0	V/ns
t <sub>3</sub>	PCI, 3V66, MemRef	Falling Edge Rate	Between 2.4V and 0.4V	1.0	4.0	V/ns
t <sub>4</sub>	CPU	CPU-CPU Skew	Measured at Crossover		150	ps
t <sub>5</sub>	3V66	3V66-3V66 Skew	Measured at 1.5V		250	ps
t <sub>6</sub>	PCI	PCI-PCI Skew	Measured at 1.5V		500	ps
t <sub>7</sub>	3V66, PCI	3V66-PCI Clock Skew	3V66 leads. Measured at 1.5V	1.5	3.5	ns
t <sub>8</sub>	CPU	Cycle-Cycle Clock Jitter	Measured at Crossover t <sub>8</sub> = t <sub>8A</sub> - t <sub>8B</sub> With all outputs running		200	ps
t <sub>9</sub>	Mref	Cycle-Cycle Clock Jitter	Measured at 1.5V t <sub>9</sub> = t <sub>9A</sub> - t <sub>9B</sub>		250	ps
t <sub>9</sub>	3V66	Cycle-Cycle Clock Jitter	Measured at 1.5V t <sub>9</sub> = t <sub>9A</sub> - t <sub>9B</sub>		300	ps
t <sub>9</sub>	USB	Cycle-Cycle Clock Jitter	Measured at 1.5V t <sub>9</sub> = t <sub>9A</sub> - t <sub>9B</sub>		350	ps
t <sub>9</sub>	PCI	Cycle-Cycle Clock Jitter	Measured at 1.5V t <sub>9</sub> = t <sub>9A</sub> - t <sub>9B</sub>		500	ps
t <sub>9</sub>	REF	Cycle-Cycle Clock Jitter	Measured at 1.5V t <sub>9</sub> = t <sub>9A</sub> - t <sub>9B</sub>		1000	ps
	CPU, PCI	Settle Time	CPU and PCI clock stabilization from power-up		3	ms
	CPU	Rise/Fall Matching	Measured with test loads <sup>[6, 7]</sup>		20%	
	CPU	Overshoot	Measured with test loads <sup>[7]</sup>		V <sub>OH</sub> + 0.2	V
	CPU	Undershoot	Measured with test loads <sup>[7]</sup>	-0.2		V
V <sub>oh</sub>	CPU	High-level Output Voltage	Measured with test loads <sup>[7]</sup>	0.65	0.74	V
V <sub>ol</sub>	CPU	Low-level Output Voltage	Measured with test loads <sup>[7]</sup>	0.0	0.05	V
V <sub>crossover</sub>	CPU	Crossover Voltage	Measured with test loads <sup>[7]</sup>	45% of V <sub>OH</sub>	55% of V <sub>OH</sub>	V

**Notes:**

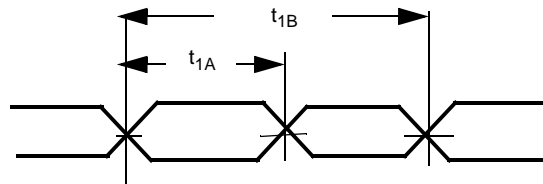
4. All parameters specified with loaded outputs. Parameters not tested in production, but are guaranteed by design characterization.
5. Duty cycle is measured at 1.5V with V<sub>DD</sub> at 3.3V on all output except CPU. Duty Cycle on CPU is measured at V<sub>Crossover</sub>.
6. Determined as a fraction of 2\*(t<sub>RP</sub> - t<sub>RN</sub>)/(t<sub>RP</sub> + t<sub>RN</sub>) Where t<sub>RP</sub> is a rising edge and t<sub>RN</sub> is an intersecting falling edge.
7. The test load is specified in test circuit.

