

## Three-PLL General Purpose FLASH Programmable Clock Generator

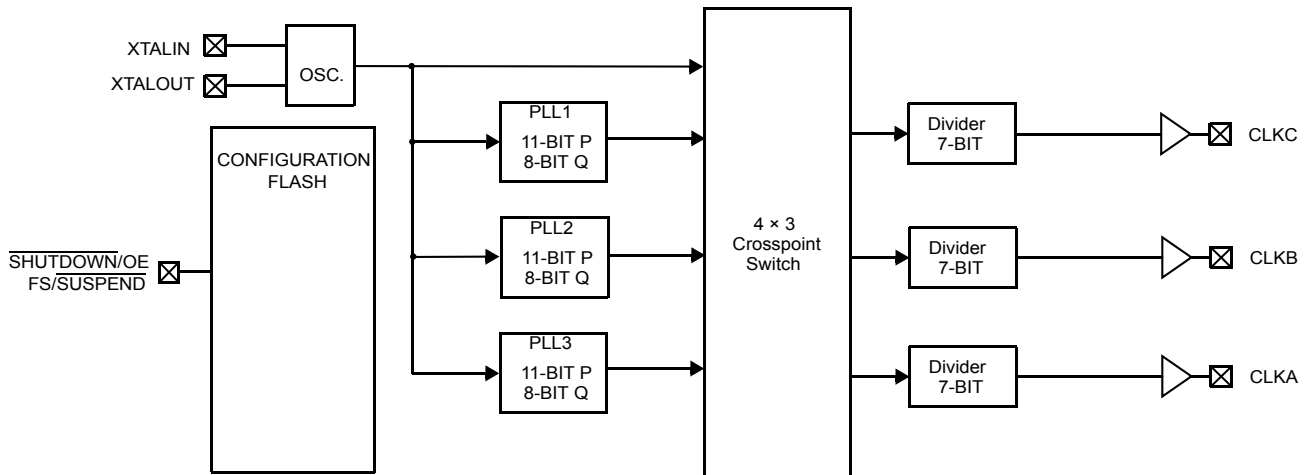
### Features

- Three integrated phase-locked loops
- Ultra-wide divide counters (eight-bit Q, eleven-bit P, and seven-bit post divide)
- Improved linear crystal load capacitors
- Flash programmability
- Field programmability
- Low-jitter, high-accuracy outputs
- Power-management options (Shutdown, OE, Suspend)
- Configurable crystal drive strength
- Frequency select option through external LVTTTL Input
- 3.3 V operation
- 8-pin small outline integrated circuit (SOIC) package (CY22381)
- 8-pin SOIC package with NiPdAu lead finish (CY223811)
- CyClocks RT™ support

### Functional Description

The CY22381 is the next-generation programmable Flash programmable clock for use in networking, telecommunication, datacom, and other general-purpose applications. The CY22381 offers up to three configurable outputs in a 8-pin SOIC, running off a 3.3 V power supply. The on-chip reference oscillator is designed to run off an 8–30-MHz crystal, or a 1–166-MHz external clock signal. The CY22381 has a three PLLs driving 3 programmable output clocks. The output clocks are derived from the PLL or the reference frequency (REF). Output post dividers are available for either. The CY223811 is the CY22381 with NiPdAu lead finish.

