

# Quad-PLL Programmable Spread Spectrum Clock Generator with Serial I<sup>2</sup>C Interface

## Features

- Four fully-integrated phase-locked loops (PLLs)
  - External crystal: 8 to 48 MHz
  - External reference: 8 to 166 MHz clock
- Wide operating output frequency range
  - 3 to 166 MHz
- Serial programmable over two-wire I<sup>2</sup>C interface
- Programmable spread spectrum with center and down spread option and Lexmark and Linear modulation profiles
- V<sub>DD</sub> supply voltage options:
  - 2.5 V, 3.0 V, and 3.3 V for CY2545
  - 1.8 V for CY2547
- Selectable output clock voltages independent of V<sub>DD</sub> supply:
  - 1.8 V, 2.5 V, 3.0 V, and 3.3 V for CY2545
  - 1.8 V for CY2547
- Power-down, output enable, or frequency select features
- Low jitter, high accuracy outputs
- Ability to synthesize nonstandard frequencies with Fractional-N capability
- Up to eight clock outputs with programmable drive strength
- Glitch-free outputs while frequency switching

- 24-pin QFN package
- Commercial and industrial temperature ranges
- One-time programmability  
For programming support, contact [Cypress technical support](#) or send an e-mail to [clocks@cypress.com](mailto:clocks@cypress.com)

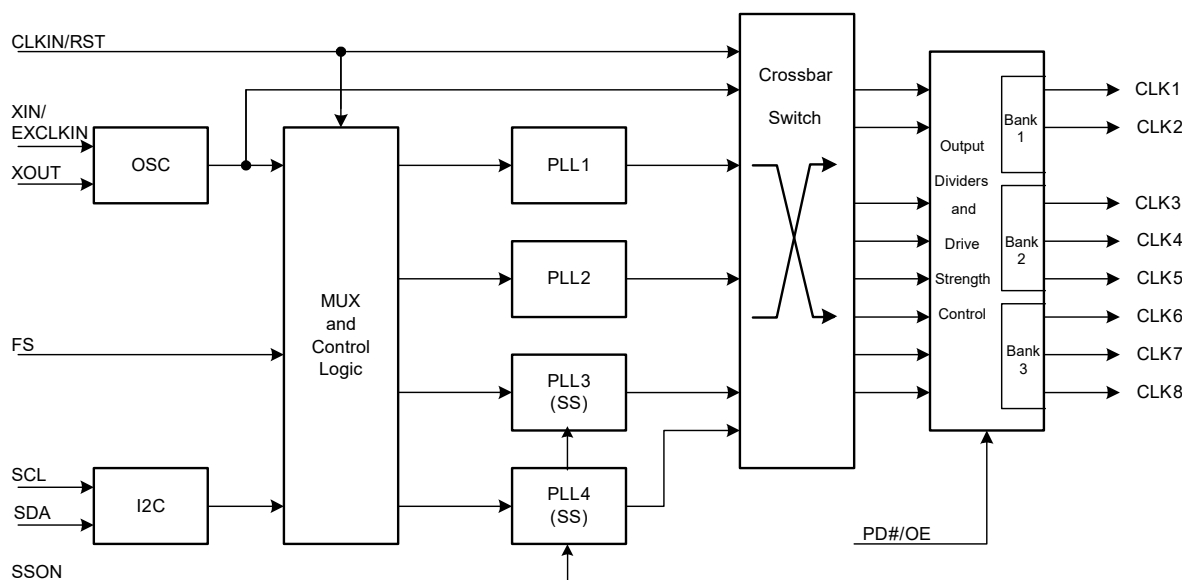
## Benefits

- Multiple high-performance PLLs allow synthesis of unrelated frequencies
- Nonvolatile programming for personalization of PLL frequencies, spread spectrum characteristics, drive strength, crystal load capacitance, and output frequencies
- Application-specific programmable EMI reduction using spread spectrum for clocks
- Programmable PLLs for system frequency margin tests
- Meets critical timing requirements in complex system designs
- Suitability for PC, consumer, portable, and networking applications
- Capable of zero PPM frequency synthesis error
- Uninterrupted system operation during clock frequency switch
- Application compatibility in standard and low-power systems

## Functional Description

For a complete list of related documentation, click [here](#).

## Logic Block Diagram

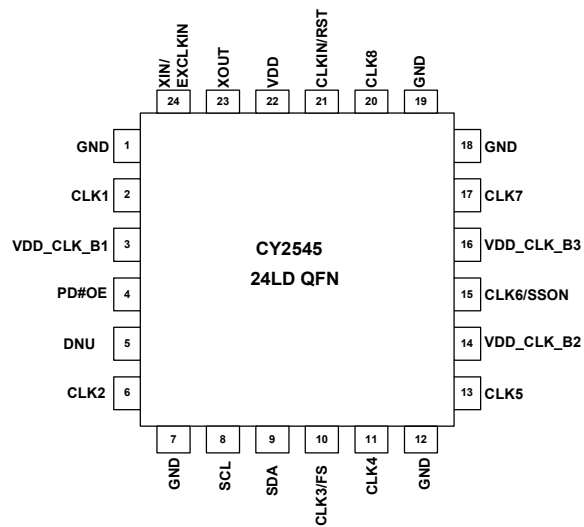


## Contents

|                                                  |           |                                                      |           |
|--------------------------------------------------|-----------|------------------------------------------------------|-----------|
| <b>Pinouts</b> .....                             | <b>3</b>  | <b>Read Operations</b> .....                         | <b>11</b> |
| <b>Pin Definitions</b> .....                     | <b>4</b>  | Current Address Read .....                           | 11        |
| <b>Pinouts</b> .....                             | <b>5</b>  | Random Read .....                                    | 11        |
| <b>Pin Definitions</b> .....                     | <b>6</b>  | Sequential Read .....                                | 11        |
| <b>Functional Overview</b> .....                 | <b>7</b>  | <b>Serial I2C Programming Interface</b> .....        | <b>11</b> |
| Four Configurable PLLs .....                     | 7         | <b>Timing Specifications</b> .....                   | <b>11</b> |
| I2C Programming .....                            | 7         | <b>Absolute Maximum Conditions</b> .....             | <b>12</b> |
| Input Reference Clocks .....                     | 7         | <b>Recommended Operating Conditions</b> .....        | <b>12</b> |
| Multiple Power Supplies .....                    | 7         | <b>DC Electrical Specifications</b> .....            | <b>13</b> |
| Output Bank Settings .....                       | 7         | <b>AC Electrical Specifications</b> .....            | <b>14</b> |
| Output Source Selection .....                    | 7         | <b>Configuration Example</b> .....                   | <b>14</b> |
| Spread Spectrum Control .....                    | 7         | <b>Recommended Crystal Specification</b> .....       | <b>15</b> |
| Frequency Select .....                           | 7         | <b>Recommended Crystal Specification</b> .....       | <b>15</b> |
| Glitch-Free Frequency Switch .....               | 7         | <b>Test and Measurement Setup</b> .....              | <b>16</b> |
| Device Reset Function .....                      | 7         | <b>Voltage and Timing Definitions</b> .....          | <b>16</b> |
| PD#/OE Mode .....                                | 7         | <b>Ordering Information</b> .....                    | <b>17</b> |
| Keep Alive Mode .....                            | 7         | Possible Configurations .....                        | 17        |
| Output Drive Strength .....                      | 8         | Ordering Code Definitions .....                      | 17        |
| Generic Configuration and Custom Frequency ..... | 8         | <b>Package Diagram</b> .....                         | <b>18</b> |
| Output Driver Supply .....                       |           | <b>Acronyms</b> .....                                | <b>19</b> |
| and Multi-Function Input Restriction .....       | 8         | <b>Document Conventions</b> .....                    | <b>19</b> |
| <b>Serial I2C Programming Interface</b> .....    |           | Units of Measure .....                               | 19        |
| <b>Protocol and Timing</b> .....                 | <b>9</b>  | <b>Document History Page</b> .....                   | <b>20</b> |
| Device Address .....                             | 10        | <b>Sales, Solutions, and Legal Information</b> ..... | <b>22</b> |
| Data Valid .....                                 | 10        | Worldwide Sales and Design Support .....             | 22        |
| Data Frame .....                                 | 10        | Products .....                                       | 22        |
| Acknowledge Pulse .....                          | 10        | PSoC® Solutions .....                                | 22        |
| <b>Write Operations</b> .....                    | <b>11</b> | Cypress Developer Community .....                    | 22        |
| Writing Individual Bytes .....                   | 11        | Technical Support .....                              | 22        |
| Writing Multiple Bytes .....                     | 11        |                                                      |           |

