

CD/MP3/WMA Audio Controller

Features

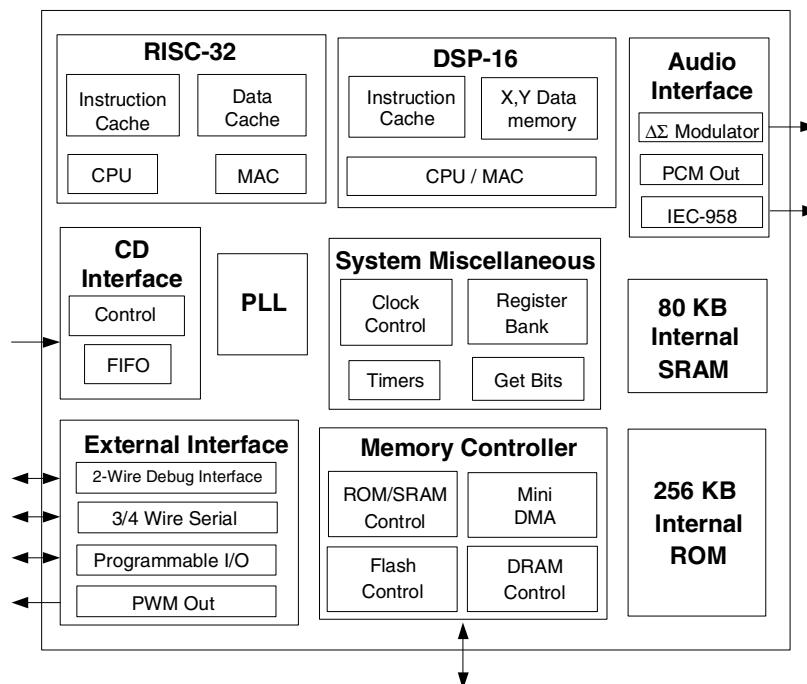
- Super on-chip Integration for low cost and low count bill of materials
- 32-Bit RISC Processor performs audio decode and system management functions
- 16-bit DSP for audio special effects
- 80 Kbytes internal SRAM, and 256 Kbytes internal ROM
- Interfaces to external SDRAM or EDO DRAM (for shock protection), and to external ROM/FLASH (for custom program storage)
- CD serial interface with advanced pattern matching and software error handling
- Integrated DAC functionality
- Simultaneous 4 channels PCM audio output and IEC-958 output.
- Large number of GPIO pins for servo control, key scan, LCD control, etc.
- Three serial control/status ports
- Sophisticated clock management and low power consumption
- Supports ISO9660 and multi-session write methods
- Low power 0.18 micron technology
- 100-pin MQFP package
- 100-pin LQFP package

Description

The CS7410 is a true system-on-a-chip for the CD-based digital audio market. With a powerful RISC processor, one DSP, integrated audio $\Delta\Sigma$ modulator, large internal SRAM and program ROM, and glueless interface to popular CD chip sets, the CS7410 is a complete single chip low-power programmable audio decoder. This powerful architecture is easily capable of MP3, WMA, and other future audio formats. The CS7410's flexible architecture and low power consumption make it an ideal low-cost solution for a wide range of player applications. For portable audio systems, the memory interface can be used to add DRAM or SRAM for Electronic Shock Protection (ESP). A flexible set of interfaces are available for end-user I/O such as a keypad and LCD control for use in mass market CD players, boom boxes, and shelf-top systems.

ORDERING INFORMATION

CS7410-CM 0° to 70° C 100-pin MQFP
 CS7410-CQ 0° to 70° C 100-pin LQFP



Preliminary Product Information

This document contains information for a new product. Cirrus Logic reserves the right to modify this product without notice.

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1. CHARACTERISTICS AND SPECIFICATIONS

1.1 AC AND DC PARAMETRIC SPECIFICATIONS

(AGND, DGND=0V, all voltages with respect to 0V)

1.1.1 Absolute Maximum Rating

| Symbol | Description | Min. | Max. | Unit |
|---------------------|---|------|------|-------|
| VDD _{IO} | Power Supply Voltage on I/O ring | -0.5 | 4.6 | Volts |
| VDD _{CORE} | Power Supply Voltage on core logic and PLL | -0.5 | 2.5 | Volts |
| V _I | Digital Input Applied Voltage (power applied) | -0.5 | 5.5 | Volts |
| I _I | Digital Input Forced Current | -10 | 10 | mA |
| I _O | Digital Output Forced Current | -50 | 50 | mA |
| T _{SOL} | Lead Soldering Temperature | | 260 | °C |
| T _{VSOL} | Vapor Phase Soldering Temperature | | 235 | °C |
| T _{STOR} | Storage Temperature (no power applied) | -40 | 125 | °C |
| T _{AMB} | Ambient Temperature (power applied) | 0 | 70 | °C |
| P _{TOT} | Power consumption | | 1 | W |

CAUTION: Operating beyond these Minimum and Maximum limits can result in permanent damage to the device. Cirrus Logic recommends that CS7410 devices operate at the settings described in the next table.

1.1.2 RECOMMENDED OPERATING CONDITIONS

| Parameter | Symbol | Min | Typ | Max | Units |
|-------------------------------------|------------------|------|------|------|-------|
| Supply Voltage, IO | V _{DD} | 3.0 | 3.3 | 3.6 | Volts |
| Supply Voltage, core and PLL | V _{DD} | 1.62 | 1.8V | 1.98 | Volts |
| Ambient Temperature (power applied) | T _{AMB} | 0 | 25 | 70 | °C |

1.1.3 Electrical Specifications

(TA = 0 to 70 °C)

| Parameter | Symbol | Conditions | Min | Typ | Max | Units |
|------------------------------|----------|------------------------------------|-----|-----|-----|------------|
| Power Supply | | | | | | |
| Supply Current, IO | I_{DD} | Normal Operating, Playing MP3 Disc | | 13 | | mA |
| Supply Current, core and PLL | I_{DD} | Normal Operating, Playing MP3 Disc | | 70 | | mA |
| Digital Pins | | | | | | |
| Input Voltage, High | V_{IH} | | 2.0 | | | Volts |
| Input Voltage, Low | V_{IL} | | | | 0.8 | Volts |
| Input Current | I_{IN} | $V_{IN} = V_{DD}$ or V_{SS} | -1 | | +1 | μ A |
| Input Pull up/down resistor | R_I | | | 75 | | K Ω |
| Output Voltage, High | V_{OH} | @ buffer rating | 2.4 | | | Volts |
| Output Voltage, Low | V_{OL} | @ buffer rating | | | 0.4 | Volts |
| High-Z-state Leakage | I_{OZ} | $V_{OUT} = V_{SS}$ or V_{DD} | -1 | | +1 | μ A |

1.1.4 DC CHARACTERISTICS

(TA= 25°C; VDD_PLL=VDD_CORE=1.8V±10%, VDD_IO=3.3V±10%)

