

3.3-V DUAL-PLL MULTICLOCK GENERATOR

Check for Samples: [PLL1707-Q1](#)

FEATURES

- Qualified for Automotive Applications
- 27-MHz Master Clock Input
- Generated Audio System Clock
 - SCKO0: $768 f_S$ ($f_S = 44.1$ kHz)
 - SCKO1: $768 f_S$, $512 f_S$ ($f_S = 48$ kHz)
 - SCKO2: $256 f_S$ ($f_S = 32, 44.1, 48, 64, 88.2, 96$ kHz)
 - SCKO3: $384 f_S$ ($f_S = 32, 44.1, 48, 64, 88.2, 96$ kHz)
- Zero PPM Error Output Clocks
- Low Clock Jitter: 50 ps (Typical)
- Multiple Sampling Frequencies:
 $f_S = 32, 44.1, 48, 64, 88.2, 96$ kHz

- 3.3-V Single Power Supply
- Parallel Control
- Package: 20-Pin SSOP (150 mil), Lead-Free Product

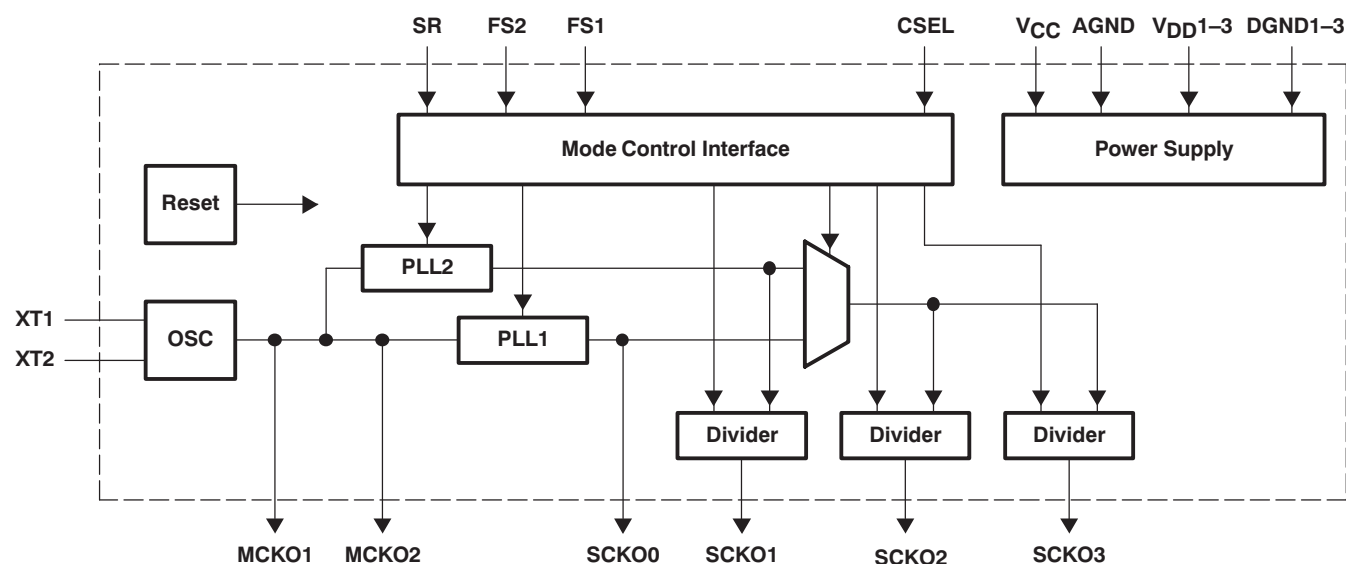
APPLICATIONS

- HDD + DVD Recorders
- DVD Recorders
- HDD Recorders
- DVD Players
- DVD Add-On Cards for Multimedia PCs
- Digital HDTV Systems
- Set-Top Boxes

DESCRIPTION

The PLL1707 is a low-cost phase-locked loop (PLL) multiclock generator. The PLL1707 can generate four system clocks from a 27-MHz reference input frequency. The clock outputs of the PLL1707 can be controlled by sampling frequency-control pins. The device gives customers both cost and space savings by eliminating external components and enables customers to achieve the very low-jitter performance needed for high performance audio DACs and/or ADCs. The PLL1707 is ideal for MPEG-2 applications that use a 27-MHz master clock such as DVD recorders, HDD recorders, DVD add-on cards for multimedia PCs, digital HDTV systems, and set-top boxes.

FUNCTIONAL BLOCK DIAGRAM



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.



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

ORDERING INFORMATION⁽¹⁾

| T _A | PACKAGE ⁽²⁾ | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|----------------|------------------------|--------------|-----------------------|------------------|
| -40°C to 85°C | SSOP - DBQ | Reel of 2500 | PLL1707IDBQRQ1 | PLL1707I |

- (1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.
 (2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

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

| | | |
|------------------|----------------------------------------------------------------|-------------------------------------|
| V _{CC} | Supply voltage: V _{DD1} -V _{DD3} | 4 V |
| ΔV _{CC} | Supply voltage differences: V _{DD1} -V _{DD3} | ±0.1 V |
| | Ground voltage differences: AGND, DGND1-DGND3 | ±0.1 V |
| V _I | Digital input voltage: FS1, FS2, SR, CSEL | -0.3 V to (V _{DD} + 0.3) V |
| V _I | Analog input voltage, XT1, XT2 | -0.3 V to (V _{CC} + 0.3) V |
| I _I | Input current (any pins except supplies) | ±10 mA |
| T _A | Ambient temperature range | -40°C to 85°C |
| T _{stg} | Storage temperature | -55°C to 150°C |
| T _J | Junction temperature | 150°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.

ELECTRICAL CHARACTERISTICS

T_A = 25°C, V_{DD1}-V_{DD3} (= V_{DD}) = V_{CC} = 3.3 V, f_M = 27 MHz, crystal oscillation, f_S = 48 kHz (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|-----------------------------|--------------------------------------|-----------------------------------|-----------------------|---------------------|-----|------|
| DIGITAL INPUT/OUTPUT | | | | | | |
| Logic input | | | CMOS compatible | | | |
| V _{IH} | Input logic level ⁽¹⁾ | | 0.7 V _{DD} | | 3.6 | Vdc |
| V _{IL} | | | | 0.3 V _{DD} | | |
| I _{IH} | Input logic current ⁽¹⁾ | V _{IN} = V _{DD} | | 65 | 100 | μA |
| I _{IL} | | V _{IN} = 0 V | | | ±10 | |
| Logic output | | | CMOS | | | |
| V _{OH} | Output logic level ⁽²⁾⁽³⁾ | I _{OH} = -4 mA | V _{DD} - 0.4 | | | Vdc |
| V _{OL} | | I _{OL} = 4 mA | | | 0.4 | Vdc |
| Sampling frequency | | Standard f _S | 32 | 44.1 | 48 | kHz |
| | | Double f _S | 64 | 88.2 | 96 | |