### Logic Block Diagram

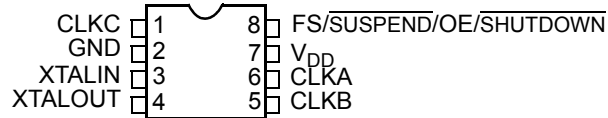


## Contents

<b>Features</b> .....	<b>1</b>	<b>Recommended Crystal Specifications</b> .....	<b>5</b>
<b>Functional Description</b> .....	<b>1</b>	<b>Electrical Characteristics</b> .....	<b>5</b>
<b>Logic Block Diagram</b> .....	<b>1</b>	<b>Switching Characteristics</b> .....	<b>6</b>
<b>Pinouts</b> .....	<b>3</b>	<b>Switching Waveforms</b> .....	<b>6</b>
<b>Pin Definitions</b> .....	<b>3</b>	Possible Configurations .....	8
<b>Operation</b> .....	<b>3</b>	<b>Ordering Information</b> .....	<b>8</b>
Configurable PLLs .....	3	<b>Package Drawing and Dimensions</b> .....	<b>9</b>
General-Purpose Input .....	3	<b>Acronyms</b> .....	<b>9</b>
Crystal Input .....	3	<b>Document Conventions</b> .....	<b>9</b>
Crystal Drive Level and Power .....	4	Units of Measure .....	9
Output Configuration .....	4	<b>Document History Page</b> .....	<b>10</b>
Power-Saving Features .....	4	<b>Sales, Solutions, and Legal Information</b> .....	<b>11</b>
Improving Jitter .....	4	Worldwide Sales and Design Support .....	11
<b>CyClocks RT Software</b> .....	<b>4</b>	Products .....	11
<b>Maximum Ratings</b> .....	<b>5</b>	PSoC Solutions .....	11
<b>Operating Conditions</b> .....	<b>5</b>		

## Pinouts

Figure 1. CY22381, CY223811- 8-pin SOIC



## Pin Definitions

Name	Pin Number	Description
CLKC	1	Configurable clock output C
GND	2	Ground
XTALIN	3	Reference crystal input or external reference clock input
XTALOUT	4	Reference crystal feedback (float if XTALIN is driven by external reference clock)
CLKB	5	Configurable clock output B
CLKA	6	Configurable clock output A
V <sub>DD</sub>	7	Power supply
FS/SUSPEND/OE/SHUTDOWN	8	General Purpose Input. Can be Frequency Control, Suspend mode control, Output Enable, or full-chip shutdown.

## Operation

The CY22381 is an upgrade to the existing CY2081. The new device has a wider frequency range, greater flexibility, improved performance, and incorporates many features that reduce PLL sensitivity to external system issues.

The device has three PLLs that allow each output to operate at an independent frequencies. These three PLLs are completely programmable.

The CY223811 is the CY22381 with NiPdAu lead finish.

### Configurable PLLs

PLL1 generates a frequency that is equal to the reference divided by an eight-bit divider (Q) and multiplied by an 11-bit divider in the PLL feedback loop (P). The output of PLL1 is sent to the crosspoint switch. The frequency of PLL1 can optionally be changed by using the external CMOS general purpose input. See the following section on “General-Purpose Input” for more detail.

PLL2 generates a frequency that is equal to the reference divided by an eight-bit divider (Q) and multiplied by an 11-bit divider in the PLL feedback loop (P). The output of PLL2 is sent to the crosspoint switch.

PLL3 generates a frequency that is equal to the reference divided by an eight-bit divider (Q) and multiplied by an 11-bit divider in the PLL feedback loop (P). The output of PLL3 is sent to the cross-point switch.

### General-Purpose Input

The CY22381 features an output control pin (pin 8) that can be programmed to control one of four features.

When programmed as a frequency select (FS), the input can select between two arbitrarily programmed frequency settings. The frequency select can change the following; the frequency of

PLL1, the output divider of CLKB, and the output divider of CLKA. Any divider change as a result of switching the FS input is guaranteed to be glitch free.

The general-purpose input can simultaneously control the Suspend feature, turning off a set of PLLs and outputs determined during programming.

When programmed as an output enable (OE) the input forces all outputs to be placed in a three-state condition when LOW.

When programmed as a Shutdown, the input forces a full chip shutdown mode when LOW.

### Crystal Input

The input crystal oscillator is an important feature of this device because of its flexibility and performance features.

The oscillator inverter has programmable drive strength. This allows for maximum compatibility with crystals from various manufacturers, processes, performances, and qualities.