1.1.4.1 SDRAM Interface

| Symbol | Description | Min | Typ | Max | Unit |
|------------|--------------------------------------|-----------------|-----|-----|------|
| t_{mper} | DR_CKO Period | 22 ¹ | | | ns |
| t_{mco} | Output Delay from DR_CKO active edge | | | 19 | ns |
| t_{mdow} | M_D[15:0] delay from DR_CKO | | | 19 | ns |
| t_{mhw} | M_D[15:0] valid time after DR_CKO | 5 | | | ns |
| t_{msur} | M_D[15:0] setup to DR_CKO | 13 | | | ns |
| t_{mhr} | M_D[15:0] hold time after DR_CKO | 0 | | | ns |

Table 1. SDRAM Characterization Data

1. Guaranteed by Design

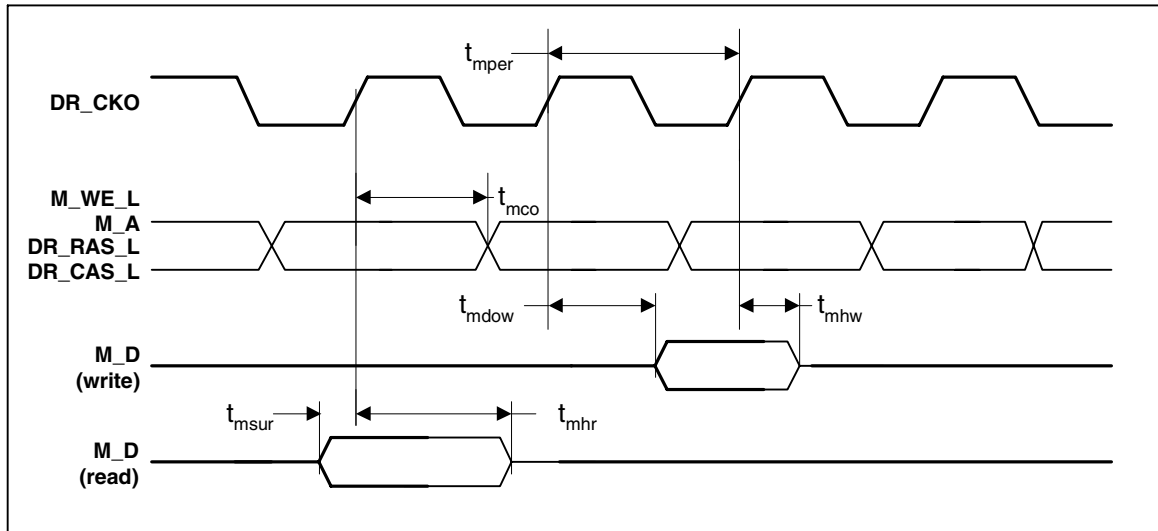


Figure 1. SDRAM Timing

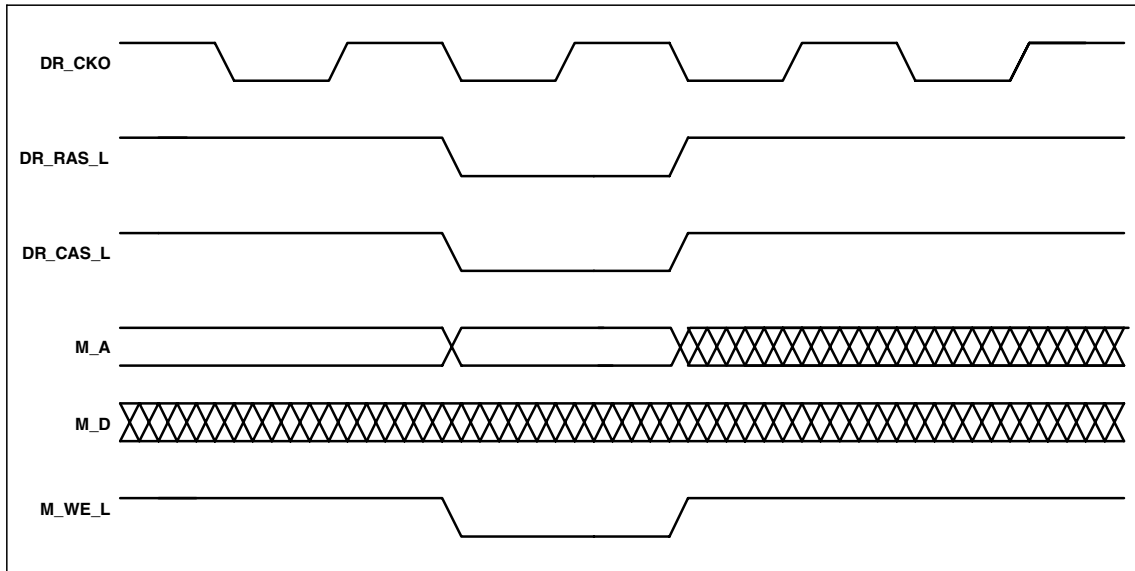


Figure 2. SDRAM Load Mode

