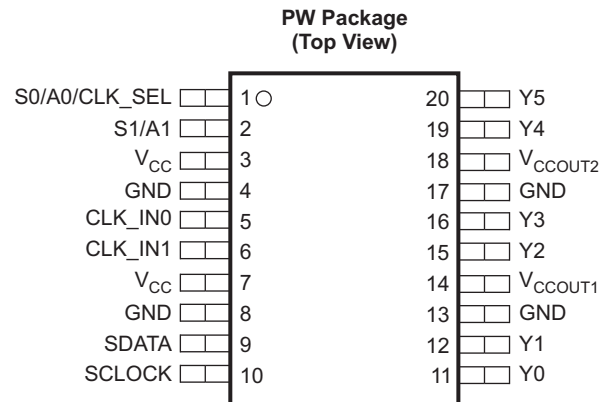


## PROGRAMMABLE 3-PLL CLOCK SYNTHESIZER/MULTIPLIER/DIVIDER

### FEATURES

- High-Performance 3:6 PLL-Based Clock Synthesizer/Multiplier/Divider
- User-Programmable PLL Frequencies
- EEPROM Programming Without the Need to Apply High Programming Voltage
- Easy In-Circuit Programming via SMBus Data Interface
- Wide PLL Divider Ratio Allows 0-ppm Output Clock Error
- Clock Inputs Accept a Crystal, a Single-Ended LVCMOS, or a Differential Input Signal
- Accepts Crystal Frequencies From 8 MHz to 54 MHz
- Accepts LVCMOS or Differential Input Frequencies up to 200 MHz
- Two Programmable Control Inputs [S0/S1, A0/A1] for User-Defined Control Signals
- Six LVCMOS Outputs With Output Frequencies up to 300 MHz
- LVCMOS Outputs Can Be Programmed for Complementary Signals
- Free Selectable Output Frequency via Programmable Output Switching Matrix [6×6] Including 7-Bit Post-Divider for Each Output
- PLL Loop Filter Components Integrated
- Low Period Jitter (Typically 60 ps)
- Features Spread-Spectrum Clocking (SSC) for Lowering System EMI
- Programmable Output Slew-Rate Control (SRC) for Lowering System EMI
- 3.3-V Device Power Supply
- Industrial Temperature Range –40°C to 85°C
- Development and Programming Kit for Easy PLL Design and Programming (TI ClockPro Software)
- Packaged in 20-Pin TSSOP

### TERMINAL ASSIGNMENT



P0087-01

### DESCRIPTION

The CDCE706 is one of the smallest and most powerful PLL synthesizer/multiplier/dividers available today. Despite its small physical outline, the CDCE706 is very flexible. It has the capability to produce an almost independent output frequency from a given input frequency.

The input frequency can be derived from an LVCMOS, differential input clock, or single crystal. The appropriate input waveform can be selected via the SMBus data interface controller.

To achieve an independent output frequency, the reference divider M and the feedback divider N for each PLL can be set to values from 1 to 511 for the M-divider and from 1 to 4095 for the N-divider. The PLL-VCO (voltage controlled oscillator) frequency then is routed from the programmable output switching matrix to any of the six outputs. The switching matrix includes an additional 7-bit post-divider (1 to 127) and an inverting logic for each output.

The deep M/N divider ratio allows the generation of zero-ppm clocks from any reference input frequency (e.g., 27 MHz).

The CDCE706 includes three PLLs; of those, one supports spread-spectrum clocking (SSC). PLL1, PLL2, and PLL3 are designed for frequencies up to 300 MHz and optimized for zero-ppm applications with wide divider factors.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## DESCRIPTION (CONTINUED)

PLL2 also supports center- and down-spread-spectrum clocking (SSC). This is a common technique to reduce electromagnetic interference. Also, the slew-rate controllable (SRC) output edges minimize EMI noise.

Based on the PLL frequency and the divider settings, the internal loop filter components are automatically adjusted to achieve the high stability and optimized jitter transfer characteristic of the PLL.

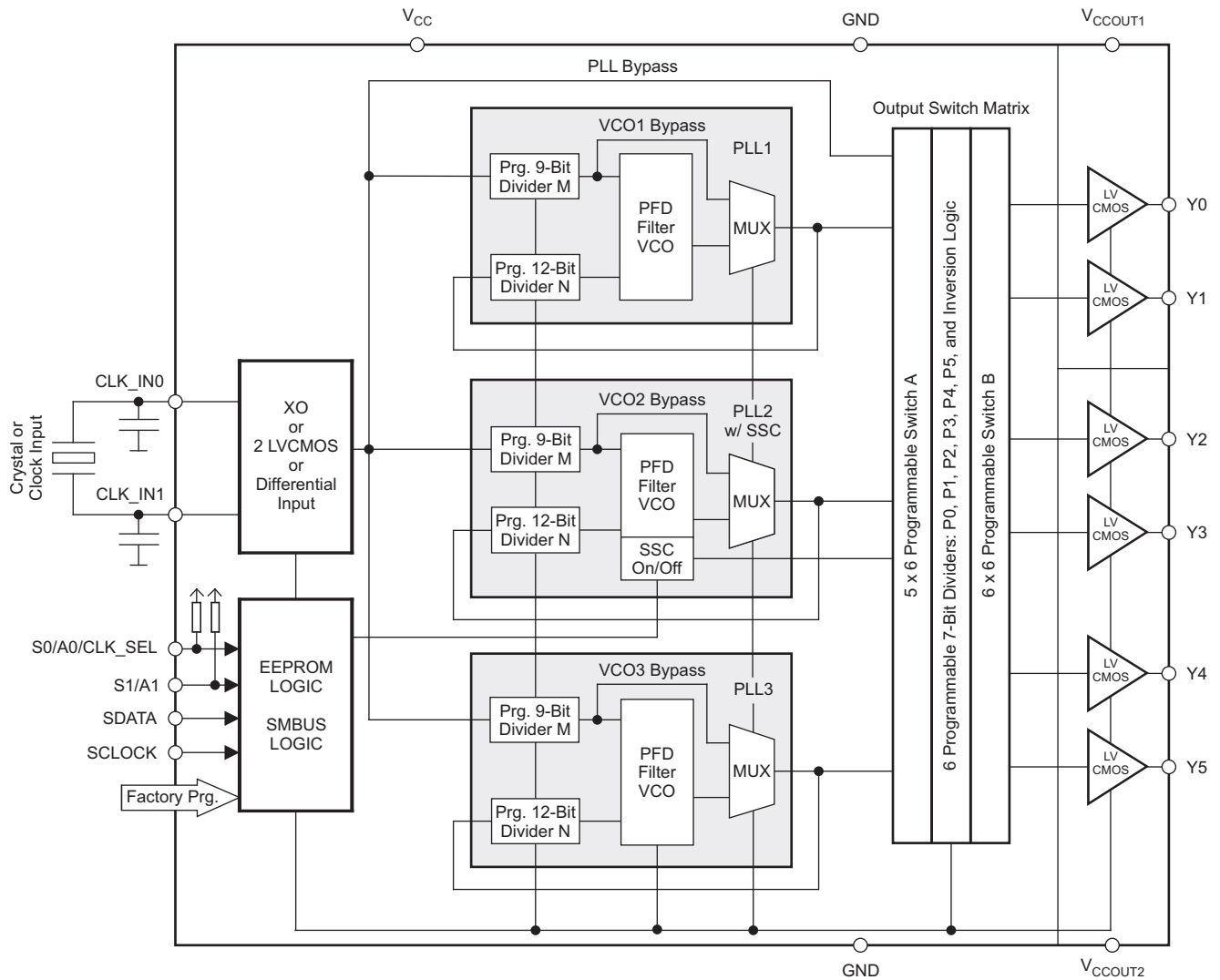
The device supports nonvolatile EEPROM programming for easily customized application. The device is preprogrammed with a factory default configuration (see [Figure 13](#)) and can be reprogrammed to a different application configuration before it goes onto the PCB or reprogrammed by in-system programming. A different device setting is programmed via the serial SMBus interface.

Two free programmable inputs, S0 and S1, can be used to control for each application the most demanding logic control settings (outputs disable to low, outputs 3-state, power down, PLL bypass, etc).

The CDCE706 has three power-supply pins,  $V_{CC}$ ,  $V_{CCOUT1}$ , and  $V_{CCOUT2}$ .  $V_{CC}$  is the power supply for the device. It operates from a single 3.3-V supply voltage.  $V_{CCOUT1}$  and  $V_{CCOUT2}$  are the power supply pins for the outputs.  $V_{CCOUT1}$  supplies the outputs Y0 and Y1, and  $V_{CCOUT2}$  supplies the outputs Y2, Y3, Y4, and Y5. Both output supplies can be 2.3 V to 3.6 V. At output voltages lower than 3.3 V, the output drive current is limited.

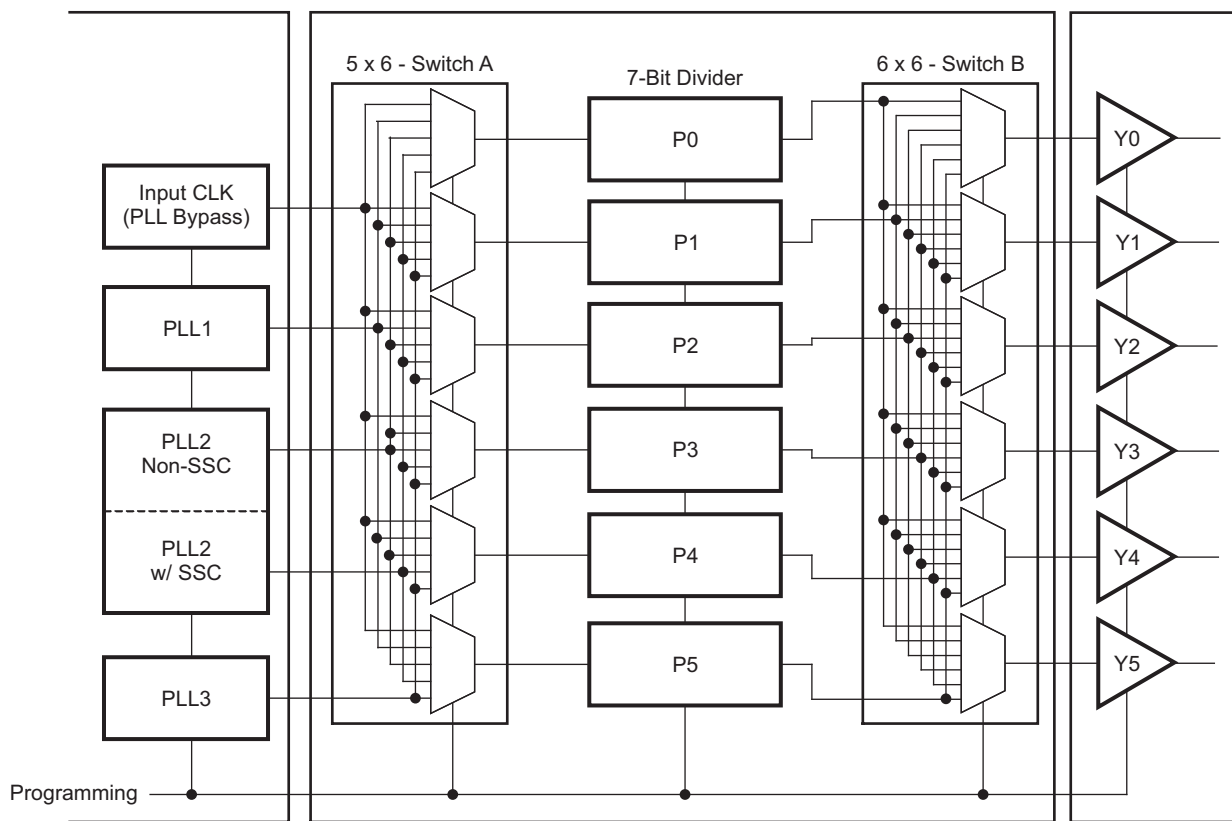
The CDCE706 is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

FUNCTIONAL BLOCK DIAGRAM



B0334-01

**OUTPUT SWITCH MATRIX**



B0335-01

**TERMINAL FUNCTIONS**

| TERMINAL            |                        | I/O    | DESCRIPTION   |
|---------------------|------------------------|--------|---|
| NAME                | TSSOP20 NO.            |        |   |
| CLK_IN0             | 5                      | I      | Dependent on SMBus settings, CLK_IN0 is the crystal-oscillator input and can also be used as an LVCMOS input or as positive differential signal inputs.   |
| CLK_IN1             | 6                      | I/O    | Depending on SMBus settings, CLK_IN1 serves as the crystal oscillator output or can be the second LVCMOS input or the negative differential signal input.   |
| GND                 | 4, 8, 13, 17           | Ground | Ground  |
| S0, A0, CLK_SEL     | 1                      | I      | User-programmable control input S0 (PLL bypass or power-down mode) or A0 (address bit 0), or CLK_SEL (selects one of two LVCMOS clock inputs), dependent on the SMBus settings; LVCMOS inputs; internal pullup 150 kΩ |
| S1, A1              | 2                      | I      | User-programmable control input S1 (output enable/disable or all output low), A1 (address bit 1), dependent on the SMBus settings; LVCMOS inputs; internal pullup 150 kΩ  |
| SCLOCK              | 10                     | I      | Serial control clock input for SMBus controller; LVCMOS input   |
| SDATA               | 9                      | I/O    | Serial control data input/output for SMBus controller; LVCMOS input   |
| V <sub>CC</sub>     | 3, 7                   | Power  | 3.3-V power supply for the device   |
| V <sub>CCOUT1</sub> | 14                     | Power  | Power supply for outputs Y0, Y1   |
| V <sub>CCOUT2</sub> | 18                     | Power  | Power supply for outputs Y2, Y3, Y4, Y5   |
| Y0 to Y5            | 11, 12, 15, 16, 19, 20 | O      | LVCMOS outputs  |

## ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

|                  |   | VALUE                         | UNIT |
|------------------|---|-------------------------------|------|
| V <sub>CC</sub>  | Supply voltage range  | –0.5 to 4.6                   | V    |
| V <sub>I</sub>   | Input voltage range <sup>(2)</sup>                                    | –0.5 to V <sub>CC</sub> + 0.5 | V    |
| V <sub>O</sub>   | Output voltage range <sup>(2)</sup>                                   | –0.5 to V <sub>CC</sub> + 0.5 | V    |
| I <sub>I</sub>   | Input current (V <sub>I</sub> < 0, V <sub>I</sub> > V <sub>CC</sub> ) | ±20                           | mA   |
| I <sub>O</sub>   | Continuous output current   | ±50                           | mA   |
| T <sub>stg</sub> | Storage temperature range   | –65 to 150                    | °C   |
| T <sub>J</sub>   | Maximum junction temperature  | 125                           | °C   |

- (1) Stresses beyond those listed under *absolute maximum ratings* may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under *recommended operating conditions* is not implied. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.
- (2) The input and output negative voltage ratings may be exceeded if the input and output clamp-current ratings are observed.

## PACKAGE THERMAL RESISTANCE

for TSSOP20 (PW) Package<sup>(1)</sup>

| PARAMETER       |   | AIRFLOW (LFM) | AIRFLOW (m/s) | °C/W |
|-----------------|---|---------------|---------------|------|
| θ <sub>JA</sub> | Thermal resistance, junction-to-ambient | 0             | 0             | 66.3 |
|                 |   | 150           | 0.762         | 59.3 |
|                 |   | 250           | 1.27          | 56.3 |
|                 |   | 500           | 2.54          | 51.9 |
| θ <sub>JC</sub> | Thermal resistance, junction-to-case    |               |               | 19.7 |

- (1) The package thermal impedance is calculated in accordance with JESD 51 and JEDEC2S2P (high-k board).

## RECOMMENDED OPERATING CONDITIONS

over operating free-air temperature range (unless otherwise noted)

|                                    |  | MIN                 | NOM                 | MAX                   | UNIT |
|------------------------------------|--|---------------------|---------------------|-----------------------|------|
| V <sub>CC</sub>                    | Device supply voltage                      | 3                   | 3.3                 | 3.6                   | V    |
| V <sub>CCOUT1</sub> <sup>(1)</sup> | Output Y0, Y1 supply voltage               | 2.3                 |                     | 3.6                   | V    |
| V <sub>CCOUT2</sub> <sup>(1)</sup> | Output Y2, Y3, Y4, Y5 supply voltage       | 2.3                 |                     | 3.6                   | V    |
| V <sub>IL</sub>                    | Low-level input voltage, LVCMOS            |                     |                     | 0.3 V <sub>CC</sub>   | V    |
| V <sub>IH</sub>                    | High-level input voltage, LVCMOS           | 0.7 V <sub>CC</sub> |                     |                       | V    |
| V <sub>Ithresh</sub>               | Input voltage threshold, LVCMOS            |                     | 0.5 V <sub>CC</sub> |                       | V    |
| V <sub>I</sub>                     | Input voltage range, LVCMOS                | 0                   |                     | 3.6                   | V    |
| V <sub>ID</sub>                    | Differential input voltage                 | 0.1                 |                     |                       | V    |
| V <sub>IC</sub>                    | Common-mode for differential input voltage | 0.2                 |                     | V <sub>CC</sub> – 0.6 | V    |
| I <sub>OH</sub> /I <sub>OL</sub>   | Output current (3.3 V)                     |                     |                     | ±6                    | mA   |
| I <sub>OH</sub> /I <sub>OL</sub>   | Output current (2.5 V)                     |                     |                     | ±4                    | mA   |
| C <sub>L</sub>                     | Output load, LVCMOS                        |                     |                     | 25                    | pF   |
| T <sub>A</sub>                     | Operating free-air temperature             | –40                 |                     | 85                    | °C   |

- (1) The minimum output voltage can be down to 1.8 V. See the *CDCx706/x906 Termination and Signal Integrity Guidelines* application report (SCAA080) for more information.

## RECOMMENDED CRYSTAL SPECIFICATIONS

|   | MIN | NOM | MAX | UNIT     |
|---|-----|-----|-----|----------|
| $f_{Xtal}$ Crystal input frequency range (fundamental mode) | 8   | 27  | 54  | MHz      |
| ESR Effective series resistance <sup>(1)(2)</sup>           | 15  |     | 60  | $\Omega$ |
| $C_{IN}$ Input capacitance CLK_IN0 and CLK_IN1              |     | 3   |     | pF       |

- (1) For crystal frequencies above 50 MHz, the effective series resistor should not exceed 50  $\Omega$  to assure stable start-up condition.  
(2) For maximum power handling (drive level), see [Figure 15](#).

