

# Three-PLL General Purpose Flash Programmable Clock Generator

## Features

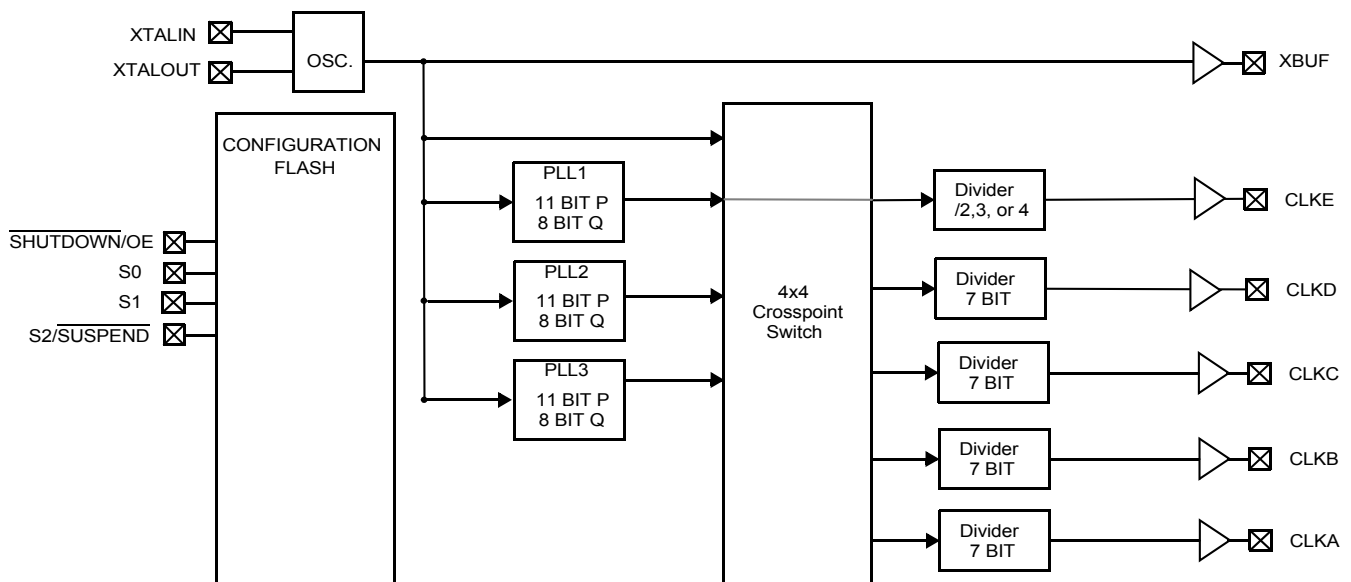
- Three Integrated Phase-locked Loops
- Ultra Wide Divide Counters (8-bit Q, 11-bit P, and 7-bit Post Divide)
- Improved Linear Crystal Load Capacitors
- Flash Programmability
- Field Programmable
- Low-jitter, High-accuracy Outputs
- Power Management Options (Shutdown, OE, Suspend)
- Configurable Crystal Drive Strength
- Frequency Select through three External LVTTTL Inputs
- 3.3 V Operation
- 16-pin TSSOP Packages
- CyClocksRT™ Support

## Benefits

- Generates up to three unique frequencies on six outputs up to 200 MHz from an external source. Functional upgrade for current CY2292 family.
- Enables 0 ppm frequency generation and frequency conversion under the most demanding applications.

- Improves frequency accuracy over temperature, age, process, and initial offset.
- Nonvolatile programming enables easy customization, fast turnaround, performance tweaking, design timing margin testing, inventory control, lower part count, and more secure product supply. In addition, any part in the family can also be programmed multiple times, which reduces programming errors and provides an easy upgrade path for existing designs.
- In-house programming of samples and prototype quantities is available using the CY3672 development kit. Production quantities are available through Cypress Semiconductor's value added distribution partners or by using third party programmers from BP Microsystems, HiLo Systems, and others.
- Performance suitable for high-end multimedia, communications, industrial, A/D Converters, and consumer applications.
- Supports numerous low power application schemes and reduces EMI by enabling unused outputs to be turned off.
- Adjusts crystal drive strength for compatibility with virtually all crystals.
- 3-bit external frequency select options for PLL1, CLKA, and CLKB.
- Industry-standard supply voltage.
- Industry-standard packaging saves on board space.
- Easy to use software support for design entry.