The input load capacitors are placed on-die to reduce external component cost. These capacitors are true parallel-plate capacitors for ultra-linear performance. These were chosen to reduce the frequency shift that occurs when non-linear load capacitance interacts with load, bias, supply, and temperature changes. Non-linear (FET gate) crystal load capacitors must not be used for MPEG, communications, or other applications that are sensitive to absolute frequency requirements

The value of the load capacitors is determined by six bits in a programmable register. The load capacitance can be set with a resolution of 0.375pF for a total crystal load range of 6pF to 30pF.

For driven clock inputs the input load capacitors may be completely bypassed. This enables the clock chip to accept driven frequency inputs up to 166 MHz. If the application requires a driven input, then XTALOUT must be left floating.

### Crystal Drive Level and Power

Crystals are specified to accept a maximum drive level. Generally, larger crystals can accept more power. The drive level specification in the table below is a general upper bound for the power driven by the oscillator circuit in the CY22381.

For a given voltage swing, power dissipation in the crystal is proportional to ESR and proportional to the square of the crystal frequency. (Note that actual ESR is sometimes much less than the value specified by the crystal manufacturer.) Power is also almost proportional to the square of  $C_L$ .

Power can be reduced to less than the DL specification in the table below by selecting a reduced frequency crystal with low  $C_L$  and low  $R_1$  (ESR).

### Output Configuration

Under normal operation there are four internal frequency sources that may be routed through a programmable crosspoint switch to any of the three outputs through programmable seven-bit output dividers. The four sources are: reference, PLL1, PLL2, and PLL3. The following is a description of each output.

CLKA's output originates from the crosspoint switch and goes through a programmable seven-bit post divider. The seven-bit post divider derives its value from one of two programmable registers controlled by FS.

CLKB's output originates from the crosspoint switch and goes through a programmable seven-bit post divider. The seven-bit post divider derives its value from one of two programmable registers controlled by FS.

CLKC's output originates from the crosspoint switch and goes through a programmable seven-bit post divider. The seven-bit post divider derives its value from one programmable register.

The Clock outputs have been designed to drive a single point load with a total lumped load capacitance of 15pF. While driving

multiple loads is possible with the proper termination, it is generally not recommended.

### Power-Saving Features

When configured as OE, the general-purpose input three-states all outputs when pulled LOW. When configured as Shutdown, a LOW on this pin three-states all outputs and shuts off the PLLs, counters, the reference oscillator, and all other active components. The resulting current on the  $V_{DD}$  pins is less than 5  $\mu$ A (typical). After leaving shutdown mode, the PLLs has to relock.

When configured as  $\overline{\text{SUSPEND}}$ , the general-purpose input can be configured to shut down a customizable set of outputs and/or PLLs, when LOW. All PLLs and any of the outputs can be shut off in nearly any combination. The only limitation is that if a PLL is shut off, all outputs derived from it must also be shut off. Suspending a PLL shuts off all associated logic, while suspending an output forces a three-state condition.

### Improving Jitter

Jitter optimization control is useful in mitigating problems related to similar clocks switching at the same moment and causing excess jitter. If one PLL is driving more than one output, the negative phase of the PLL can be selected for one of the outputs. This prevents the output edges from aligning, allowing superior jitter performance.

### CyClocks RT Software

CyClocks RT is our second-generation application that allows users to configure this device. The easy-to-use interface offers complete control of the many features of this family including input frequency, PLL and output frequencies, and different functional options. Data sheet frequency range limitations are checked and performance tuning is automatically applied. You can download a free copy of CyClocks RT on Cypress's web site at <http://www.cypress.com>.

## Maximum Ratings

Exceeding maximum ratings may shorten the useful life of the device. User guidelines are not tested.