## EEPROM SPECIFICATION

|                                    | MIN | TYP  | MAX | UNIT   |
|------------------------------------|-----|------|-----|--------|
| EEcyc Programming cycles of EEPROM | 100 | 1000 |     | Cycles |
| EEret Data retention               | 10  |      |     | Years  |

## TIMING REQUIREMENTS

over recommended ranges of supply voltage, load, and operating-free air temperature

|   | MIN             | NOM | MAX  | UNIT    |
|---|-----------------|-----|------|---------|
| <b>CLK_IN REQUIREMENTS</b>  |                 |     |      |         |
| $f_{CLK\_IN}$ CLK_IN clock input frequency (LVCMOS or differential)           | PLL mode        | 1   | 200  | MHz     |
|   | PLL bypass mode | 0   | 200  |         |
| $t_r/t_f$ Rise and fall time, CLK_IN signal (20% to 80%)                      |                 |     | 4    | ns      |
| duty <sub>REF</sub> Duty cycle, CLK_IN at $V_{CC}/2$                          | 40%             |     | 60%  |         |
| <b>SMBus TIMING REQUIREMENTS (see <a href="#">Figure 11</a>)</b>              |                 |     |      |         |
| $f_{SCLK}$ SCLK frequency   |                 |     | 100  | kHz     |
| $t_{h(START)}$ START hold time  | 4               |     |      | $\mu$ s |
| $t_{w(SCLL)}$ SCLK low-pulse duration   | 4.7             |     |      | $\mu$ s |
| $t_{w(SCLH)}$ SCLK high-pulse duration  | 4               |     | 50   | $\mu$ s |
| $t_{su(START)}$ START setup time  | 0.6             |     |      | $\mu$ s |
| $t_{h(SDATA)}$ SDATA hold time  | 0.3             |     |      | $\mu$ s |
| $t_{su(SDATA)}$ SDATA setup time  | 0.25            |     |      | $\mu$ s |
| $t_{r(SDATA)}/t_{r(SM)}$ SCLK/SDATA input rise time                           |                 |     | 1000 | ns      |
| $t_{f(SDATA)}/t_{f(SM)}$ SCLK/SDATA input fall time                           |                 |     | 300  | ns      |
| $t_{su(STOP)}$ STOP setup time  | 4               |     |      | $\mu$ s |
| $t_{(BUS)}$ Bus free time   | 4.7             |     |      | $\mu$ s |
| $t_{(POR)}$ Time in which the device must be operational after power-on reset |                 |     | 500  | ms      |

## DEVICE CHARACTERISTICS

over recommended operating free-air temperature range and test load (unless otherwise noted), see [Figure 1](#)

| PARAMETER  | TEST CONDITIONS  | MIN | TYP <sup>(1)</sup> | MAX | UNIT    |
|--|--|-----|--------------------|-----|---------|
| <b>OVERALL PARAMETER</b>   |  |     |                    |     |         |
| $I_{CC}$ Supply current <sup>(2)</sup>                                   | All PLLs on, all outputs on, $f_{OUT} = 80$ MHz, $f_{CLK\_IN} = 27$ MHz, $f_{VCO} = 160$ MHz |     | 90                 | 115 | mA      |
| $I_{CCPD}$ Power-down current  | Every circuit powered down except SMBus, $f_{IN} = 0$ MHz, $V_{CC} = 3.6$ V                  |     | 50                 |     | $\mu$ A |
| $V_{PUC}$ Supply voltage $V_{CC}$ threshold for power-up control circuit |  |     | 2.1                |     | V       |

- (1) All typical values are at nominal  $V_{CC}$ .  
(2) For calculating total supply current, add the current from [Figure 2](#), [Figure 3](#), and [Figure 4](#). Using the high-speed mode of the VCO reduces the current consumption. See [Figure 3](#).

**DEVICE CHARACTERISTICS (continued)**

 over recommended operating free-air temperature range and test load (unless otherwise noted), see [Figure 1](#)

| PARAMETER  |   | TEST CONDITIONS  |                               | MIN | TYP <sup>(1)</sup> | MAX  | UNIT |
|--|---|--|-------------------------------|-----|--------------------|------|------|
| $f_{VCO}$  | VCO frequency of internal PLL (any of three PLLs)                           | Normal speed-mode <sup>(3)</sup>                                       | All PLLs                      | 80  |                    | 200  | MHz  |
|  |   |  | PLL2 with SSC                 | 80  |                    | 167  |      |
|  |   | High-speed mode <sup>(3)</sup>   |                               | 180 |                    | 300  |      |
| $f_{OUT}$  | LVCMOS output frequency range <sup>(4)</sup> , See <a href="#">Figure 4</a> | $V_{CC} = 2.5\text{ V}$  |                               |     |                    | 250  | MHz  |
|  |   | $V_{CC} = 3.3\text{ V}$  |                               |     |                    | 300  |      |
| <b>LVCMOS PARAMETER</b>  |   |  |                               |     |                    |      |      |
| $V_{IK}$   | LVCMOS input voltage  | $V_{CC} = 3\text{ V}$ , $I_I = -18\text{ mA}$                          |                               |     |                    | -1.2 | V    |
| $I_I$  | LVCMOS input current (CLK_IN0 and CLK_IN1)                                  | $V_I = 0\text{ V}$ or $V_{CC}$ , $V_{CC} = 3.6\text{ V}$               |                               |     |                    | ±5   | µA   |
| $I_{IH}$   | LVCMOS input current (S1/S0)  | $V_I = V_{CC}$ , $V_{CC} = 3.6\text{ V}$                               |                               |     |                    | 5    | µA   |
| $I_{IL}$   | LVCMOS input current (S1/S0)  | $V_I = 0\text{ V}$ , $V_{CC} = 3.6\text{ V}$                           |                               | -35 |                    | -10  | µA   |
| $C_I$  | Input capacitance at CLK_IN0 and CLK_IN1                                    | $V_I = 0\text{ V}$ or $V_{CC}$   |                               |     | 3                  |      | pF   |
| <b>LVCMOS PARAMETER FOR <math>V_{CCOUT} = 3.3\text{-V Mode}</math></b> |   |  |                               |     |                    |      |      |
| $V_{OH}$   | LVCMOS high-level output voltage  | $V_{CCOUT} = 3\text{ V}$ , $I_{OH} = -0.1\text{ mA}$                   |                               | 2.9 |                    |      | V    |
|  |   | $V_{CCOUT} = 3\text{ V}$ , $I_{OH} = -4\text{ mA}$                     |                               | 2.4 |                    |      |      |
|  |   | $V_{CCOUT} = 3\text{ V}$ , $I_{OH} = -6\text{ mA}$                     |                               | 2.1 |                    |      |      |
| $V_{OL}$   | LVCMOS low-level output voltage   | $V_{CCOUT} = 3\text{ V}$ , $I_{OL} = 0.1\text{ mA}$                    |                               |     |                    | 0.1  | V    |
|  |   | $V_{CCOUT} = 3\text{ V}$ , $I_{OL} = 4\text{ mA}$                      |                               |     |                    | 0.5  |      |
|  |   | $V_{CCOUT} = 3\text{ V}$ , $I_{OL} = 6\text{ mA}$                      |                               |     |                    | 0.85 |      |
| $t_{PLH}$ ,<br>$t_{PHL}$   | Propagation delay   | All PLL bypass   |                               |     | 9                  |      | ns   |
|  |   | VCO bypass   |                               |     | 11                 |      |      |
| $t_{r0}/t_{f0}$  | Rise and fall time for output slew rate 0                                   | $V_{CCOUT} = 3.3\text{ V}$ (20%–80%)                                   |                               | 1.7 | 3.3                | 4.8  | ns   |
| $t_{r1}/t_{f1}$  | Rise and fall time for output slew rate 1                                   | $V_{CCOUT} = 3.3\text{ V}$ (20%–80%)                                   |                               | 1.5 | 2.5                | 3.2  | ns   |
| $t_{r2}/t_{f2}$  | Rise and fall time for output slew rate 2                                   | $V_{CCOUT} = 3.3\text{ V}$ (20%–80%)                                   |                               | 1.2 | 1.6                | 2.1  | ns   |
| $t_{r3}/t_{f3}$  | Rise and fall time for output slew rate 3 (default configuration)           | $V_{CCOUT} = 3.3\text{ V}$ (20%–80%)                                   |                               | 0.4 | 0.6                | 1    | ns   |
| $t_{jit(cc)}$  | Cycle-to-cycle jitter <sup>(5)(6)</sup>                                     | 1 PLL, 1 output  | $f_{OUT} = 50\text{ MHz}$     |     | 55                 | 90   | ps   |
|  |   |  | $f_{OUT} = 245.76\text{ MHz}$ |     | 45                 | 80   |      |
|  |   | 3 PLLs, 3 outputs  | $f_{OUT} = 50\text{ MHz}$     |     | 125                | 155  |      |
|  |   |  | $f_{OUT} = 245.76\text{ MHz}$ |     | 60                 | 95   |      |
| $t_{jit(per)}$   | Peak-to-peak period jitter <sup>(5)(6)</sup>                                | 1 PLL, 1 output  | $f_{OUT} = 50\text{ MHz}$     |     | 60                 | 90   | ps   |
|  |   |  | $f_{OUT} = 245.76\text{ MHz}$ |     | 55                 | 80   |      |
|  |   | 3 PLLs, 3 outputs  | $f_{OUT} = 50\text{ MHz}$     |     | 145                | 180  |      |
|  |   |  | $f_{OUT} = 245.76\text{ MHz}$ |     | 70                 | 105  |      |
| $t_{sk(o)}$  | Output skew (see <sup>(7)</sup> and <a href="#">Table 5</a> )               | 1.6-ns rise/fall time at $f_{VCO} = 150\text{ MHz}$ ,<br>$P_{div} = 3$ |                               |     |                    | 200  | ps   |
| odc  | Output duty cycle <sup>(8)</sup>  | $f_{VCO} = 100\text{ MHz}$ , $P_{div} = 1$                             |                               | 45% |                    | 55%  |      |

(3) Normal-speed mode or high-speed mode must be selected by the VCO frequency selection bit in byte 6, bits [7:5]. The minimum  $f_{VCO}$  can be lower, but impacts jitter performance.

(4) Do not exceed the maximum power dissipation of the 20-pin TSSOP package (600 mW at no air flow).

(5) 50,000 cycles

(6) Jitter depends on configuration. Jitter data is normal  $t_r/t_f$ , input frequency = 3.84 MHz,  $f_{VCO} = 245.76\text{ MHz}$ .

(7) The  $t_{sk(o)}$  specification is only valid for equal loading of all outputs.

(8) odc depends on output rise and fall time ( $t_r/t_f$ ). The data is for normal  $t_r/t_f$  and is valid for both SSC on and off.

**DEVICE CHARACTERISTICS (continued)**

over recommended operating free-air temperature range and test load (unless otherwise noted), see [Figure 1](#)

| PARAMETER   |   | TEST CONDITIONS   | MIN                           | TYP <sup>(1)</sup> | MAX  | UNIT |    |
|---|---|---|-------------------------------|--------------------|------|------|----|
| <b>LVC MOS PARAMETER FOR V<sub>CCOUT</sub> = 2.5-V Mode<sup>(9)</sup></b> |   |   |                               |                    |      |      |    |
| V <sub>OH</sub>   | LVCMOS high-level output voltage                                  | V <sub>CCOUT</sub> = 2.3 V, I <sub>OH</sub> = 0.1 mA              | 2.2                           |                    |      | V    |    |
|   |   | V <sub>CCOUT</sub> = 2.3 V, I <sub>OH</sub> = –3 mA               | 1.7                           |                    |      |      |    |
|   |   | V <sub>CCOUT</sub> = 2.3 V, I <sub>OH</sub> = –4 mA               | 1.5                           |                    |      |      |    |
| V <sub>OL</sub>   | LVCMOS low-level output voltage                                   | V <sub>CCOUT</sub> = 2.3 V, I <sub>OL</sub> = 0.1 mA              |                               |                    | 0.1  | V    |    |
|   |   | V <sub>CCOUT</sub> = 2.3 V, I <sub>OL</sub> = 3 mA                |                               |                    | 0.5  |      |    |
|   |   | V <sub>CCOUT</sub> = 2.3 V, I <sub>OL</sub> = 4 mA                |                               |                    | 0.85 |      |    |
| t <sub>PLH</sub> ,<br>t <sub>PHL</sub>                                    | Propagation delay   | All PLL bypass  |                               | 9                  |      | ns   |    |
|   |   | VCO bypass  |                               | 11                 |      |      |    |
| t <sub>r0</sub> /t <sub>f0</sub>  | Rise and fall time for output slew rate 0                         | V <sub>CCOUT</sub> = 2.5 V (20%–80%)                              | 2                             | 3.9                | 5.6  | ns   |    |
| t <sub>r1</sub> /t <sub>f1</sub>  | Rise and fall time for output slew rate 1                         | V <sub>CCOUT</sub> = 2.5 V (20%–80%)                              | 1.8                           | 2.9                | 4.4  | ns   |    |
| t <sub>r2</sub> /t <sub>f2</sub>  | Rise and fall time for output slew rate 2                         | V <sub>CCOUT</sub> = 2.5 V (20%–80%)                              | 1.3                           | 2                  | 3.2  | ns   |    |
| t <sub>r3</sub> /t <sub>f3</sub>  | Rise and fall time for output slew rate 3 (default configuration) | V <sub>CCOUT</sub> = 2.5 V (20%–80%)                              | 0.4                           | 0.8                | 1.1  | ns   |    |
| t <sub>jit(cc)</sub>  | Cycle-to-cycle jitter <sup>(10)(11)</sup>                         | 1 PLL, 1 output   | f <sub>OUT</sub> = 50 MHz     |                    | 60   | 105  | ps |
|   |   |   | f <sub>OUT</sub> = 245.76 MHz |                    | 50   | 85   |    |
|   |   | 3 PLLs, 3 outputs   | f <sub>OUT</sub> = 50 MHz     |                    | 130  | 160  |    |
|   |   |   | f <sub>OUT</sub> = 245.76 MHz |                    | 60   | 95   |    |
| t <sub>jit(per)</sub>   | Peak-to-peak period jitter <sup>(10)(11)</sup>                    | 1 PLL, 1 output   | f <sub>OUT</sub> = 50 MHz     |                    | 65   | 110  | ps |
|   |   |   | f <sub>OUT</sub> = 245.76 MHz |                    | 60   | 90   |    |
|   |   | 3 PLLs, 3 outputs   | f <sub>OUT</sub> = 50 MHz     |                    | 145  | 180  |    |
|   |   |   | f <sub>OUT</sub> = 245.76 MHz |                    | 70   | 105  |    |
| t <sub>sk(o)</sub>  | Output skew (see <sup>(12)</sup> and <a href="#">Table 5</a> )    | 2-ns rise/fall time at f <sub>VCO</sub> = 150 MHz, Pdiv = 3       |                               |                    | 250  | ps   |    |
| odc   | Output duty cycle <sup>(13)</sup>                                 | f <sub>VCO</sub> = 100 MHz, Pdiv = 1                              | 45%                           |                    | 55%  |      |    |
| <b>SMBus PARAMETER</b>  |   |   |                               |                    |      |      |    |
| V <sub>IK</sub>   | SCLK and SDATA input clamp voltage                                | V <sub>CC</sub> = 3 V, I <sub>I</sub> = –18 mA                    |                               |                    | –1.2 | V    |    |
| I <sub>LK</sub>   | SCLK and SDATA input current                                      | V <sub>I</sub> = 0 V or V <sub>CC</sub> , V <sub>CC</sub> = 3.6 V |                               |                    | ±5   | μA   |    |
| V <sub>IH</sub>   | SCLK input, high voltage  |   | 2.1                           |                    |      | V    |    |
| V <sub>IL</sub>   | SCLK input, low voltage   |   |                               |                    | 0.8  | V    |    |
| V <sub>OL</sub>   | SDATA low-level output voltage                                    | I <sub>OL</sub> = 4 mA, V <sub>CC</sub> = 3 V                     |                               |                    | 0.4  | V    |    |
| C <sub>I</sub>  | Input capacitance at SCLK   | V <sub>I</sub> = 0 V or V <sub>CC</sub>                           |                               | 3                  | 10   | pF   |    |
|   | Input capacitance at SDATA  | V <sub>I</sub> = 0 V or V <sub>CC</sub>                           |                               | 3                  | 10   | pF   |    |

(9) There is a limited drive capability at output supply voltage of 2.5 V. For proper termination, see the *CDCx706/x906 Termination and Signal Integrity Guidelines* application report, [SCAA080](#).

(10) 50,000 cycles

(11) Jitter depends on configuration. Jitter data is normal t<sub>r</sub>/t<sub>f</sub>, input frequency = 3.84 MHz, f<sub>VCO</sub> = 245.76 MHz.

(12) The t<sub>sk(o)</sub> specification is only valid for equal loading of all outputs.

(13) odc depends on output rise and fall time (t<sub>r</sub>/t<sub>f</sub>). The data is for normal t<sub>r</sub>/t<sub>f</sub> and is valid for both SSC on and off.



PARAMETER MEASUREMENT INFORMATION

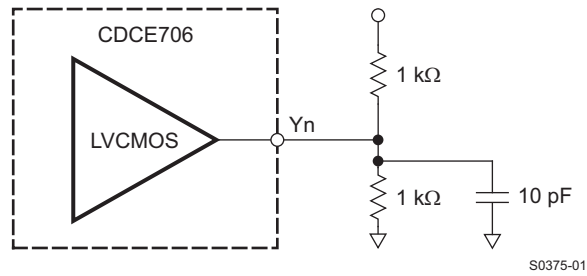
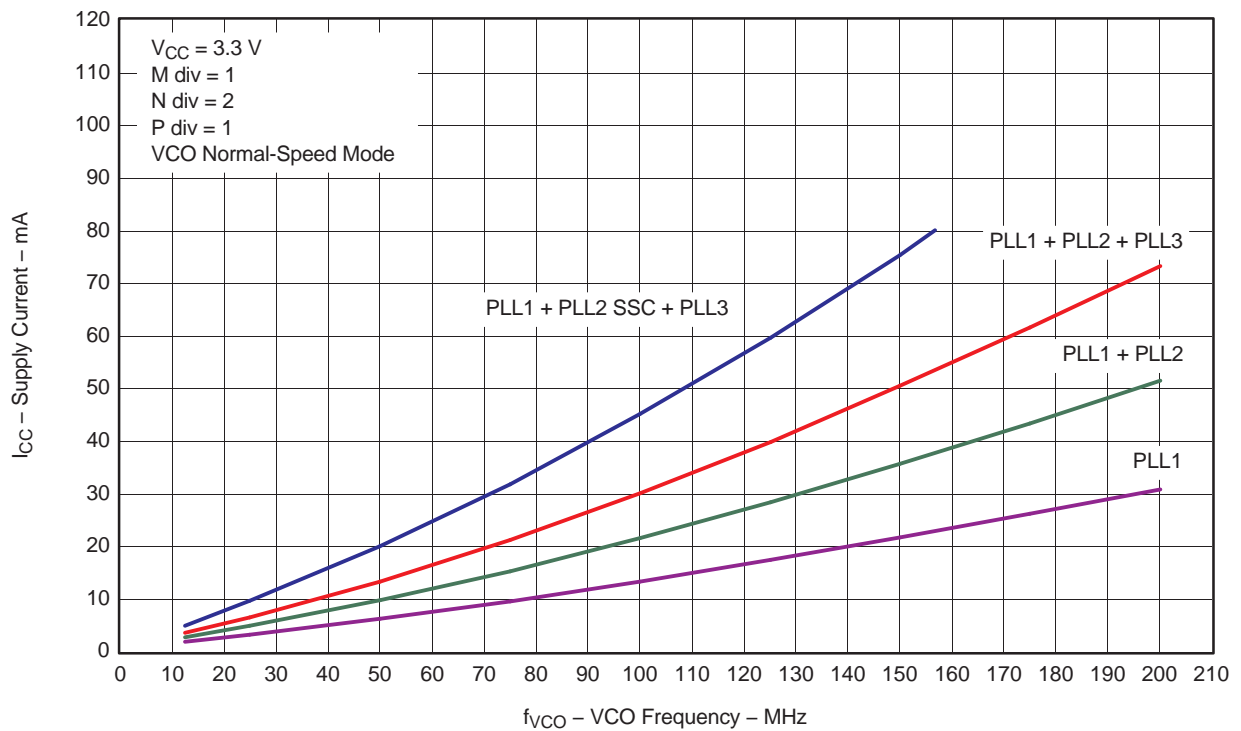