## Logic Block Diagram

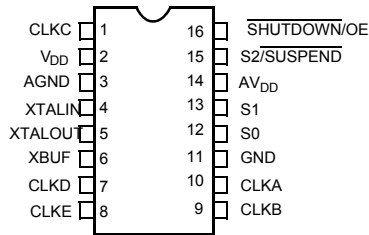


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## Pin Configuration

**Figure 1. CY22392 - 16-pin TSSOP**



## Pin Definitions

| Name             | Pin Number | Description   |
|------------------|------------|---|
| CLKC             | 1          | Configurable clock output C   |
| V <sub>DD</sub>  | 2          | Power supply  |
| AGND             | 3          | Analog Ground   |
| XTALIN           | 4          | Reference crystal input or external reference clock input   |
| XTALOUT          | 5          | Reference crystal feedback  |
| XBUF             | 6          | Buffered reference clock output   |
| CLKD             | 7          | Configurable clock output D   |
| CLKE             | 8          | Configurable clock output E   |
| CLKB             | 9          | Configurable clock output B   |
| CLKA             | 10         | Configurable clock output A   |
| GND              | 11         | Ground  |
| S0               | 12         | General Purpose Input for Frequency Control; bit 0  |
| S1               | 13         | General Purpose Input for Frequency Control; bit 1  |
| AV <sub>DD</sub> | 14         | Analog Power Supply   |
| S2/SUSPEND       | 15         | General Purpose Input for Frequency Control; bit 2. Optionally Suspend mode control input.  |
| SHUTDOWN/OE      | 16         | Places outputs in three-state condition and shuts down chip when Low. Optionally, only places outputs in tristate condition and does not shut down chip when Low. |

## Operation

The CY22392 is an upgrade to the existing CY2292. 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 which, when combined with the reference, enable up to four independent frequencies to be output on up to six pins. These three PLLs are completely programmable.

### Configurable PLLs

PLL1 generates a frequency that is equal to the reference divided by an 8-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 output of PLL1 is also sent to a /2, /3, or /4 synchronous post-divider that is output through CLKE. The frequency of PLL1 can be changed by external CMOS inputs, S0, S1, S2. See the following section on General Purpose Inputs for more details.

PLL2 generates a frequency that is equal to the reference divided by an 8-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 8-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 Inputs

S0, S1, and S2 are general purpose inputs that can be programmed to enable eight different frequency settings. Options that may be switched with these general purpose inputs are as follows: the frequency of PLL1, the output divider of CLKB, and the output divider of CLKA.

CLKA and CLKB both have 7-bit dividers that point to one of two programmable settings (register 0 and register 1). Both clocks share a single register control, so both must be set to register 0, or both must be set to register 1.

For example, the part may be programmed to use S0, S1, and S2 (0, 0, 0 to 1, 1, 1) to control eight different values of P and Q on PLL1. For each PLL1 P and Q setting, one of the two CLKA and CLKB divider registers can be chosen. Any divider change as a result of switching S0, S1, or S2 is guaranteed to be glitch free.

### 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 enables 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, POTS dial tone, 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 0.375 pF for a total crystal load range of 6 pF to 30 pF.

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.

### Output Configuration

Under normal operation there are four internal frequency sources that may be routed through a programmable crosspoint switch to any of the four programmable 7-bit output dividers. The four sources are: reference, PLL1, PLL2, and PLL3. In addition, many outputs have a unique capability for even greater flexibility. The following is a description of each output.