## Pinouts

**Figure 1. 24-pin QFN pinout**



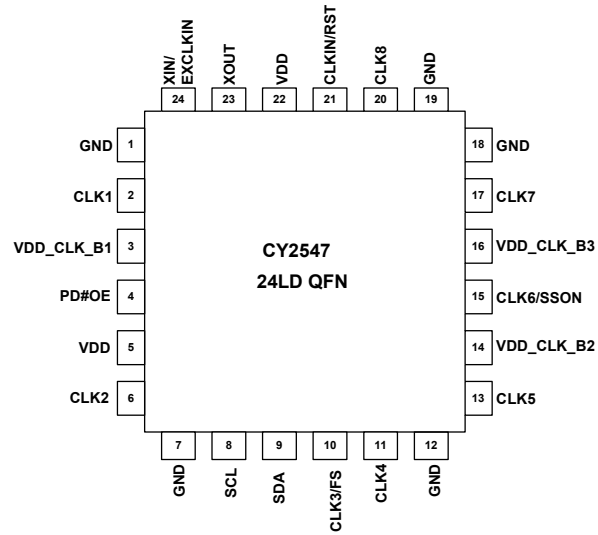
## Pin Definitions

CY2545 (24-pin QFN ( $V_{DD}$  = 2.5 V, 3.0 V or 3.3 V Supply))

| Pin No. | Name              | I/O          | Description                                                                                                                                                                            |
|---------|-------------------|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | GND               | Power        | Power supply ground                                                                                                                                                                    |
| 2       | CLK1              | Output       | Programmable clock output with spread spectrum. Output voltage depends on Bank1 voltage                                                                                                |
| 3       | $V_{DD\_CLK\_B1}$ | Power        | Power supply for Bank1 (CLK1, CLK2) output: 2.5 V/3.0 V/3.3 V and must be equal to or more than the $V_{DD}$ power supply.                                                             |
| 4       | PD#/OE            | Input        | Multifunction programmable pin: Output enable or Power-down mode                                                                                                                       |
| 5       | DNU               | DNU          | Do not use this pin                                                                                                                                                                    |
| 6       | CLK2              | Output       | Programmable clock output with spread spectrum. Output voltage depends on Bank1 voltage                                                                                                |
| 7       | GND               | Power        | Power supply ground                                                                                                                                                                    |
| 8       | SCL               | Input        | Serial data clock                                                                                                                                                                      |
| 9       | SDA               | Input/Output | Serial data input/output                                                                                                                                                               |
| 10      | CLK3/FS           | Output/Input | Multifunction programmable pin: Programmable clock output with no spread spectrum or frequency select input pin. Output voltage of CLK3 depends on Bank2 voltage                       |
| 11      | CLK4              | Output       | Programmable clock output with no spread spectrum. Output voltage depends on Bank2 voltage                                                                                             |
| 12      | GND               | Power        | Power supply ground                                                                                                                                                                    |
| 13      | CLK5              | Output       | Programmable clock output with spread spectrum. Output voltage depends on Bank2 voltage                                                                                                |
| 14      | $V_{DD\_CLK\_B2}$ | Power        | Power supply for Bank2 (CLK3, CLK4, CLK5) output: 1.8 V/2.5 V/3.0 V/3.3 V                                                                                                              |
| 15      | CLK6/SSON         | Output/Input | Multifunction programmable pin: Programmable clock output with spread spectrum or spread spectrum ON/OFF control input pin. Output voltage of CLK6 depends on Bank3 voltage            |
| 16      | $V_{DD\_CLK\_B3}$ | Power        | Power supply for Bank3 (CLK6, CLK7, CLK8) output: 2.5 V/3.0 V/3.3 V                                                                                                                    |
| 17      | CLK7              | Output       | Programmable clock output with spread spectrum. Output voltage depends on Bank3 voltage                                                                                                |
| 18      | GND               | Power        | Power supply ground                                                                                                                                                                    |
| 19      | GND               | Power        | Power supply ground                                                                                                                                                                    |
| 20      | CLK8              | Output       | Programmable clock output with spread spectrum. Output voltage depends on Bank3 voltage                                                                                                |
| 21      | CLKIN/RST         | Input/Input  | Multifunction programmable pin. High true reset input or 2.5 V/3.0 V/3.3 V external reference clock input. The signal level of CLKIN input must track $V_{DD}$ power supply on pin 22. |
| 22      | $V_{DD}$          | Power        | Power supply for core and inputs: 2.5 V/3.0 V/3.3 V                                                                                                                                    |
| 23      | XOUT              | Output       | Crystal output                                                                                                                                                                         |
| 24      | XIN/EXCLKIN       | Input        | Crystal input or 1.8 V external clock input                                                                                                                                            |

## Pinouts

**Figure 2. 24-pin QFN pinout**



## Pin Definitions

CY2547 (24-pin QFN ( $V_{DD} = 1.8\text{ V}$  Supply))

| Pin No. | Name              | I/O          | Description                                                                                                                                                                             |
|---------|-------------------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | GND               | Power        | Power supply ground                                                                                                                                                                     |
| 2       | CLK1              | Output       | Programmable clock output with spread spectrum. Output voltage depends on Bank1 voltage                                                                                                 |
| 3       | $V_{DD\_CLK\_B1}$ | Power        | Power supply for Bank1 (CLK1, CLK2) output: 1.8 V                                                                                                                                       |
| 4       | PD#/OE            | Input        | Multifunction programmable pin: Output enable or Power-down mode                                                                                                                        |
| 5       | $V_{DD}$          | Power        | Power supply for core and inputs: 1.8 V                                                                                                                                                 |
| 6       | CLK2              | Output       | Programmable output clock with spread spectrum. Output voltage depends on Bank1 voltage                                                                                                 |
| 7       | GND               | Power        | Power supply ground                                                                                                                                                                     |
| 8       | SCL               | Input        | Serial data clock                                                                                                                                                                       |
| 9       | SDA               | Input/Output | Serial data input                                                                                                                                                                       |
| 10      | CLK3/FS           | Output/Input | Multifunction programmable pin: Programmable clock output with no spread spectrum or frequency select input pin. Output voltage of CLK3 depends on $V_{DD\_CLK\_B2}$ voltage            |
| 11      | CLK4              | Output       | Programmable output clock with no spread spectrum. Output voltage depends on Bank2 voltage                                                                                              |
| 12      | GND               | Power        | Power supply ground                                                                                                                                                                     |
| 13      | CLK5              | Output       | Programmable clock output with spread spectrum. Output voltage depends on Bank2 voltage                                                                                                 |
| 14      | $V_{DD\_CLK\_B2}$ | Power        | Power supply for Bank2 (CLK3, CLK4, CLK5) output: 1.8 V                                                                                                                                 |
| 15      | CLK6/SSON         | Output/Input | Multifunction programmable pin: Programmable clock output with spread spectrum or spread spectrum ON/OFF control input pin. Output voltage of CLK6 depends on $V_{DD\_CLK\_B3}$ voltage |
| 16      | $V_{DD\_CLK\_B3}$ | Power        | Power supply for Bank3 (CLK6, CLK7, CLK8) output: 1.8 V                                                                                                                                 |
| 17      | CLK7              | Output       | Programmable clock output with spread spectrum. Output voltage depends on Bank3 voltage                                                                                                 |
| 18      | GND               | Power        | Power supply ground                                                                                                                                                                     |
| 19      | GND               | Power        | Power supply ground                                                                                                                                                                     |
| 20      | CLK8              | Output       | Programmable clock output with spread spectrum. Output voltage depends on Bank3 voltage                                                                                                 |
| 21      | CLKIN/RST         | Input/Input  | Multifunction programmable pin: High true reset input or 1.8 V external low voltage reference clock input                                                                               |
| 22      | $V_{DD}$          | Power        | Power supply for core and inputs: 1.8 V                                                                                                                                                 |
| 23      | XOUT              | Output       | Crystal output                                                                                                                                                                          |
| 24      | XIN/EXCLKIN       | Input        | Crystal input or 1.8 V external clock input                                                                                                                                             |

## Functional Overview

### Four Configurable PLLs

The CY2545 and CY2547 have four I<sup>2</sup>C programmable PLLs available to generate output frequencies ranging from 3 to 166 MHz. The advantage of having four PLLs is that a single device generates up to four independent frequencies from a single crystal. Two sets of frequencies for each PLL can be programmed. This enables in system frequency switching using multifunction frequency select pin, FS.