Figure 1. Test Load

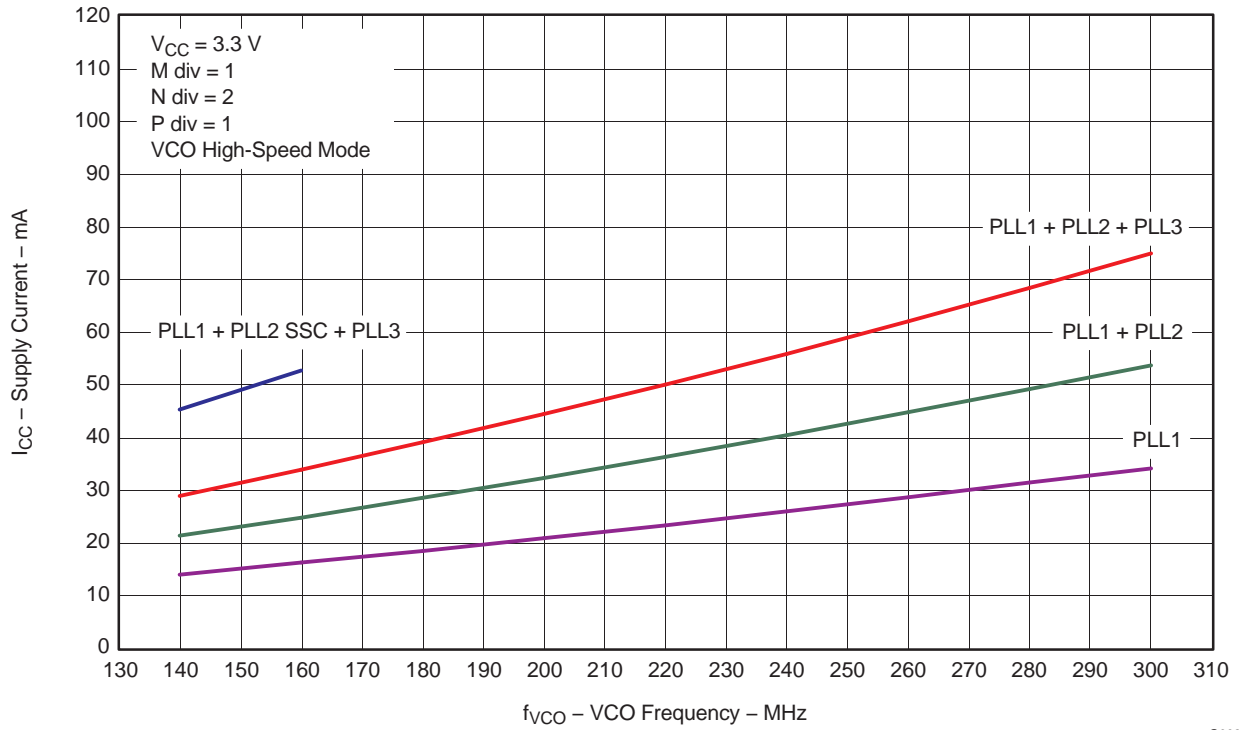
TYPICAL CHARACTERISTICS



G001

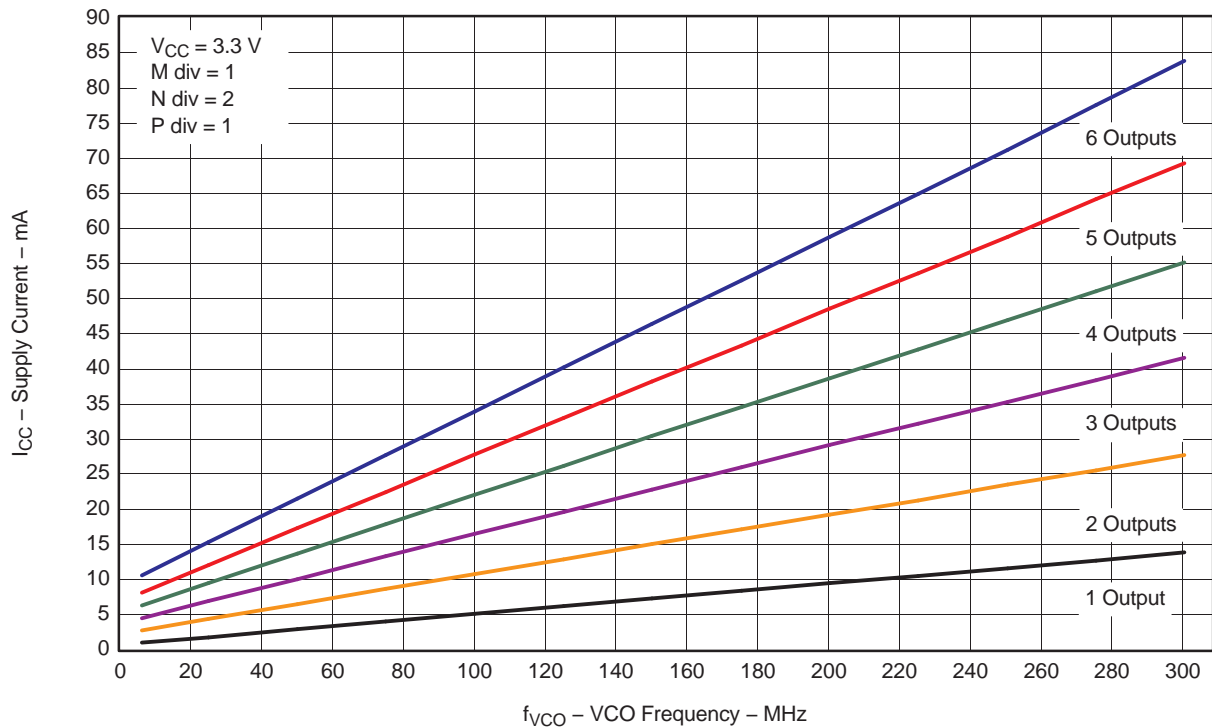
Figure 2.  $I_{CC}$  vs Number of PLLs and VCO Frequency (VCO at Normal-Speed Mode, Byte 6 Bits [7:5])

TYPICAL CHARACTERISTICS (continued)



G002

Figure 3.  $I_{CC}$  vs Number of PLLs and VCO Frequency (VCO at High-Speed Mode, Byte 6 Bits [7:5])



G003

Figure 4.  $I_{CCOUT}$  vs Number of Outputs and VCO Frequency

TYPICAL CHARACTERISTICS (continued)

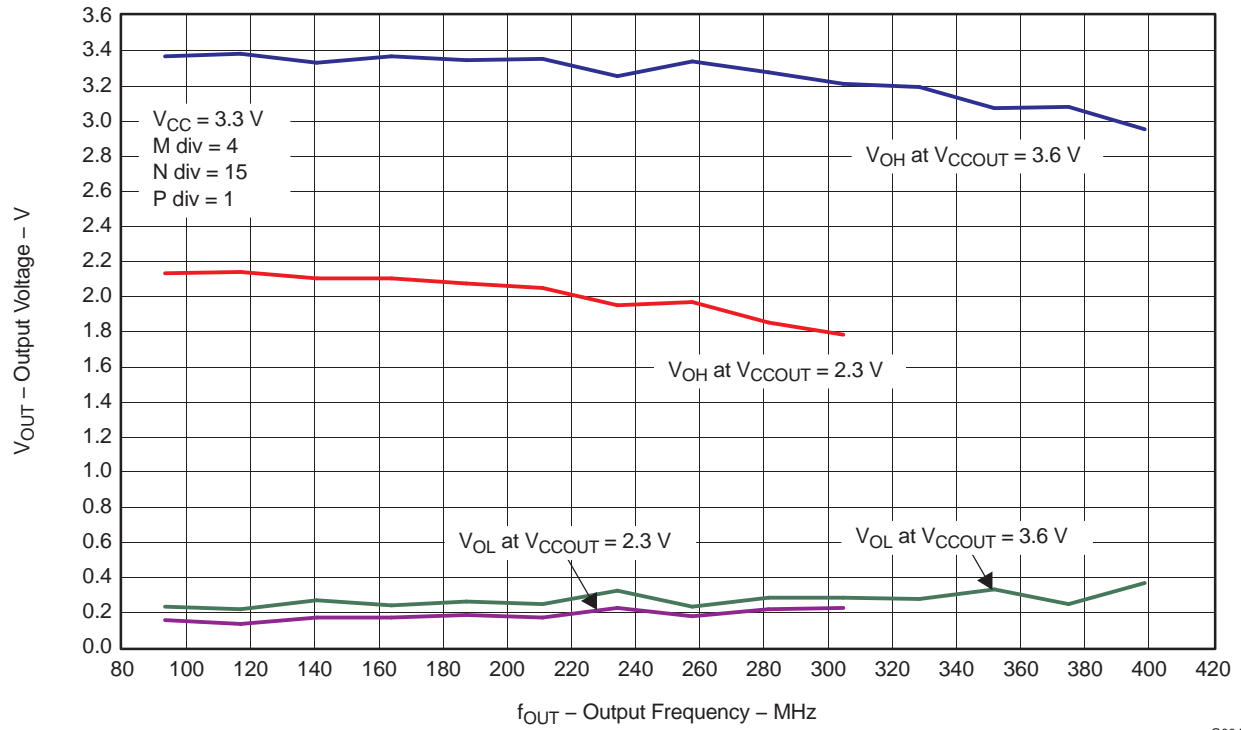


Figure 5. Output Swing vs Output Frequency

G004

## APPLICATION INFORMATION

### SMBus Data Interface

To enhance the flexibility and function of the clock synthesizer, a two-signal serial interface is provided. It follows the SMBus specification Version 2.0, which is based on the principles of operation of I<sup>2</sup>C. More details of the SMBus specification can be found at <http://www.smbus.org>.

Through the SMBus, various device functions, such as individual clock output buffers, can be individually enabled or disabled. The registers associated with the SMBus data interface initialize to their default setting on power up; therefore, using this interface is optional. The clock device register changes are normally made on system initialization, if any are required.

### Data Protocol

The clock-driver serial protocol accepts byte-write, byte-read, block-write, and block-read operations from the controller.

For block-write/read operations, the bytes must be accessed in sequential order from lowest to highest byte (most significant bit first) with the ability to stop after any complete byte has been transferred. For byte-write and byte-read operations, the system controller can access individually addressed bytes.

Once a byte has been sent, it is written into the internal register and becomes effective immediately after the rising edge of the ACK bit. This applies to each transferred byte, independently of whether this is a byte-write or a block-write sequence.

If the EEPROM write cycle is initiated, the data of the internal SMBus register is written into the EEPROM. During EEPROM write, no data is allowed to be sent to the device via the SMBus until the programming sequence is completed. Data, however, can be read out during the programming sequence (byte read or block read). The programming status can be monitored by EEPIP, byte 24 bit 7.

The offset of the indexed byte is encoded in the command code, as described in [Table 1](#).

The block-write and block-read protocol is outlined in [Figure 9](#) and [Figure 10](#), whereas [Figure 7](#) and [Figure 8](#) outline the corresponding byte-write and byte-read protocol.

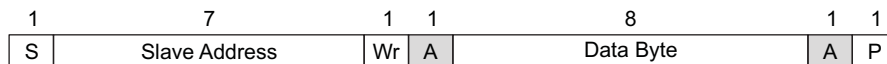
### Slave Receiver Address (7 bits)

| A6 | A5 | A4 | A3 | A2 | A1 <sup>(1)</sup> | A0 <sup>(1)</sup> | $\bar{R}/W$ |
|----|----|----|----|----|-------------------|-------------------|-------------|
| 1  | 1  | 0  | 1  | 0  | 0                 | 1                 | 0           |

(1) Address bits A0 and A1 are programmable by the configuration inputs S0 and S1 (byte 10 bits [1:0] and bits [3:2]). This allows addressing up to four devices connected to the same SMBus.

**Table 1. Command Code Definition**

| Bits | Description  |
|------|--|
| 7    | 0 = Block-read or block-write operation<br>1 = Byte-read or byte-write operation |
| 6–0  | Byte offset for read and write operations  |

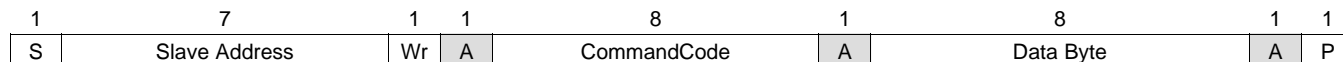


- S Start Condition
- Sr Repeated Start Condition
- Rd Read (Bit Value = 1)
- Wr Write (Bit Value = 0)
- A Acknowledge (ACK = 0 and NACK = 1)
- P Stop Condition
- PE Packet Error
- Master-to-Slave Transmission
- Slave-to-Master Transmission

M0053-01

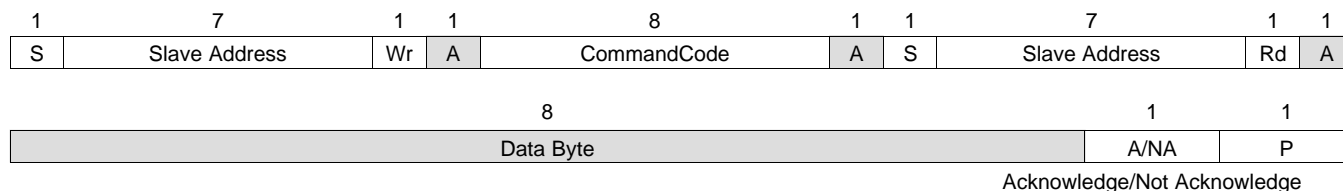
**Figure 6. Generic Programming Sequence**

**Byte-Write Programming Sequence**



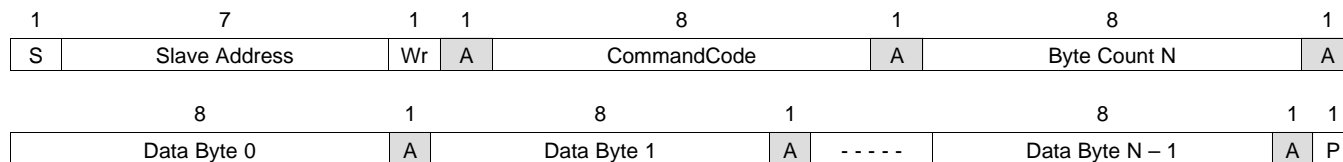
**Figure 7. Byte-Write Protocol**

**Byte-Read Programming Sequence**



**Figure 8. Byte-Read Protocol**

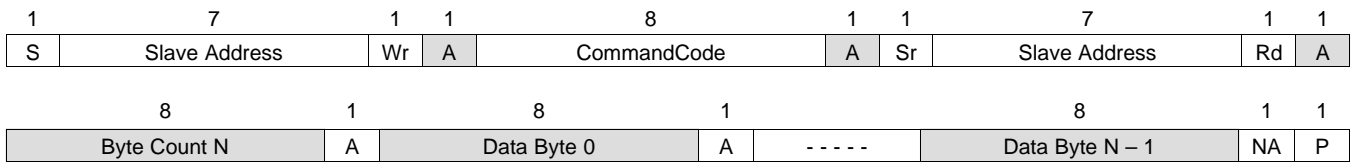
**Block-Write Programming Sequence<sup>(1)</sup>**



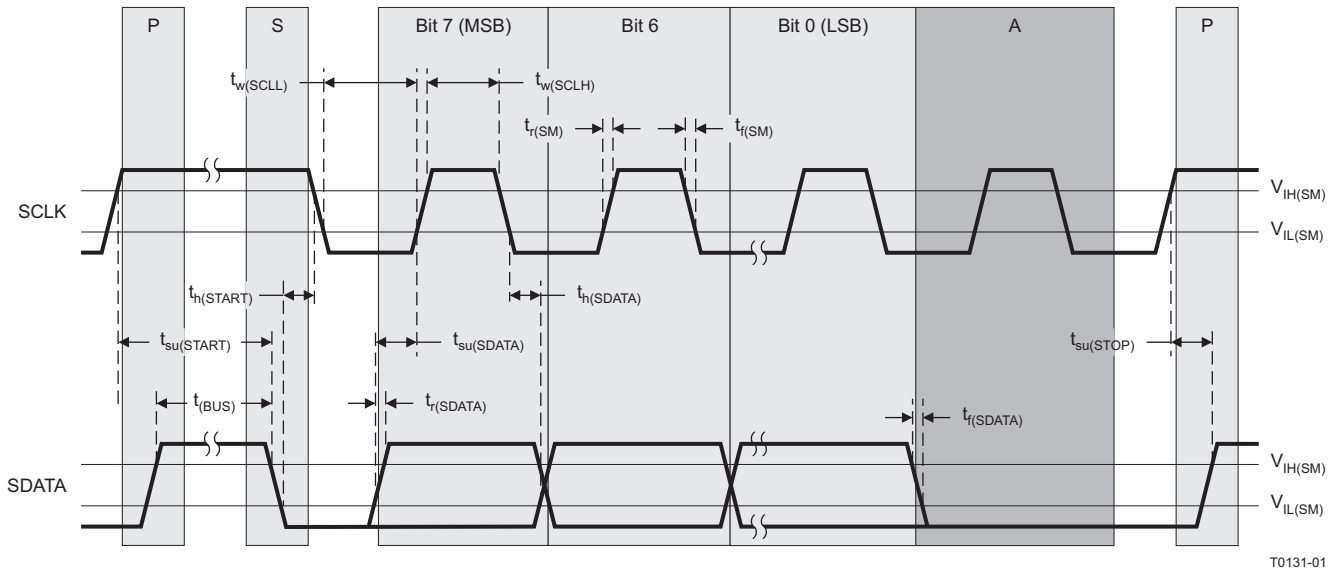
(1) Data Byte 0 is reserved for revision code and vendor identification. However, this byte is used for internal test. Do not write into it other than 0000 0001.

**Figure 9. Block-Write Protocol**

**Block-Read Programming Sequence**



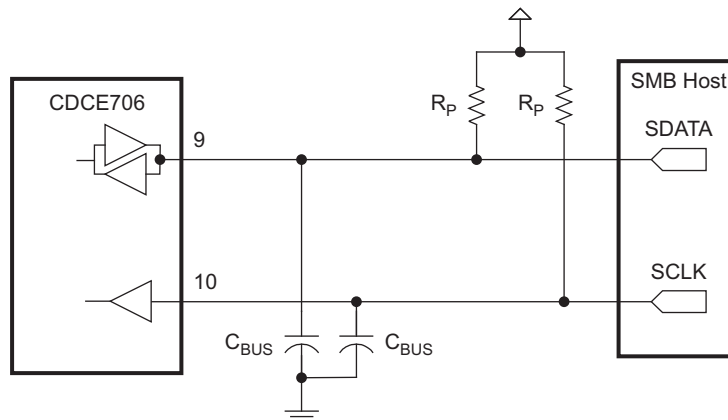
**Figure 10. Block-Read Protocol**



**Figure 11. Timing Diagram, Serial Control Interface**

**SMBus Hardware Interface**

Figure 12 shows how the CDCE706 clock synthesizer is connected to the SMBus. Note that the current through the pullup resistors ( $R_p$ ) must meet the SMBus specifications (minimum 100  $\mu A$ , maximum 350  $\mu A$ ). If the CDCE706 is not connected to the SMBus, the SDATA and SCLK inputs must be connected with 10-k $\Omega$  resistors to  $V_{CC}$  to avoid floating input conditions.