CLKA's output originates from the crosspoint switch and goes through a programmable 7-bit post divider. The 7-bit post divider derives its value from one of two programmable registers. Each of the eight possible combinations of S0, S1, S2 controls which of the two programmable registers is loaded into CLKA's 7-bit post divider. See the section [General Purpose Inputs](#) for more information.

CLKB's output originates from the crosspoint switch and goes through a programmable 7-bit post divider. The 7-bit post divider derives its value from one of two programmable registers. Each of the eight possible combinations of S0, S1, and S2 controls which of the two programmable registers is loaded into CLKA's 7-bit post divider. See the section [General Purpose Inputs](#) for more information.

CLKC's output originates from the crosspoint switch and goes through a programmable 7-bit post divider. The 7-bit post divider derives its value from one programmable register.

CLKD's output originates from the crosspoint switch and goes through a programmable 7-bit post divider. The 7-bit post divider derives its value from one programmable register.

CLKE's output originates from PLL1 and goes through a post divider that may be programmed to /2, /3, or /4.

XBUF is simply the buffered reference.

The clock outputs have been designed to drive a single point load with a total lumped load capacitance of 15 pF. While driving multiple loads is possible with proper termination, it is generally not recommended.

### Power Saving Features

The SHUTDOWN/OE input tristates the outputs when pulled low. If system shutdown is enabled, a Low on this pin also shuts off the PLLs, counters, the reference oscillator, and all other active components. The resulting current on the V<sub>DD</sub> pins is less than 5  $\mu$ A (typical). After leaving shutdown mode, the PLLs must reload.

The S2/SUSPEND 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 simply forces a tristate condition.

**Improving Jitter**

Jitter Optimization Control is useful in mitigating problems related to similar clocks switching at the same moment, 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 (CLKA–CLKD). This prevents the output edges from aligning, enabling superior jitter performance.

**Power Supply Sequencing**

For parts with multiple V<sub>DD</sub> pins, there are no power supply sequencing requirements. The part is not fully operational until all V<sub>DD</sub> pins have been brought up to the voltages specified in the [Operating Conditions](#). All grounds must be connected to the same ground plane.

**CyberClocks™ Software**

The CyberClocks application enables users to configure this device. Within CyberClocks, select the CyClocksRT tool. The easy-to-use interface offers complete control of the many features of this family including input frequency, PLL, output frequencies, and different functional options. Data sheet frequency range limitations are checked and performance tuning is automatically applied. CyClocksRT also has a power estimation feature that enables you to see the power consumption of your specific configuration. Download a copy of CyberClocks free on Cypress’s web site at [www.cypress.com](http://www.cypress.com). Install and run it on any PC running Windows.

**Device Programming**

Part numbers starting with CY22392F are ‘field programmable’ devices. Field programmable devices are shipped

unprogrammed, and must be programmed prior to installation on a PCB. After a programming file (.jed) is created using CyberClocks software, devices can be programmed in small quantities using the CY3672 programmer and CY3698 adapter. Volume programming is available through Cypress Semiconductor’s value added distribution partners or by using third party programmers from BP Microsystems, HiLo Systems, and others. For sufficiently large volumes, Cypress can supply pre-programmed devices with a part number extension that is configuration-specific.

**Junction Temperature Limitations**

It is possible to program the CY22392 such that the maximum junction temperature rating is exceeded. The package  $\theta_{JA}$  is 115 °C/W. Use the CyClocksRT power estimation feature to verify that the programmed configuration meets the junction temperature and package power dissipation maximum ratings.