### I<sup>2</sup>C Programming

The CY2545 and CY2547 have a serial I<sup>2</sup>C interface that programs the configuration memory array to synthesize output frequencies by programmable output divider, spread characteristics, drive strength, and crystal load capacitance. I<sup>2</sup>C can also be used for in system control of these programmable features.

### Input Reference Clocks

The input to the CY2545 and CY2547 is either a crystal or a clock signal. The input frequency range for crystals is 8 MHz to 48 MHz. There is provision for two reference clock inputs, CLKIN and EXCLKIN with frequency range of 8 MHz to 166 MHz. For both devices, when CLKIN signal at pin 21 is used as a reference input, a valid signal at EXCLKIN (as specified in the AC and DC Electrical Specification table), must be present for the devices to operate properly.

### Multiple Power Supplies

The CY2545 and CY2547 are designed to operate at internal core supply voltage of 1.8 V. In the case of the high voltage part (CY2545), an internal regulator is used to generate 1.8 V from the 2.5 V/3.0 V/3.3 V V<sub>DD</sub> supply voltage at pin 22. For the low voltage part (CY2547), this internal regulator is bypassed and 1.8 V at V<sub>DD</sub> pin 22 is directly used.

### Output Bank Settings

These devices have eight clock outputs grouped in three output driver banks. The Bank 1, Bank 2, and Bank 3 correspond to (CLK1, CLK2), (CLK3, CLK4, CLK5), and (CLK6, CLK7, CLK8), respectively. Separate power supplies are used for each of these banks and they can be any of 1.8 V, 2.5 V, 3.0 V, or 3.3 V for CY2545 and 1.8 V for CY2547 giving user multiple choice of output clock voltage levels.

### Output Source Selection

These devices have eight clock outputs (CLK1 - 8). There are six available clock sources for these outputs. These clock sources are: XIN/EXCLKIN, CLKIN, PLL1, PLL2, PLL3, or PLL4. Output clock source selection is done using four out of six crossbar switch. Thus, any one of these six available clock sources can be arbitrarily selected for the clock outputs. This gives user a flexibility to have up to four independent clock outputs.

### Spread Spectrum Control

Two of the four PLLs (PLL3 and PLL4) have spread spectrum capability for EMI reduction in the system. The device uses a Cypress proprietary PLL and Spread Spectrum Clock (SSC) technology to synthesize and modulate the frequency of the PLL. The spread spectrum feature can be turned on or off using a multifunction control pin (CLK7/SSON). It can be programmed to either center spread range from  $\pm 0.125\%$  to  $\pm 2.50\%$  or down spread range from  $-0.25\%$  to  $-5.0\%$  with Lexmark or Linear profile.

### Frequency Select

The device can store two different PLL frequency configurations, output source selection and output divider values for all eight outputs in its nonvolatile memory location. There is a multifunction programmable pin, CLK3/FS which, if programmed as frequency select input, can be used to select between these two arbitrarily programmed settings.

### Glitch-Free Frequency Switch

When the frequency select pin (FS) is used to switch frequency, the outputs are glitch-free provided frequency is switched using output dividers. This feature enables uninterrupted system operation while clock frequency is switched.

### Device Reset Function

There is a multifunction CLKIN/RST (pin 21) that can be programmed to use for the device reset function. There are two different programmable modes of operation for this device reset function. First one (called POR like reset), when used brings the device in the default register settings losing all configuration changes made through the I<sup>2</sup>C interface. The second (called Clean Start), keeps the I<sup>2</sup>C programmed values while giving all outputs a simultaneous clean start from its low pull-down state.

### PD#/OE Mode

PD#/OE (Pin 4) is programmable to operate as either power-down (PD#) or output enable (OE) mode. PD# is a low true input. If activated it shuts off the entire chip, resulting in minimum device power consumption. Setting this signal high brings the device into operational mode with default register settings.

When this pin is programmed as output enable (OE), clock outputs are enabled or disabled using OE pin. Individual clock outputs can be programmed to be sensitive to this OE pin.

### Keep Alive Mode

By activating the device in the keep alive mode, power-down mode is changed to power saving mode. This disables all PLLs and outputs, but preserves the contents of the volatile registers. Thus, any configuration changes made through the I<sup>2</sup>C interface are preserved. By deactivating the keep alive mode, I<sup>2</sup>C memory is not preserved during power-down, but power consumption is reduced relative to the keep alive mode.

## Output Drive Strength

The DC drive strength of the individual clock output can be programmed for different values. Table 1 shows the typical rise and fall times for different drive strength settings.

**Table 1. Output Drive Strength**

| Output Drive Strength | Rise/Fall Time (ns)<br>(Typical Value) |
|-----------------------|----------------------------------------|
| Low                   | 6.8                                    |
| Mid Low               | 3.4                                    |
| Mid High              | 2.0                                    |
| High                  | 1.0                                    |

## Generic Configuration and Custom Frequency

There is a generic set of output frequencies available from the factory that can be used for the device evaluation purposes. The device, CY2545/CY2547 can be custom programmed to any desired frequencies and listed features. For customer specific programming and I<sup>2</sup>C programmable memory bitmap definitions, contact your local Cypress Field Application Engineer (FAE) or sales representative.

## Output Driver Supply and Multi-Function Input Restriction

There are two programmable Output/Input function pins for CLK3/FS and CLK6/SSON. These are configurable as clock output or select input or spread spectrum ON/OFF control input pin.

- When configured as Output, the driver supply voltage is defined by  $V_{DD\_CLK\_Bx}$  and can be individually used with 1.8 V, 2.5 V, 3.0 V, or 3.3 V power supply apart from the  $V_{DD}$  supply.
- When configured as Input, the input threshold level is defined by  $V_{DD}$  supply while the protection diode is connected to the respective  $V_{DD\_CLK\_Bx}$  power supply. Therefore, if  $V_{DD\_CLK\_Bx}$  is less than  $V_{DD} - 0.5$  V, a large leakage current would flow from the input pin to the  $V_{DD\_CLK\_Bx}$  supply. The device does not permit this condition; it is required that the power supply for the bank ( $V_{DD\_CLK\_Bx}$ ) is more than  $V_{DD} - 0.5$  V.

**Example:** In CY2545, if  $V_{DD\_CLK\_B2} = 1.8$  V, CLK3/FS is configured as FS, and  $V_{DD} = 3.3$  V, there will be a leakage current from FS high to  $V_{DD\_CLK\_B2}$ . The multi-function pin should only be used as clock output if the  $V_{DD\_CLK\_Bx}$  is less than  $V_{DD} - 0.5$  V. In other words, when these multi-function programmable pins are configured as input, the power supply for the bank ( $V_{DD\_CLK\_Bx}$ ) should be more than  $V_{DD} - 0.5$  V.