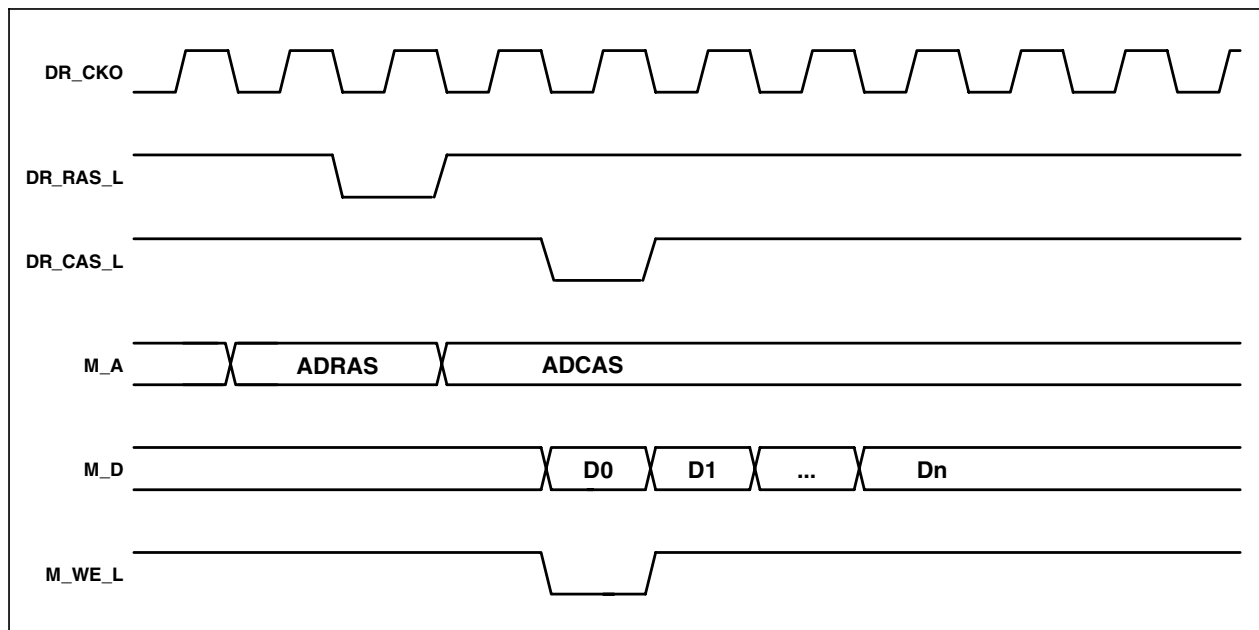


Figure 3. SDRAM Burst Write

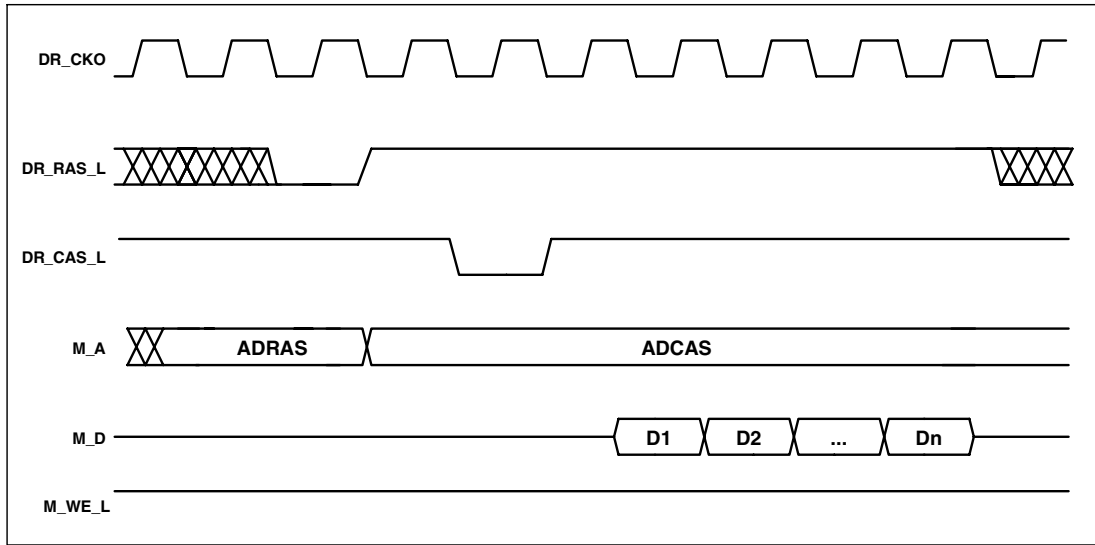


Figure 4. SDRAM Burst Read

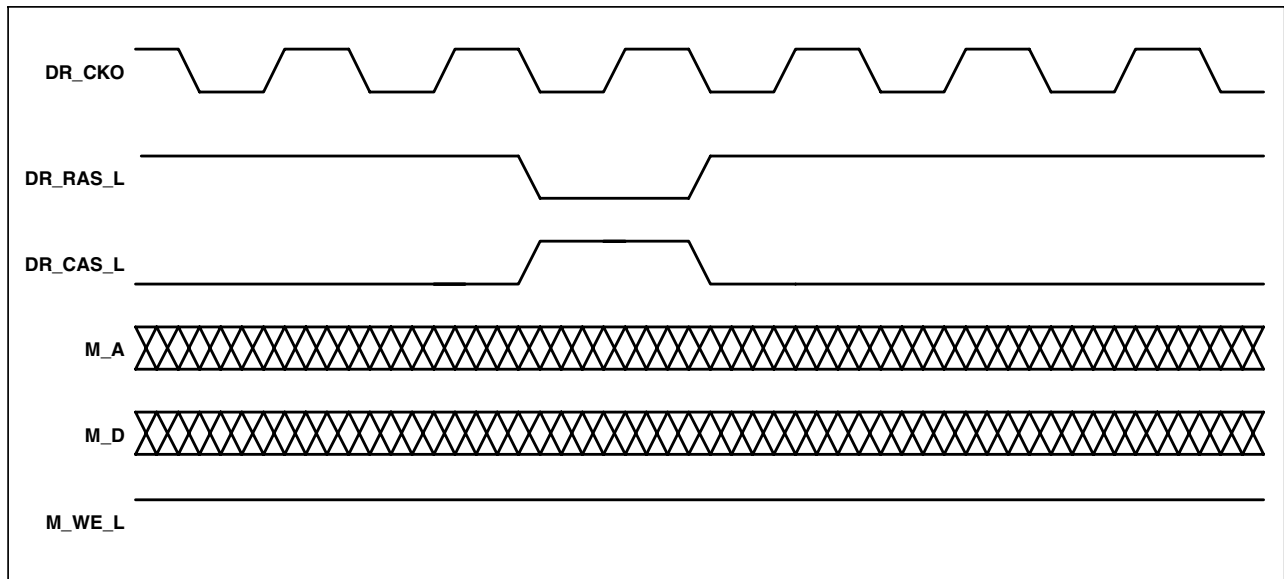


Figure 5. SDRAM Refresh

1.1.4.2 Serial Interface

| Symbol | Description | Min | Typ | Max | Unit |
|----------------|-----------------------------------|-----------------|-----|-----|------|
| t_{clk_per} | Clock period | 66 ¹ | | | ns |
| t_{DMs} | Master-mode data setup | 28 | | | ns |
| t_{DMh} | Master-mode data hold | 28 | | | ns |
| t_{DSs} | Slave-mode data setup | 15 | | | ns |
| t_{CMs} | Master chip select to clock setup | 28 | | | ns |
| t_{DSh} | Slave mode data hold | 0 | | | ns |