**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 + (AV <sub>DD</sub> + 0.5 V) |
| Storage Temperature .....  | –65 °C to +125 °C                      |
| Junction Temperature .....                                       | 125 °C                                 |
| Data Retention at T <sub>j</sub> = 125 °C .....                  | > 10 years                             |
| Maximum Programming Cycles .....                                 | 100                                    |
| Package Power Dissipation .....                                  | 350 mW                                 |
| Static Discharge Voltage<br>(per MIL-STD-883, Method 3015) ..... | 2000 V                                 |
| Latch up (according to JEDEC 17) .....                           | ≥ ±200 mA                              |

**Operating Conditions**

The following table lists the recommended operating conditions.<sup>[1]</sup>

| Parameter                         | Description  | Min   | Typ | Max   | Unit |
|-----------------------------------|--|-------|-----|-------|------|
| V <sub>DD</sub> /AV <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>             | Maximum Load Capacitance   | –     | –   | 15    | pF   |
| f <sub>REF</sub>                  | External Reference Crystal   | 8     | –   | 30    | MHz  |
|                                   | External Reference Clock <sup>[2]</sup> , Commercial   | 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   |

**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.

## Electrical Characteristics

| Parameter             | Description                                 | Conditions   | 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, 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>LOAD_IN</sub>  | Input Pin Capacitance <sup>[3]</sup>        | Except crystal pins  | –   | 7   | –   | pF               |
| V <sub>IH</sub>       | High Level Input Voltage                    | CMOS levels, % of AV <sub>DD</sub>                                 | 70% | –   | –   | AV <sub>DD</sub> |
| V <sub>IL</sub>       | Low Level Input Voltage                     | CMOS levels, % of AV <sub>DD</sub>                                 | –   | –   | 30% | AV <sub>DD</sub> |
| I <sub>IH</sub>       | Input High Current                          | V <sub>IN</sub> = AV <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               |
| I <sub>DD</sub>       | Total Power Supply Current                  | 3.3 V Power Supply; 2 outputs at 166 MHz; 4 outputs at 83 MHz      | –   | 100 | –   | mA               |
|                       |   | 3.3 V Power Supply; 2 outputs at 20 MHz; 4 outputs at 40 MHz       | –   | 50  | –   | 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, 4]</sup>       | Clock output limit, Commercial   | –    | –   | 200 | MHz  |
|                  |  | Clock output limit, Industrial   | –    | –   | 166 | MHz  |
| t <sub>2</sub>   | Output Duty Cycle <sup>[3, 5]</sup>      | Duty cycle for outputs, defined as t <sub>2</sub> ÷ t <sub>1</sub> , F <sub>out</sub> < 100 MHz, divider ≥ 2, measured at V <sub>DD</sub> /2   | 45%  | 50% | 55% |      |
|                  |  | Duty cycle for outputs, defined as t <sub>2</sub> ÷ t <sub>1</sub> , 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, 80% to 20% 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, 6]</sup>           | Peak-to-peak period jitter, CLK outputs measured at V <sub>DD</sub> /2   | –    | 400 | –   | ps   |
| t <sub>7</sub>   | Lock Time <sup>[3]</sup>                 | PLL Lock Time from Power up  | –    | 1.0 | 3   | ms   |