**Figure 12. SMBus Hardware Interface**

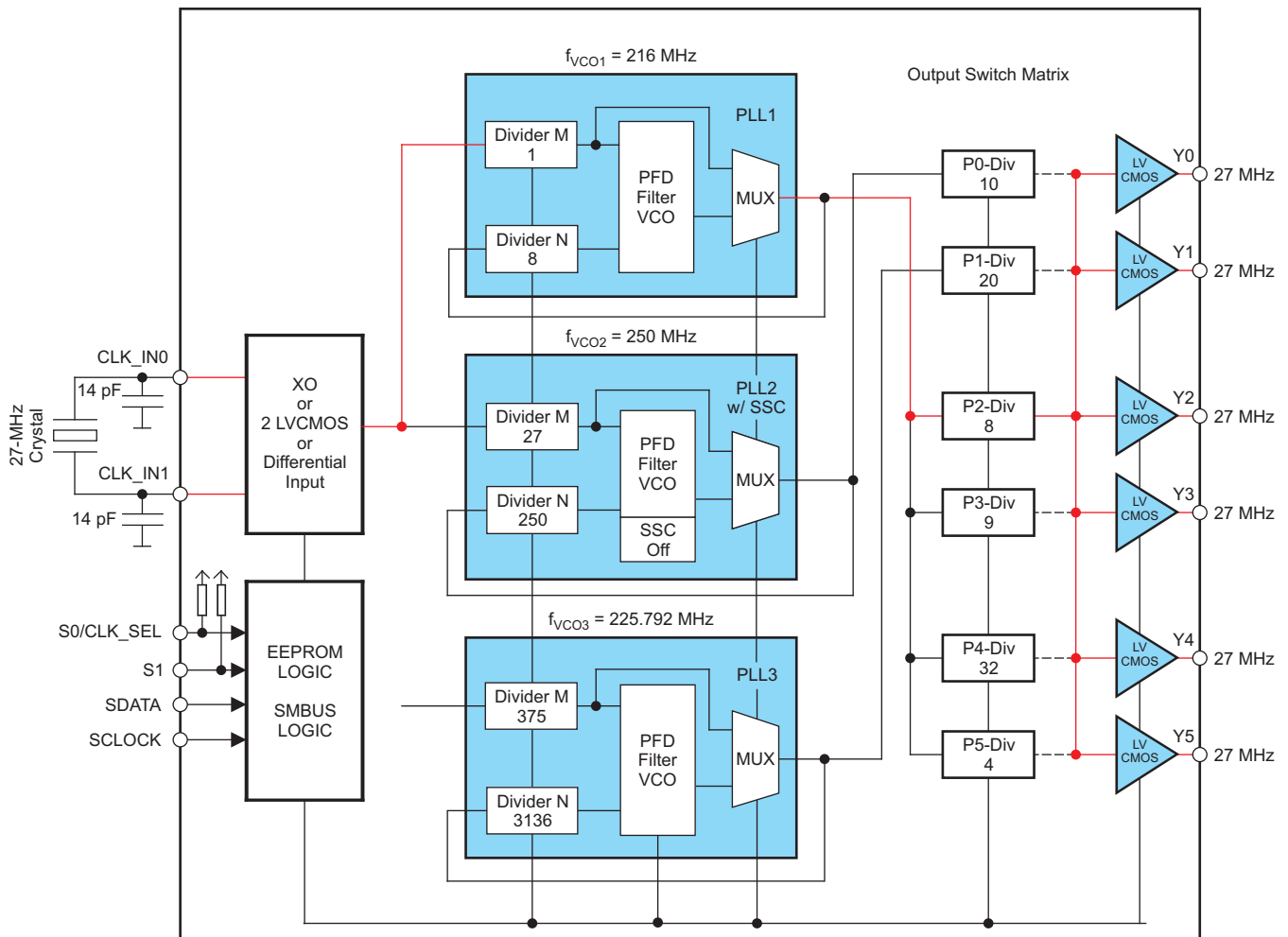
**Table 2. Register Configuration Command Bitmap**

| Adr     | Bit 7                                | Bit 6                    | Bit 5                           | Bit 4                                 | Bit 3                           | Bit 2                   | Bit 1              | Bit 0 |
|---------|--------------------------------------|--------------------------|---------------------------------|---------------------------------------|---------------------------------|-------------------------|--------------------|-------|
| Byte 0  | Revision Code                        |                          |                                 |                                       | Vendor Identification           |                         |                    |       |
| Byte 1  | PLL1 Reference Divider M 9-Bit [7:0] |                          |                                 |                                       |                                 |                         |                    |       |
| Byte 2  | PLL1 Feedback Divider N 12-Bit [7:0] |                          |                                 |                                       |                                 |                         |                    |       |
| Byte 3  | PLL1 Mux                             | PLL2 Mux                 | PLL3 Mux                        | PLL1 Feedback Divider N 12-Bit [11:8] |                                 |                         | PLL1 Ref Div M [8] |       |
| Byte 4  | PLL2 Reference Divider M 9-Bit [7:0] |                          |                                 |                                       |                                 |                         |                    |       |
| Byte 5  | PLL2 Feedback Divider N 12-Bit [7:0] |                          |                                 |                                       |                                 |                         |                    |       |
| Byte 6  | PLL1 $f_{VCO}$ Selection             | PLL2 $f_{VCO}$ Selection | PLL3 $f_{VCO}$ Selection        | PLL2 Feedback Divider N 12-Bit [11:8] |                                 |                         | PLL2 Ref Div M [8] |       |
| Byte 7  | PLL3 Reference Divider 9-Bit M [7:0] |                          |                                 |                                       |                                 |                         |                    |       |
| Byte 8  | PLL3 Feedback Divider N [12-Bit 7:0] |                          |                                 |                                       |                                 |                         |                    |       |
| Byte 9  | PLL Selection for P0 (Switch A)      |                          |                                 | PLL3 Feedback Divider N 12-Bit [11:8] |                                 |                         | PLL3 Ref Div M [8] |       |
| Byte 10 | PLL Selection for P1 (Switch A)      |                          |                                 | Inp. Clock Selection                  | Configuration Inputs S1         | Configuration Inputs S0 |                    |       |
| Byte 11 | Input Signal Source                  |                          | PLL Selection for P3 (Switch A) |                                       | PLL Selection for P2 (Switch A) |                         |                    |       |
| Byte 12 | Reserved                             | Power Down               | PLL Selection for P5 (Switch A) |                                       | PLL Selection for P4 (Switch A) |                         |                    |       |
| Byte 13 | Reserved                             | 7-Bit Divider P0 [6:0]   |                                 |                                       |                                 |                         |                    |       |
| Byte 14 | Reserved                             | 7-Bit Divider P1 [6:0]   |                                 |                                       |                                 |                         |                    |       |
| Byte 15 | Reserved                             | 7-Bit Divider P2 [6:0]   |                                 |                                       |                                 |                         |                    |       |
| Byte 16 | Reserved                             | 7-Bit Divider P3 [6:0]   |                                 |                                       |                                 |                         |                    |       |
| Byte 17 | Reserved                             | 7-Bit Divider P4 [6:0]   |                                 |                                       |                                 |                         |                    |       |
| Byte 18 | Reserved                             | 7-Bit Divider P5 [6:0]   |                                 |                                       |                                 |                         |                    |       |
| Byte 19 | Reserved                             | Y0 Inv. or Non-Inv       | Y0 Slew-Rate Control            | Y0 Enable or Low                      | Y0 Divider Selection (Switch B) |                         |                    |       |
| Byte 20 | Reserved                             | Y1 Inv. or Non-Inv       | Y1 Slew-Rate Control            | Y1 Enable or Low                      | Y1 Divider Selection (Switch B) |                         |                    |       |
| Byte 21 | Reserved                             | Y2 Inv. or Non-Inv       | Y2 Slew-Rate Control            | Y2 Enable or Low                      | Y2 Divider Selection (Switch B) |                         |                    |       |
| Byte 22 | Reserved                             | Y3 Inv. or Non-Inv       | Y3 Slew-Rate Control            | Y3 Enable or Low                      | Y3 Divider Selection (Switch B) |                         |                    |       |
| Byte 23 | Reserved                             | Y4 Inv. or Non-Inv       | Y4 Slew-Rate Control            | Y4 Enable or Low                      | Y4 Divider Selection (Switch B) |                         |                    |       |
| Byte 24 | EEPIP [read only]                    | Y5 Inv or Non-Inv        | Y5 Slew-Rate Control            | Y5 Enable or Low                      | Y5 Divider Selection (Switch B) |                         |                    |       |
| Byte 25 | EELOCK                               | SSC Modulation Selection |                                 |                                       | Frequency Selection for SSC     |                         |                    |       |
| Byte 26 | EEWRITE                              | 7-Bit Byte Count         |                                 |                                       |                                 |                         |                    |       |

## Default Device Setting

The internal EEPROM of the CDCE706 is preprogrammed with a factory-default configuration as shown in [Figure 13](#). This puts the device in an operating mode without the need to program it first. The default setting appears after power is switched on or after a power-down/up sequence until it is reprogrammed by the user to a different application configuration. A new register setting is programmed via the serial SMBus Interface.

A different default setting can be programmed on customer request. Contact a Texas Instruments Sales and Marketing representative for more information.



B0336-01

NOTE: All outputs are enabled and in noninverting mode. S0, S1, and SSC comply according the default setting described in byte 10 and byte 25.

**Figure 13. Default Device Setting**

The output frequency can be calculated:

$$f_{out} = \frac{f_{in} \times N}{M \times P}, \text{ i.e., } f_{out} = \frac{27 \text{ MHz} \times 8}{(1 \times 8)} = 27 \text{ MHz}$$

(1)



## Functional Description of the Logic

All bytes are readable/writeable, unless otherwise expressly mentioned.

| Byte 0 (Read-Only): Vendor Identification Bits [3:0]; Revision Code Bit [7:4] <sup>(1)</sup> |   |   |   |                       |   |   |   |  |
|--|---|---|---|-----------------------|---|---|---|--|
| Revision Code  |   |   |   | Vendor Identification |   |   |   |  |
| X  | X | X | X | 0                     | 0 | 0 | 1 |  |

(1) Byte 0 is only readable by the byte-read instruction (see [Figure 8](#)).

| Bytes 1 to 9: Reference Divider M of PLL1, PLL2, PLL3 <sup>(1)</sup> |    |    |    |    |    |    |    |    |             |                            |
|--|----|----|----|----|----|----|----|----|-------------|----------------------------|
| M8   | M7 | M6 | M5 | M4 | M3 | M2 | M1 | M0 | Div by      | Default <sup>(2) (3)</sup> |
| 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | Not allowed |                            |
| 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 1           |                            |
| 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 2           |                            |
| 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 1  | 3           |                            |
|  |    |    |    | •  |    |    |    |    |             |                            |
|  |    |    |    | •  |    |    |    |    |             |                            |
| 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 1  | 509         |                            |
| 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 510         |                            |
| 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 511         |                            |

(1) By selecting the PLL divider factors,  $M \leq N$  and  $80 \text{ MHz} \leq f_{VCO} \leq 300 \text{ MHz}$ .

(2) Unless customer-specific setting

(3) Default setting of divider M for PLL1 = 1, for PLL2 = 27, and for PLL3 = 375.

| Bytes 1 to 9: Feedback Divider N of PLL1, PLL2, PLL3 <sup>(1)</sup> |     |    |    |    |    |    |    |    |    |    |    |             |                            |
|---|-----|----|----|----|----|----|----|----|----|----|----|-------------|----------------------------|
| N11   | N10 | N9 | N8 | N7 | N6 | N5 | N4 | N3 | N2 | N1 | N0 | Div by      | Default <sup>(2) (3)</sup> |
| 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | Not allowed |                            |
| 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 1           |                            |
| 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0  | 2           |                            |
| 0   | 0   | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 1  | 3           |                            |
|   |     |    |    |    |    |    | •  |    |    |    |    |             |                            |
|   |     |    |    |    |    |    | •  |    |    |    |    |             |                            |
| 1   | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 1  | 4093        |                            |
| 1   | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 4094        |                            |
| 1   | 1   | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 4095        |                            |

(1) By selecting the PLL divider factors,  $M \leq N$  and  $80 \text{ MHz} \leq f_{VCO} \leq 300 \text{ MHz}$ .

(2) Unless customer-specific setting

(3) Default setting of divider N for PLL1 = 8, for PLL2 = 250, and for PLL3 = 3136.

| Byte 3 Bits [7:5]: PLL (VCO) Bypass Multiplexer |                      |                        |
|---|----------------------|------------------------|
| PLLxMUX   | PLL (VCO) MUX Output | Default <sup>(1)</sup> |
| 0   | PLLx                 | Yes                    |
| 1   | VCO bypass           |                        |

(1) Unless customer-specific setting

| Byte 6 Bits [7:5]: VCO Frequency Selection Mode for Each PLL <sup>(1)</sup> |                     |                        |
|---|---------------------|------------------------|
| PLLxVFCO  | VCO Frequency Range | Default <sup>(2)</sup> |
| 0   | 80 MHz–200 MHz      |                        |
| 1   | 180 MHz–300 MHz     | Yes                    |

(1) This bit selects the normal-speed mode or the high-speed mode for the dedicated VCO in PLL1, PLL2, or PLL3. At power up, the high-speed mode is selected,  $f_{VCO}$  is 180 MHz–300 MHz. In case of a higher  $f_{VCO}$ , this bit must be set to 1.

(2) Unless customer-specific setting

| Bytes 9 to 12: Output Switch Matrix (5 × 6 Switch A) PLL Selection for P-Divider P0–P5 |        |        |                              |                        |
|--|--------|--------|------------------------------|------------------------|
| SWAPx2   | SWAPx1 | SWAPx0 | Any Output Px                | Default <sup>(1)</sup> |
| 0  | 0      | 0      | PLL bypass (input clock)     |                        |
| 0  | 0      | 1      | PLL1                         | P2, P3, P4, P5         |
| 0  | 1      | 0      | PLL2 non-SSC                 | P0                     |
| 0  | 1      | 1      | PLL2 with SSC <sup>(2)</sup> |                        |
| 1  | 0      | 0      | PLL3                         | P1                     |
| 1  | 0      | 1      | Reserved                     |                        |
| 1  | 1      | 0      | Reserved                     |                        |
| 1  | 1      | 1      | Reserved                     |                        |

(1) Unless customer-specific setting

(2) PLL2 has an SSC output and a non-SSC output. If SSC bypass is selected (see byte 25, bits [6:4]), the SSC circuitry of PLL2 is powered down and the SSC output is reset to logic low. The non-SSC output of PLL2 is not affected by this mode and can still be used.

| Byte 10, Bits [1:0]: Configuration Settings of Input S0/A0/CLK_SEL |     |   |                        |
|--|-----|---|------------------------|
| S01  | S00 | Function  | Default <sup>(1)</sup> |
| 0  | 0   | If S0 is low, the PLLs and the clock-input stage go into power-down mode, outputs are in the high-impedance state, all actual register settings are maintained, SMBus stays active. If S0 is high, then the device is powered on and outputs are active. <sup>(2)</sup>   | Yes                    |
| 0  | 1   | If S0 is low, the PLL and all dividers (M-Div and P-Div) are bypassed and PLL is in power down, all outputs are active (inv. or non-inv.), actual register settings are maintained, SMBus stays active; this mode is useful for production test. If S0 is high, then the device is powered on and outputs are active. |                        |
| 1  | 0   | CLK_SEL (input clock selection—overwrites the CLK_SEL setting in byte 10, bit [4]) <sup>(3)</sup><br>—CLK_SEL when set low selects CLK_IN_IN0.<br>—CLK_SEL when set high selects CLK_IN_IN1.  |                        |
| 1  | 1   | In this mode, the control input S0 is interpreted as address bit A0 of the slave receiver address byte <sup>(4)</sup> .   |                        |

(1) Unless customer-specific setting

(2) Power-down mode overwrites the high-impedance state or low state of the S1 setting in byte 10, bits [3:2].

(3) If the clock input (CLK\_IN0/CLK\_IN1) is selected as crystal input or differential clock input (byte 11, bits [7:6]), then this setting is not relevant.

(4) To use this pin as slave receiver address bit A0, an initialization pattern must be sent to the CDCE706. When S00/S01 is set to 1, the S0 input pin is interpreted in the next read or write cycle as address bit A0 of the slave receiver address byte. Note that right after byte 10 (S00/S01) has been written, A0 (via the S0-pin) is immediately active (also when byte 10 is sent within a block-write sequence). After the initialization, each CDCE706 has its own S0-dependent slave receiver address and can be addressed according to its new valid address.

| Byte 10, Bits [3:2]: Configuration Settings of Input S1/A1 |     |  |                        |
|--|-----|--|------------------------|
| S11  | S10 | Function   | Default <sup>(1)</sup> |
| 0  | 0   | If S1 is set low, all outputs are switched to a low-state (non-inv.) or high-state (inv.). If S1 is high, then all the outputs are active. | Yes                    |
| 0  | 1   | If S1 is set low, all outputs are switched to a high-impedance state. If S1 is high, then all the outputs are active.                      |                        |
| 1  | 0   | Reserved   |                        |
| 1  | 1   | In this mode, control input S1 is interpreted as address bit A1 of the slave receiver address byte. <sup>(2)</sup>                         |                        |

(1) Unless customer-specific setting

(2) To use this pin as slave-receiver address bit A1, an initialization pattern must be sent to the CDCE706. When S10/S11 is set to be 1, the S1 input pin is interpreted in the next read or write cycle as address bit A1 of the slave receiver address byte. Note that right after byte 10 (S10/S11) has been written, A1 (via the S1-pin) is immediately active (also when byte 10 is sent within a block-write sequence). After the initialization, each CDCE706 has its own S1-dependent slave receiver address and can be addressed according to its new valid address.

| Byte 10, Bit [4]: Input Clock Selection <sup>(1)</sup> |             |                        |
|--|-------------|------------------------|
| CLKSEL   | Input Clock | Default <sup>(2)</sup> |
| 0  | CLK_IN0     | Yes                    |
| 1  | CLK_IN1     |                        |

(1) This bit is not relevant if crystal input or differential clock input is selected, byte 11, bits [7:6].

(2) Unless customer-specific setting

| <b>Byte 11, Bits [7:6]: Input Signal Source<sup>(1)</sup></b> |     |  |                        |
|---|-----|--|------------------------|
| IS1   | IS0 | Function   | Default <sup>(2)</sup> |
| 0   | 0   | CLK_IN0 is the crystal oscillator input, and CLK_IN1 serves as the crystal oscillator output.            | Yes                    |
| 0   | 1   | CLK_IN0 and CLK_IN1 are two LVCMOS inputs. CLK_IN0 or CLK_IN1 is selectable via the CLK_SEL control pin. |                        |
| 1   | 0   | CLK_IN0 and CLK_IN1 serve as differential signal inputs.   |                        |
| 1   | 1   | Reserved   |                        |

(1) In case the crystal input or differential clock input is selected, the input clock selection, byte 10, bit [4], is not relevant.