- (1) Pins 5, 6, 7, 12: FS1, FS2, SR, CSEL (Schmitt-trigger input with internal pulldown, 3.3-V tolerant)
 (2) Pins 2, 3, 14, 15, 18, 19: SCKO2, SCKO3, MCKO1, MCKO2, SCKO0, SCKO1
 (3) Not production tested

ELECTRICAL CHARACTERISTICS (continued)
 $T_A = 25^\circ\text{C}$, $V_{DD1}\text{-}V_{DD3} (= V_{DD}) = V_{CC} = 3.3\text{ V}$, $f_M = 27\text{ MHz}$, crystal oscillation, $f_S = 48\text{ kHz}$ (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|----------------------------------------------------------|--------------|--------|--------------|--------------------|
| MASTER CLOCK (MCKO1, MCKO2) ($f_M = 27\text{ MHz}$, $C_1 = C_2 = 15\text{ pF}$, $C_L = 20\text{ pF}$ on measurement pin) | | | | | | |
| Master clock frequency | | | 26.73 | 27 | 27.27 | MHz |
| V_{IH} | Input level ⁽⁴⁾⁽⁵⁾ | | 0.7 V_{CC} | | 0.3 V_{CC} | V |
| V_{IL} | | | | | | |
| I_{IH} | Input current ⁽⁴⁾ | $V_{IN} = V_{CC}$ | | | ± 10 | μA |
| I_{IL} | | $V_{IN} = 0\text{ V}$ | | | ± 10 | |
| Output voltage ⁽⁶⁾ | | | 3.5 | | | Vp-p |
| Output rise time | | 20% to 80% of V_{DD} | 2 | | | ns |
| Output fall time | | 80% to 20% of V_{DD} | 2 | | | ns |
| Duty cycle | | For crystal oscillation | 45 | 51 | 55 | % |
| | | For external clock | 50 | | | |
| Clock jitter ⁽⁷⁾ | | | 50 | | | ps |
| Power-up time ⁽⁸⁾ | | | 0.5 | | 1.5 | ms |
| PLL AC CHARACTERISTICS (SCKO0-SCKO3) ($f_M = 27\text{ MHz}$, $C_L = 20\text{ pF}$ on measurement pin) | | | | | | |
| SCKO0 | Output system clock frequency ⁽⁹⁾ | Fixed | 33.8688 | | | MHz |
| SCKO1 | | Selectable for 48 kHz | 24.576 | | 36.864 | |
| SCKO2 | | 256 f_S | 8.192 | 12.288 | 24.576 | |
| SCKO3 | | 384 f_S | 12.288 | 18.432 | 36.864 | |
| Output rise time | | 20% to 80% of V_{DD} | 2 | | | ns |
| Output fall time | | 80% to 20% of V_{DD} | 2 | | | ns |
| Output duty cycle | | | 45 | 50 | 55 | % |
| Output clock jitter ⁽⁷⁾⁽⁵⁾ | | SCKO0, SCKO1 | 58 | | 100 | ps |
| | | SCKO2, SCKO3 | 50 | | 100 | ps |
| Frequency settling time ⁽¹⁰⁾ | | To stated output frequency | 50 | | 150 | ns |
| Power-up time ⁽¹¹⁾ | | To stated output frequency | 3 | | 6 | ms |
| POWER SUPPLY | | | | | | |
| V_{CC} , V_{DD} | Supply voltage | | 2.7 | 3.3 | 3.6 | V |
| $I_{DD} + I_{CC}$ | Supply current ⁽¹²⁾ | $V_{DD} = V_{CC} = 3.3\text{ V}$, $f_S = 48\text{ kHz}$ | 19 | | 35 | mA |
| | Power dissipation | $V_{DD} = V_{CC} = 3.3\text{ V}$, $f_S = 48\text{ kHz}$ | 63 | | 130 | mW |
| TEMPERATURE | | | | | | |
| | Operating temperature | | -40 | | 85 | $^\circ\text{C}$ |
| θ_{JA} | Thermal resistance | | 150 | | | $^\circ\text{C/W}$ |

(4) Pin 10: XT1

(5) Not production tested

(6) Pin 11: XT2

(7) Jitter performance is specified as standard deviation of jitter for 27-MHz crystal oscillation and default SCKO frequency setting. Jitter performance varies with master clock mode, SCKO frequency setting and load capacitance on each clock output.

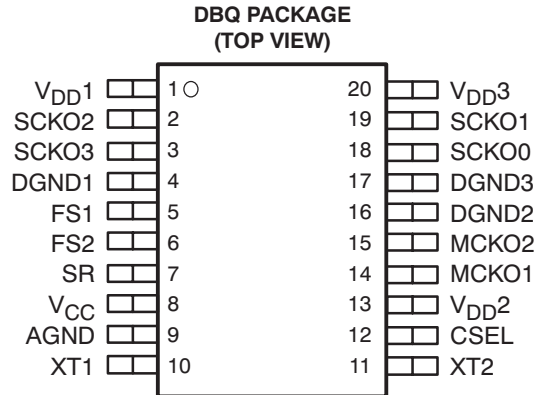
(8) The delay time from power on to oscillation

(9) The MIN and MAX values are the low and high selectable frequencies based on frequency (f_S) selected (see [Table 2](#) through [Table 4](#))

(10) The settling time when the sampling frequency is changed

(11) The delay time from power on to lockup

(12) $f_M = 27\text{-MHz}$ crystal oscillation, no load on MCKO1, MCKO2, SCKO0, SCKO1, SCKO2, SCKO3. Power supply current varies with sampling frequency selection and load condition.



TERMINAL FUNCTIONS

| TERMINAL | | I/O | DESCRIPTION |
|-----------------|-----|-----|-----------------------------------------------------------------------|
| NAME | NO. | | |
| AGND | 9 | - | Analog ground |
| CSEL | 12 | I | SCKO1 frequency selection control(1) |
| DGND1 | 4 | - | Digital ground 1 |
| DGND2 | 16 | - | Digital ground 2 |
| DGND3 | 17 | - | Digital ground 3 |
| FS1 | 5 | I | Sampling frequency group control 1(1) |
| FS2 | 6 | I | Sampling frequency group control 2(1) |
| MCKO1 | 14 | O | 27-MHz master clock output 1 |
| MCKO2 | 15 | O | 27-MHz master clock output 2 |
| SCKO0 | 18 | O | System clock output 0 (33.8688 MHz fixed) |
| SCKO1 | 19 | O | System clock output 1 (selectable for 48 kHz) |
| SCKO2 | 2 | O | System clock output 2 (256 f _S selectable) |
| SCKO3 | 3 | O | System clock output 3 (384 f _S selectable) |
| SR | 7 | I | Sampling rate control(1) |
| V _{CC} | 8 | - | Analog power supply, 3.3 V |
| VDD1 | 1 | - | Digital power supply 1, 3.3 V |
| VDD2 | 13 | - | Digital power supply 2, 3.3 V |
| VDD3 | 20 | - | Digital power supply 3, 3.3 V |
| XT1 | 10 | I | 27-MHz crystal oscillator, or external clock input |
| XT2 | 11 | O | 27-MHz crystal oscillator, must be OPEN for external clock input mode |