### Notes

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

## Switching Waveforms

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

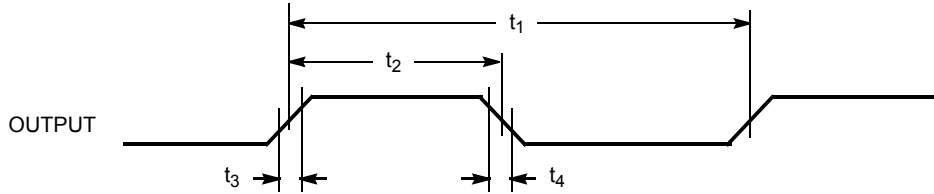


Figure 3. Output Three-State Timing

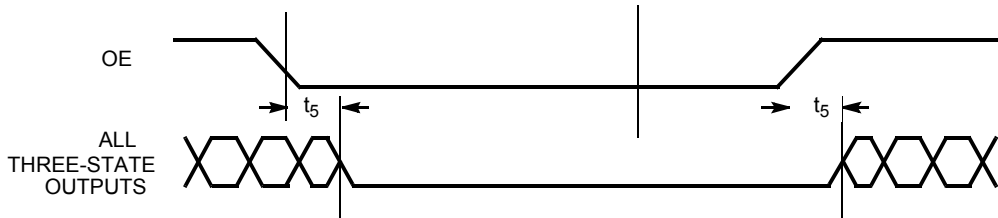


Figure 4. CLK Output Jitter

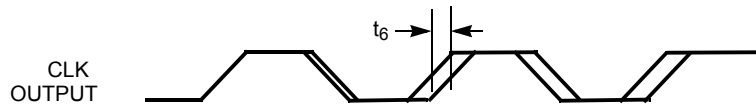
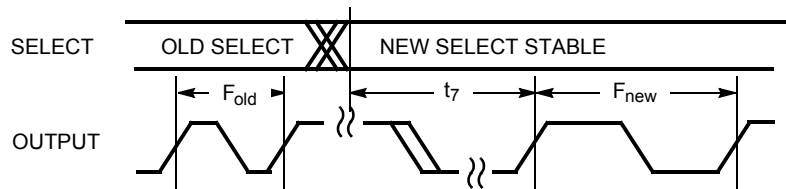
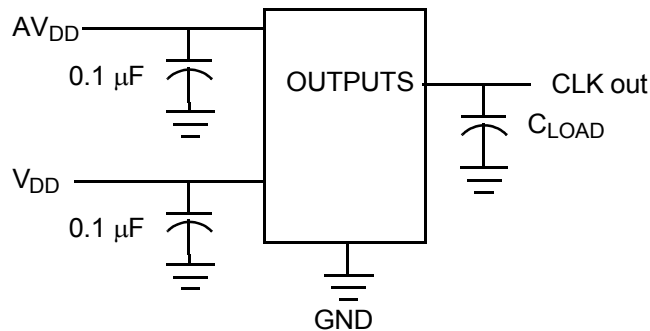


Figure 5. Frequency Change



## Test Circuit



## Ordering Information

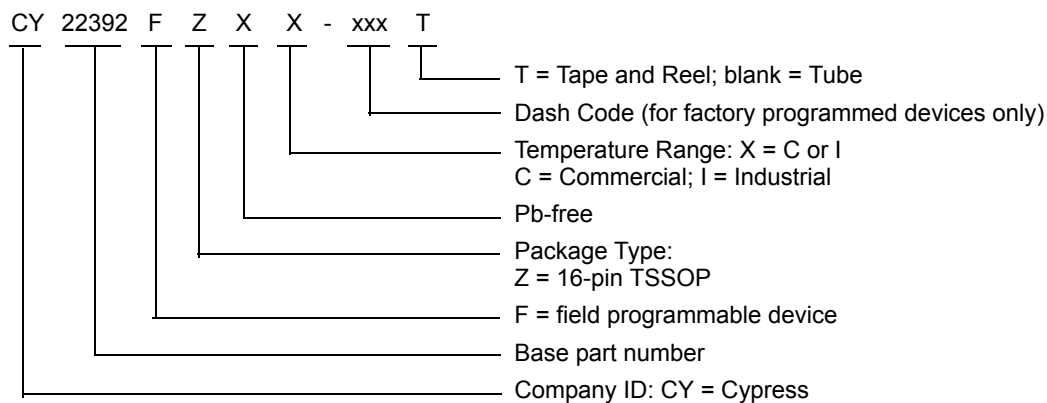
| Ordering Code | Package Name | Package Type  | Operating Range                               | Operating Voltage |
|---------------|--------------|---|---|-------------------|
| Pb-free       |              |   |   |                   |
| CY22392FXC    | ZZ16         | 16-pin TSSOP  | Commercial (T <sub>A</sub> = 0 °C to 70 °C)   | 3.3 V             |
| CY22392FXCT   | ZZ16         | 16-pin TSSOP – Tape and Reel  | Commercial (T <sub>A</sub> = 0 °C to 70 °C)   | 3.3 V             |
| CY22392FXI    | ZZ16         | 16-pin TSSOP  | Industrial (T <sub>A</sub> = –40 °C to 85 °C) | 3.3 V             |
| CY22392FXIT   | ZZ16         | 16-pin TSSOP – Tape and Reel  | Industrial (T <sub>A</sub> = –40 °C to 85 °C) | 3.3 V             |
| Programmer    |              |   |   |                   |
| CY3672-USB    |              | FTG Programmer  |   |                   |
| CY3698        |              | CY22392F, CY22393F<br>CY22394F and CY22395F<br>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 Name | Package Type                 | Operating Range                               | Operating Voltage |
|--------------------------------|--------------|------------------------------|---|-------------------|
| Pb-free                        |              |                              |   |                   |
| CY22392ZXC-xxx <sup>[7]</sup>  | ZZ16         | 16-pin TSSOP                 | Commercial (T <sub>A</sub> = 0 °C to 70 °C)   | 3.3 V             |
| CY22392ZXC-xxxT <sup>[7]</sup> | ZZ16         | 16-pin TSSOP – Tape and Reel | Commercial (T <sub>A</sub> = 0 °C to 70 °C)   | 3.3 V             |
| CY22392ZXI-xxx <sup>[7]</sup>  | ZZ16         | 16-pin TSSOP                 | Industrial (T <sub>A</sub> = –40 °C to 85 °C) | 3.3 V             |
| CY22392ZXI-xxxT <sup>[7]</sup> | ZZ16         | 16-pin TSSOP – Tape and Reel | Industrial (T <sub>A</sub> = –40 °C to 85 °C) | 3.3 V             |