Supply voltage .....	-0.5 V to +7.0 V
DC input voltage .....	-0.5 V to + (V <sub>DD</sub> + 0.5 V)
Storage temperature .....	-65 °C +125 °C
Junction temperature .....	125 °C

Data retention at T <sub>j</sub> = 125 °C .....	> 10 years
Maximum programming cycles .....	100
Package power dissipation .....	250 mW
Static discharge voltage (per MIL-STD-883, Method 3015) .....	≥ 2000V
Latch up (per JEDEC 17) .....	≥ ±200 mA

## Operating Conditions

Parameter	Description	Min	Typ	Max	Unit
V <sub>DD</sub>	Supply voltage	3.135	3.3	3.465	V
T <sub>A</sub>	Commercial operating temperature, ambient	0	-	+70	°C
	Industrial operating temperature, ambient	-40	-	+85	°C
C <sub>LOAD_OUT</sub>	Max. load capacitance	-	-	15	pF
f <sub>REF</sub>	External reference crystal	8	-	30	MHz
	External reference clock <sup>[2]</sup> , cCommercial	1	-	166	MHz
	External reference clock <sup>[2]</sup> , industrial	1	-	150	MHz
t <sub>PU</sub>	Power up time for all VDD's to reach minimum specified voltage (power ramps must be monotonic)	0.05	-	500	ms

## Recommended Crystal Specifications

Parameter	Description	Description	Min	Typ.	Max	Unit
F <sub>NOM</sub>	Nominal crystal frequency	Parallel resonance, fundamental mode	8	-	30	MHz
C <sub>LNOM</sub>	Nominal load capacitance		8	-	20	pF
R <sub>1</sub>	Equivalent series resistance (ESR)	Fundamental mode	-	-	50	Ω
DL	Crystal drive level	No external series resistor assumed	-	0.5	2	mW

## Electrical Characteristics

Parameter	Description	Conditions <sup>[1]</sup>	Min	Typ	Max	Unit
I <sub>OH</sub>	Output high current <sup>[3]</sup>	V <sub>OH</sub> = V <sub>DD</sub> - 0.5, V <sub>DD</sub> = 3.3 V	12	24	-	mA
I <sub>OL</sub>	Output low current <sup>[3]</sup>	V <sub>OL</sub> = 0.5 V, V <sub>DD</sub> = 3.3 V	12	24	-	mA
C <sub>XTAL_MIN</sub>	Crystal load capacitance <sup>[3]</sup>	Capload at minimum setting	-	6	-	pF
C <sub>XTAL_MAX</sub>	Crystal load capacitance <sup>[3]</sup>	Capload at maximum setting	-	30	-	pF
C <sub>IN</sub>	Input pin capacitance <sup>[3]</sup>	Except crystal pins	-	7	-	pF
V <sub>IH</sub>	HIGH-level input voltage	CMOS levels, % of V <sub>DD</sub>	70%	-	-	V <sub>DD</sub>
V <sub>IL</sub>	LOW-level input voltage	CMOS levels, % of V <sub>DD</sub>	-	-	30%	V <sub>DD</sub>
I <sub>IH</sub>	Input HIGH current	V <sub>IN</sub> = V <sub>DD</sub> - 0.3 V	-	<1	10	μA
I <sub>IL</sub>	Input LOW current	V <sub>IN</sub> = +0.3 V	-	<1	10	μA
I <sub>OZ</sub>	Output leakage current	Three-state outputs	-	-	10	μA

### Notes

1. Unless otherwise noted, Electrical and Switching Characteristics are guaranteed across these operating conditions.
2. External input reference clock must have a duty cycle between 40% and 60%, measured at V<sub>DD</sub>/2.
3. Guaranteed by design, not 100% tested.