## Switching Waveforms

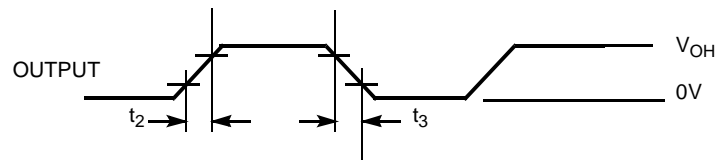
### Duty Cycle Timing (Single Ended Output)



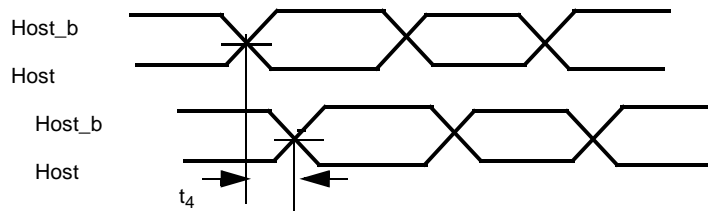
### Duty Cycle Timing (CPU Differential Output)



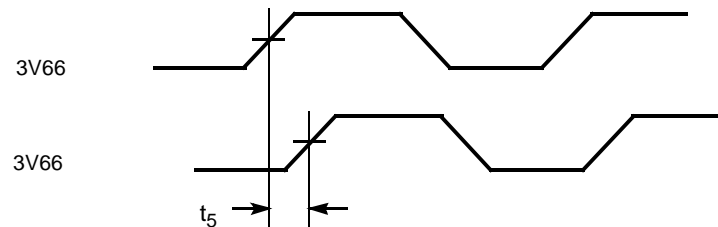
### All Outputs Rise/Fall Time

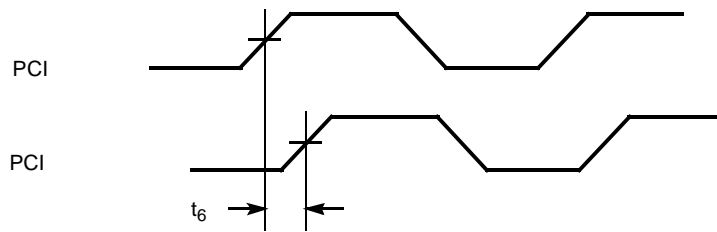
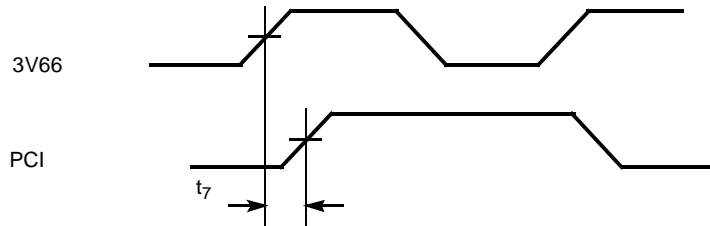
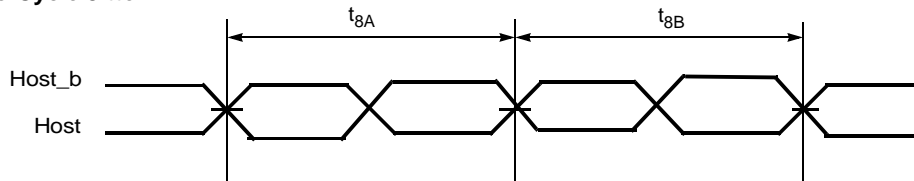
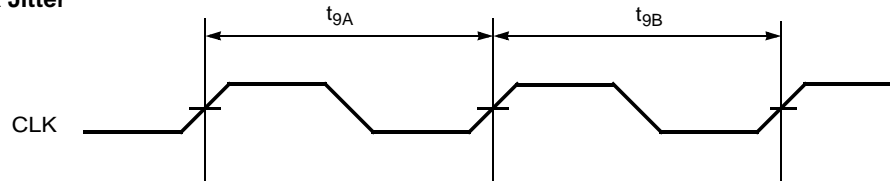
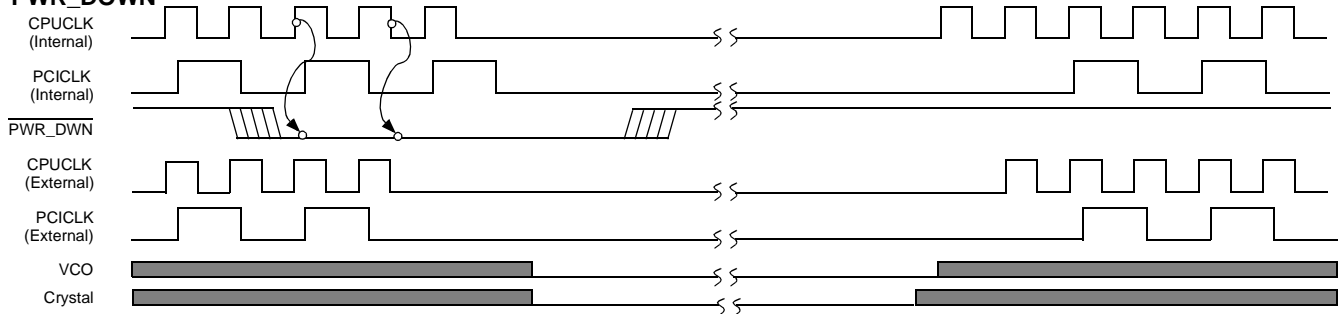