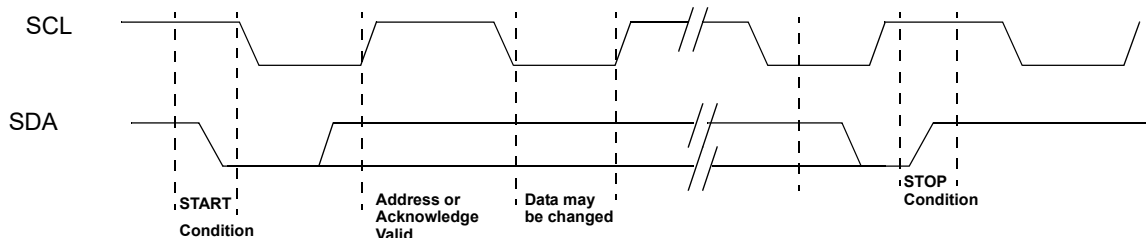
## Serial I<sup>2</sup>C Programming Interface Protocol and Timing

To enhance the flexibility and function of the clock synthesizer, a two signal serial interface is provided. Through the Serial Data Interface, various device functions, such as individual clock output buffers, are individually enabled or disabled. The registers associated with the Serial Data Interface initialize to their default setting upon power-up and therefore, use of this interface is optional. Clock device register changes are normally made at system initialization, if any are required.

The CY2545 and CY2547 use a 2-wire serial interface SDA and SCL that operates up to 400 kbits/s in read or write mode. The SDA and SCL timing and data transfer sequence is shown in [Figure 3](#). The basic write serial format is:

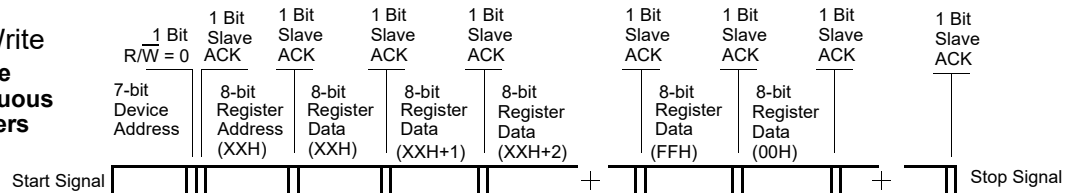
Start Bit; 7-bit Device Address (DA); R/W Bit; Slave Clock Acknowledge (ACK); 8-bit Memory Address (MA); ACK; 8-bit Data; ACK; 8-bit Data in MA+1 if desired; ACK; 8-bit Data in MA+2; ACK; etc. until STOP Bit. The basic serial format is illustrated in [Figure 4](#).

**Figure 3. Data Transfer Sequence on the Serial Bus**



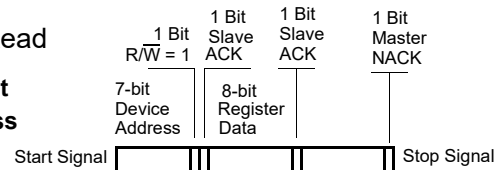
**Figure 4. Data Frame Architecture**

### SDA Write Multiple Contiguous Registers

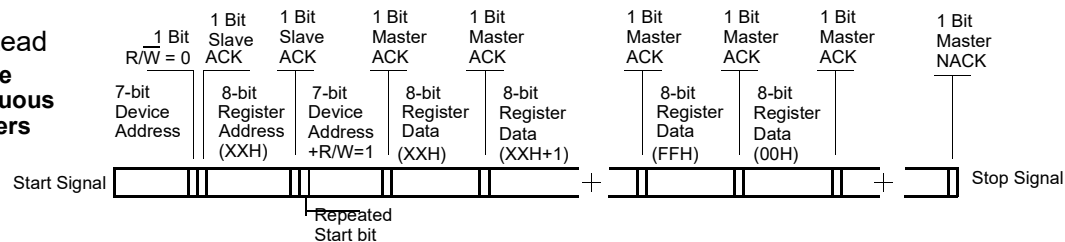


### SDA Read Current Address

#### Read



### SDA Read Multiple Contiguous Registers



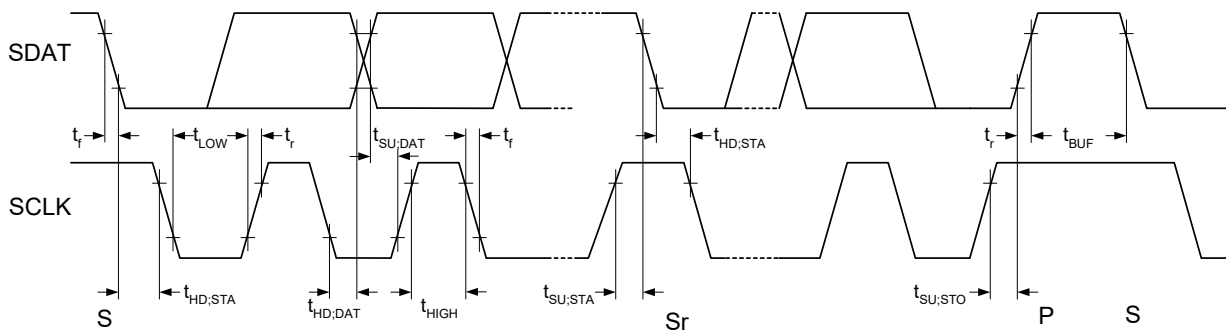
### Device Address

The device serial interface address is 69H. The device address is combined with a read/write bit as the LSB and is sent after each start bit.

### Data Valid

Data is valid when the clock is HIGH, and is only transitioned when the clock is LOW, as illustrated in Figure 5.

**Figure 5. Data Valid and Data Transition Periods**



### Data Frame

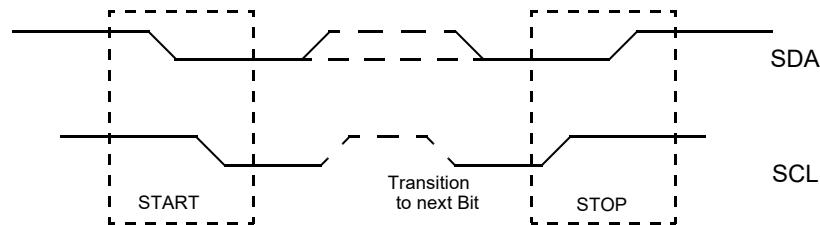
A start and stop sequence indicates every new data frame, as illustrated in Figure 6.

**Start Sequence** - The start frame is indicated by SDA going LOW when SCL is HIGH. Every time a start signal is supplied, the next 8-bit data must be the device address (seven bits) and a R/W bit,

followed by register address (eight bits) and register data (eight bits).

**Stop Sequence** - The stop frame is indicated by SDA going HIGH when SCL is HIGH. A stop frame frees the bus to go to another part on the same bus or to another random register address.

**Figure 6. Start and Stop Frame**

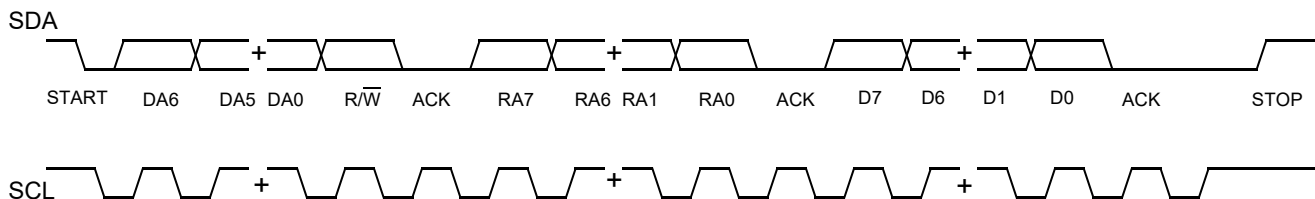


### Acknowledge Pulse

During write mode the CY2545/CY2547 responds with an acknowledge pulse after every eight bits. Do this by pulling the SDA line LOW during the  $N \times 9^{\text{th}}$  clock cycle as illustrated in

Figure 7 (N = the number of bytes transmitted). During read mode, the master generates the acknowledge pulse after reading the data packet.