(2) Unless customer-specific setting

| <b>Byte 12, Bit [6]: Power-Down Mode (Except SMBus)</b> |                           |                        |
|---|---------------------------|------------------------|
| PD  | Power-Down Mode           | Default <sup>(1)</sup> |
| 0   | Normal device operation   | Yes                    |
| 1   | Power down <sup>(2)</sup> |                        |

(1) Unless customer-specific setting

(2) In power down, all PLLs and the clock-input stage go into power-down mode, all outputs are in the high-impedance state, all actual register settings are maintained, and the SMBus stays active. The power-down mode overwrites the high-impedance state or low state of the S0 and S1 settings in byte 10.

| <b>Bytes 13 to 18, Bit [6:0]: Outputs Switch Matrix 6 × 7-Bit Divider P0–P5</b> |        |        |        |        |        |        |             |                           |
|---|--------|--------|--------|--------|--------|--------|-------------|---------------------------|
| DIVYx6  | DIVYx5 | DIVYx4 | DIVYx3 | DIVYx2 | DIVYx1 | DIVYx0 | Div by      | Default <sup>(1)(2)</sup> |
| 0   | 0      | 0      | 0      | 0      | 0      | 0      | Not allowed |                           |
| 0   | 0      | 0      | 0      | 0      | 0      | 1      | 1           |                           |
| 0   | 0      | 0      | 0      | 0      | 1      | 0      | 2           |                           |
|   |        | •      |        |        |        |        |             |                           |
|   |        | •      |        |        |        |        |             |                           |
|   |        | •      |        |        |        |        |             |                           |
| 1   | 1      | 1      | 1      | 1      | 0      | 1      | 125         |                           |
| 1   | 1      | 1      | 1      | 1      | 1      | 0      | 126         |                           |
| 1   | 1      | 1      | 1      | 1      | 1      | 1      | 127         |                           |

(1) Unless customer-specific setting

(2) Default settings of divider P0 = 10, P1 = 20, P2 = 8, P3 = 9, P4 = 32, and P5 = 4.

| <b>Bytes 19 to 24, Bits [5:4]: LVCMOS Output Rise/Fall Time Setting at Y0–Y5</b> |        |                                   |                        |
|--|--------|-----------------------------------|------------------------|
| SRCYx1   | SRCYx0 | Yx                                | Default <sup>(1)</sup> |
| 0  | 0      | Nominal +3 ns ( $t_{r0}/t_{f0}$ ) |                        |
| 0  | 1      | Nominal +2 ns ( $t_{r1}/t_{f1}$ ) |                        |
| 1  | 0      | Nominal +1 ns ( $t_{r2}/t_{f2}$ ) |                        |
| 1  | 1      | Nominal ( $t_{r3}/t_{f3}$ )       | Yes                    |

(1) Unless customer-specific setting

| <b>Bytes 19 to 24, Bits [2:0]: Outputs Switch Matrix (6 × 6 Switch B) Divider (P0–P5) Selection for Outputs Y0–Y5</b> |        |        |               |                        |
|---|--------|--------|---------------|------------------------|
| SWBYx2  | SWBYx1 | SWBYx0 | Any Output Yx | Default <sup>(1)</sup> |
| 0   | 0      | 0      | Divider P0    |                        |
| 0   | 0      | 1      | Divider P1    |                        |
| 0   | 1      | 0      | Divider P2    | Y0, Y1, Y2, Y3, Y4, Y5 |
| 0   | 1      | 1      | Divider P3    |                        |
| 1   | 0      | 0      | Divider P4    |                        |
| 1   | 0      | 1      | Divider P5    |                        |
| 1   | 1      | 0      | Reserved      |                        |
| 1   | 1      | 1      | Reserved      |                        |

(1) Unless customer-specific setting

| Bytes 19 to 24, Bit [3]: Output Y0–Y5 Enable or Low-State |                |                        |
|---|----------------|------------------------|
| ENDISYx   | Output Yx      | Default <sup>(1)</sup> |
| 0   | Disable to low |                        |
| 1   | Enable         | Yes                    |

(1) Unless customer-specific setting

| Bytes 19 to 24, Bit [6]: Output Y0–Y5 Noninverting/Inverting |                  |                        |
|--|------------------|------------------------|
| INVIYx   | Output Yx Status | Default <sup>(1)</sup> |
| 0  | Noninverting     | Yes                    |
| 1  | Inverting        |                        |

(1) Unless customer-specific setting

| Byte 24, Bit [7] (Read-Only): EEPROM Programming In Process Status <sup>(1)</sup> |                               |         |
|---|-------------------------------|---------|
| EEPIP   | Indicate EEPROM Write Process | Default |
| 0   | No programming                |         |
| 1   | Programming in process        |         |

(1) This *read-only* bit indicates an EEPROM write process. It is set to high if programming starts and resets to low if programming is completed. Any data written to the EEPIP bit is ignored. During programming, no data are allowed to be sent to the device via the SMBus until the programming sequence is completed. Data, however, can be read out during the programming sequence (byte read or block read).

| Byte 25, Bits [3:0]: SSC Modulation Frequency Selection in the Range of 30 kHz to 60 kHz <sup>(1)</sup> |       |       |       |                   |                        |                        |      |      |      |      |      |      |                        |     |
|---|-------|-------|-------|-------------------|------------------------|------------------------|------|------|------|------|------|------|------------------------|-----|
| FSSC3   | FSSC2 | FSSC1 | FSSC0 | Modulation Factor | $f_{\text{mod}}$ [kHz] | $f_{\text{vco}}$ (MHz) |      |      |      |      |      |      | Default <sup>(2)</sup> |     |
|   |       |       |       |                   |                        | 100                    | 110  | 120  | 130  | 140  | 150  | 160  |                        | 167 |
| 0   | 0     | 0     | 0     | 5680              |                        | 17.6                   | 19.4 | 21.1 | 22.9 | 24.6 | 26.4 | 28.2 | 29.4                   |     |
| 0   | 0     | 0     | 1     | 5412              |                        | 18.5                   | 20.3 | 22.2 | 24.0 | 25.9 | 27.7 | 29.6 | 30.9                   |     |
| 0   | 0     | 1     | 0     | 5144              |                        | 19.4                   | 21.4 | 23.3 | 25.3 | 27.2 | 29.2 | 31.1 | 32.5                   |     |
| 0   | 0     | 1     | 1     | 4876              |                        | 20.5                   | 22.6 | 24.6 | 26.7 | 28.7 | 30.8 | 32.8 | 34.2                   |     |
| 0   | 1     | 0     | 0     | 4608              |                        | 21.7                   | 23.9 | 26.0 | 28.2 | 30.4 | 32.6 | 34.7 | 36.2                   |     |
| 0   | 1     | 0     | 1     | 4340              |                        | 23.0                   | 25.3 | 27.6 | 30.0 | 32.3 | 34.6 | 36.9 | 38.5                   |     |
| 0   | 1     | 1     | 0     | 4072              |                        | 24.6                   | 27.0 | 29.5 | 31.9 | 34.4 | 36.8 | 39.3 | 41.0                   |     |
| 0   | 1     | 1     | 1     | 3804              |                        | 26.3                   | 28.9 | 31.5 | 34.2 | 36.8 | 39.4 | 42.1 | 43.9                   |     |
| 1   | 0     | 0     | 0     | 3536              |                        | 28.3                   | 31.1 | 33.9 | 36.8 | 39.6 | 42.4 | 45.2 | 47.2                   |     |
| 1   | 0     | 0     | 1     | 3286              |                        | 30.4                   | 33.5 | 36.5 | 39.6 | 42.6 | 45.6 | 48.7 | 50.8                   | Yes |
| 1   | 0     | 1     | 0     | 3000              |                        | 33.3                   | 36.7 | 40.0 | 43.3 | 46.7 | 50.0 | 53.3 | 55.7                   |     |
| 1   | 0     | 1     | 1     | 2732              |                        | 36.6                   | 40.3 | 43.9 | 47.6 | 51.2 | 54.9 | 58.6 | 61.1                   |     |
| 1   | 1     | 0     | 0     | 2464              |                        | 40.6                   | 44.6 | 48.7 | 52.8 | 56.8 | 60.9 | 64.9 | 67.8                   |     |
| 1   | 1     | 0     | 1     | 2196              |                        | 45.5                   | 50.1 | 54.6 | 59.2 | 63.8 | 68.3 | 72.9 | 76.0                   |     |
| 1   | 1     | 1     | 0     | 1928              |                        | 51.9                   | 57.1 | 62.2 | 67.4 | 72.6 | 77.8 | 83.0 | 86.6                   |     |
| 1   | 1     | 1     | 1     | 1660              |                        | 60.2                   | 66.3 | 72.3 | 78.3 | 84.3 | 90.4 | 96.4 | 100.6                  |     |

(1) The PLL must be bypassed (turned off) when changing the *SSC Modulation Frequency Factor* on-the-fly. This can be done by the following programming sequence: bypass PLL2 (byte 3, bit 6 = 1); write new *Modulation Factor* (byte 25); re-activate PLL2 (byte 3, bit 6 = 0).

(2) Unless customer-specific setting

| Byte 25, Bits [6:4]: SSC Modulation Amount <sup>(1)</sup> |      |      |  |                        |
|---|------|------|--|------------------------|
| SSC2  | SSC1 | SSC0 | Function   | Default <sup>(2)</sup> |
| 0   | 0    | 0    | SSC modulation amount 0% = SSC bypass for PLL <sup>(3)</sup> | Yes                    |
| 0   | 0    | 1    | SSC modulation amount $\pm 0.1\%$ (center spread)            |                        |
| 0   | 1    | 0    | SSC modulation amount $\pm 0.25\%$ (center spread)           |                        |
| 0   | 1    | 1    | SSC modulation amount $\pm 0.4\%$ (center spread)            |                        |
| 1   | 0    | 0    | SSC modulation amount 1% (down spread)                       |                        |
| 1   | 0    | 1    | SSC modulation amount 1.5% (down spread)                     |                        |
| 1   | 1    | 0    | SSC modulation amount 2% (down spread)                       |                        |
| 1   | 1    | 1    | SSC modulation amount 3% (down spread)                       |                        |

- (1) The PLL must be bypassed (turned off) when changing SSC Modulation Amount on-the-fly. This can be done by the following programming sequence: bypass PLL2 (byte 3, bit 6 = 1); write new Modulation Amount (byte 25); re-activate PLL2 (byte 3, bit 6 = 0).
- (2) Unless customer-specific setting
- (3) If SSC bypass is selected, the SSC circuitry of PLL2 is powered down and the SSC output is reset to logic low. The non-SSC output of PLL2 is not affected by this mode and can still be used.

| Byte 25, Bit [7]: Permanently Lock EEPROM Data |  |                        |
|--|--|------------------------|
| EELOCK   | Permanently Lock EEPROM <sup>(1)</sup> | Default <sup>(2)</sup> |
| 0  | No                                     | Yes                    |
| 1  | Yes                                    |                        |

- (1) If this bit is set, the actual data in the EEPROM is permanently locked. Note that the EEPROM lock becomes effective when this bit is set in the EEPROM and not in the internal volatile register. No further programming is possible, even if this bit is set low. Data, however can still be written via SMBUS to the internal register to change device function on the fly. But new data no longer can be stored into the EEPROM.
- (2) Unless customer-specific setting

| Byte 26, Bits [6:0]: Byte Count <sup>(1)</sup> |     |     |     |     |     |     |              |                        |
|--|-----|-----|-----|-----|-----|-----|--------------|------------------------|
| BC6  | BC5 | BC4 | BC3 | BC2 | BC1 | BC0 | No. of Bytes | Default <sup>(2)</sup> |
| 0  | 0   | 0   | 0   | 0   | 0   | 0   | Not allowed  |                        |
| 0  | 0   | 0   | 0   | 0   | 0   | 1   | 1            |                        |
| 0  | 0   | 0   | 0   | 0   | 1   | 0   | 2            |                        |
| 0  | 0   | 0   | 0   | 0   | 1   | 1   | 3            |                        |
|  |     |     | •   |     |     |     |              |                        |
|  |     |     | •   |     |     |     |              |                        |
|  |     |     | •   |     |     |     |              |                        |
| 0  | 0   | 1   | 1   | 0   | 1   | 1   | 27           | Yes                    |
|  |     |     | •   |     |     |     |              |                        |
|  |     |     | •   |     |     |     |              |                        |
|  |     |     | •   |     |     |     |              |                        |
| 1  | 1   | 1   | 1   | 1   | 0   | 1   | 125          |                        |
| 1  | 1   | 1   | 1   | 1   | 1   | 0   | 126          |                        |
| 1  | 1   | 1   | 1   | 1   | 1   | 1   | 127          |                        |

- (1) Defines the number of bytes, which is sent from this device at the next block-read protocol.
- (2) Unless customer-specific setting

| Byte 26, Bit [7]: Initiate EEPROM Write Cycle <sup>(1)</sup> |                           |                        |
|--|---------------------------|------------------------|
| EEWRITE  | Starts EEPROM Write Cycle | Default <sup>(2)</sup> |
| 0  | No                        | Yes                    |
| 1  | Yes                       |                        |

- (1) The EEPROM WRITE cycle is initiated with the rising edge of the EEWRITE bit. The EEPROM WRITE bit must be sent last to ensure that the content of all internal registers is stored in the EEPROM. Do not interrupt the EEPROM WRITE cycle; otherwise, random data can be stored in the EEPROM. A static level-high does not trigger an EEPROM WRITE cycle. This bit stays high until the user resets it to low (it is not automatically reset after the programming has been completed). Therefore, to initiate an EEPROM WRITE cycle, it is recommended to send a zero-one sequence to the EEWRITE bit in byte 26.
- During EEPROM programming, no data are allowed to be sent to the device via the SMBus until the programming sequence has been completed. Data, however, can be read out during the programming sequence (byte read or block read). The programming status can be monitored by reading out EEPIP, byte 24, bit 7. If EELOCK is set, no EEPROM programming is possible.
- (2) Unless customer-specific setting

## FUNCTIONAL DESCRIPTION

### Clock Inputs (CLK\_IN0 and CLK\_IN1)

The CDCE706 features two clock inputs which can be used as:

- Crystal oscillator input (default setting)
- Two independent single-ended LVCMOS inputs
- Differential signal input

The dedicated clock input can be selected by the *input signal source* bits [7:6] of byte 11.

### Crystal Oscillator Inputs

The input frequency range in crystal mode is 8 MHz to 54 MHz. The CDCE706 uses Pierce-type oscillator circuitry with included feedback resistance for the inverting amplifier. The user, however, must add external capacitors ( $C_{X0}$ ,  $C_{X1}$ ) to match the input load capacitor from the crystal (see Figure 14). The required values can be calculated:

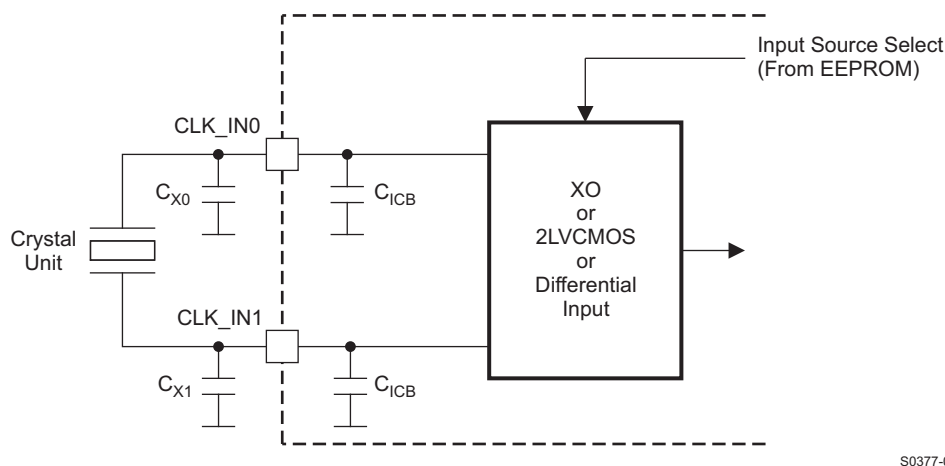
$$C_{X0} = C_{X1} = 2 \times C_L - C_{ICB},$$

where  $C_L$  is the crystal load capacitor as specified for the crystal unit and  $C_{ICB}$  is the input capacitance of the device, including the board capacitance (stray capacitance of PCB).

For example, for a fundamental 27-MHz crystal with  $C_L$  of 9 pF and  $C_{ICB}$  of 4 pF,

$$C_{X0} = C_{X1} = (2 \times 9 \text{ pF}) - 3 \text{ pF} = 15 \text{ pF}.$$

It is important to use a short PCB trace from the device to the crystal unit to keep the stray capacitance of the oscillator loop to a minimum.



S0377-01

**Figure 14. Crystal Input Circuitry**

In order to ensure stable oscillation, a certain drive power must be applied. The CDCE706 features an input oscillator with adaptive gain control, which relieves the user of manually programming the gain. Additionally, adaptive gain control eliminates the use of external resistors to compensate the ESR of the crystal. The drive level is the amount of power dissipated by the oscillating crystal unit and is usually specified in terms of power dissipated by the resonator (equivalent series resistance (ESR)). Figure 15 gives the resulting drive level vs crystal frequency and ESR.

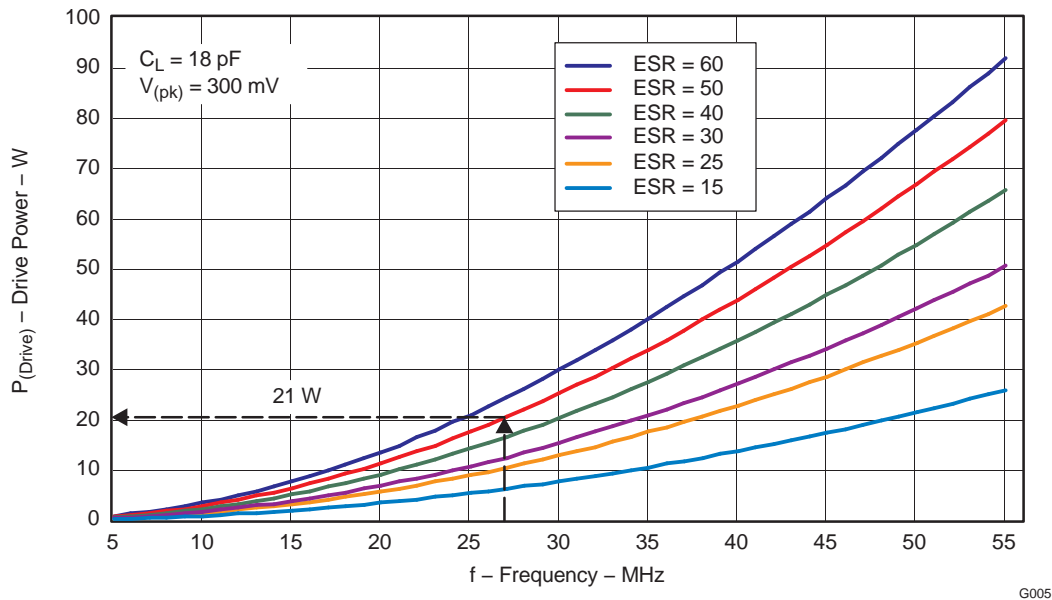


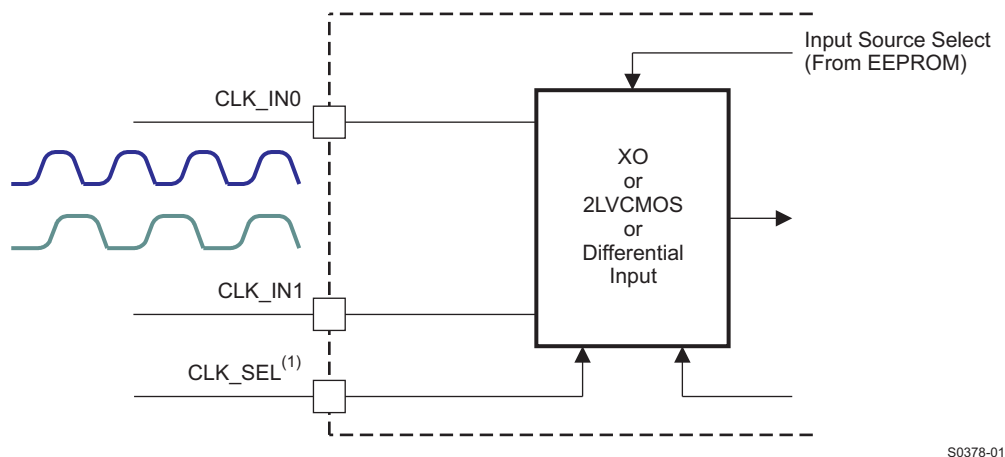
Figure 15. Crystal Drive Power

For example, if a 27-MHz crystal with ESR of 50 Ω is used and  $2 \times C_L$  is 18 pF, the drive power is 21 μW. Drive level should be held to a minimum to avoid overdriving the crystal. The maximum power dissipation is specified for each type of crystal in the oscillator specifications, i.e., 100 μW for the example above.

**Single-Ended LVCMOS Clock Inputs**

When selecting the LVCMOS clock mode, CLK\_IN0 and CLK\_IN1 act as regular clock input pins and can be driven up to 200 MHz. Both clock input circuits are equal in design and can be used independently of each other (see Figure 16). The internal clock select bit, byte 10, bit [4], selects one of the two input clocks. CLK\_IN0 is the default selection. There is also the option to program the external control pin S0/A0/CLK\_SEL as the clock-select pin, byte 10, bits [1:0].

The two clock inputs can be used for redundancy switching, i.e., to switch between a primary clock and secondary clock. Note that a phase difference between the clock inputs may require PLL correction. Also, in case of different frequencies between the primary and secondary clock, the PLL must re-lock to the new frequency.



(1) CLK\_SEL is optional and can be configured by EEPROM setting.

Figure 16. LVCMOS Clock Input Circuitry

### Differential Clock Inputs

The CDCE706 supports differential signaling as well. In this mode, the CLK\_IN0 and CLK\_IN1 pins serve as differential signal inputs and can be driven up to 200 MHz.

The minimum magnitude of the differential input voltage is 100 mV over a differential common-mode input voltage range of 200 mV to  $V_{CC} - 0.6$  V. If LVDS or LVPECL signal levels are applied, ac coupling and a biasing structure are recommended to adjust the different physical layers (see Figure 17). The capacitor removes the dc component of the signal (common-mode voltage), whereas the ac component (voltage swing) is passed on. A resistor pullup and/or pulldown network represents the biasing structure used to set the common-mode voltage on the receiver side of the ac-coupling capacitor. DC coupling is also possible.