### CPU-CPU Clock Skew

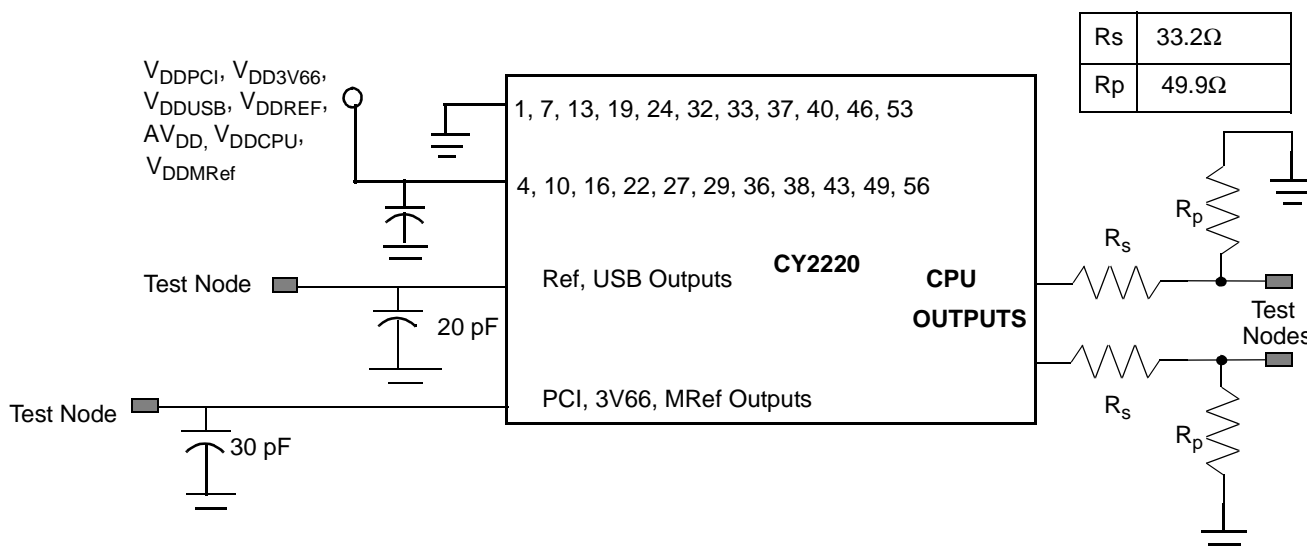


### 3V66-3V66 Clock Skew



**Switching Waveforms (continued)**
**PCI-PCI Clock Skew**

**3V66-PCI Clock Skew**

**CPU Clock Cycle-Cycle Jitter**

**Cycle-Cycle Clock Jitter**

**PWR\_DOWN<sup>[8]</sup>**

**Note:**

8. Shaded section on the VCO and Crystal waveforms indicates that the VCO and crystal oscillator are active, and there is a valid clock.