TYPICAL PERFORMANCE CURVES

All specifications at $T_A = 25^\circ\text{C}$, $V_{DD1-3} (= V_{DD}) = V_{CC} = +3.3\text{ V}$, $f_M = 27\text{ MHz}$, crystal oscillation, $C_1, C_2 = 15\text{ pF}$, default frequency (33.8688 MHz for SCKO0, 36.864 MHz for SCKO1, $256 f_S$ and $384 f_S$ of 48 kHz for SCKO2 and SCKO3), $C_L = 20\text{ pF}$ on measurement pin, unless otherwise noted.

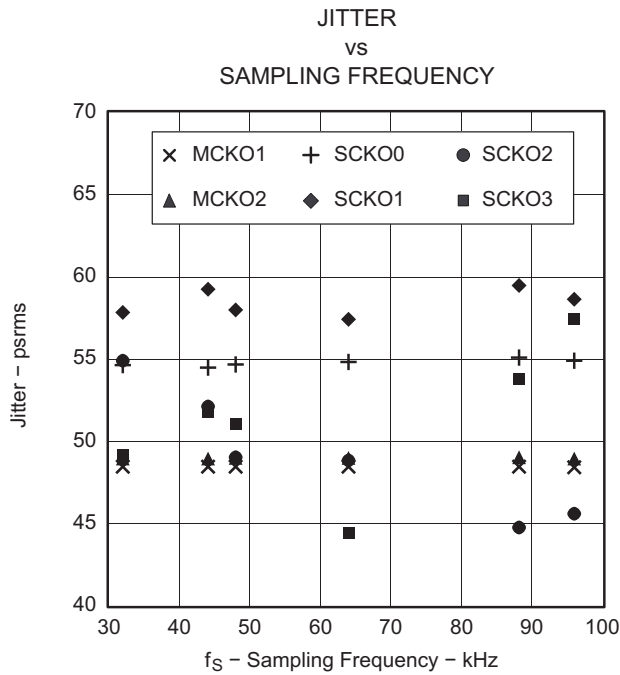


Figure 1.

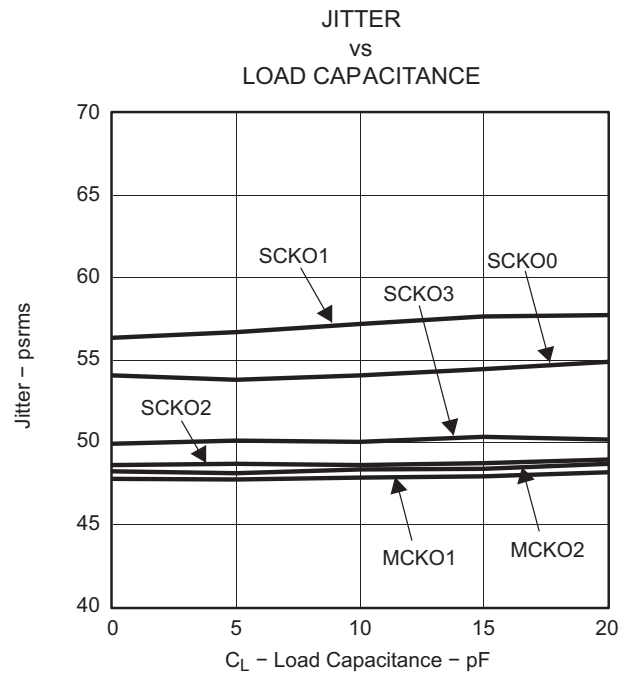


Figure 2.

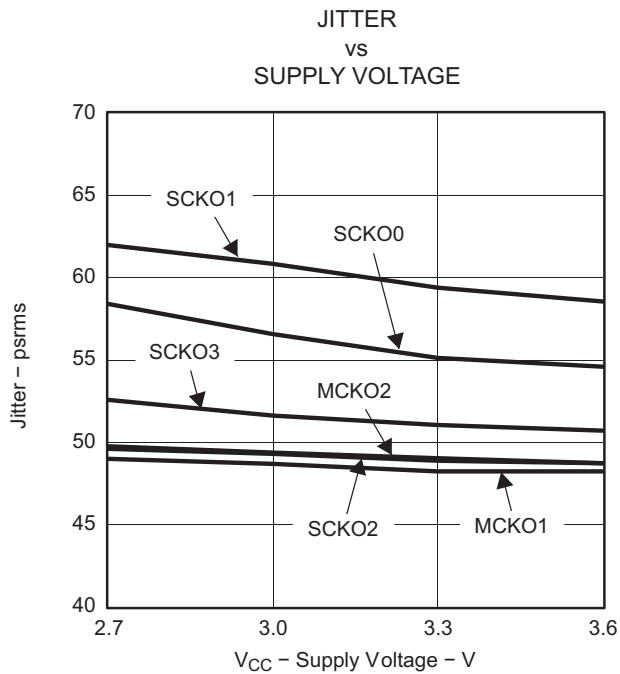


Figure 3.

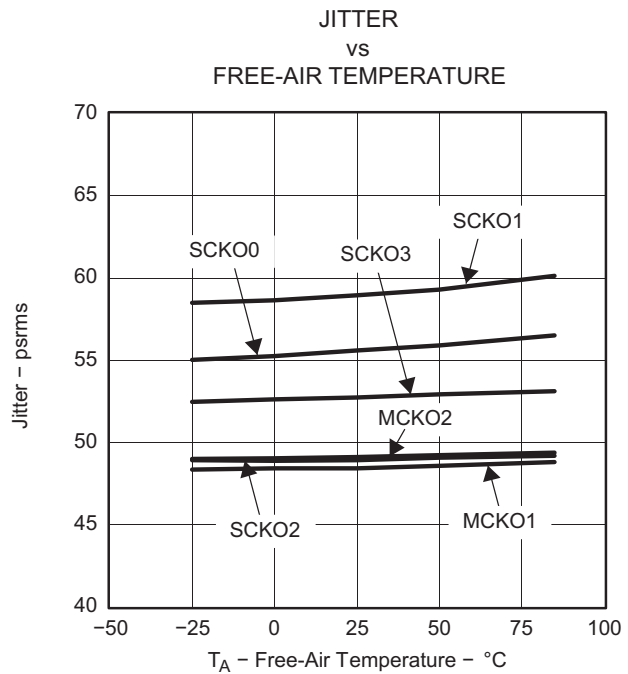


Figure 4.