Table 2. Serial Interface Characterization Data

1. Guaranteed by Design

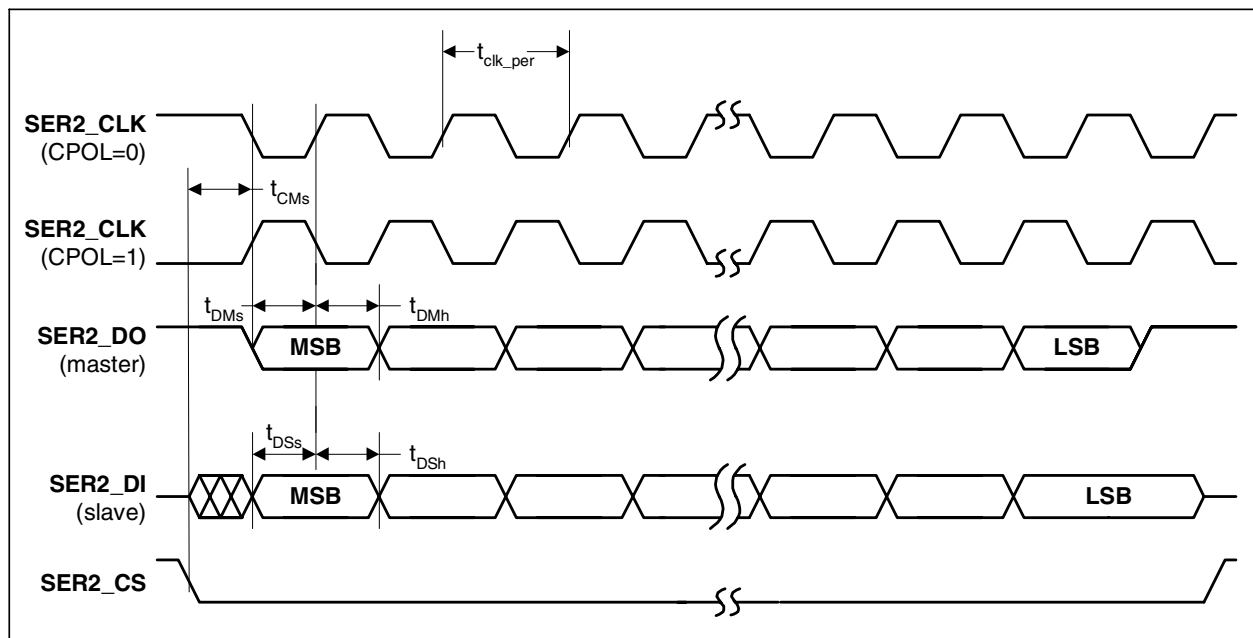


Figure 6. Serial Interface Timing Diagram

1.1.4.3 EDO DRAM interface

| Symbol | Description | Min | Typ | Max | Unit |
|------------------|---|------------|------------|------------|-------------|
| t _{RAS} | RAS low time | 72 | | | ns |
| t _{RP} | RAS high pulse time | 40 | | | ns |
| t _{RCL} | RAS fall to CAS fall | 38 | | | ns |
| t _{CAS} | CAS low time | 30 | | | ns |
| t _{CPN} | CAS high time | 15 | | | ns |
| t _{CAH} | CAS fall to address row | 29 | | | ns |
| t _{ASR} | Address row to RAS fall | 10 | | | ns |
| t _{RAH} | RAS fall to address column | 18 | | | ns |
| t _{ASC} | second address column (burst) to CAS fall | 10 | | | ns |
| t _{AA} | Column address to data setup | | | 35 | ns |
| t _{CAC} | CAS fall to data setup | | | 17 | ns |
| t _{CSR} | CAS fall to RAS fall | 19 | | | ns |
| t _{CHR} | RAS fall to CAS rise | 18 | | | ns |
| t _{CRH} | CAS rise to RAS rise | 6 | | | ns |
| t _{WDS} | Write data setup to CAS fall | 12 | | | ns |
| t _{WDH} | Write data hold to CAS fall | 29 | | | ns |
| t _{WS} | Write enable setup to CAS fall | 13 | | | ns |
| t _{WH} | Write enable hold to CAS fall | 20 | | | ns |
| t _{ROE} | RAS fall to OE fall | -5 | | 5 | ns |
| t _{OER} | RAS rise to OE rise | -5 | | 5 | ns |
| t _{DCH} | Read data hold to CAS rise | 0 | | | ns |

Table 3. EDO DRAM Characterization Data

Note: Values shown are for minimum internal clock period (11ns) and all programmed wait states enabled.