**Test Circuit**<sup>[9, 10]</sup>

**Ordering Information**

Ordering Code	Package Name	Package Type	Operating Range
CY2220PVC-1	O56	56-Pin SSOP	Commercial
CY2220PVC-2	O56	56-Pin SSOP	Commercial

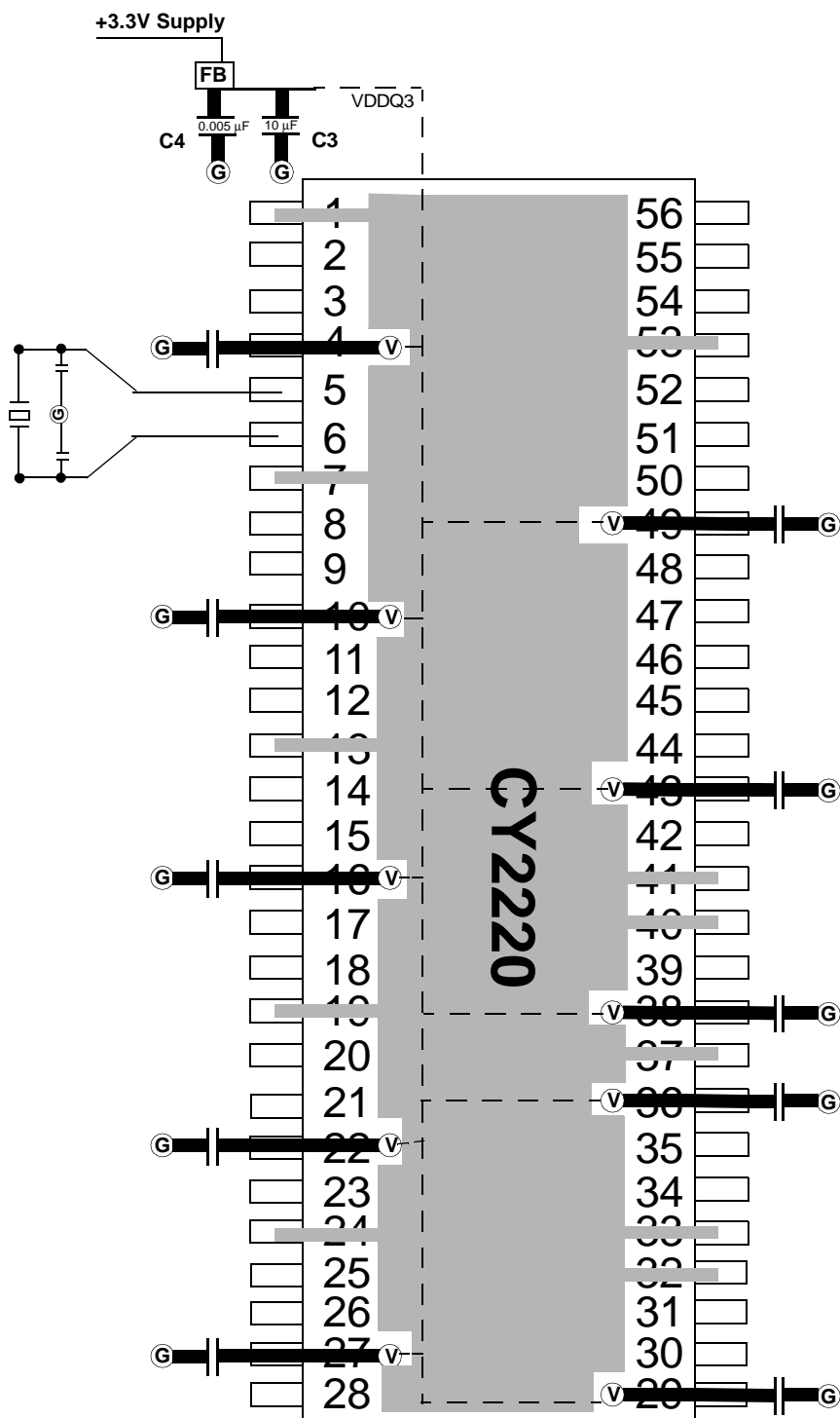
**Notes:**

9. Each supply pin must have an individual decoupling capacitor.

10. All capacitors must be placed as close to the pins as is physically possible.



Layout Example



FB = Dale ILB1206 - 300 (30Ω @ 100 MHz)