TYPICAL PERFORMANCE CURVES (continued)

All specifications at $T_A = 25^\circ\text{C}$, $V_{DD1-3} (= V_{DD}) = V_{CC} = +3.3\text{ V}$, $f_M = 27\text{ MHz}$, crystal oscillation, $C_1, C_2 = 15\text{ pF}$, default frequency (33.8688 MHz for SCKO0, 36.864 MHz for SCKO1, 256 f_S and 384 f_S of 48 kHz for SCKO2 and SCKO3), $C_L = 20\text{ pF}$ on measurement pin, unless otherwise noted.

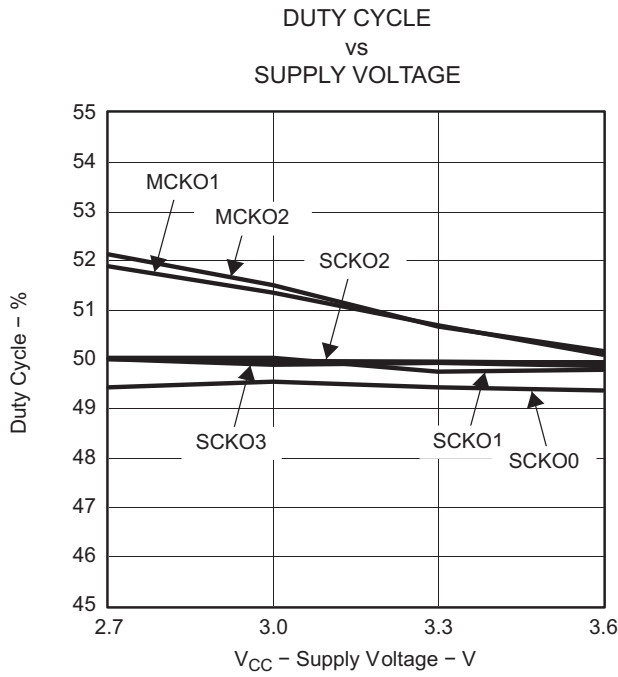


Figure 5.

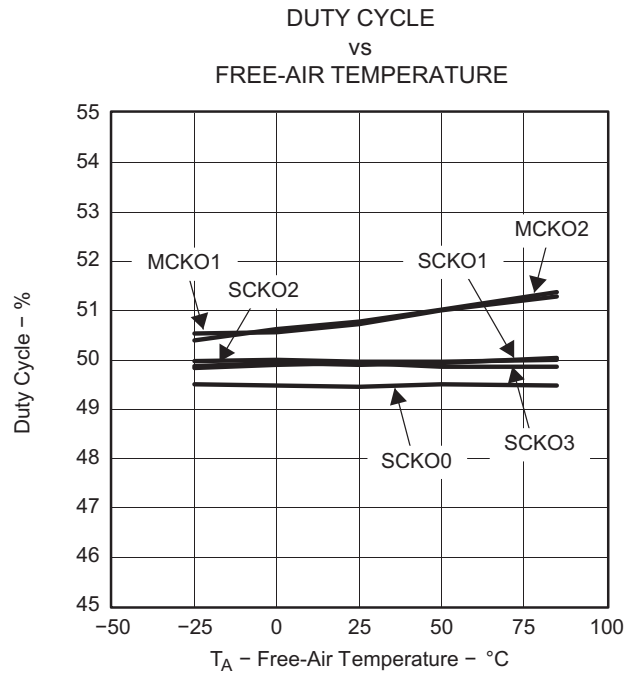


Figure 6.

THEORY OF OPERATION

Master Clock and System Clock Output

The PLL1707 consists of a dual PLL clock and master clock generator which generates four system clocks and two buffered 27-MHz clocks from a 27-MHz master clock. Figure 7 shows the block diagram of the PLL1707. The PLL is designed to accept a 27-MHz master clock.