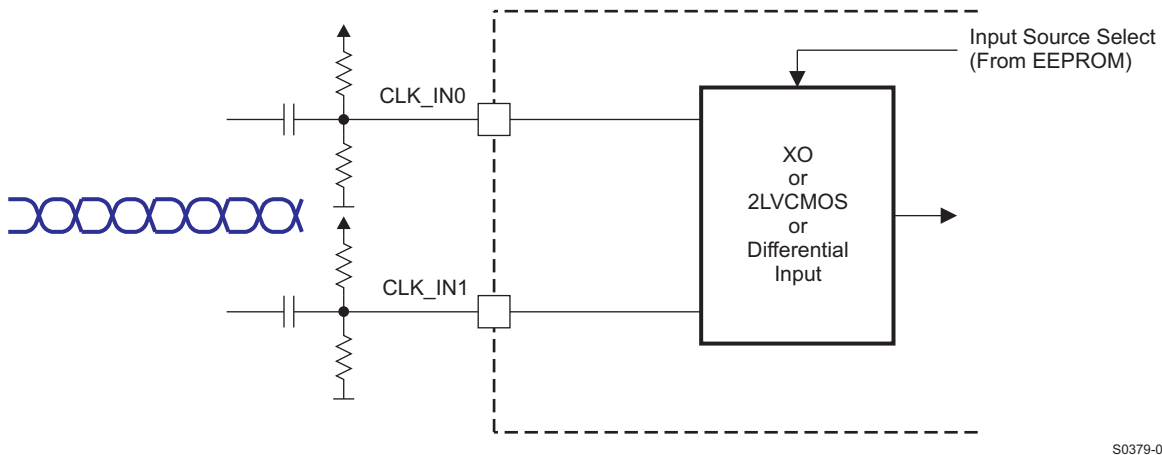


Figure 17. Differential Clock Input Circuitry

### PLL Configuration and Setting

The CDCE706 includes three PLLs which are equal in function and performance, except PLL2, which in addition supports spread-spectrum clocking (SSC) generation. Figure 18 shows the block diagram of the PLL.

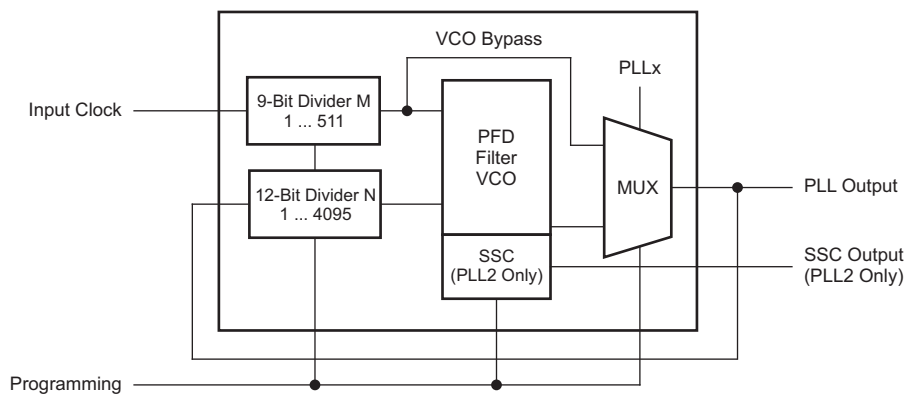


Figure 18. PLL Architecture

All three PLLs are designed for easiest configuration. The user must define only the input and output frequencies or the divider (M, N, P) setting. All other parameters, such as charge-pump current, filter components, phase margin, or loop bandwidth are controlled and set by the device itself. This assures optimized jitter attenuation and loop stability.

The PLLs supports normal-speed mode ( $80 \text{ MHz} \leq f_{VCO} \leq 200 \text{ MHz}$ ) and high-speed mode ( $180 \text{ MHz} \leq f_{VCO} \leq 300 \text{ MHz}$ ), which can be selected by PLLxFVCO (bits [7:5] of byte 6). The speed option assures stable operation and lowest jitter.



Divider M and divider N operate internally as a fractional divider for  $f_{VCO}$  up to 250 MHz. This allows a fractional divider ratio for zero-ppm output clock error.

In the case of  $f_{VCO} > 250$  MHz, it is recommended that only integer factors of N/M are used.

For optimized jitter performance, keep divider M as small as possible. Also, the fractional divider concept requires a PLL divider configuration,  $M \leq N$  (or  $N/M \geq 1$ ).

Additionally, each PLL supports two bypass options:

- PLL bypass
- VCO bypass

In PLL bypass mode, the PLL is completely bypassed, so that the input clock is switched directly to output switch A (SWAPxx of bytes 9 to 12). In the VCO bypass mode, only the VCO of the PLL is bypassed by setting PLLxMUX to 1 (bits [7:5] of byte 3). But divider M still is useable and expands the output divider by an additional 9 bits. This gives a total divider range of  $M \times P = 511 \times 127 = 64,897$ . In VCO bypass mode, the PLL block is powered down and minimizes current consumption.

**Table 3. Example for Divide, Multiplication, and Bypass Operation**

| Function                      | Equation <sup>(1)</sup>           | $f_{IN}$<br>[MHz] | $f_{OUT-desired}$<br>[MHz] | $f_{OUT-actual}$<br>[MHz] | Divider |    |    |        | $f_{VCO}$ [MHz] |
|-------------------------------|-----------------------------------|-------------------|----------------------------|---------------------------|---------|----|----|--------|-----------------|
|                               |                                   |                   |                            |                           | M       | N  | P  | N/M    |                 |
| Fractional <sup>(2)</sup>     | $f_{OUT} = f_{IN} \times (N/M)/P$ | 30.72             | 155.52                     | 155.52                    | 16      | 81 | 1  | 5.0625 | 155.52          |
| Integer factor <sup>(3)</sup> | $f_{OUT} = f_{IN} \times (N/M)/P$ | 27                | 270                        | 270                       | 1       | 10 | 1  | 10     | 270             |
| VCO bypass                    | $f_{OUT} = f_{IN}/(M \times P)$   | 30.72             | 0.06                       | 0.06                      | 8       | —  | 64 | —      | —               |

(1) P-divider of output-switch matrix is included in the calculation.

(2) Fractional operation for  $f_{VCO} \leq 250$  MHz

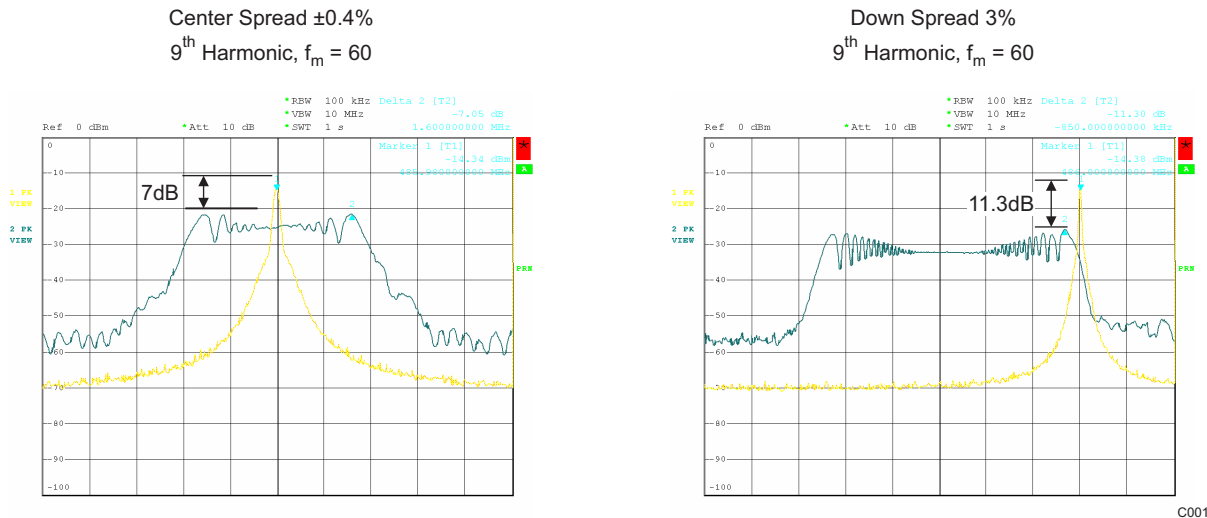
(3) Integer operation for  $f_{VCO} > 250$  MHz

## Spread-Spectrum Clocking and EMI Reduction

In addition to the basic PLL function, PLL2 supports spread-spectrum clocking (SSC). Thus, PLL 2 features two outputs, an SSC output and a non-SSC output. Both outputs can be used in parallel. The mean phase of the center-spread, SSC-modulated signal is equal to the phase of the nonmodulated input frequency. SSC is selected by output switch A (SWAPxx of bytes 9 to 12).

SSC also is bypassable (byte 25, bits [6:4]) by powering down the SSC output and setting it to the logic-low state. The non-SSC output of PLL2 is not affected by this mode and can still be used.

SSC is an effective method to reduce electromagnetic interference (EMI) noise in high-speed applications. It reduces the RF energy peak of the clock signal by modulating the frequency and spreads the energy of the signal to a broader frequency range. Because the energy of the clock signal remains constant, a varying frequency that broadens the overtones necessarily lowers their amplitudes. [Figure 19](#) shows the effect of SSC on a 54-MHz clock signal for DSP.



**Figure 19. Spread-Spectrum Clocking With Center Spread and Down Spread**

The peak amplitude of the modulated clock is 11.3 dB lower than the nonmodulated carrier frequency for down spread and radiates less electromagnetic energy.

In SSC mode, the user can select the SSC modulation amount and SSC modulation frequency. The modulation amount is the frequency deviation relative to the carrier (min/max frequency), whereas the modulation frequency determines the speed of the frequency variation. In SSC mode, the maximum VCO frequency is limited to 167 MHz.

**SSC Modulation Amount**

The CDCE706 supports center-spread modulation and down-spread modulation. In center spread, the clock is symmetrically shifted around the carrier frequency and can be  $\pm 0.1\%$ ,  $\pm 0.25\%$ , or  $\pm 0.4\%$ . For down spread, the clock frequency is always lower than the carrier frequency and can be 1%, 1.5%, 2%, or 3%. The down spread is preferred if a system cannot tolerate an operating frequency higher than the nominal frequency (overclocking problem).

Example:

|   | Modulation Type                 | Minimum Frequency | Center Frequency | Maximum Frequency |
|---|---------------------------------|-------------------|------------------|-------------------|
| A | $\pm 0.25\%$ center spread      | 53.865 MHz        | 54 MHz           | 54.135 MHz        |
| B | 1% down spread                  | 53.46 MHz         | —                | 54 MHz            |
| C | 0.5% down spread <sup>(1)</sup> | 53.73 MHz         | 53.865 MHz       | 54 MHz            |

(1) A down spread of 0.5% of a 54-MHz carrier is equivalent to 59.865 MHz at a center spread of  $\pm 0.25\%$ .

**SSC Modulation Frequency**

The modulation frequency (sweep rate) can be selected between 30 kHz and 60 kHz. It is also based on the VCO frequency as shown in the *SSC Modulation Amount* as shown in the [Byte 25, Bits \[6:4\]](#) table. As shown in [Figure 20](#), the damping increases with higher modulation frequencies. It may be limited by the tracking skew of a downstream PLL. The CDCE706 uses a triangle modulation profile which is one of the common profiles for SSC.

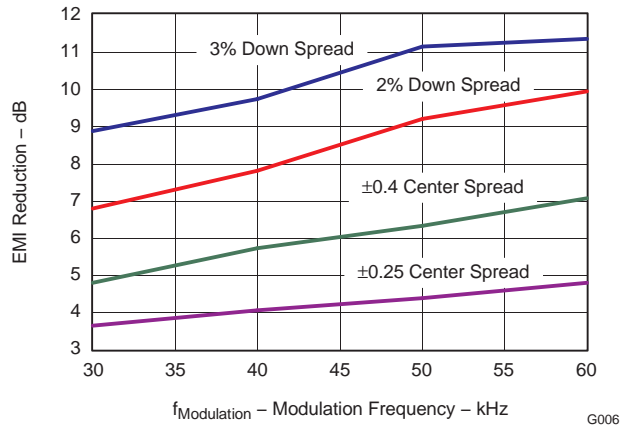


Figure 20. EMI Reduction vs  $f_{\text{Modulation}}$  and  $f_{\text{Amount}}$

**Further EMI Reduction**

The optimum damping is a combination of modulation amount, modulation frequency, and the harmonics which are considered. Note that higher-order harmonic frequencies result in stronger EMI reduction because of higher frequency deviation.

As seen in Figure 21 and Figure 22, a slower output slew rate and/or smaller output-signal amplitude helps to reduce EMI emission even more. Both measures reduce the RF energy of clock harmonics. The CDCE706 allows slew rate control in four steps between 0.6 ns and 3.3 ns (bytes 19–24, bits [5:4]). The output amplitude is set by the two independent output supply voltage pins,  $V_{\text{CCOUT1}}$  and  $V_{\text{CCOUT2}}$ , and can vary from 2.3 V to 3.6 V. Even a lower output supply voltage down to 1.8 V works, but the maximum frequency must be considered.

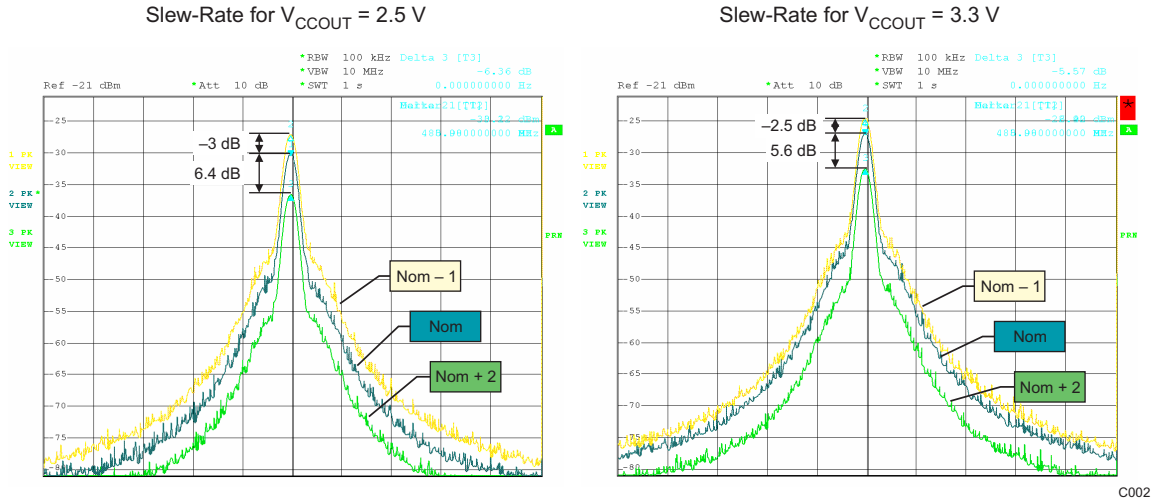
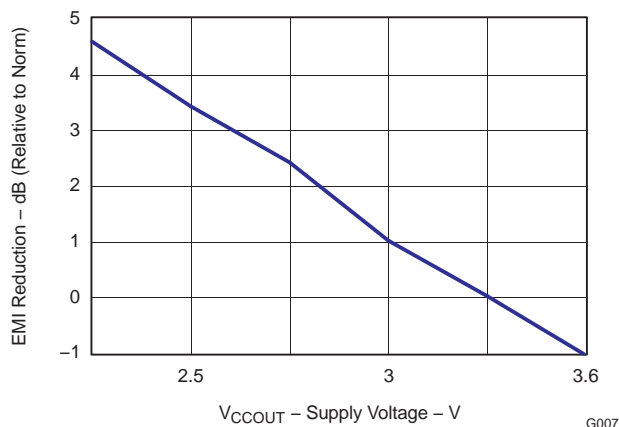


Figure 21. EMI Reduction vs Slew-Rate and  $V_{\text{CCOUT}}$



**Figure 22. EMI Reduction vs V<sub>CCOUT</sub>**

## Multifunction Control Inputs S0 and S1

The CDCE706 features two user-definable input pins which can be used as external control pins or address pins. When programmed as control pins, they can function as the clock-select pin, enable/disable pin, or device power-down pin. If both pins are used as address bits, up to four devices can be connected to the same SMBus. The function is set in byte 10, bits [3:0]. Table 4 shows the possible settings for the different output conditions, clock select, and device addresses.

**Table 4. Configuration Setting of Control Inputs**

| Configuration Bits |     |                    |     | External Control Pins |                    | Device Function   |                          |                   |                     |
|--------------------|-----|--------------------|-----|-----------------------|--------------------|---|--------------------------|-------------------|---------------------|
| Byte 10, Bit [3:2] |     | Byte 10, Bit [1:0] |     |                       |                    |   |                          |                   |                     |
| S11                | S10 | S01                | S00 | S1 (Pin 2)            | S0 (Pin 1)         | Yx Outputs  | Power Down               | Pin 2             | Pin 1               |
| 0                  | X   | 0                  | X   | 1                     | 1                  | Active  | No                       | Output ctrl       | Output ctrl         |
| 0                  | 0   | 0                  | X   | 0                     | 1                  | Low/high <sup>(1)</sup>                                     | No                       | Output ctrl       | Output ctrl         |
| 0                  | 1   | 0                  | X   | 0                     | 1                  | High impedance  | Outputs only             | Output ctrl       | Output ctrl         |
| 0                  | X   | 0                  | 0   | X                     | 0                  | High impedance  | PLL, inputs, and outputs | Output ctrl       | Output ctrl and pd  |
| 0                  | X   | 0                  | 1   | 0                     | 0                  | S10 = 0: low/high <sup>(1)</sup><br>S10 = 1: high impedance | PLL only                 | Output ctrl       | PLL and div. bypass |
| 0                  | X   | 0                  | 1   | 1                     | 0                  | Active  | PLL only                 | Output ctrl       | PLL and div. bypass |
| 0                  | X   | 1                  | 0   | 0                     | 0/1 <sup>(2)</sup> | S10 = 0: Low/High <sup>(1)</sup><br>S10 = 1: high impedance | No                       | Output ctrl       | CLK_SEL             |
| 0                  | X   | 1                  | 0   | 1                     | 0/1 <sup>(2)</sup> | Active  | No                       | Output ctrl       | CLK_SEL             |
| 1                  | 1   | 1                  | 1   | X                     | X                  | Active  | No                       | A1 <sup>(3)</sup> | A0 <sup>(3)</sup>   |

(1) A noninverting output is set to low, and an inverting output is set to high.

(2) If S0 is 0, CLK\_IN0 is selected; if S0 is 1, CLK\_IN1 is selected.

(3) S0 and S1 are interpreted as address bits A0 and A1 of the slave receiver address byte.

As shown in Table 4, there is a specific order of the different output conditions: power-down mode overwrites high-impedance state, high-impedance state overwrites low-state, and low-state overwrites active-state.

## Output Switching Matrix

The flexible architecture of the output switch matrix allows the user to switch any of the internal clock signal sources via a free-selectable post-divider to any of the six outputs.

As shown in Figure 23, the CDCE706 is based on two banks of switches and six post-dividers. Switch A comprises six five-input multiplexers which select one of the four PLL clock outputs or directly select the input clock and feed it to one of the 7-bit post-dividers (P-divider). Switch B is made up of six six-input multiplexers which take any P-divider and feed it to one of the six outputs, Yx.

Switch B was added to the output switch matrix to ensure that output frequencies derived from one P-divider are 100% phase-aligned. Also, the P-divider is built in a way that every divide factor is automatically duty-cycle corrected. Changing the divider value on the fly may cause a glitch on the output.