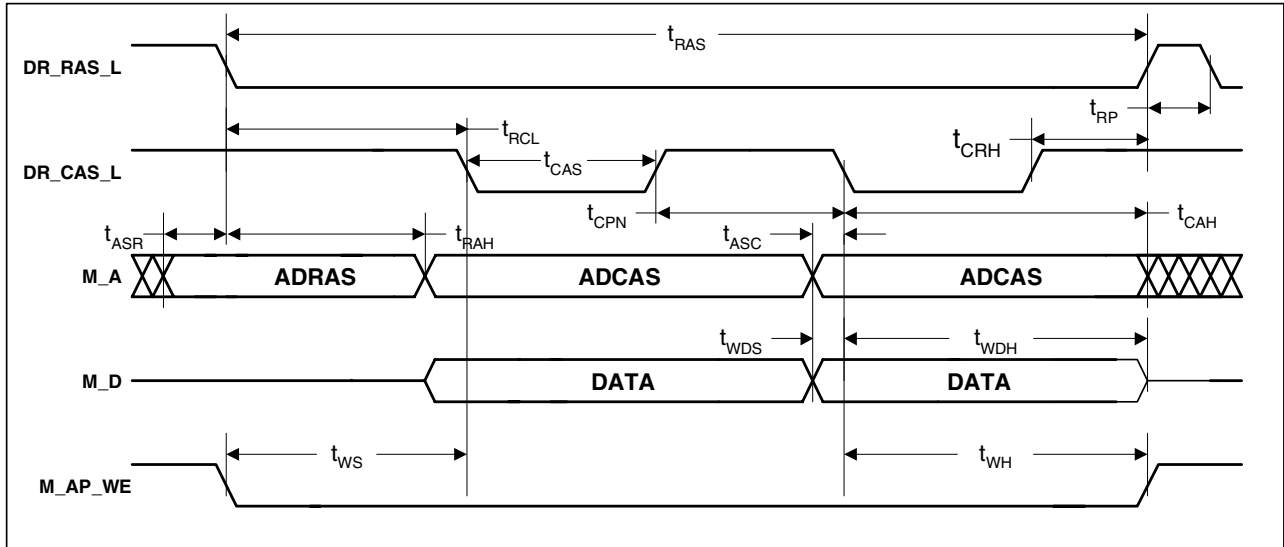


Figure 7. EDO Page Write Timing Diagram

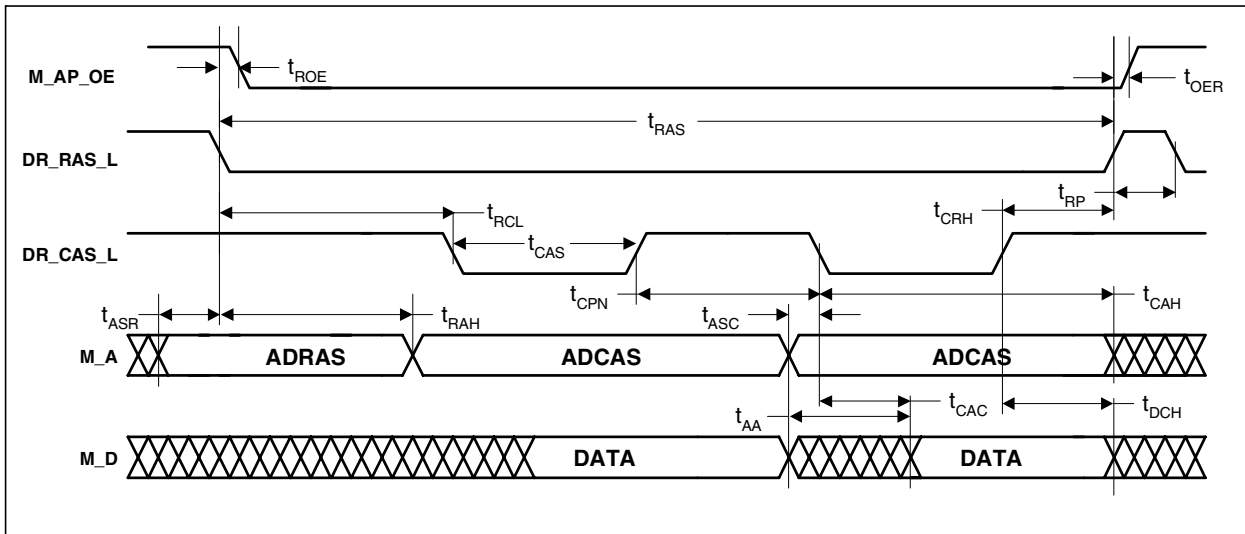


Figure 8. EDO Page Read Timing Diagram

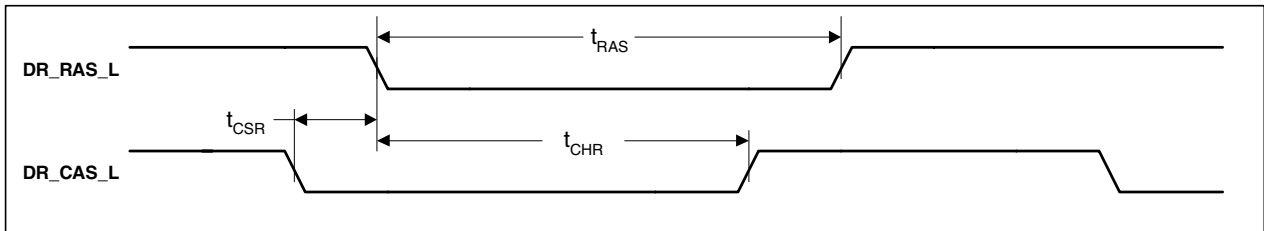


Figure 9. EDO Refresh Timing Diagram

1.1.4.4 FLASH / ROM Interface

| Symbol | Description | Min | Typ | Max | Unit |
|------------|---------------------------------------|-----|-----|-----|------|
| t_{CSpw} | CE low period | 135 | | | ns |
| t_{RDd1} | CE fall to output enable fall | 5 | | | ns |
| t_{RDd2} | CE rise to output enable rise | -5 | | 5 | ns |
| t_{ADs} | Address setup to CE fall | -10 | | 10 | ns |
| t_{DAs} | Data setup after address ¹ | | | 28 | ns |
| t_{WRSU} | All outputs setup before WE | 95 | | | ns |
| t_{WRPW} | WE pulse width | 170 | | | ns |
| t_{WRH} | All outputs hold after WE | 95 | | | ns |

Table 4. FLASH/ROM Read Characterization Data

1. Value shown for 3 programmed wait states.

Note: Values shown are for minimum internal clock period (11ns) and no programmed wait states.

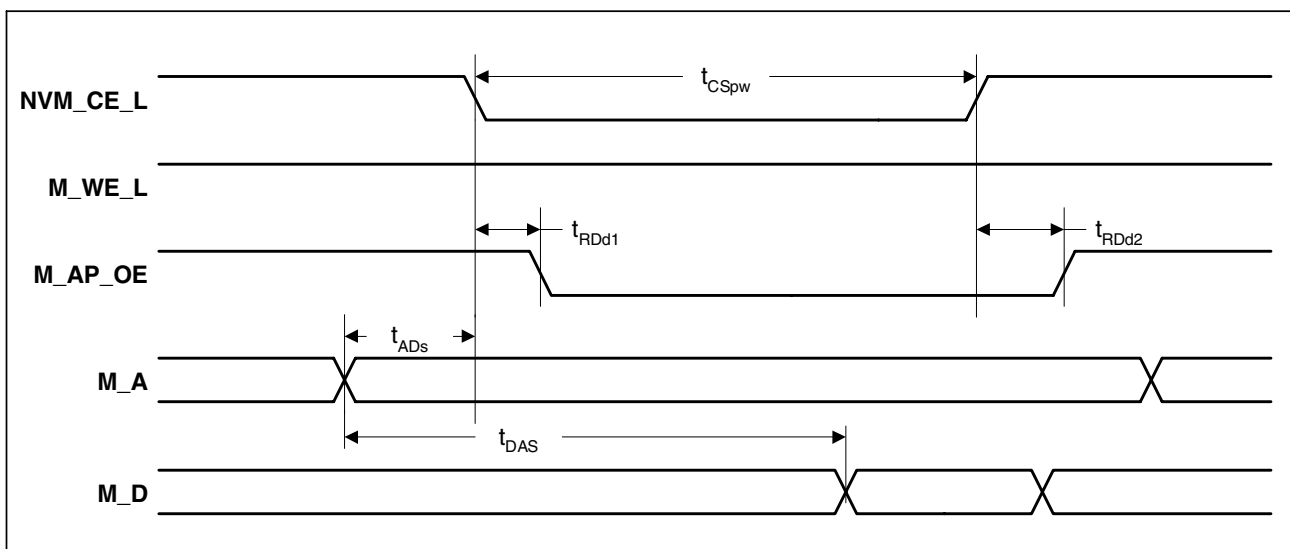


Figure 10. FLASH/ROM Read

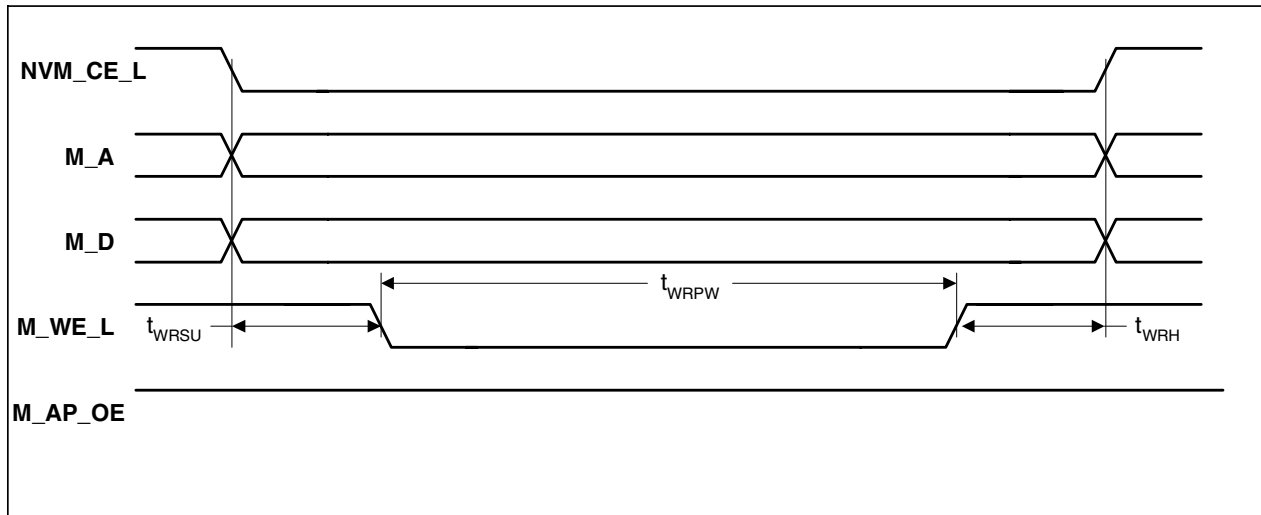


Figure 11. FLASH/ROM Write

1.1.4.5 Audio Output Interface

| Symbol | Description | Min | Typ | Max | Units |
|-------------|--|-----|-----|-----|-------|
| t_{axch} | PCM_XCLK High Time (PCM_XCLK is Input/Output) ¹ | 42 | 50 | | % |
| t_{axcl} | PCM_XCLK Low Time (PCM_XCLK is Input/Output) ¹ | 42 | 50 | | % |
| t_{axper} | PCM_XCLK period (Input/Output) ¹ | 55 | | | ns |
| t_{aoper} | PCM_BCK period (Output) ¹ | 440 | | | ns |
| t_{sdmo} | PCM_BCK delay from PCM_XCLK output transition ² | | | 7 | ns |
| t_{sdmi} | PCM_BCK delay from PCM_XCLK input transition ² | | | 15 | ns |
| t_{lrds} | PCM_LRCK delay from PCM_BCK transition ² | | | 7 | ns |
| t_{adsm} | PCM_D[3:0] delay from PCM_BCK transition ² | | | 7 | ns |