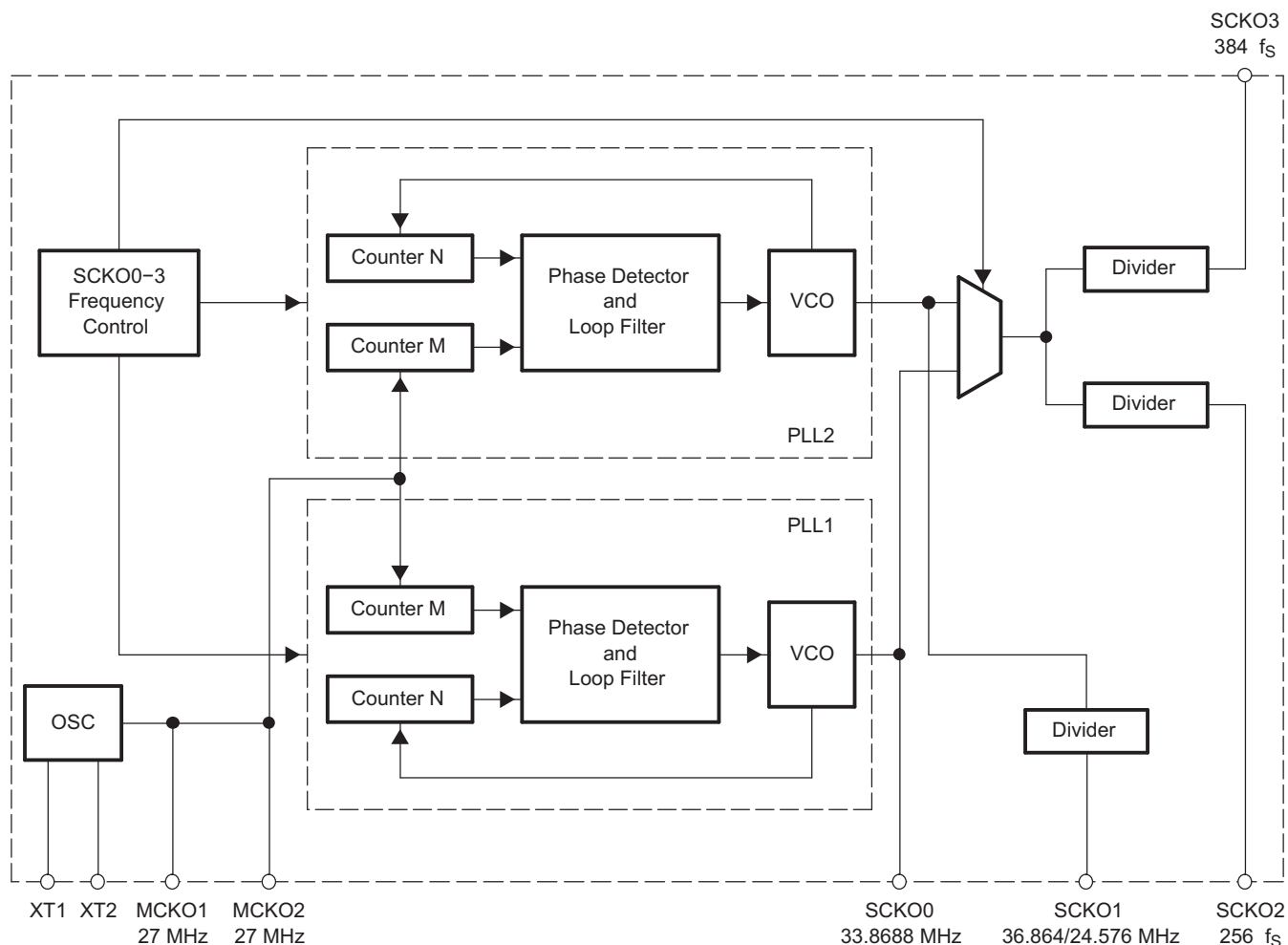


Figure 7. Block Diagram

The master clock can be either a crystal oscillator placed between XT1 (pin 10) and XT2 (pin 11), or an external input to XT1. If an external master clock is used, XT2 must be open. Figure 8 illustrates possible system clock connection options, and Figure 9 illustrates the 27-MHz master clock timing requirement.

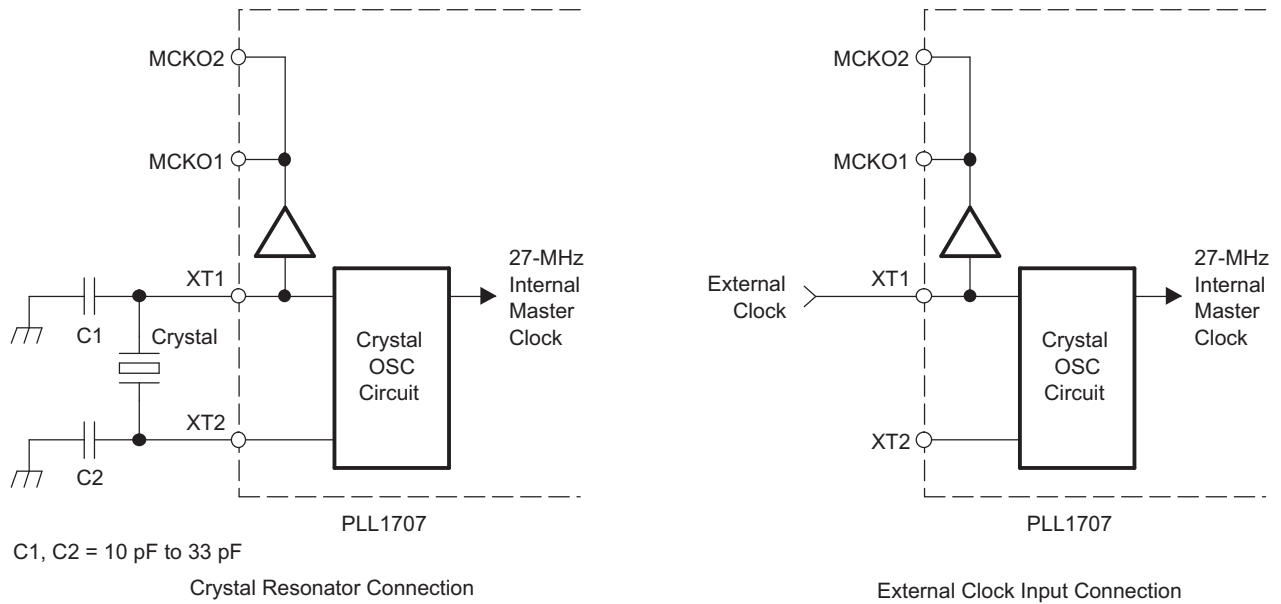


Figure 8. Master Clock Generator Connection Diagram

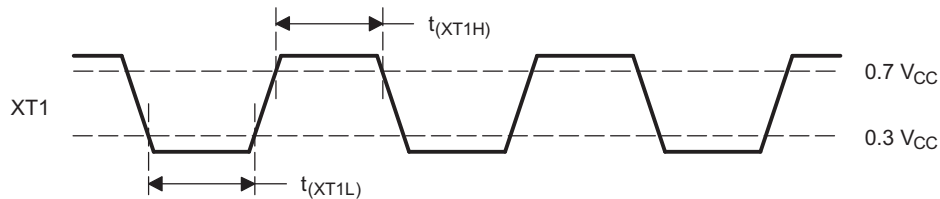


Figure 9. External Master Clock Timing Requirements

Table 1. External Master Clock Timing Requirements

| DESCRIPTION | SYMBOL | MIN | MAX | UNIT |
|----------------------------------|--------------|-----|-----|------|
| Master clock pulse duration HIGH | $t_{(XT1H)}$ | 10 | | ns |
| Master clock pulse duration LOW | $t_{(XT1L)}$ | 10 | | ns |

The PLL1707 provides a very low-jitter high-accuracy clock. SCKO0 outputs a fixed 33.8688-MHz clock, SCKO1 outputs $512 f_s$ or $768 f_s$ ($f_s = 48 \text{ kHz}$), which is selected by hardware or software control (see Table 2). The output frequency of the remaining clocks is determined by the sampling frequency (f_s) under hardware or software control. SCKO2 and SCKO3 output $256\text{-}f_s$ and $384\text{-}f_s$ system clocks, respectively. Table 3 shows each sampling frequency which can be programmed. The system clock output frequencies for programmed sampling frequencies are shown in Table 4.

Table 2. Generated System Clock SCKO1 Frequency

| f_s | SCKO1 FREQUENCY |
|-----------|-----------------|
| $512 f_s$ | 24.576 MHz |
| $768 f_s$ | 36.864 MHz |

Table 3. Sampling Frequencies

| SAMPLING RATE | SAMPLING FREQUENCY (kHz) | | |
|-------------------------------|--------------------------|------|----|
| Standard sampling frequencies | 32 | 44.1 | 48 |
| Double sampling frequencies | 64 | 88.2 | 96 |

Table 4. Sampling Frequencies and System Clock Output Frequencies

| SAMPLING FREQUENCY (kHz) | SAMPLING RATE | 256 f _S SCKO2 (MHZ) | 384 f _S SCKO3 (MHZ) |
|--------------------------|---------------|--------------------------------|--------------------------------|
| 32 | Standard | 8.192 | 12.288 |
| 44.1 | Standard | 11.2896 | 16.9344 |
| 48 | Standard | 12.288 | 18.432 |
| 64 | Double | 16.384 | 24.576 |
| 88.2 | Double | 22.5792 | 33.8688 |
| 96 | Double | 24.576 | 36.864 |

Response time from power on (or applying the clock to XT1) to SCKO settling time is typically 3 ms. Delay time from sampling frequency change to SCKO settling is 300 ns maximum.