## Electrical Characteristics

Parameter	Description	Conditions <sup>[1]</sup>	Min	Typ	Max	Unit
I <sub>DD</sub>	Total power supply current	3.3 V Power supply; 3 outputs at 50 MHz	–	35	–	mA
		3.3 V Power supply; 3 outputs at 166 MHz	–	70	–	mA
I <sub>DDS</sub>	Total power supply current in shutdown mode	Shutdown active	–	5	20	μA

## Switching Characteristics

Parameter	Name	Description	Min	Typ.	Max	Unit
1/t <sub>1</sub>	Output frequency <sup>[3, 5]</sup>	Clock output limit, commercial	–	–	200	MHz
		Clock output limit, industrial	–	–	166	MHz
t <sub>2</sub>	Output duty cycle <sup>[3, 6]</sup>	Duty cycle for outputs, defined as $t_2 \div t_1$ , F <sub>out</sub> < 100 MHz, divider $\geq 2$ , measured at V <sub>DD</sub> /2	45%	50%	55%	
		Duty cycle for outputs, defined as $t_2 \div t_1$ , F <sub>out</sub> > 100 MHz or divider = 1, measured at V <sub>DD</sub> /2	40%	50%	60%	
t <sub>3</sub>	Rising edge slew rate <sup>[3]</sup>	Output clock rise time, 20% to 80% of V <sub>DD</sub>	0.75	1.4	–	V/ns
t <sub>4</sub>	Falling edge slew rate <sup>[3]</sup>	Output clock fall time, 20% to 80% of V <sub>DD</sub>	0.75	1.4	–	V/ns
t <sub>5</sub>	Output three-state timing <sup>[3]</sup>	Time for output to enter or leave three-state mode after SHUTDOWN/OE switches	–	150	300	ns
t <sub>6</sub>	Clock jitter <sup>[3, 7]</sup>	Peak-to-peak period jitter, CLK outputs measured at V <sub>DD</sub> /2	–	200	–	ps
t <sub>7</sub>	Lock time <sup>[3]</sup>	PLL Lock Time from Power up	–	1.0	3	ms

## Switching Waveforms

Figure 2. All Outputs, Duty Cycle and Rise and Fall Time

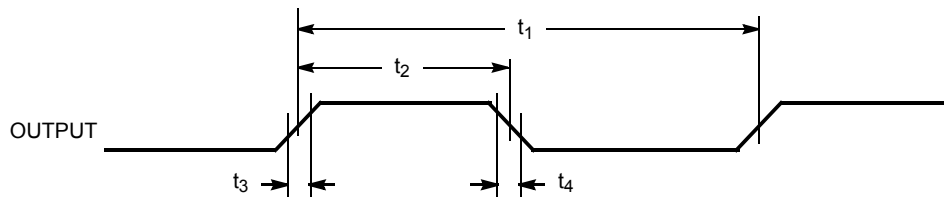
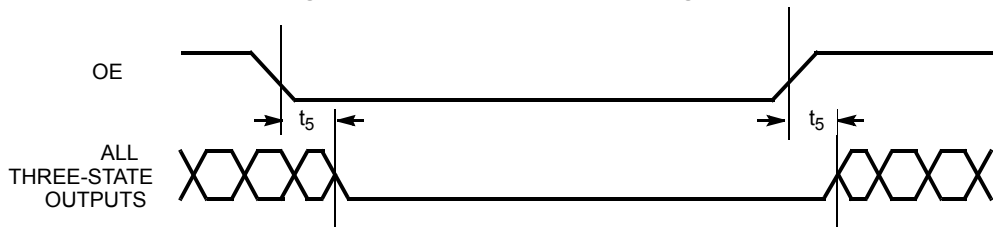