## Ordering Code Definitions



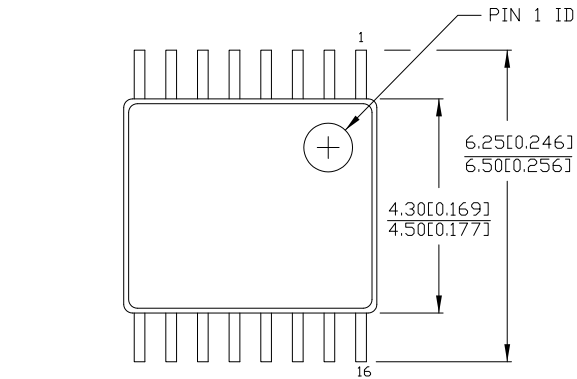
### Note

7. The CY22392ZXC-xxx and CY22392ZXI-xxx are factory programmed configurations. Factory programming is available for high-volume design opportunities of 100 Ku/year or more in production. For more details, contact your local Cypress FAE or Cypress Sales Representative.



## Package Diagram

Figure 6. 16-pin TSSOP 4.40 mm Body Z16.173/ZZ16.173, 51-85091

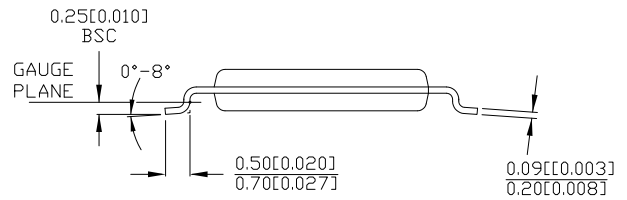
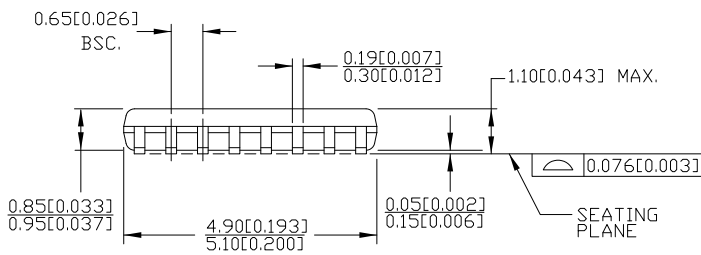


DIMENSIONS IN MM[INCHES] MIN.  
MAX.