The delay time for hardware control to use SR, FS2, FS1, or CSEL is 150 ns maximum. Figure 10 illustrates SCKO transient timing in the PLL1707. Clock transient timing is not synchronized with the SCKOs. External buffers are recommended on all output clocks in order to avoid degrading the jitter performance of the PLL1707.

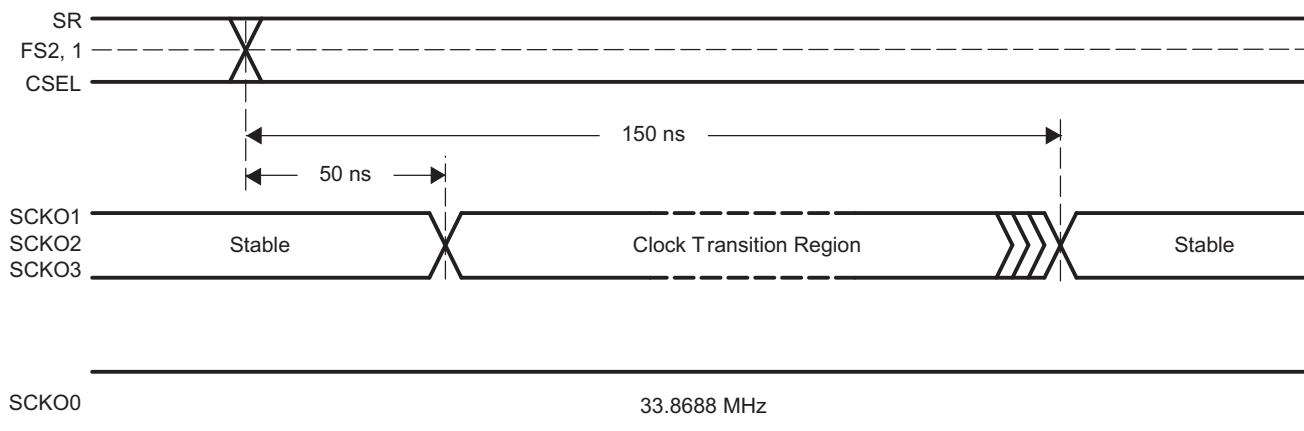


Figure 10. SCKO Transient Timing

Power-On Reset

The PLL1707 has an internal power-on reset circuit. Throughout the reset period, all clock outputs are enabled with the default settings after power-up time. Initialization by internal power-on reset is done automatically during 1024 master clocks at V_{DD} > 2.0 V (TYP). Power-on reset timing is shown in Figure 11.

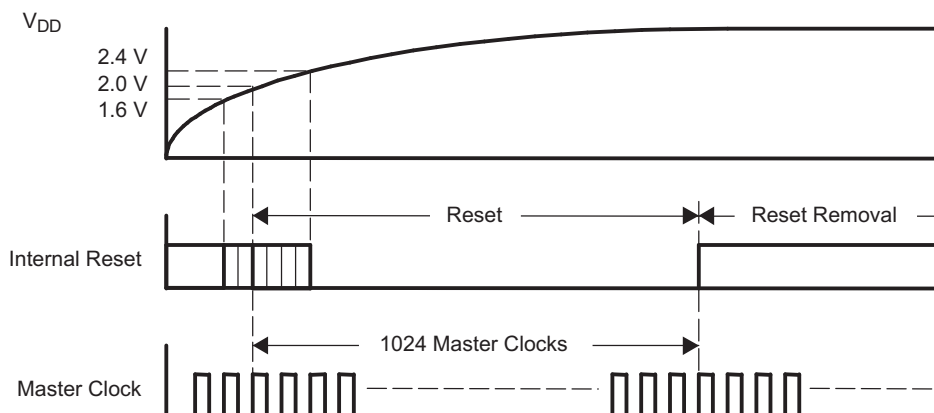


Figure 11. Power-On Reset Timing

Functional Control

The built-in functions of the PLL1707 can be controlled in the parallel mode (hardware mode), which uses SR (pin 7), FS1 (pin 5) and FS2 (pin 6). The selectable functions are shown in [Table 5](#).

Table 5. Selectable Functions

| SELECTABLE FUNCTION | PARALLEL MODE |
|------------------------------------------------------|---------------|
| Sampling frequency select (32 kHz, 44.1 kHz, 48 kHz) | Yes |
| Sampling rate select (standard/double) | Yes |

PLL1707 (Parallel Mode)

In the parallel mode, the following functions can be selected:

Sampling Frequency Group Select

The sampling frequency group can be selected by FS1 (pin 5) and FS2 (pin 6).

Table 6. Sampling Frequency Group Select

| FS2 (PIN 6) | FS1 (PIN 5) | SAMPLING FREQUENCY |
|-------------|-------------|--------------------|
| LOW | LOW | 48 kHz |
| LOW | HIGH | 44.1 kHz |
| HIGH | LOW | 32 kHz |
| HIGH | HIGH | Reserved |

Sampling Rate Select

The sampling rate can be selected by SR (pin 7)

Table 7. Sampling Rate Select

| SR (PIN 7) | SAMPLING RATE |
|------------|---------------|
| LOW | Standard |
| HIGH | Double |