**Figure 7. Frame Format (Device Address, R/W, Register Address, Register Data)**



## Write Operations

### Writing Individual Bytes

A valid write operation must have a full 8-bit register address after the device address word from the master, which is followed by an acknowledge bit from the slave (ack = 0/LOW). The next eight bits must contain the data word intended for storage. After the data word is received, the slave responds with another acknowledge bit (ack = 0/LOW), and the master must end the write sequence with a STOP condition.

### Writing Multiple Bytes

To write multiple bytes at a time, the master does not end the write sequence with a STOP condition; instead, the master sends multiple contiguous bytes of data to be stored. After each byte, the slave responds with an acknowledge bit, the same as after the first byte, and accepts data until the STOP condition responds to the acknowledge bit. When receiving multiple bytes, the CY2545 and CY2547 internally increment the register address.

## Read Operations

Read operations are initiated the same way as write operations except that the R/W bit of the slave address is set to '1' (HIGH). There are three basic read operations: current address read, random read, and sequential read.

### Current Address Read

The CY2545 and CY2547 have an onboard address counter that retains 1 more than the address of the last word access. If the last word written or read was word 'n', then a current address

read operation returns the value stored in location 'n+1'. When the CY2545/CY2547 receive the slave address with the R/W bit set to a '1', the CY2545/CY2547 issue an acknowledge and transmit the 8-bit word. The master device does not acknowledge the transfer, but generates a STOP condition, which causes the CY2545/CY2547 to stop transmission.

### Random Read

Through random read operations, the master may access any memory location. To perform this type of read operation, first the word address must be set. This is done by sending the address to the CY2545/CY2547 as part of a write operation. After sending the word address, the master generates a START condition following the acknowledge. This terminates the write operation before any data is stored in the address, but not before the internal address pointer is set. Next, the master reissues the control byte with the R/W byte set to '1'. The CY2545/CY2547 then issue an acknowledge and transmit the 8-bit word. The master device does not acknowledge the transfer, but generates a STOP condition, which causes the CY2545/CY2547 to stop transmission.

### Sequential Read

Sequential read operations follow the same process as random reads except that the master issues an acknowledge instead of a STOP condition after transmitting the first 8-bit data word. This action increments the internal address pointer, and subsequently output of the next 8-bit data word. By continuing to issue acknowledges instead of STOP conditions, the master serially reads the entire contents of the slave device memory. When the internal address pointer points to the FFH register, after the next increment, the pointer points to the 00H register.

## Serial I<sup>2</sup>C Programming Interface Timing Specifications

| Parameter           | Description                                     | Min | Max | Unit |
|---------------------|-------------------------------------------------|-----|-----|------|
| f <sub>SCLK</sub>   | Frequency of SCLK                               | –   | 400 | kHz  |
| t <sub>HD:STA</sub> | Hold time START condition                       | 0.6 | –   | μs   |
| t <sub>LOW</sub>    | Low period of the SCLK clock                    | 1.3 | –   | μs   |
| t <sub>HIGH</sub>   | High period of the SCLK clock                   | 0.6 | –   | μs   |
| t <sub>SU:STA</sub> | Setup time for a repeated START condition       | 0.6 | –   | μs   |
| t <sub>HD:DAT</sub> | Data hold time                                  | 100 | –   | ns   |
| t <sub>SU:DAT</sub> | Data setup time                                 | 100 | –   | ns   |
| t <sub>R</sub>      | Rise time                                       | –   | 300 | ns   |
| t <sub>F</sub>      | Fall time                                       | –   | 300 | ns   |
| t <sub>SU:STO</sub> | Setup time for STOP condition                   | 0.6 | –   | μs   |
| t <sub>BUF</sub>    | Bus-free time between STOP and START conditions | 1.3 | –   | μs   |

## Absolute Maximum Conditions

| Parameter          | Description                       | Condition               | Min  | Max            | Unit |
|--------------------|-----------------------------------|-------------------------|------|----------------|------|
| $V_{DD}$           | Supply voltage for CY2545         |                         | -0.5 | 4.5            | V    |
| $V_{DD}$           | Supply voltage for CY2547         |                         | -0.5 | 2.6            | V    |
| $V_{DD\_CLK\_BX}$  | Output bank supply voltage        |                         | -0.5 | 4.5            | V    |
| $V_{IN}$           | Input voltage for CY2545          | Relative to $V_{SS}$    | -0.5 | $V_{DD} + 0.5$ | V    |
| $V_{IN}$           | Input voltage for CY2547          | Relative to $V_{SS}$    | -0.5 | 2.2            | V    |
| $T_S$              | Temperature and storage           | Nonfunctional           | -65  | +150           | °C   |
| ESD <sub>HBM</sub> | ESD protection (human body model) | JEDEC EIA/JESD22-A114-E | 2000 |                | V    |
| UL-94              | Flammability rating               | V-0 at 1/8 in.          | –    | 10             | ppm  |
| MSL                | Moisture sensitivity level        |                         | 3    |                |      |

## Recommended Operating Conditions

| Parameter         | Description                                                                                       | Min  | Typ | Max  | Unit |
|-------------------|---------------------------------------------------------------------------------------------------|------|-----|------|------|
| $V_{DD}$          | $V_{DD}$ operating voltage for CY2545                                                             | 2.25 | –   | 3.60 | V    |
| $V_{DD}$          | $V_{DD}$ operating voltage for CY2547                                                             | 1.65 | 1.8 | 1.95 | V    |
| $V_{DD\_CLK\_BX}$ | Output driver voltage for bank 1, 2, and 3 for CY2545                                             | 1.43 | –   | 3.60 | V    |
|                   | Output driver voltage for bank 1, 2, and 3 for CY2547                                             | 1.43 | –   | 1.98 | V    |
| $T_{AC}$          | Commercial ambient temperature                                                                    | 0    | –   | +70  | °C   |
| $T_{AI}$          | Industrial ambient temperature                                                                    | -40  | –   | +85  | °C   |
| $C_{LOAD}$        | Maximum load capacitance                                                                          | –    | –   | 15   | pF   |
| $t_{PU}$          | Power-up time for all $V_{DD}$ to reach minimum specified voltage (power ramps must be monotonic) | 0.05 | –   | 500  | ms   |