Table 5. Audio Output Interface Symbols and Characterization Data

1. Guaranteed by Design

2. Active clock edge is programmable. Timing is referenced from the active edge.

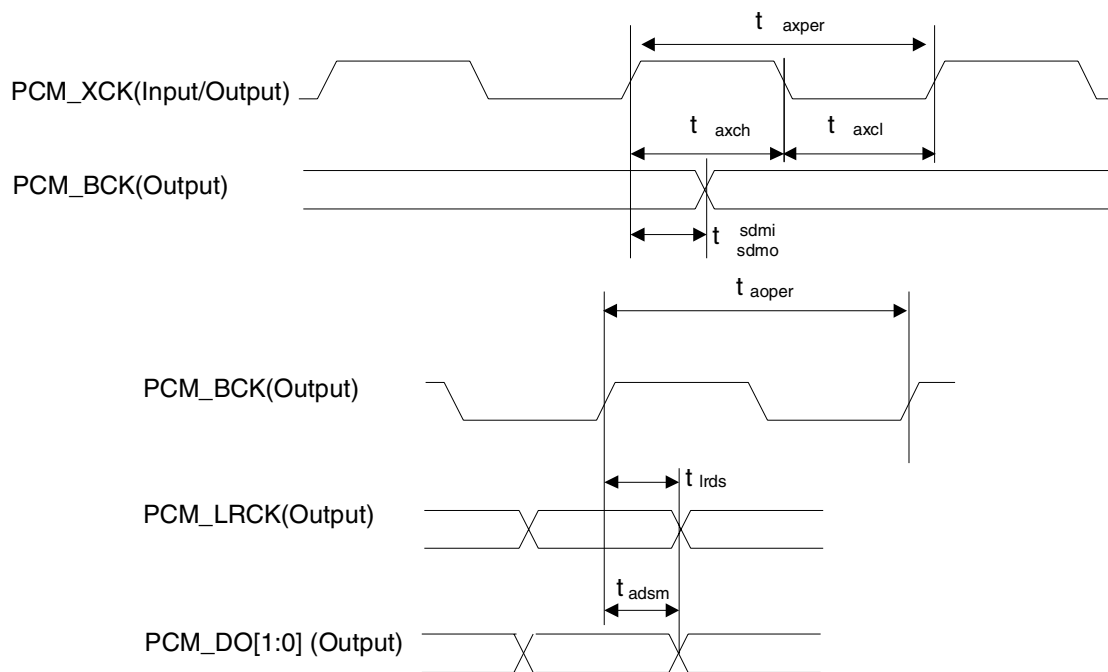


Figure 12. Audio Output Timing

1.1.4.6 CD Interface

| Symbol | Description | Min | Typ | Max | Units |
|------------|--|-----|-----|-----|-------|
| t_{slri} | CD_LRCK setup to CD_BCK active edge | 7 | | | ns |
| t_{sdi} | CD_DATA and CD_C2P0 setup to CD_BCK active edge | 7 | | | ns |
| t_{hdsi} | CD_DATA and CD_C2P0 hold time after CD_BCK active edge | 3 | | | ns |

Note: Active edge of CD_BCLK is programmable

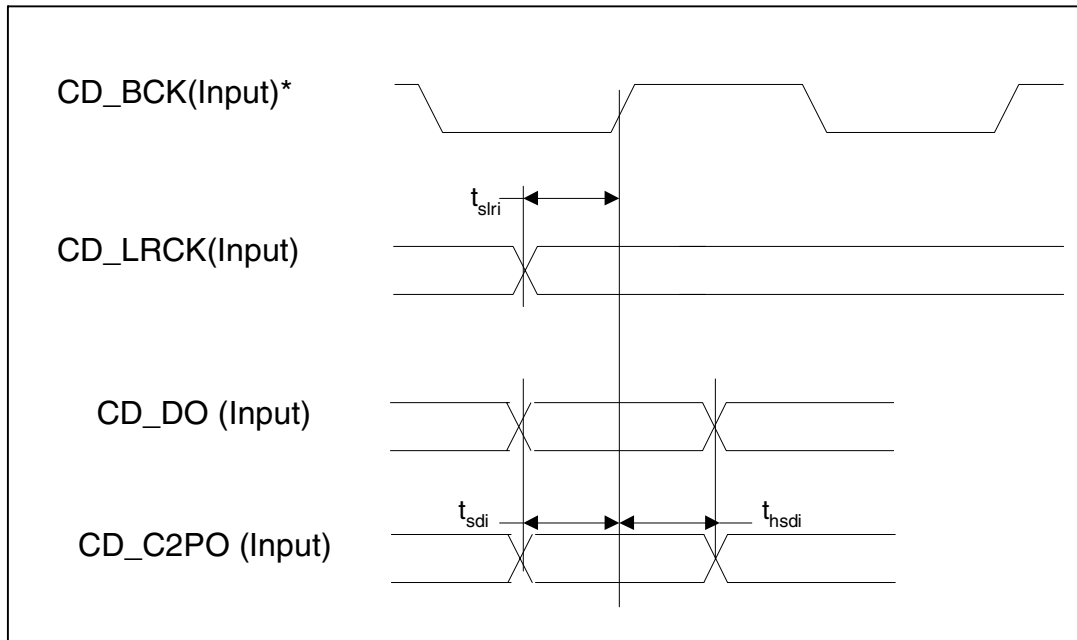
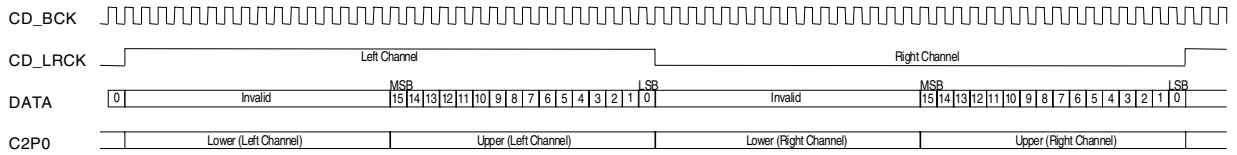
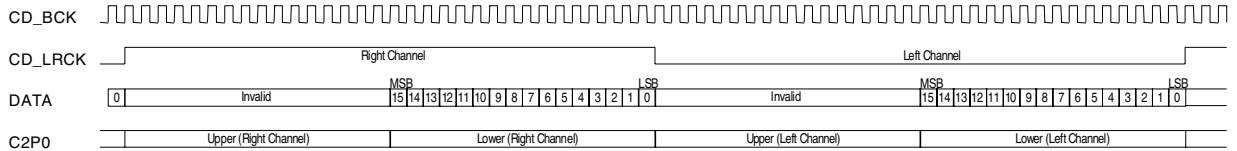