REFERENCE JEDEC MO-153

PACKAGE WEIGHT 0.05gms

| PART #   |                |
|----------|----------------|
| Z16.173  | STANDARD PKG.  |
| ZZ16.173 | LEAD FREE PKG. |



51-85091 \*C

## Acronyms

| Acronym | Description                                |
|---------|--|
| CMOS    | complementary metal oxide semiconductor    |
| EMI     | electromagnetic interference               |
| FET     | field-effect transistor                    |
| FTG     | frequency timing generator                 |
| JEDEC   | joint electron devices engineering council |
| LVTTL   | low voltage transistor-transistor logic    |
| OSC     | oscillator                                 |
| PCB     | printed circuit board                      |
| PLL     | phase locked loop                          |
| TSSOP   | thin shrink small outline package          |

## Document Conventions

### Units of Measure

| Symbol | Unit of Measure   |
|--------|-------------------|
| °C     | degree Celsius    |
| MHz    | Mega Hertz        |
| μA     | micro Amperes     |
| μF     | micro Farad       |
| mA     | milli Amperes     |
| mm     | milli meter       |
| ms     | milli seconds     |
| mW     | milli Watts       |
| ns     | nano seconds      |
| %      | percent           |
| pF     | pico Farad        |
| ppm    | parts per million |
| ps     | pico seconds      |
| V      | Volts             |
| W      | Watts             |

Document History Page

| Document Title: CY22392, Three-PLL General Purpose Flash Programmable Clock Generator<br>Document Number: 38-07013 |         |                 |                 |   |
|--|---------|-----------------|-----------------|---|
| REV.   | ECN     | Orig. of Change | Submission Date | Description of Change   |
| **   | 106738  | TLG             | 07/03/01        | New Data Sheet  |
| *A   | 108515  | JWK             | 08/23/01        | Updates based on characterization results. Removed "Preliminary" heading. Added paragraph on Junction Temperature limitations and part configurations. Removed soldering temperature rating. Split crystal load into two typical specs representing digital settings range. Changed t <sub>5</sub> max to 300 ns. Changed t <sub>7</sub> typical to 1.0 ms. |
| *B   | 110052  | CKN             | 12/09/01        | Preliminary to Final.   |
| *C   | 121864  | RBI             | 12/14/02        | Power up requirements added to Operating Conditions Information   |
| *D   | 237811  | RGL             | See ECN         | Added Lead Free Devices   |
| *E   | 2584052 | AESA            | 10/10/08        | Updated template. Added Note "Not recommended for new designs." Added part number CY22392FC, CY22392FCT, CY22392ZC-xxxT, CY22392ZI-xxxT, CY3672-USB, CY3698, CY22392FXCT, CY22392FXIT, CY22392ZXC-xxxT, and CY22392ZXI-xxxT, in ordering information table. Removed part number CY22392FI in ordering information table. Changed Lead-Free to Pb-Free.      |
| *F   | 2740247 | KVM / PYRS      | 07/17/2009      | Updated the software section and added a section on programming. Added Electrical Characteristics table which was accidentally dropped in rev *E<br>Ordering Information table: changed package name for Pb-free devices from Z16 to ZZ16; removed part number CY22392FCT   |
| *G   | 2897246 | KVM             | 03/22/10        | Updated <a href="#">Ordering Information</a> . Added note regarding Possible Configurations in <a href="#">Ordering Information</a> section. Updated Note 7 and removed Note 8. Added <a href="#">Possible Configurations</a> table for "xxx" parts. Updated .  |
| *H   | 3340710 | PURU            | 08/09/2011      | Added <a href="#">Ordering Code Definitions</a> .<br>updated <a href="#">Package Diagram</a> .<br>Added <a href="#">Acronyms and Units of Measure</a> .<br>Updated in new template.   |

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