## DC Electrical Specifications

| Parameter                         | Description                                                       | Conditions                                                               | Min                          | Typ | Max                   | Unit |
|-----------------------------------|-------------------------------------------------------------------|--------------------------------------------------------------------------|------------------------------|-----|-----------------------|------|
| V <sub>OL</sub>                   | Output low voltage                                                | I <sub>OL</sub> = 2 mA, drive strength = [00]                            | –                            | –   | 0.4                   | V    |
|                                   |                                                                   | I <sub>OL</sub> = 3 mA, drive strength = [01]                            |                              |     |                       |      |
|                                   |                                                                   | I <sub>OL</sub> = 7 mA, drive strength = [10]                            |                              |     |                       |      |
|                                   |                                                                   | I <sub>OL</sub> = 12 mA, drive strength = [11]                           |                              |     |                       |      |
| V <sub>OH</sub>                   | Output high voltage                                               | I <sub>OH</sub> = –2 mA, drive strength = [00]                           | V <sub>DD_CLK_BX</sub> – 0.4 | –   | –                     | V    |
|                                   |                                                                   | I <sub>OH</sub> = –3 mA, drive strength = [01]                           |                              |     |                       |      |
|                                   |                                                                   | I <sub>OH</sub> = –7 mA, drive strength = [10]                           |                              |     |                       |      |
|                                   |                                                                   | I <sub>OH</sub> = –12 mA, drive strength = [11]                          |                              |     |                       |      |
| V <sub>OLSD</sub>                 | Output low voltage, SDA                                           | I <sub>OL</sub> = 4 mA                                                   | –                            | –   | 0.4                   | V    |
| V <sub>IL1</sub>                  | Input low voltage of PD#/OE, RST, FS, and SSON                    |                                                                          | –                            | –   | 0.2 × V <sub>DD</sub> | V    |
| V <sub>IL2</sub>                  | Input low voltage of CLKIN for CY2545                             |                                                                          | –                            | –   | 0.2 × V <sub>DD</sub> | V    |
| V <sub>IL3</sub>                  | Input low voltage of EXCLKIN for CY2545                           |                                                                          | –                            | –   | 0.3                   | V    |
| V <sub>IL4</sub>                  | Input low voltage of CLKIN, EXCLKIN for CY2547                    |                                                                          | –                            | –   | 0.2 × V <sub>DD</sub> | V    |
| V <sub>IH1</sub>                  | Input high voltage of PD#/OE, RST, FS, and SSON                   |                                                                          | 0.8 × V <sub>DD</sub>        | –   | –                     | V    |
| V <sub>IH2</sub>                  | Input high voltage of CLKIN for CY2545                            |                                                                          | 0.8 × V <sub>DD</sub>        | –   | –                     | V    |
| V <sub>IH3</sub>                  | Input high voltage of EXCLKIN for CY2545                          |                                                                          | 1.62                         | –   | 2.2                   | V    |
| V <sub>IH4</sub>                  | Input high voltage of CLKIN, EXCLKIN for CY2547                   |                                                                          | 0.8 × V <sub>DD</sub>        | –   | –                     | V    |
| I <sub>ILPD</sub>                 | Input low current of RST and PD#/OE                               | V <sub>IL</sub> = 0 V                                                    | –                            | –   | 10                    | μA   |
| I <sub>IHPD</sub>                 | Input high current of RST and PD#/OE                              | V <sub>IH</sub> = V <sub>DD</sub>                                        | –                            | –   | 10                    | μA   |
| I <sub>ILSR</sub>                 | Input low current of SSON and FS                                  | V <sub>IL</sub> = 0 V<br>(Internal pull-down = 160 k typ)                | –                            | –   | 10                    | μA   |
| I <sub>IHSR</sub>                 | Input high current of SSON and FS                                 | V <sub>IH</sub> = V <sub>DD</sub><br>(Internal pull-down = 160 k typ)    | 14                           | –   | 36                    | μA   |
| R <sub>DN</sub>                   | Pull-down resistor of (CLK1-CLK8) when off, CLK6/SSON and CLK3/FS |                                                                          | 100                          | 160 | 250                   | kΩ   |
| I <sub>DD</sub> <sup>[1, 2]</sup> | Supply current for CY2547                                         | PD# = high, no load                                                      | –                            | 20  | –                     | mA   |
|                                   | Supply current for CY2545                                         | PD# = high, no load                                                      | –                            | 22  | –                     | mA   |
| I <sub>DDS</sub> <sup>[1]</sup>   | Standby current                                                   | PD# = low, no load, with I <sup>2</sup> C circuit not in keep alive mode | –                            | 3   | –                     | μA   |
| I <sub>PD</sub> <sup>[1]</sup>    | Power-down current                                                | PD# = low, no load, with I <sup>2</sup> C circuit in keep alive mode     | –                            | –   | 1                     | mA   |
| C <sub>IN</sub> <sup>[1]</sup>    | Input capacitance                                                 | SSON, RST, PD#/OE or FS inputs                                           | –                            |     | 7                     | pF   |

### Notes

- Guaranteed by design but not 100% tested.
- Configuration dependent.

## AC Electrical Specifications

| Parameter          | Description                                  | Conditions                                                                                                                              | Min | Typ | Max | Unit |
|--------------------|----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|------|
| $F_{IN}$ (crystal) | Crystal frequency, XIN                       |                                                                                                                                         | 8   | –   | 48  | MHz  |
| $F_{IN}$ (clock)   | Input clock frequency                        | Clock inputs CLKIN or EXCLKIN                                                                                                           | 8   | –   | 166 | MHz  |
| $F_{CLK}$          | Output clock frequency                       | CY2545 ( $V_{DD\_CLK\_BX} = 2.5\text{ V}, 3.0\text{ V}, 3.3\text{ V}$ ) and CY2547                                                      | 3   | –   | 166 | MHz  |
|                    |                                              | CY2545 ( $V_{DD\_CLK\_BX} = 1.8\text{ V}$ )                                                                                             | 3   | –   | 50  | MHz  |
| DC1                | Output duty cycle, all clocks except ref out | Duty cycle is defined in <a href="#">Figure 9</a> ; $t_1/t_2$ , measured 50% of $V_{DD}$                                                | 45  | 50  | 55  | %    |
| DC2                | Ref out clock duty cycle                     | Ref In Min 45%, Max 55%                                                                                                                 | 40  | –   | 60  | %    |
| $T_{RF1}^{[3]}$    | Output rise/fall time                        | Measured from 20% to 80% of $V_{DD\_CLK\_BX}$ , as shown in <a href="#">Figure 10</a> , $C_{LOAD} = 15\text{ pF}$ , Drive strength [00] | –   | 6.8 | –   | ns   |
| $T_{RF2}^{[3]}$    | Output rise/fall time                        | Measured from 20% to 80% of $V_{DD\_CLK\_BX}$ , as shown in <a href="#">Figure 10</a> , $C_{LOAD} = 15\text{ pF}$ , Drive strength [01] | –   | 3.4 | –   | ns   |
| $T_{RF3}^{[3]}$    | Output rise/fall time                        | Measured from 20% to 80% of $V_{DD\_CLK\_BX}$ , as shown in <a href="#">Figure 10</a> , $C_{LOAD} = 15\text{ pF}$ , Drive strength [10] | –   | 2.0 | –   | ns   |
| $T_{RF4}^{[3]}$    | Output rise/fall time                        | Measured from 20% to 80% of $V_{DD\_CLK\_BX}$ , as shown in <a href="#">Figure 10</a> , $C_{LOAD} = 15\text{ pF}$ , Drive strength [11] | –   | 1.0 | –   | ns   |
| $T_{CCJ}^{[3, 4]}$ | Cycle-to-cycle jitter max (Pk-Pk)            | Configuration dependent. See <a href="#">Configuration Example</a>                                                                      | –   | 150 | –   | ps   |
| $T_{LOCK}^{[3]}$   | PLL lock time                                | Measured from 90% of the applied power supply level                                                                                     | –   | 1   | 3   | ms   |

## Configuration Example

For C-C Jitter

| Ref. Freq. (MHz) | CLK1 Output |                     | CLK2 Output |                     | CLK3 Output |                     | CLK4 Output |                     | CLK5 Output |                     |
|------------------|-------------|---------------------|-------------|---------------------|-------------|---------------------|-------------|---------------------|-------------|---------------------|
|                  | Freq. (MHz) | C-C Jitter Typ (ps) | Freq. (MHz) | C-C Jitter Typ (ps) | Freq. (MHz) | C-C Jitter Typ (ps) | Freq. (MHz) | C-C Jitter Typ (ps) | Freq. (MHz) | C-C Jitter Typ (ps) |
| 14.3181          | 8.0         | 134                 | 166         | 103                 | 48          | 92                  | 74.25       | 81                  | Not used    |                     |
| 19.2             | 74.25       | 99                  | 166         | 94                  | 8           | 91                  | 27          | 110                 | 48          | 75                  |
| 27               | 48          | 67                  | 27          | 109                 | 166         | 103                 | 74.25       | 97                  | Not used    |                     |
| 48               | 48          | 93                  | 27          | 123                 | 166         | 137                 | 166         | 138                 | 8           | 103                 |

### Notes

3. Guaranteed by design but not 100% tested.
4. Configuration dependent.

## Recommended Crystal Specification

For SMD Package

| Parameter | Description                 | Range 1 | Range 2 | Range 3 | Unit     |
|-----------|-----------------------------|---------|---------|---------|----------|
| Fmin      | Minimum frequency           | 8       | 14      | 28      | MHz      |
| Fmax      | Maximum frequency           | 14      | 28      | 48      | MHz      |
| R1        | Motional resistance (ESR)   | 135     | 50      | 30      | $\Omega$ |
| C0        | Shunt capacitance           | 4       | 4       | 2       | pF       |
| CL        | Parallel load capacitance   | 18      | 14      | 12      | pF       |
| DL(max)   | Maximum crystal drive level | 300     | 300     | 300     | $\mu$ W  |