Figure 3. Output Three-State Timing

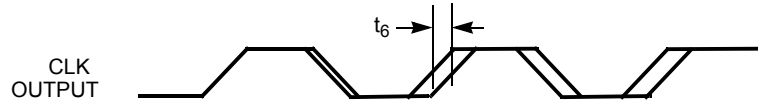


### Notes

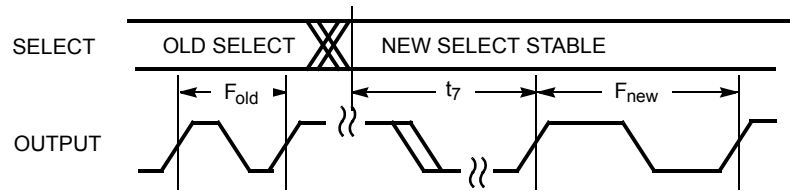
4. Guaranteed by design, not 100% tested.
5. Guaranteed to meet 20% – 80% output thresholds and duty cycle specifications.
6. Reference Output duty cycle depends on XTALIN duty cycle.
7. Jitter varies significantly with configuration. Reference Output jitter depends on XTALIN jitter and edge rate.

**Switching Waveforms** (continued)

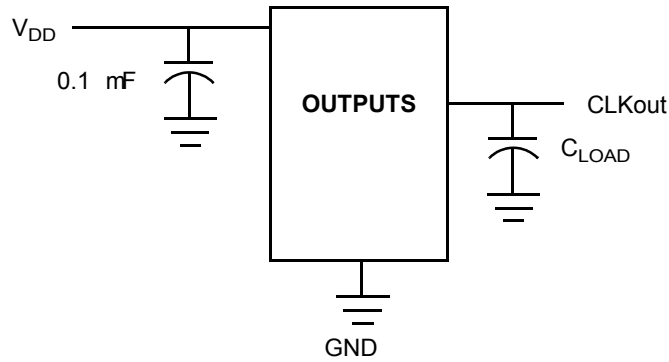
**Figure 4. CLK Output Jitter**



**Figure 5. Frequency Change**



**Test Circuit**



## Ordering Information

Ordering Code	Package Type	Operating Range	Operating Voltage
<b>Pb-Free</b>			
CY223811FXI	8-SOIC with NiPdAu lead frame	Industrial (T <sub>A</sub> =-40 °C to 85 °C)	3.3 V
CY22381FXC <sup>[10]</sup>	8-SOIC	Commercial (T <sub>A</sub> =0 °C to 70 °C)	3.3 V
CY22381FXCT	8-SOIC – Tape and Reel	Commercial (T <sub>A</sub> =0 °C to 70 °C)	3.3 V
CY22381FXI	8-SOIC	Industrial (T <sub>A</sub> =-40 °C to 85 °C)	3.3 V
CY22381FXIT	8-SOIC – Tape and Reel	Industrial (T <sub>A</sub> =-40 °C to 85 °C)	3.3 V
<b>Programmer</b>			
CY3672-USB	Programmer		
CY3699	CY22381F Adapter for CY3672-USB		

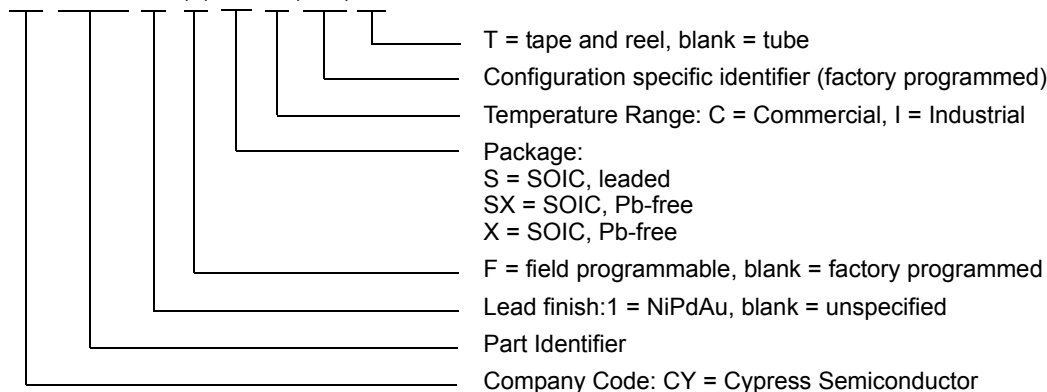
Some product offerings are factory programmed customer specific devices with customized part numbers. The Possible Configurations table shows the available device types, but not complete part numbers. Contact your local Cypress FAE or Sales Representative for more information.