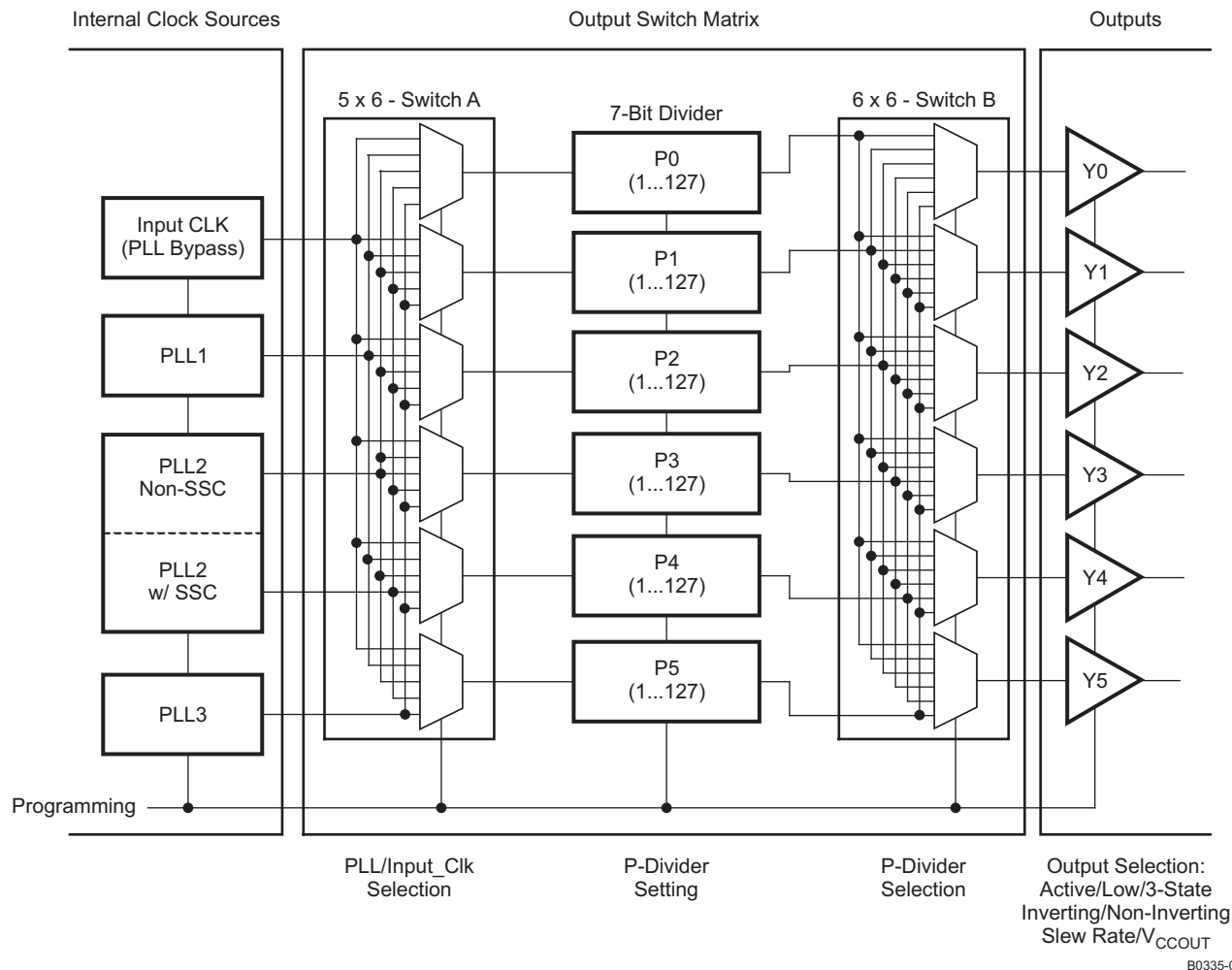


Figure 23. CDCE706 Output Switch Matrix

In addition, the outputs can be switched active, low, high-impedance state, and/or 180-degree phase-shifted. Also, the output slew rate and the output voltage are user-selectable.

### LVC MOS Output Configuration

The output stage of the CDCE706 supports all common output settings, such as enable, disable, low-state, and signal inversion (180-degree phase shift). It further features slew-rate control (0.6 ns to 3.3 ns) and variable output supply voltage (2.3 V to 3.6 V).

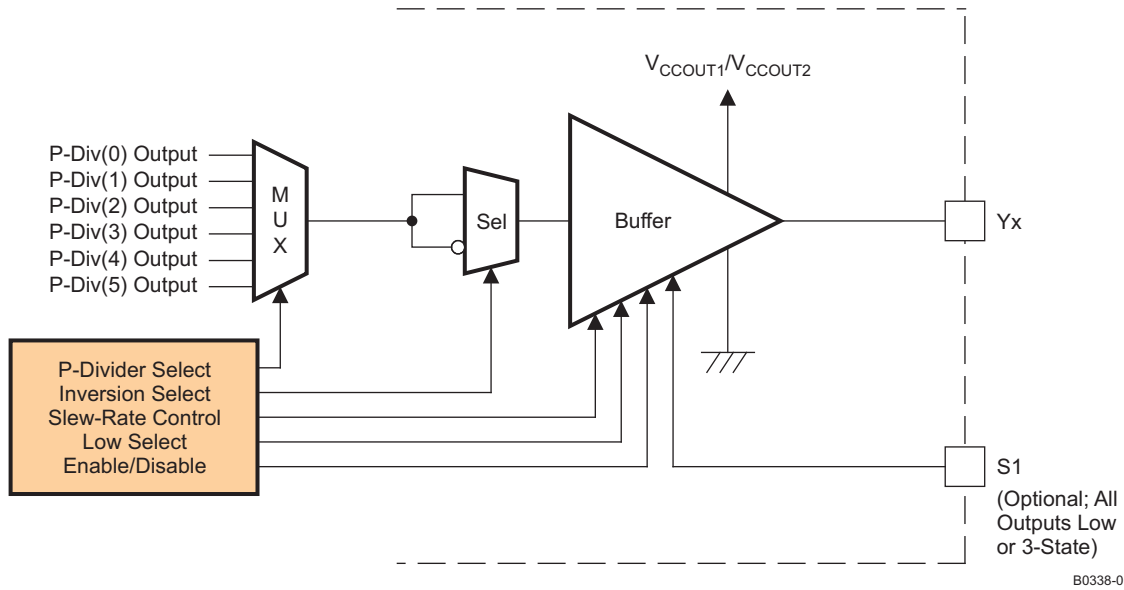


Figure 24. Block Diagram of Output Architecture

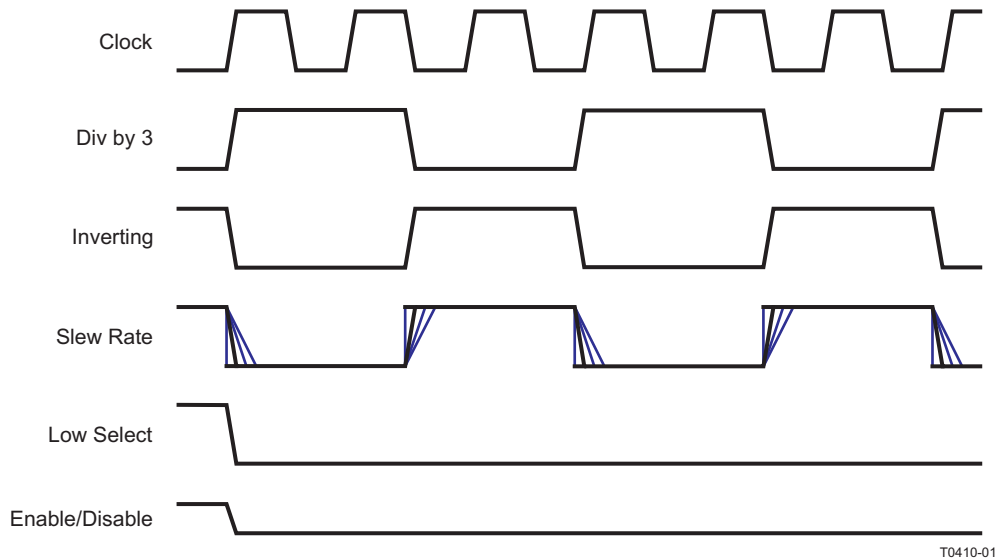


Figure 25. Example for Output Waveforms

All output settings are programmable via SMBus:

- Enable, disable, low-state via external control pins S0 and S1 → byte 10, bits[3:0]
- Enable or disable-to-low → bytes 19 to 24, bit[3]
- Inverting/noninverting → bytes 19 to 24, bit[6]
- Slew-rate control → bytes 19 to 24, bits[5:4]
- Output swing → external pins V<sub>CCOUT1</sub> (pin 14) and V<sub>CCOUT2</sub> (pin 18)

## Performance Data: Output Skew, Jitter, Cross-Coupling, Noise Rejection (Spur Suppression), and Phase Noise

### Output Skew

Skew is an important parameter for clock distribution circuits. It is defined as the time difference between outputs that are driven by the same input clock. [Table 5](#) shows the output skew ( $t_{sk(o)}$ ) of the CDCE706 for high-to-low and low-to-high transitions over the entire range of supply voltages, operating temperature and output voltage swing.

**Table 5. Output Skew**

| PARAMETER               | CONDITION                  | TYP | MAX | UNIT |
|-------------------------|----------------------------|-----|-----|------|
| $t_{sk(o)}$ Output skew | $V_{CCOUT} = 2.5\text{ V}$ | 130 | 250 | ps   |
|                         | $V_{CCOUT} = 3.3\text{ V}$ | 130 | 200 | ps   |

### Jitter Performance

Jitter is a major parameter for PLL-based clock driver circuits. This becomes important as speed increases and timing budget decreases. The PLL and internal circuits of CDCE706 are designed for lowest jitter. The peak-to-peak period jitter is only 60 ps (typical). [Table 6](#) gives the peak-to-peak and rms deviation of cycle-to-cycle jitter, period jitter and phase jitter as taken during characterization.

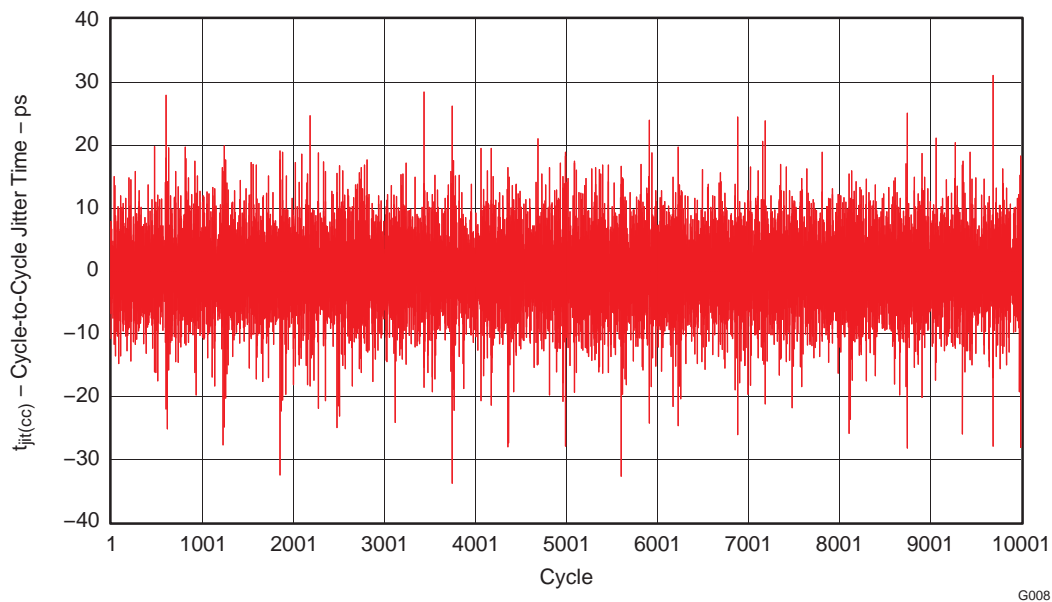
**Table 6. Jitter Performance of CDCE706**

| PARAMETER                           | CONDITION                     | TYP <sup>(1)</sup> |                 | MAX <sup>(1)</sup> |                 | UNIT |
|-------------------------------------|-------------------------------|--------------------|-----------------|--------------------|-----------------|------|
|                                     |                               | Peak-Peak          | rms (One Sigma) | Peak-Peak          | rms (One Sigma) |      |
| $t_{jit(cc)}$ Cycle-to-cycle jitter | $f_{out} = 50\text{ MHz}$     | 55                 | –               | 75                 | –               | ps   |
|                                     | $f_{out} = 133\text{ MHz}$    | 50                 | –               | 85                 | –               |      |
|                                     | $f_{out} = 245.76\text{ MHz}$ | 45                 | –               | 60                 | –               |      |
| $t_{jit(per)}$ Period jitter        | $f_{out} = 50\text{ MHz}$     | 60                 | 4               | 76                 | 7               | ps   |
|                                     | $f_{out} = 133\text{ MHz}$    | 55                 | 5               | 84                 | 11              |      |
|                                     | $f_{out} = 245.76\text{ MHz}$ | 55                 | 5               | 72                 | 8               |      |
| $t_{jit(phase)}$ Phase jitter       | $f_{out} = 50\text{ MHz}$     | 730                | 90              | 840                | 115             | ps   |
|                                     | $f_{out} = 133\text{ MHz}$    | 930                | 130             | 1310               | 175             |      |
|                                     | $f_{out} = 245.76\text{ MHz}$ | 720                | 90              | 930                | 125             |      |

(1) All typical and maximum values are at  $V_{CC} = 3.3\text{ V}$ , temperature = 25°C,  $V_{CCOUT} = 3.3\text{ V}$ ; one output is switching, data taken over several 10,000 cycles.

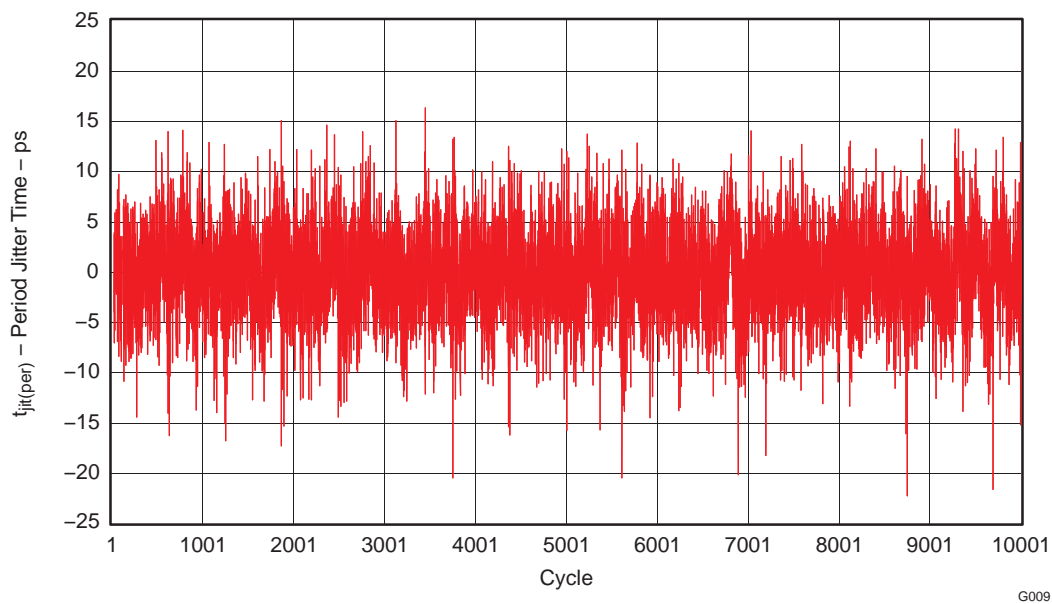
[Figure 26](#), [Figure 27](#), and [Figure 28](#) show the relationship between cycle-to-cycle jitter, period jitter, and phase jitter over 10,000 samples. The jitter varies with a smaller or wider sample window. The cycle-to-cycle jitter and period jitter show the measured value, whereas the phase jitter is the accumulated period jitter.

*Cycle-to-Cycle jitter* ( $t_{jit(cc)}$ ) is the variation in cycle time of a clock signal between adjacent cycles, over a random sample of adjacent cycle pairs. Cycle-to-cycle jitter is never greater than the period jitter. It is also known as adjacent-cycle jitter.



**Figure 26. Snapshot of Cycle-to-Cycle Jitter**

*Period jitter* ( $t_{\text{jitter(per)}}$ ) is the deviation in cycle time of a clock signal with respect to the ideal period ( $1/f_0$ ) over a random sample of cycles. In reference to a PLL, period jitter is the worst-case period deviation from the ideal that would ever occur on the PLL outputs. This is also referred to as short-term jitter.



**Figure 27. Snapshot of Period Jitter**

*Phase jitter* ( $t_{\text{jitter(phase)}}$ ) is the long-term variation of the clock signal. It is the cumulative deviation in  $t(\Theta)$  for a controlled edge with respect to a  $t(\Theta)$  mean in a random sample of cycles. Phase jitter, time-interval error (TIE), and wander are used in literature to describe long-term variation in frequency. As of ITU-T: G.810, wander is defined as phase variation at rates less than 10 Hz, whereas jitter is defined as phase variation greater than 10 Hz. The measurement interval must be long enough to gain a meaningful result. Wander can be caused by temperature drift, aging, supply-voltage drift, etc.



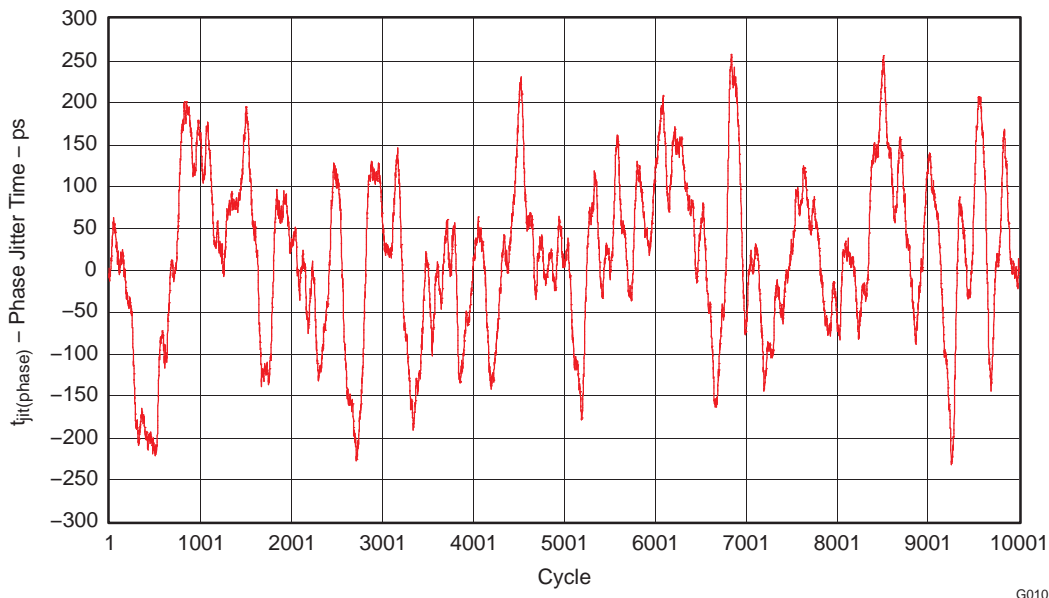


Figure 28. Snapshot of Phase Jitter

Jitter depends on the VCO frequency ( $f_{VCO}$ ) of the PLL. A higher  $f_{VCO}$  results in better jitter performance compared to a lower  $f_{VCO}$ . The VCO frequency can be defined via the M- and N-dividers of the PLL.

As the CDCE706 supports a wide frequency range, the device offers VCO frequency-selection bits, bits [7:5] of byte 6. These bits define the jitter-optimized frequency range of each PLL. The user can select between the normal-speed mode (80 MHz to 200 MHz) and the high-speed mode (180 MHz to 300 MHz). Figure 29 shows the jitter performance over  $f_{VCO}$  for the two frequency ranges.