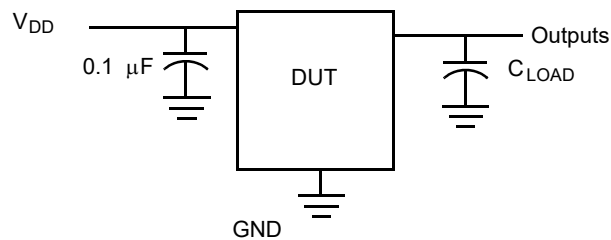
## Recommended Crystal Specification

For Thru-Hole Package

| Parameter | Description                 | Range 1 | Range 2 | Range 3 | Unit     |
|-----------|-----------------------------|---------|---------|---------|----------|
| Fmin      | Minimum frequency           | 8       | 14      | 24      | MHz      |
| Fmax      | Maximum frequency           | 14      | 24      | 32      | MHz      |
| R1        | Motional resistance (ESR)   | 90      | 50      | 30      | $\Omega$ |
| C0        | Shunt capacitance           | 7       | 7       | 7       | pF       |
| CL        | Parallel load capacitance   | 18      | 12      | 12      | pF       |
| DL(max)   | Maximum crystal drive level | 1000    | 1000    | 1000    | $\mu$ W  |

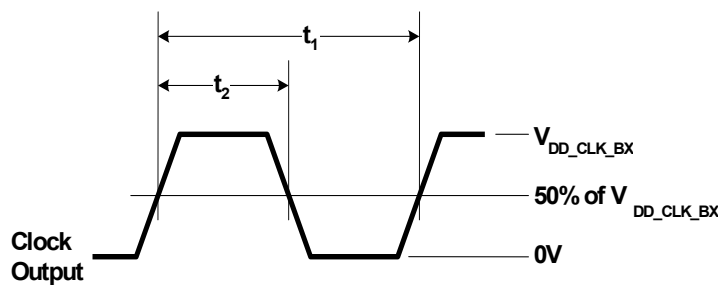
## Test and Measurement Setup

**Figure 8. Test and Measurement Setup**

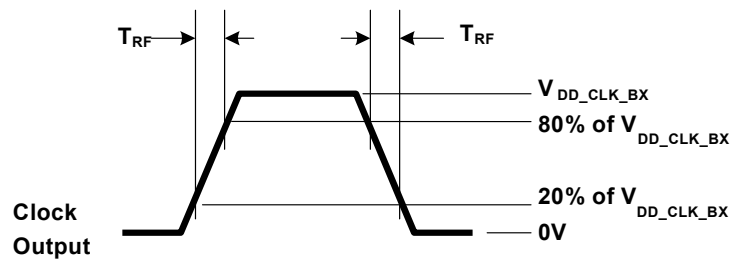


## Voltage and Timing Definitions

**Figure 9. Duty Cycle Definition**



**Figure 10. Rise Time =  $T_{RF}$  Fall Time =  $T_{RF}$**



## Ordering Information

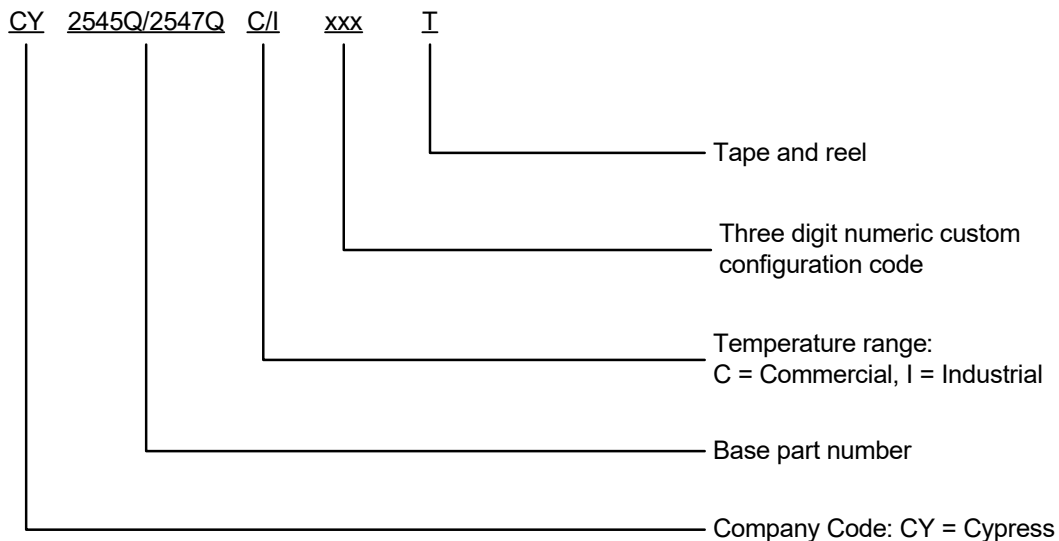
| Part Number    | Type               | Package                    | Supply Voltage (V <sub>DD</sub> ) | Production Flow              |
|----------------|--------------------|----------------------------|-----------------------------------|------------------------------|
| <b>Pb-free</b> |                    |                            |                                   |                              |
| CY2547QI       | Field Programmable | 24-pin QFN                 | 1.8 V                             | Industrial, –40 °C to +85 °C |
| CY2547QIT      | Field Programmable | 24-pin QFN – Tape and Reel | 1.8 V                             | Industrial, –40 °C to +85 °C |

Products are also offered as factory programmed customer specific devices with customized part numbers. The [Possible Configurations](#) shows the available device types, but not complete part numbers. Contact your local Cypress FAE or sales representative for more information.

## Possible Configurations

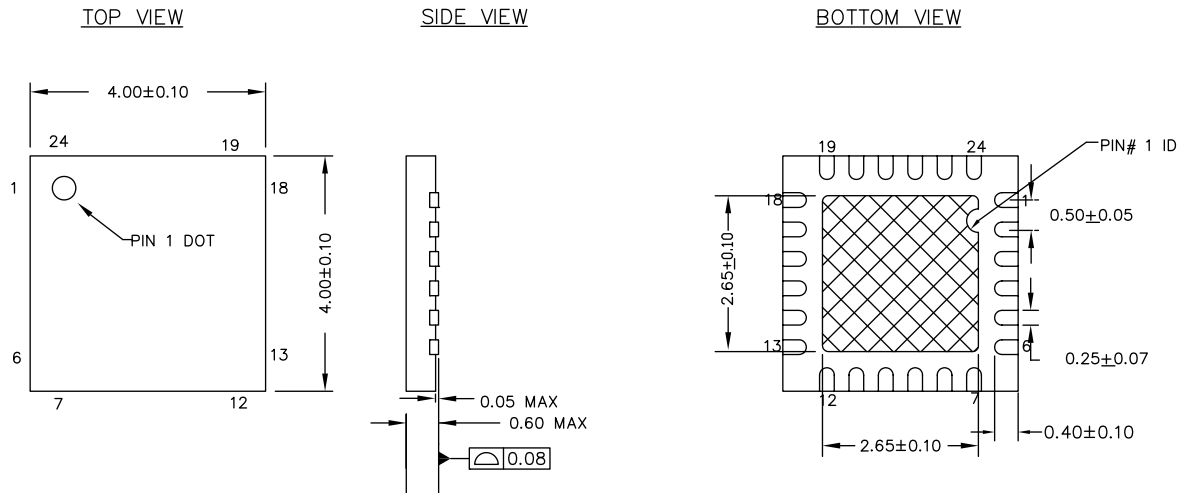
| Part Number    | Type               | Package                    | Supply Voltage (V <sub>DD</sub> ) | Production Flow              |
|----------------|--------------------|----------------------------|-----------------------------------|------------------------------|
| <b>Pb-free</b> |                    |                            |                                   |                              |
| CY2545QCxxx    | Factory Configured | 24-pin QFN                 | 2.5 V, 3.0 V or 3.3 V             | Commercial, 0 °C to +70 °C   |
| CY2545QCxxxT   | Factory Configured | 24-pin QFN – Tape and Reel | 2.5 V, 3.0 V or 3.3 V             | Commercial, 0 °C to +70 °C   |
| CY2547QCxxx    | Factory Configured | 24-pin QFN                 | 1.8 V                             | Commercial, 0 °C to +70 °C   |
| CY2547QCxxxT   | Factory Configured | 24-pin QFN – Tape and Reel | 1.8 V                             | Commercial, 0 °C to +70 °C   |
| CY2545QIxxx    | Factory Configured | 24-pin QFN                 | 2.5 V, 3.0 V or 3.3 V             | Industrial, –40 °C to +85 °C |
| CY2545QIxxxT   | Factory Configured | 24-pin QFN – Tape and Reel | 2.5 V, 3.0 V or 3.3 V             | Industrial, –40 °C to +85 °C |
| CY2547QIxxx    | Factory Configured | 24-pin QFN                 | 1.8 V                             | Industrial, –40 °C to +85 °C |
| CY2547QIxxxT   | Factory Configured | 24-pin QFN – Tape and Reel | 1.8 V                             | Industrial, –40 °C to +85 °C |