## Possible Configurations

Ordering Code	Package Type	Operating Range	Operating Voltage
CY22381SI-xxxT <sup>[8, 9]</sup>	8-SOIC – Tape and Reel	Industrial (T <sub>A</sub> =-40°C to 85°C)	3.3 V
<b>Pb-Free</b>			
CY22381SXC-xxx <sup>[8]</sup>	8-SOIC	Commercial (T <sub>A</sub> =0 °C to 70 °C)	3.3 V
CY22381SXC-xxxT <sup>[8]</sup>	8-SOIC – Tape and Reel	Commercial (T <sub>A</sub> =0 °C to 70 °C)	3.3 V
CY22381SXI-xxx <sup>[8]</sup>	8-SOIC	Industrial (T <sub>A</sub> =-40 °C to 85 °C)	3.3 V
CY22381SXI-xxxT <sup>[8]</sup>	8-SOIC – Tape and Reel	Industrial (T <sub>A</sub> =-40 °C to 85 °C)	3.3 V

## Ordering Code Definitions

CY 22381 (1) (F) SX C (-xxx) (T)



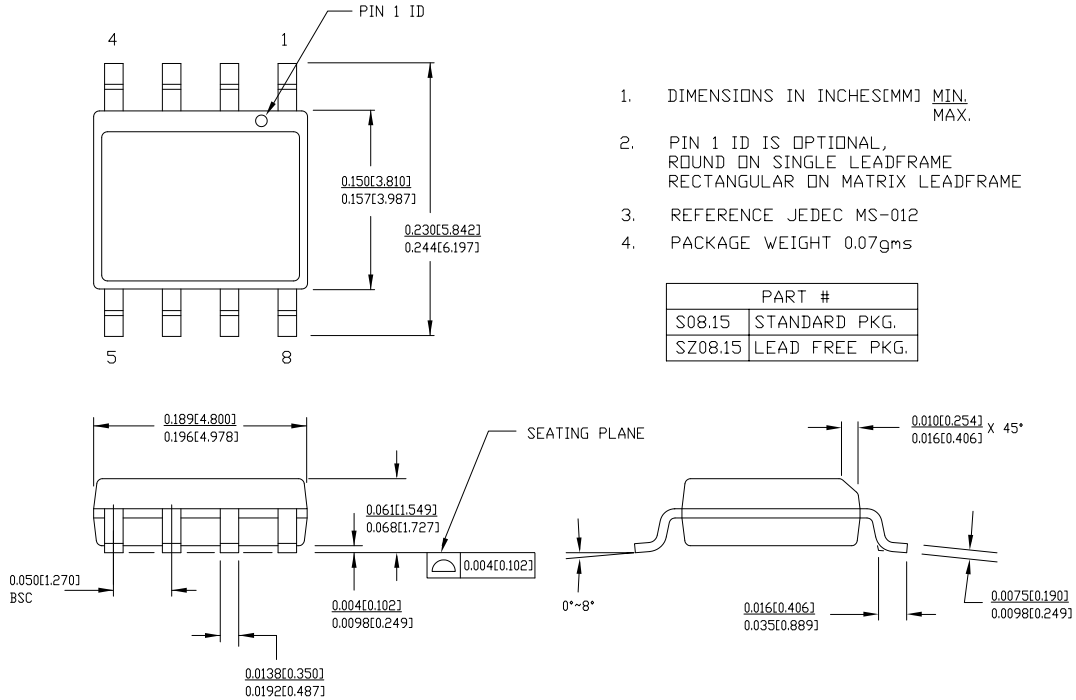
### Notes

8. The CY22381SI-xxx, CY22381SXC-xxx and CY22381SXI-xxx are factory programmed configurations. Factory programming is available for high-volume design opportunities of 100K/year or more in production. For more details, contact your local Cypress FAE or Cypress Sales Representative.
9. Not recommended for new designs.
10. The CY22381FSZC and CY22381FXC are identical. For new designs, use CY22381FXC.