System Clock SCKO1 Frequency Select

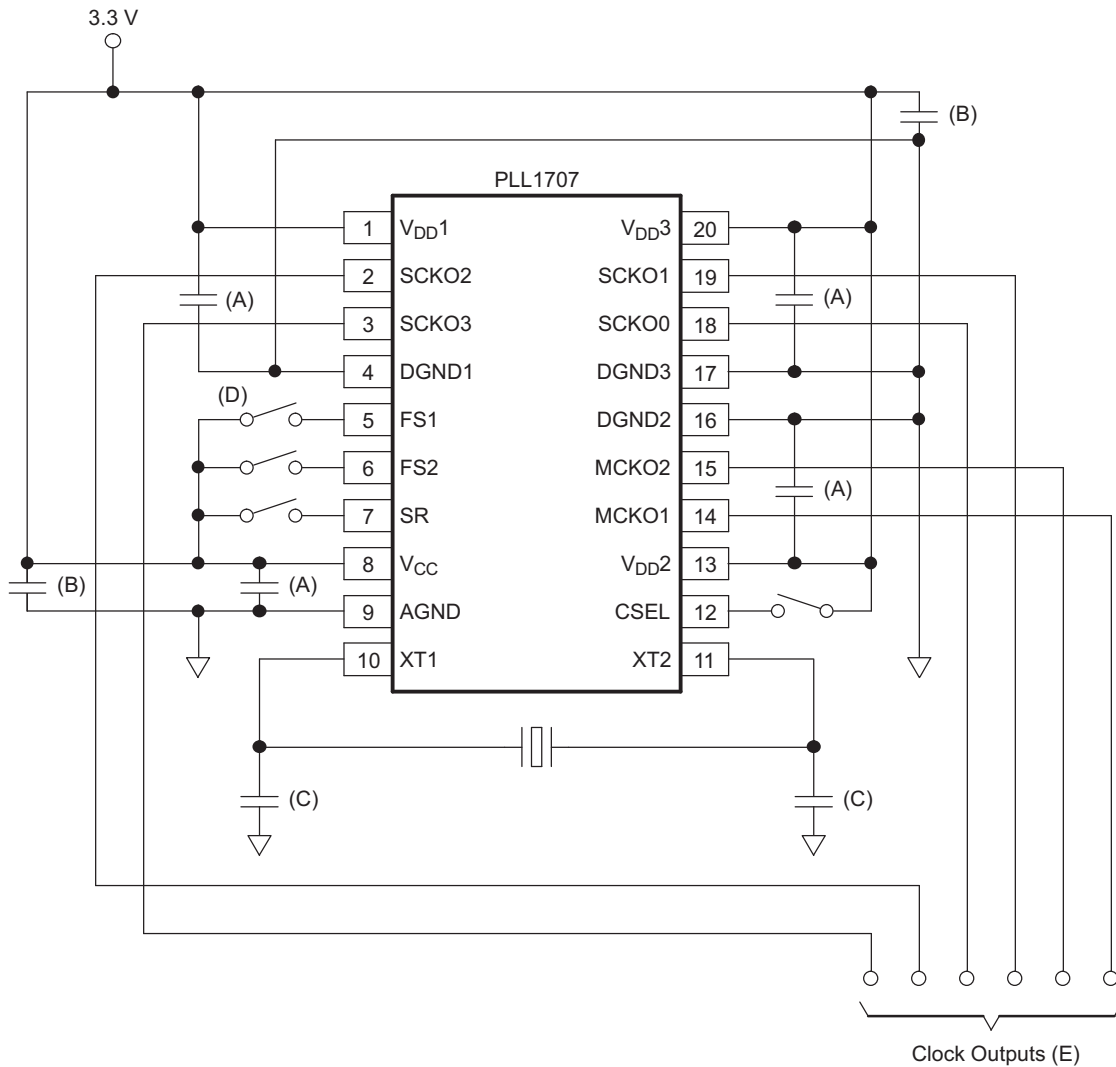
System clock SCKO1 frequency can be selected by CSEL (pin 12).

Table 8. System Clock SCKO1 Frequency Select

| CSEL (PIN 12) | SCKO1 FREQUENCY |
|---------------|-----------------|
| LOW | 36.864 MHz |
| HIGH | 24.576 MHz |

Connection Diagram

Figure 12 shows the typical connection circuit for the PLL1707. There are four grounds for digital and analog power supplies. However, the use of one common ground connection is recommended to avoid latch-up or other power-supply-related troubles. Power supplies should be bypassed as close as possible to the device.



- A. 0.1- μ F ceramic capacitor typical, depending on quality of power supply and pattern layout
- B. 10- μ F aluminum electrolytic capacitor typical, depending on quality of power supply and pattern layout
- C. 27-MHz quartz crystal and 10 pF to 33 pF \times 2 ceramic capacitors, which generate the appropriate amplitude of oscillation on XT1/XT2
- D. This connection is for PLL1707 (parallel mode)
- E. For good jitter performance, minimize the load capacitance on the clock output. It is recommended to drive the clock outputs through buffers, especially if there are heavy loads on SCKO0 and SCKO1, and to minimize mutual interference by separating them or inserting a guard pattern between them.

Figure 12. Typical Connection Diagram

MPEG-2 Applications

Typical applications for the PLL1707 are MPEG-2 based systems such as DVD recorders, HDD recorders, DVD players, DVD add-on cards for multimedia PCs, digital HDTV systems, and set-top boxes. The PLL1707 provides audio system clocks for a CD-DA DSP, DVD DSP, Karaoke DSP, ADC(s), and DAC(s) from a 27-MHz video clock.