## Ordering Code Definitions



## Package Diagram

Figure 11. 24-pin QFN (4 × 4 × 0.55 mm) LQ24A (2.65 × 2.65 E-Pad (Sawn)) Package Outline, 001-13937



### NOTES :

1.  HATCH IS SOLDERABLE EXPOSED METAL.
2. REFERENCE JEDEC # MO-248
3. PACKAGE WEIGHT :  $29 \pm 3$  mg
4. ALL DIMENSIONS ARE IN MILLIMETERS

001-13937 \*F

## Acronyms

**Table 2. Acronyms Used in this Document**

| Acronym          | Description                               |
|------------------|-------------------------------------------|
| EIA              | Electronic Industries Alliance            |
| ESD              | Electrostatic Discharge                   |
| ESR              | Equivalent Series Resistance              |
| I <sup>2</sup> C | Inter Integrated Circuit                  |
| JEDEC            | Joint Electron Device Engineering Council |
| PLL              | Phase-Locked Loop                         |
| QFN              | Quad Flat No-lead                         |

## Document Conventions

### Units of Measure

**Table 3. Units of Measure**

| Symbol | Units of Measure  |
|--------|-------------------|
| °C     | degree Celsius    |
| kHz    | kilohertz         |
| MHz    | megahertz         |
| μA     | microampere       |
| μs     | microsecond       |
| μW     | microwatt         |
| mA     | milliampere       |
| ms     | millisecond       |
| ns     | nanosecond        |
| W      | ohm               |
| ppm    | parts per million |
| %      | percent           |
| pF     | picofarad         |
| ps     | picosecond        |
| V      | volt              |
| W      | watt              |

## Document History Page

| Document Title: CY2545/CY2547, Quad-PLL Programmable Spread Spectrum Clock Generator with Serial I <sup>2</sup> C Interface<br>Document Number: 001-13196 |         |                 |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-----------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Revision                                                                                                                                                  | ECN     | Orig. of Change | Submission Date | Description of Change                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| **                                                                                                                                                        | 870780  | RGL / AESA      | 03/23/2007      | New data sheet.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| *A                                                                                                                                                        | 1504843 | RGL / AESA      | 10/03/2007      | Replaced V <sub>DD CORE</sub> with V <sub>DD</sub> in all instances across the document.<br>Updated <a href="#">Serial I<sup>2</sup>C Programming Interface Timing Specifications</a> :<br>Changed minimum value of t <sub>SU</sub> parameter from 100 ns to 250 ns.<br>Updated <a href="#">Absolute Maximum Conditions</a> :<br>Replaced "MIL-STD-883, Method 3015" with "JEDEC EIA/JESD22-A114-E" in "Conditions" column of ESD <sub>HBM</sub> parameter.<br>Updated <a href="#">Recommended Operating Conditions</a> :<br>Updated all details of V <sub>DD</sub> parameter (Combined three rows into one row for CY2545). |
| *B                                                                                                                                                        | 2899681 | CXQ             | 03/26/2010      | Updated <a href="#">Ordering Information</a> :<br>Updated part numbers.<br>Updated <a href="#">Package Diagram</a> :<br>spec 51-85203 – Changed revision from *A to *B.                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| *C                                                                                                                                                        | 3302754 | CXQ             | 07/05/2011      | Added <a href="#">Ordering Code Definitions</a> under <a href="#">Ordering Information</a> .<br>Added <a href="#">Acronyms and Units of Measure</a> .<br>Updated to new template.                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| *D                                                                                                                                                        | 4401186 | AJU             | 06/06/2014      | Updated <a href="#">Package Diagram</a> :<br>spec 51-85203 – Changed revision from *B to *D.<br>Updated to new template.<br>Completing Sunset Review.                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| *E                                                                                                                                                        | 4586478 | TAVA            | 12/03/2014      | Updated <a href="#">Functional Description</a> :<br>Added "For a complete list of related documentation, click <a href="#">here</a> ." at the end.<br>Updated <a href="#">Serial I<sup>2</sup>C Programming Interface Protocol and Timing</a> :<br>Updated <a href="#">Figure 4</a> (Updated the last ACK in SDA Read-Current Address Read and SDA Read-Multiple Contiguous Registers to "NACK").                                                                                                                                                                                                                            |
| *F                                                                                                                                                        | 5140921 | TAVA            | 03/14/2016      | Updated <a href="#">Serial I<sup>2</sup>C Programming Interface Protocol and Timing</a> :<br>Updated <a href="#">Data Valid</a> :<br>Updated <a href="#">Figure 5</a> .<br>Updated <a href="#">Serial I<sup>2</sup>C Programming Interface Timing Specifications</a> :<br>Updated all details.<br>Updated <a href="#">Ordering Information</a> :<br>Updated part numbers.<br>Updated <a href="#">Ordering Code Definitions</a> .<br>Updated <a href="#">Package Diagram</a> :<br>Removed spec 51-85203 *D.<br>Added spec 001-13937 *F.<br>Updated to new template.                                                           |
| *G                                                                                                                                                        | 5475518 | BPIN            | 10/14/2016      | Updated <a href="#">Ordering Information</a> :<br>Updated part numbers.<br>Updated to new template.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

**Document History Page** (continued)

| Document Title: CY2545/CY2547, Quad-PLL Programmable Spread Spectrum Clock Generator with Serial I <sup>2</sup> C Interface<br>Document Number: 001-13196 |         |                 |                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-----------------|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Revision                                                                                                                                                  | ECN     | Orig. of Change | Submission Date | Description of Change                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| *H                                                                                                                                                        | 5778174 | PSR             | 06/19/2017      | Updated <a href="#">Features</a> :<br>Added one-time programmability.<br>Updated <a href="#">Pin Definitions</a> :<br>Updated details in "Description" column corresponding to pin numbers 2, 6, 11, 13, 17, and 20.<br>Updated <a href="#">Pin Definitions</a> :<br>Updated details in "Description" column corresponding to pin numbers 2, 6, 11, 13, 17, and 20.<br>Updated <a href="#">Functional Overview</a> :<br>Added <a href="#">Output Driver Supply and Multi-Function Input Restriction</a> .<br>Updated to new template. |
| *I                                                                                                                                                        | 5955034 | XHT             | 11/02/2017      | Updated <a href="#">DC Electrical Specifications</a> :<br>Updated details in "Max" column corresponding to $V_{IL2}$ , $V_{IL3}$ , and $V_{IL4}$ parameters.<br>Updated details in "Min" column corresponding to $V_{IH2}$ , and $V_{IH4}$ parameters.<br>Updated to new template.                                                                                                                                                                                                                                                    |

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