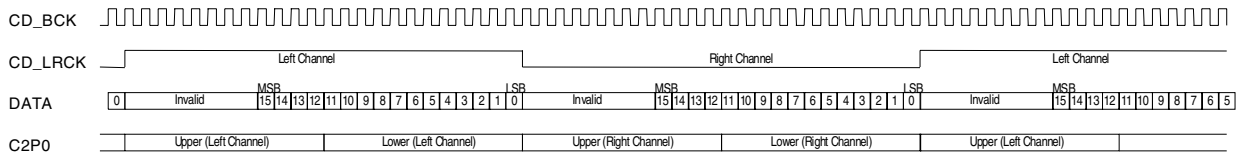
Figure 13. CD Interface Timing



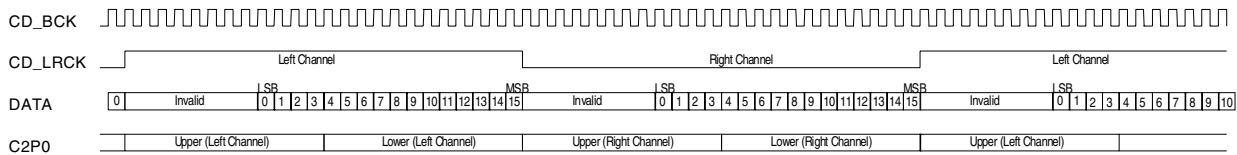
32-bit BCK, MSB First, Right Channel Low, C2P0 LSB First, Data latch timing high



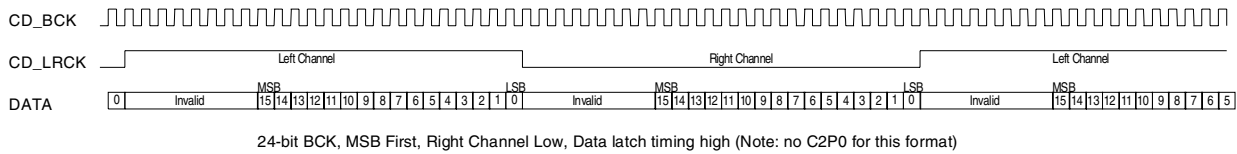
32-bit BCK, MSB First, Left Channel Low, C2P0 MSB First, Data latch timing low



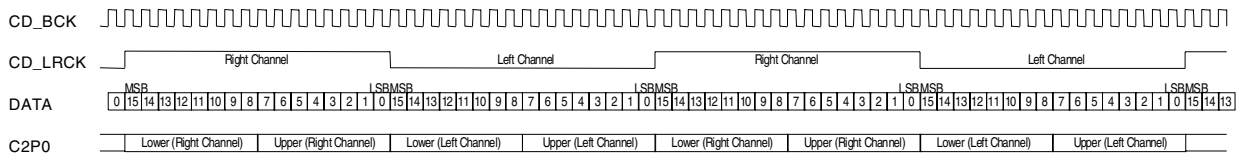
24-bit BCK, MSB First, Right Channel Low, C2P0 MSB First, Data latch timing high



24-bit BCK, LSB First, Right Channel Low, C2P0 MSB First, Data latch timing low



24-bit BCK, MSB First, Right Channel Low, Data latch timing high (Note: no C2P0 for this format)



16-bit BCK, MSB First, Left Channel Low, C2P0 LSB First, Data latch timing high

Figure 14. CD Interface Timing Diagrams

1.1.4.7 Miscellaneous Timings

| Symbol | Description | Min | Typ | Max | Unit |
|----------------|-----------------------|------|-------|-----|------|
| t_{xclper}^1 | XTLCLK period | | 59.05 | | ns |
| t_{rstl} | RST_N Low Pulse Width | 1000 | | | ns |
| t_{gph} | GPIO PW High | 50 | | | ns |
| t_{gpl} | GPIO PW Low | 50 | | | ns |

1. Value represents typical application with 16.934 MHz crystal

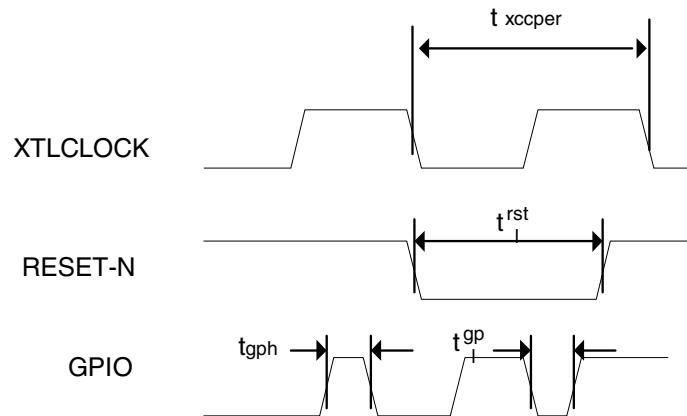


Figure 15. Miscellaneous Timings

2. CS7410 SUMMARY

2.1 CS7410 Typical Application

Figure 16 shows an example of a complete audio player using the CS7410.

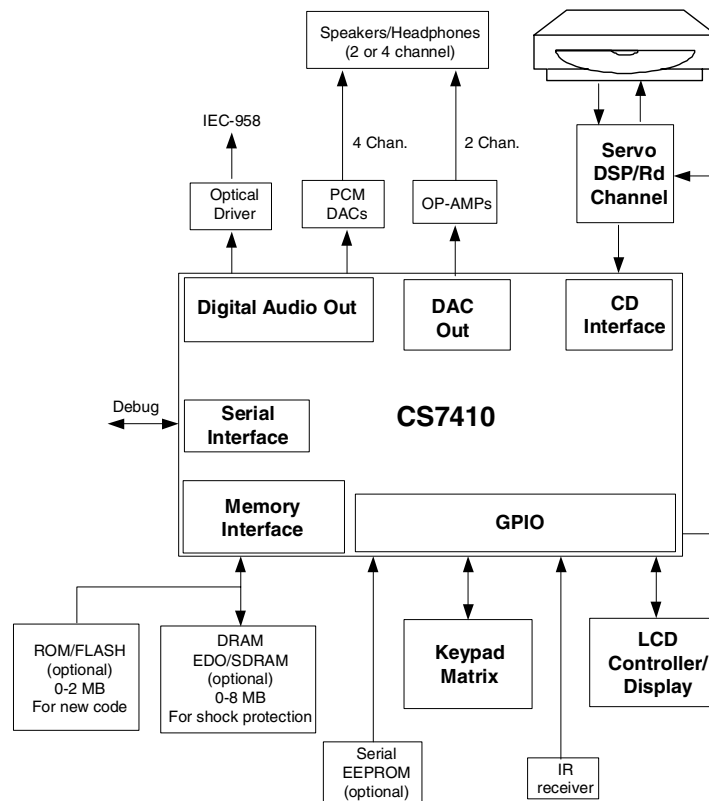


Figure 16. CS7410 Application

2.2 CS7410 Block Summaries

2.2.1 RISC-32

- Powerful 32-bit RISC processor
- Comprehensive development tool support
- Big or little endian data formats supported
- 32x32 (64-bit result) MAC, 2 cycles / multiply with C support
- 4 Kbyte instruction cache, 2 Kbyte data cache
- Single cycle instructions, runs up to 90 MHz