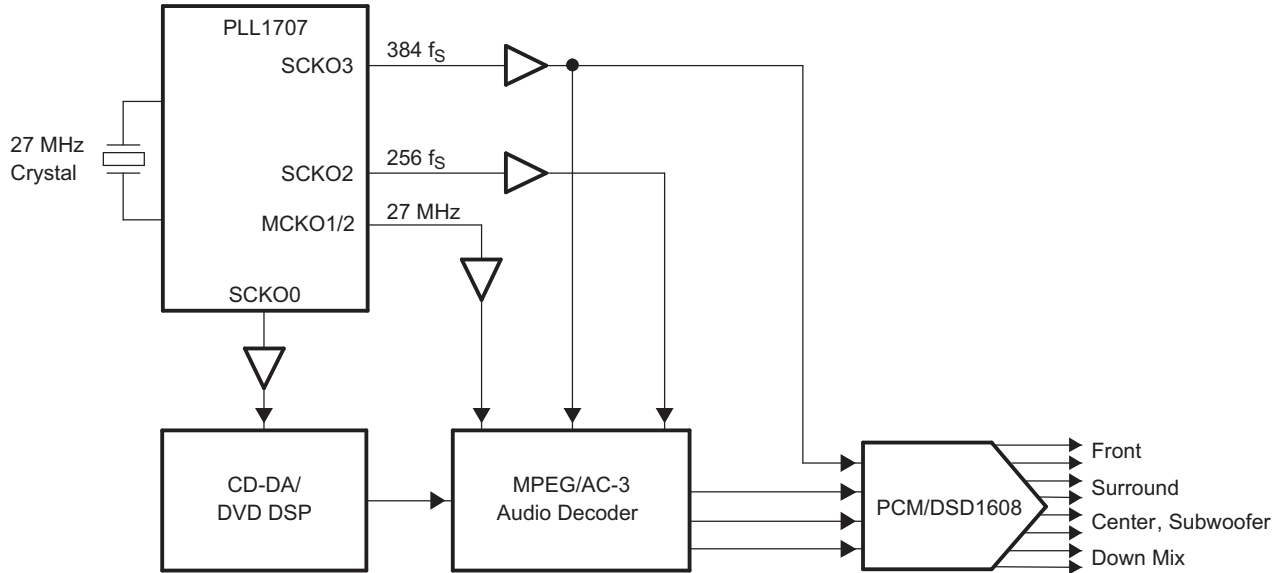


Figure 13. Block Diagram of DVD Player Application

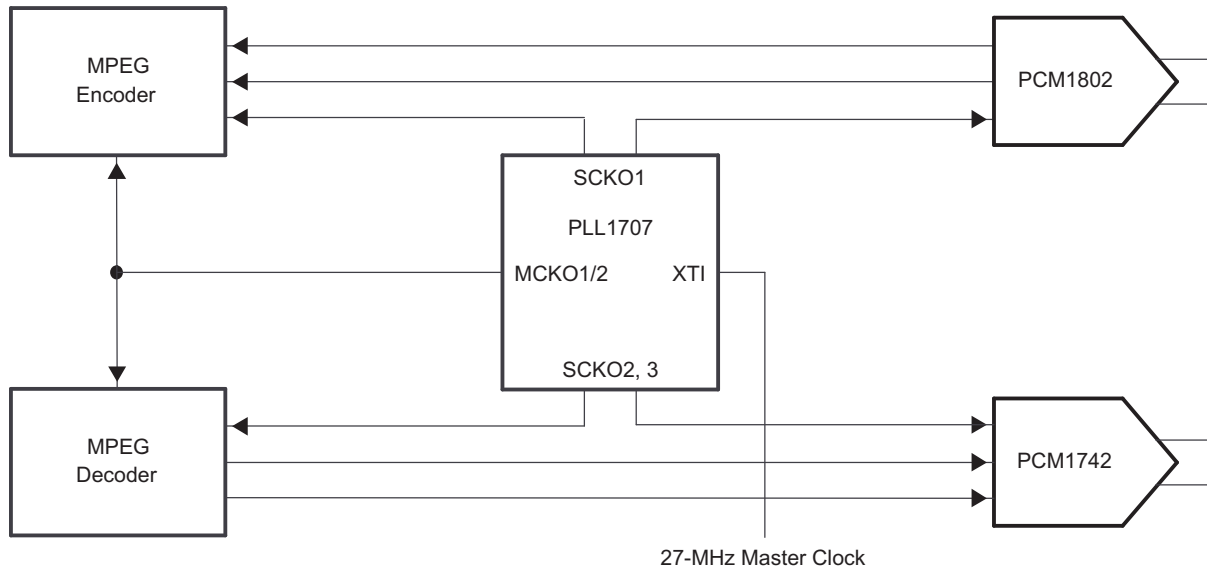


Figure 14. Block Diagram of HDD+DVD Recorder Application

PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/ Ball Finish | MSL Peak Temp ⁽³⁾ | Samples (Requires Login) |
|------------------|-----------------------|--------------|-----------------|------|-------------|----------------------------|----------------------|------------------------------|-----------------------------|
| PLL1707IDBQRQ1 | ACTIVE | SSOP/QSOP | DBQ | 20 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR | |

⁽¹⁾ 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.

⁽²⁾ 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.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

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)

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

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In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

OTHER QUALIFIED VERSIONS OF PLL1707-Q1 :

- Catalog: [PLL1707](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION



QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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 |
|----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| PLL1707IDBQRQ1 | SSOP/QSOP | DBQ | 20 | 2000 | 330.0 | 16.4 | 6.5 | 9.0 | 2.1 | 8.0 | 16.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS

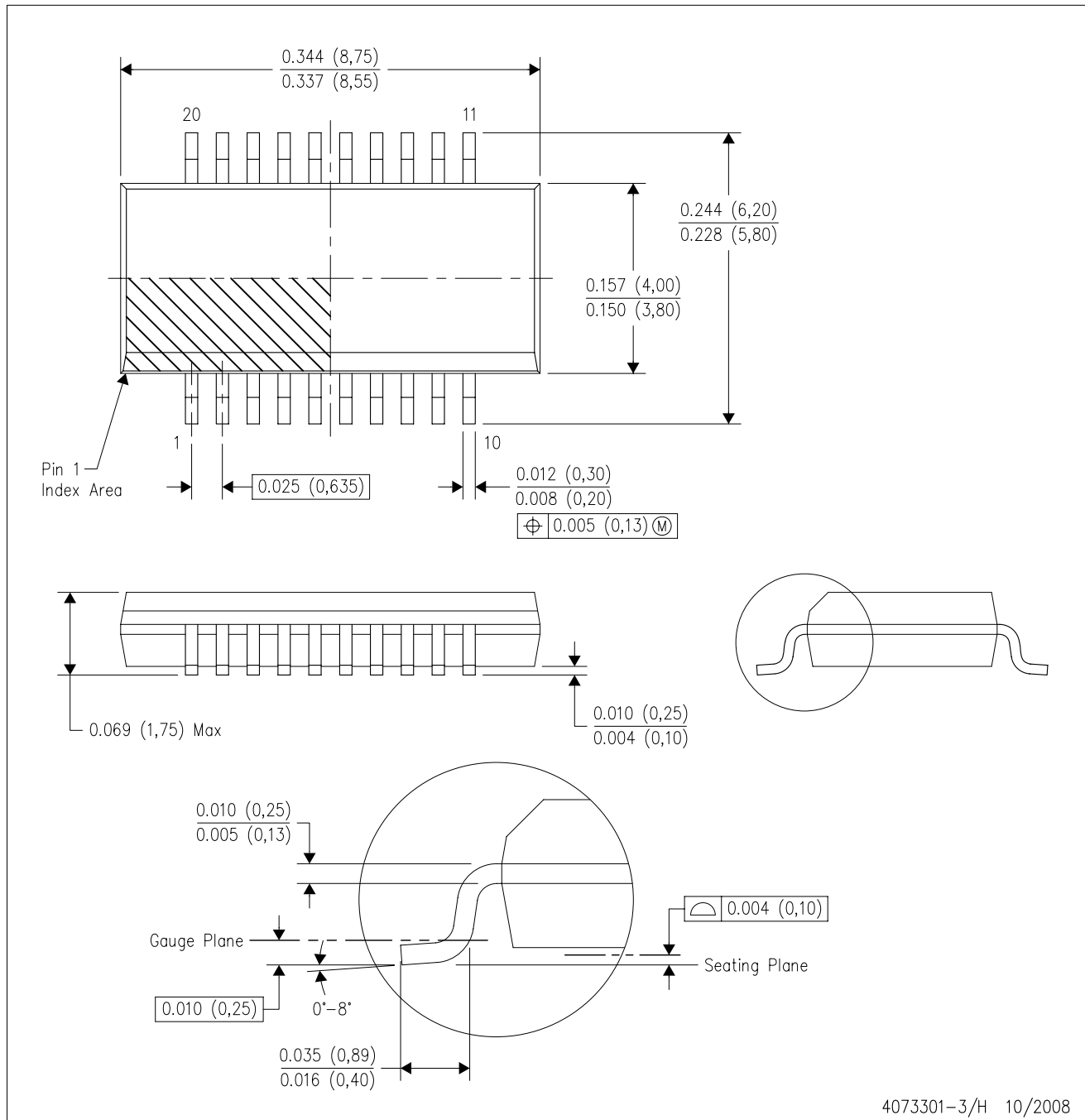


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| PLL1707IDBQRQ1 | SSOP/QSOP | DBQ | 20 | 2000 | 346.0 | 346.0 | 33.0 |

DBQ (R-PDSO-G20)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15) per side.
 - D. Falls within JEDEC MO-137 variation AD.

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