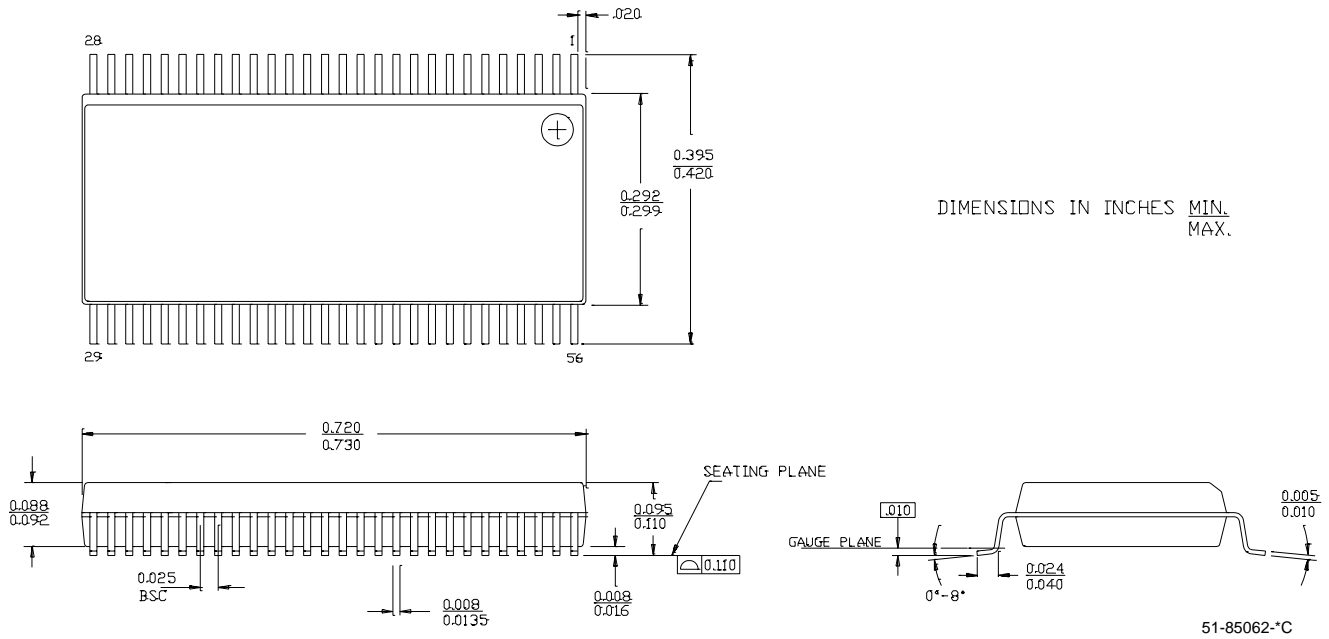
Ceramic Caps C3 = 10–22 μF C4 = 0.005 μF

ⓐ = VIA to GND plane layer Ⓥ = VIA to respective supply plane layer

**Note:** Each supply plane or strip should have a ferrite bead and capacitors  
All bypass caps = 0.01 μF ceramic

**Package Diagram**

**56-Lead Shrunken Small Outline Package O56**



<b>Document Title: CY2220 133-MHz Spread Spectrum Clock Synthesizer/Driver with Differential CPU Outputs</b>				
<b>Document Number: 38-07206</b>				
<b>REV.</b>	<b>ECN NO.</b>	<b>Issue Date</b>	<b>Orig. of Change</b>	<b>Description of Change</b>
**	111730	01/17/02	DSG	Change from Spec number: 38-00813 to 38-07206
*A	121841	12/30/02	RBI	Power up requirements added to Operating Conditions Information