## Package Drawing and Dimensions

**Figure 6. 8-Pin (150-mil) SOIC**



1. DIMENSIONS IN INCHES[MM] MIN. MAX.
2. PIN 1 ID IS OPTIONAL, ROUND ON SINGLE LEADFRAME RECTANGULAR ON MATRIX LEADFRAME
3. REFERENCE JEDEC MS-012
4. PACKAGE WEIGHT 0.07gms

PART #	
S08.15	STANDARD PKG.
SZ08.15	LEAD FREE PKG.

51-85066-\*D

## Acronyms

Acronym	Description
CMOS	complementary metal oxide semiconductor
ESR	equivalent series resistance
FET	field effect transistor
MPEG	motion picture experts group
OE	output enable
PLL	phase-locked loop
SOIC	small outline integrated circuit

## Document Conventions

### Units of Measure

Symbol	Unit of Measure
°C	degree Celcius
μA	micro Amperes
mA	milli Amperes
ms	milli seconds
mW	milli Watts
MHz	Mega Hertz
μA	micro Amps
μF	micro Farads
ns	nano seconds
pF	pico Farad
ps	pico seconds
V	Volts

## Document History Page

Document Title: CY22381, CY223811 Three-PLL General Purpose Flash Programmable Clock Generator Document Number: 38-07012				
Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	106737	TLG	07/03/01	New data sheet
*A	108514	JWK	08/23/01	Updated based on characterization results. Removed "Preliminary" heading Removed soldering temperature rating. Split crystal load into two typical specs representing digital settings range. Changed $t_5$ max to 300 ns Changed $t_6$ typical to 200 ps. Changed $t_7$ typical to 1.0 ms
*B	110053	CKN	12/10/01	Changed from preliminary to final
*C	121863	RBI	12/14/02	Added power up requirements to Operating Conditions information
*D	279431	RGL	See ECN	Added lead-free devices
*E	2584052	AESA	10/10/08	Updated template. Added Note 8 and 9. Added part number CY22381FC, CY22381FCT, CY3672-USB, CY3699, CY22381FSZC in ordering information table. Removed part number CY22381FI, CY22381FIT, CY22381SC-xxx, CY22381SC-xxxT, CY22381SI-xxx, and CY22381SI-xxxT in Ordering Information table. Added CY223811FXI (NiPdAu lead finish). Changed Lead-Free to Pb-Free.
*F	2620588	KVM/AESA	12/11/08	Add CY223811 to the document title Distinguish between CY22381 and CY223811 in page 1 Features section Add part number CY22381SI-xxxT in Ordering Information table.
*G	2897317	KVM	03/22/10	Removed obsolete parts from Ordering Information table and moved 'xx' parts to Possible Configurations table Updated package diagram
*H	3065190	KVM/BASH	01/17/11	Add crystal parameter table, ordering code definition, acronym and units tables. Crystal Drive Level and Power. Remove FTG from CY3672. Removed Benefits section and replaced with Functional Description section.
*I	3259420	BASH	05/17/2011	Updated as per template

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<a href="#">PSoC</a>	<a href="http://cypress.com/go/psoc">cypress.com/go/psoc</a>
<a href="#">Touch Sensing</a>	<a href="http://cypress.com/go/touch">cypress.com/go/touch</a>
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<a href="#">Wireless/RF</a>	<a href="http://cypress.com/go/wireless">cypress.com/go/wireless</a>

### PSoC Solutions

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PSoC 1 | PSoC 3 | PSoC 5

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