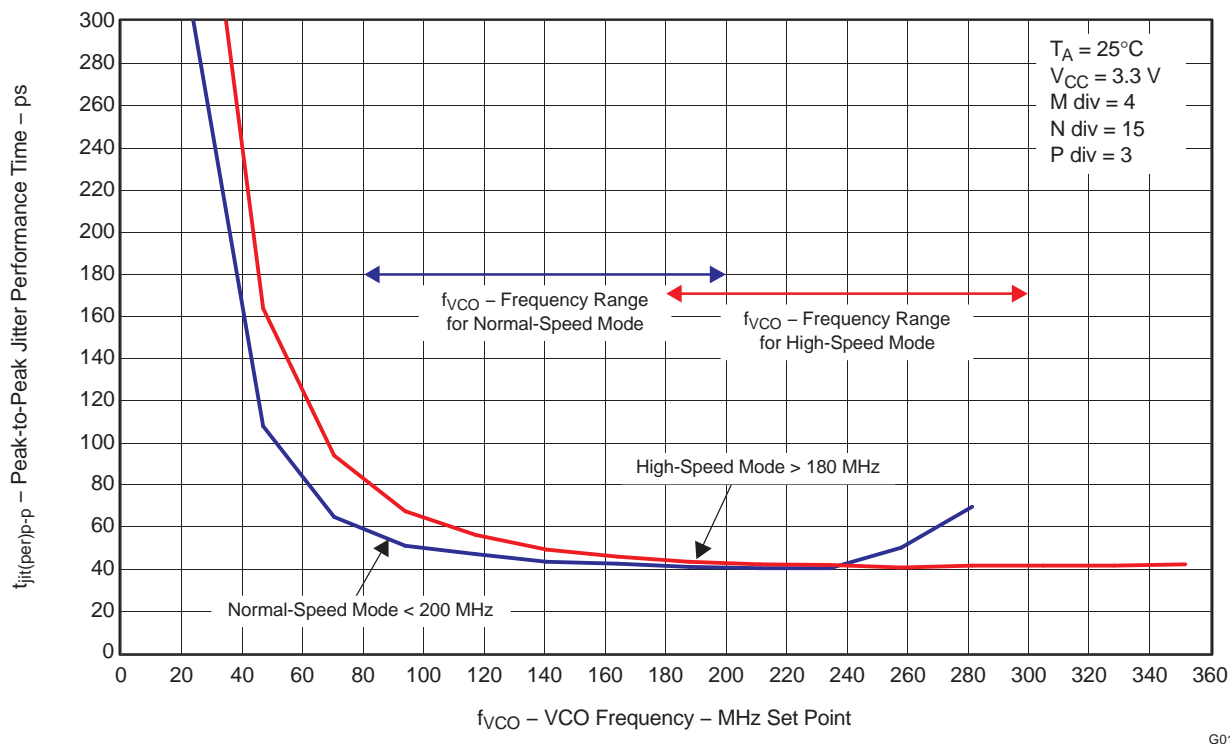


Figure 29. Period Jitter vs  $f_{VCO}$  for Normal-Speed Mode and High-Speed Mode

The TI Pro Clock software automatically calculates the PLL parameter for jitter-optimized performance.

### Cross-Coupling, Spur Suppression, and Noise Rejection

Cross-coupling in ICs occurs through interactions between several parts of the chip such as between output stages, metal lines, bond wires, substrate, etc. The coupling can be capacitive, inductive, and resistive (ohmic), induced by output switching, leakage current, ground bouncing, power supply transients, etc.

The CDCE706 is designed using RFSiGe process technology. This process gives excellent performance in linearity, low power consumption, best-in-class noise performance, and very good isolation characteristics between the on-chip components.

The good isolation is a major benefit of the RFSiGe process because it minimizes the coupling effect. Even if all three PLLs are active and all outputs are on, the noise suppression is well above 50 dB. Figure 30 and Figure 31 show an example of noise coupling, spur-suppression, and power-supply noise rejection of the CDCE706. The measurement conditions are shown in Figure 30 and Figure 31.

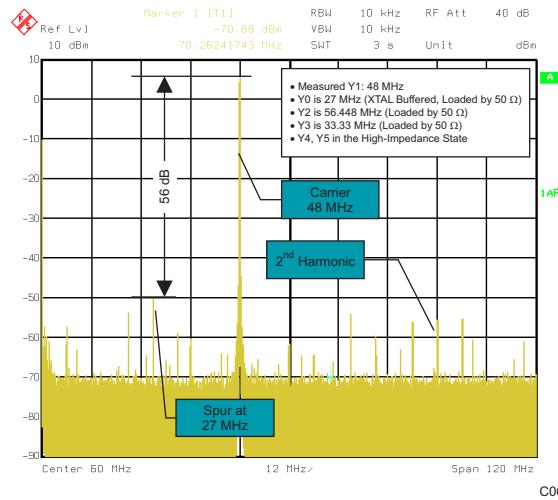


Figure 30. Noise Coupling and Spur Suppression

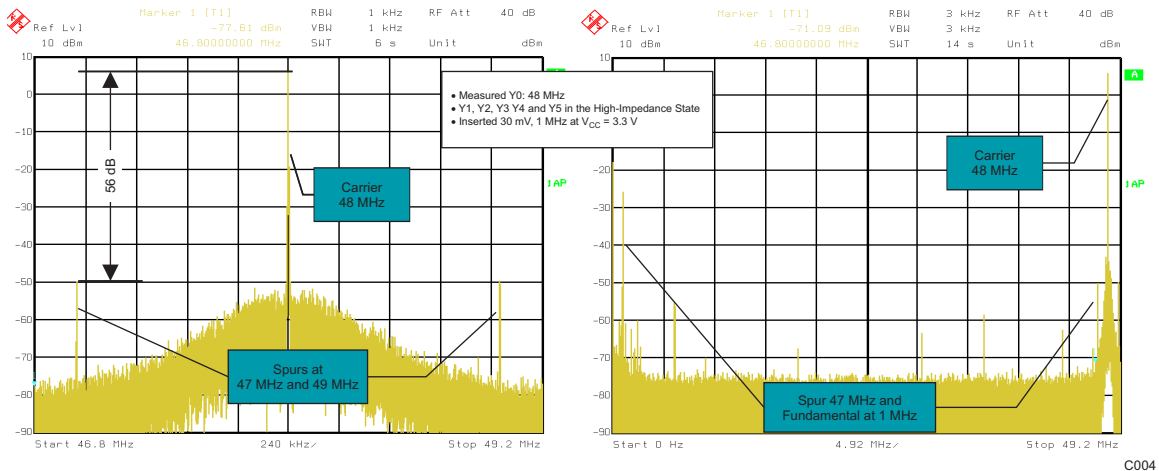


Figure 31. Power-Supply Noise Rejection

### Phase Noise Characteristic

In high-speed communication systems, the phase-noise characteristic of the PLL frequency synthesizer is of high interest. Phase noise describes the stability of the clock signal in the frequency domain, similar to the jitter specification in the time domain.

Phase noise is a result of random and discrete noise causing a broad slope and spurious peaks. The discrete spurious components could be caused by known clock frequencies in the signal source, power line interference, and mixer products. The broadening caused by random noise fluctuation is due to phase noise. It can be the result of thermal noise, shot noise, and/or flicker noise in active and passive devices.

An important factor for the PLL synthesizer is the loop bandwidth (–3-dB cutoff frequency)—large loop bandwidth (LBW) results in fast transient response but less reference spur attenuation. The LBW of the CDCE706 is about 100 kHz to 250 kHz, depending on the selected PLL parameter.

For the CDCE706, two phase-noise characteristics are of interest, the phase noise of the crystal-input stage and the phase noise of the internal PLL (VCO). Figure 32 shows the respective phase noise characteristic.

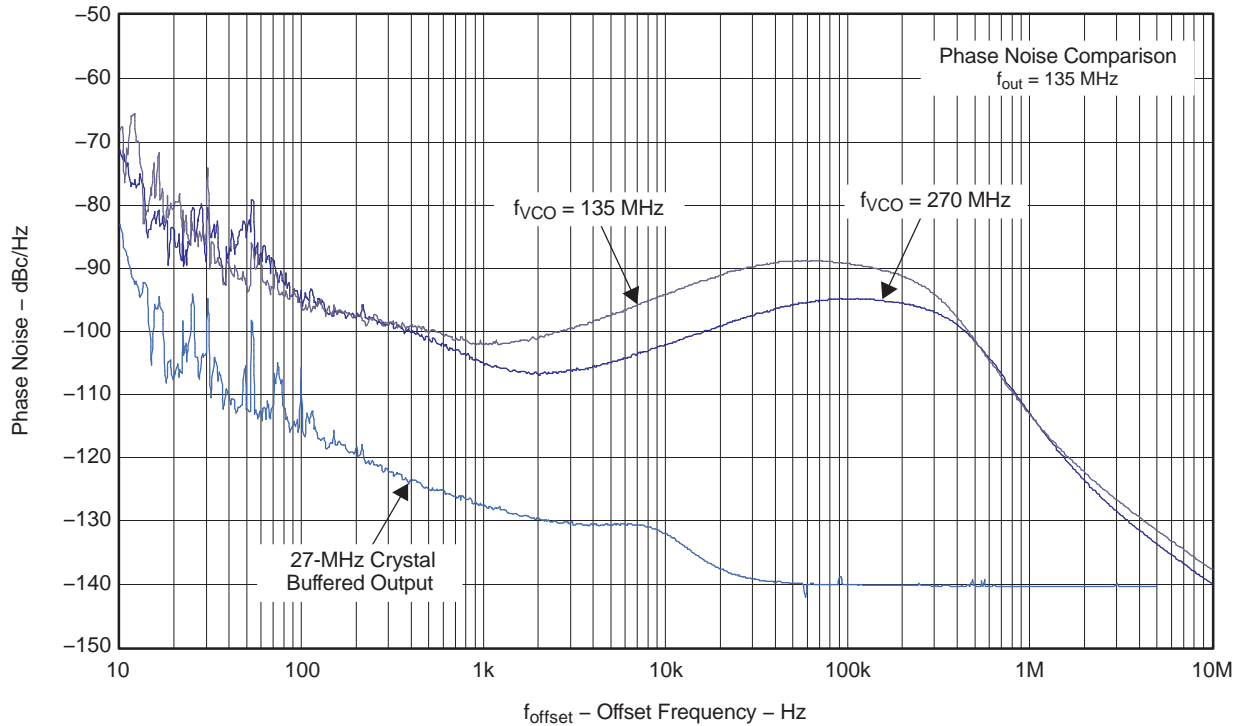


Figure 32. Phase Noise Characteristic

### PLL-Lock Time

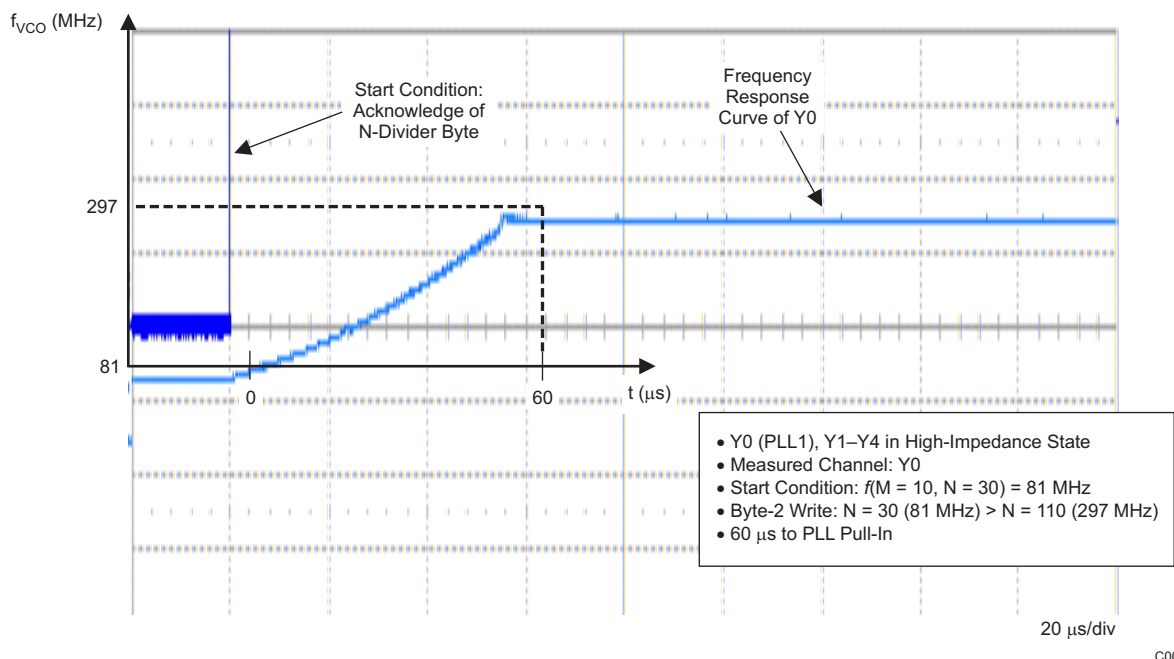
Some applications use frequency switching, e.g., changing frequency in a TV application (switching between channels) or changing the PCI-X frequency in computers. The time spent by the PLL in achieving the new frequency is of main interest. The lock time is the time it takes to jump from one specified frequency to another specified frequency within a given frequency tolerance (see Figure 33). It should be low, because a long lock time impacts the data rate of the system.

The PLL-lock time depends on the device configuration and can be changed by the VCO frequency, i.e., by changing the M/N divider values. Table 7 gives the typical lock times of the CDCE706 and Figure 33 shows a snapshot of a frequency switch.

Table 7. CDCE706 PLL Lock-Times

| Description  | Lock Time          | Unit |
|--|--------------------|------|
| Frequency change via reprogramming of N/M counter                        | 100                | μs   |
| Frequency change via CLK_SEL pin (switching between CLK_IN0 and CLK_IN1) | 100                | μs   |
| Power-up lock time with system clock                                     | 50                 | μs   |
| Power-up lock time with 27-MHz crystal at CLK_IN0 and CLK_IN1            | 300 <sup>(1)</sup> | μs   |

(1) Is the result of crystal lock time (200 μs) and PLL lock time (100 μs).



**Figure 33. Snapshot of the PLL Lock-Time**

### Power-Supply Sequencing

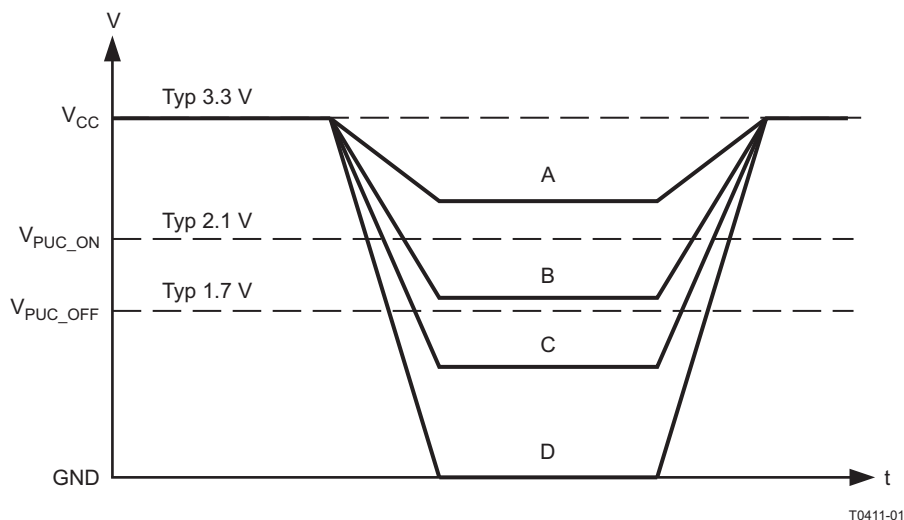
The CDCE706 includes three power-supply pins,  $V_{CC}$ ,  $V_{CCOUT1}$ , and  $V_{CCOUT2}$ . There are no power-supply sequencing requirements, as the three power nodes are separated from each other. So, power can be supplied in any order to the three nodes.

Also, the part has power-up circuitry which switches the device on if  $V_{CC}$  exceeds 2.1 V (typ) and switches the device off at  $V_{CC} < 1.7$  V (typ). In power-down mode, all outputs and clock inputs are switched off.

### Device Behavior During Supply-Voltage Drops

The CDCE706 has a power-up circuit, which activates the device functionality at  $V_{PUC\_ON}$  (typical 2.1 V). At the same time, the EEPROM information is loaded into the register. This mechanism ensures that there is a predefined default after power up and no need to reprogram the CDCE706 in the application.

In the event of a supply-voltage drop, the power-up circuit ensures that there is always a defined setup within the register. [Figure 34](#) shows possible voltage drops with different amplitudes.



**Figure 34. Different Voltage Drops on  $V_{CC}$  During Operation**

The CDCE706 power-up circuit has built-in hysteresis. If the voltage stays above  $V_{PUC\_OFF}$ , which is typically at 1.7 V, the register content stays unchanged. If the voltage drops below  $V_{PUC\_OFF}$ , the internal register is reloaded by the EEPROM after  $V_{PUC\_ON}$  is crossed again.  $V_{PUC\_ON}$  is typically 2.1 V. Table 8 shows the content of the EEPROM and the register after the voltage-drop scenarios shown in Figure 34.

**Table 8. EEPROM and Register Content After  $V_{CC}$  Drop**

| Power Drop | EEPROM Content | Register Content     |
|------------|----------------|----------------------|
| A          | Unchanged      | Unchanged            |
| B          | Unchanged      | Unchanged            |
| C          | Unchanged      | Reloaded from EEPROM |
| D          | Unchanged      | Reloaded from EEPROM |

### EVM and Programming Software

The CDCE706 EVM is a development kit consisting of a performance evaluation module, the TI Pro Clock software, and the User's Guide. Contact a Texas Instruments sales or marketing representative for more information.

**PACKAGING INFORMATION**

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| CDCE706PW        | ACTIVE                | TSSOP        | PW              | 20   | 70          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CDCE706PWG4      | ACTIVE                | TSSOP        | PW              | 20   | 70          | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CDCE706PWR       | ACTIVE                | TSSOP        | PW              | 20   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |
| CDCE706PWRG4     | ACTIVE                | TSSOP        | PW              | 20   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM           |

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

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**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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**TAPE AND REEL INFORMATION**
**REEL DIMENSIONS**

**TAPE DIMENSIONS**


|    |   |
|----|---|
| A0 | Dimension designed to accommodate the component width     |
| B0 | Dimension designed to accommodate the component length    |
| K0 | Dimension designed to accommodate the component thickness |
| W  | Overall width of the carrier tape                         |
| P1 | Pitch between successive cavity centers                   |

**TAPE AND REEL INFORMATION**

\*All dimensions are nominal

| Device     | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| CDCE706PWR | TSSOP        | PW              | 20   | 2000 | 330.0              | 16.4               | 6.95    | 7.1     | 1.6     | 8.0     | 16.0   | Q1            |

**TAPE AND REEL BOX DIMENSIONS**



\*All dimensions are nominal

| Device     | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|------------|--------------|-----------------|------|------|-------------|------------|-------------|
| CDCE706PWR | TSSOP        | PW              | 20   | 2000 | 367.0       | 367.0      | 38.0        |



PW (R-PDSO-G20)

PLASTIC SMALL OUTLINE



4040064-5/G 02/11

- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
  - D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
  - E. Falls within JEDEC MO-153

PW (R-PDSO-G20)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-7351 is recommended for alternate design.
  - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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| Computers and Peripherals     | <a href="http://www.ti.com/computers">www.ti.com/computers</a>                           |
| Consumer Electronics          | <a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>                   |
| Energy and Lighting           | <a href="http://www.ti.com/energy">www.ti.com/energy</a>                                 |
| Industrial                    | <a href="http://www.ti.com/industrial">www.ti.com/industrial</a>                         |
| Medical                       | <a href="http://www.ti.com/medical">www.ti.com/medical</a>                               |
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