2.2.2 DSP-16

- Powerful 16-bit DSP processor
- 16-bit fixed point logic, with 36 bit accumulator.
- Single-cycle throughput, 2-cycle latency multiply accumulate, 16-bit simple integer logic
- 512 byte instruction cache, 8 Kbyte program visible local memory
- Single cycle instructions, runs up to 90 MHz
- DSP MAC is pipelined, 1 cycle / multiply

2.2.3 System Controls

- Includes 32 hardware lockable semaphore registers
- Two general-purpose registers for inter-processor communication
- Three 32-bit timers for I/O and other uses, with programmable interval rates
- “Getbits” module accelerates peripheral stream parsing
- Both hardware and software interrupts on data or debug

2.2.4 Memory System

- Large internal SRAM (80 Kbyte) and internal program ROM (256 Kbyte)
- Supports both Synchronous and EDO DRAM (256 KBytes to 8 MBytes) for ESP
- Supports one bank of FLASH and ROM (up to 2 MBytes) for nonvolatile storage
- 4-, 8-, or 16-bit data bus for DRAM, 8-bit data bus for ROM

2.2.5 CD Interface

- Glueless interfaces to CD servo chip set, supporting all standard CD formats
- Includes pattern matching hardware to support fast ESP recovery

2.2.6 Audio Interface

- Supports 4 channels PCM, I²S connectivity at up to 24 bits
- Flexible audio clocking scheme using internal PLL and dividers, or external pins

- Simultaneous IEC-958 output with programmable channel status and user data
- Integrated sigma-delta ($\Delta\Sigma$) stereo audio modulator

2.2.7 External Interface

- 2-wire serial slave port, used for debug
- 3- or 4-wire synchronous serial master/slave port for external controller or slave peripheral
- Separate synchronous serial master port optimized for receiving CD sub-codes
- Up to 29 programmable bi-directional I/O (GPIO) and up to 9 output only (GPO) pins (some multiplexed with other peripherals)
- All pins defined as GPIOs can be used to receive edge or level detection interrupts.
- Pulse-width modulated (PWM) output pin can be used to create simple ADC using low-cost comparator (i.e., for battery voltage monitor)

2.2.8 System Functions

- Internal oscillator uses external crystal, or receives clock (i.e. 16.9 MHz) from CD servo
- Internal PLL generates any system clock frequency, chip can run up to 90 MHz
- Includes clock divider and clock shutoff circuits for low power/sleep modes
- Advanced 0.18 micron CMOS technology, runs off 1.8 V and 3.3 V
- All I/O pins are 3.3 V, with 5 V tolerance
- 100-pin MQFP package
- 100-pin LQFP package

3. FUNCTIONAL DESCRIPTION

3.1 RISC-32 Processor

The CS7410 includes a powerful, proprietary 32-bit RISC processor backed by powerful software development tools. The RISC-32 has a MIPS-compatible instruction set, as well as a MAC engine which performs multiply/accumulate in 2 cycles with C support, effectively achieving single cycle throughput.

There are other instructions that are designed to help with performing audio decoding. The RISC processor coordinates on-chip multi-threaded tasks, as well as supervises system activities such as keypad and front panel display control.

3.2 DSP-16 Processor

The CS7410 contains a proprietary digital signal processor (DSP) called DSP-16, which is optimized for audio and sound applications. In the CS7410, the DSP-16 assists with audio decoding and provides added functions such as surround sound and equalization. The DSP performs 16-bit simple integer operations, and has a 16-bit fixed point logic unit with a 32-bit accumulator.

There are 24 general-purpose registers, and eight independent address generation registers, featuring: post-increment ALU, linear and circular buffer operations, bit reverse ALU operations, and dual operand read from memory. The multiply-accumulator has single-cycle throughput, with two cycle latency. The DSP is optimized for bit packing and unpacking operations. The interface to main memory is designed for bursting flexible block sizes and skip counts.

3.3 Memory Control

The Memory Controller performs the arbitration functions for all the other modules in the CS7410, allowing access to internal ROM and SRAM, and

to external ROM and DRAM. The Memory Controller services and arbitrates a number of clients and stores their code and/or data within the local memory. This arbitration and scheduling guarantees the allocation of sufficient bandwidth to the various clients. An optimal application will use only internal ROM and SRAM for code and data storage, which results in the best timing and lowest power consumption.

External DRAM may be used for runtime code storage or for ESP RAM. In both of these applications, the data throughput requirement is low, and the Memory Controller acts as a DMA engine to move data between external and internal memory with minimal power consumption. The internal ROM contains most of the code required for audio decoding and system functions.

Additional code can be stored in external ROM (managed by the Memory Controller) or a small serial ROM (controlled by GPIOs). The CS7410 also supports code storage in external FLASH with in-system write capability for customer code updates. Future firmware releases will provide a complete solution requiring no external ROM.

3.4 CD Interface

The CD Interface receives compressed or uncompressed (direct audio) data from the CD servo/read channel chip, performs descrambling and CRC checking, and writes the data to an internal FIFO. Additional C3 error decoding is done in software. The CD interface is compatible with all commonly used CD formats.

The CS7410 contains a hardware pattern matching circuit to scan the incoming CD data for a pattern of up to 64 bytes. This circuit is used to assist the Electronic Shock Protection function by quickly locating and matching the incoming data with data stored in the ESP RAM.

3.5 System Control Functions

The system control functions are used to coordinate the activities of the multiple processors, and to provide the supporting system operations. Two 32-bit communication registers are available for inter-processor communication, and 32 semaphore registers are used for resource locking. Three timers are available for general-purpose functions, as well as more specialized functions, such as watchdog timers and performance monitoring.

The large number of general purpose I/Os offers flexibility in system configurations. Three separate synchronous serial interfaces, conforming to industry-standard protocols, are available for a variety of system interface functions. Four general purpose software interrupts and twelve hardware interrupts help reduce peripheral overhead and improve UI responsiveness. Power-down control of the internal clocks is also possible. An internal PLL is used to generate the internal system and memory clocks as well as audio clocks for all supported sample rates.

3.6 Audio Output

Decoded audio data is written into an output FIFO in 16-, 18-, 20- or 24-bit PCM format. A flexible audio output stage can simultaneously output 4 channels of PCM data to external audio DACs, plus an independent IEC-958 encoded output. The IEC-958 output has fully programmable channel status (commercial), and provides a flexible solution to support all IEC-958 modes for user data. The audio output circuit contains an auto-mute detect circuit, which can generate internal or external mute controls

PCM FIFO data up to 18 bits can also be output by the on-board sigma-delta stereo modulator. The sigma-delta modulator yields a typical 85 dB signal-to-noise ratio with few external components required, resulting in a low-cost, low parts count analog front end. The modulator has a 32x upsampling filter, followed by a 32x interpolator, and finally a 5th-order Sigma-Delta modulator. The auto-mute circuit also works on the modulator output, and there are separate programmable attenuators for the modulator output and both PCM outputs.

4. PIN DESCRIPTION

4.1 Pin Identification

Figure 17 shows the CS7410 pins grouped by function, also showing the number of pins in each group.

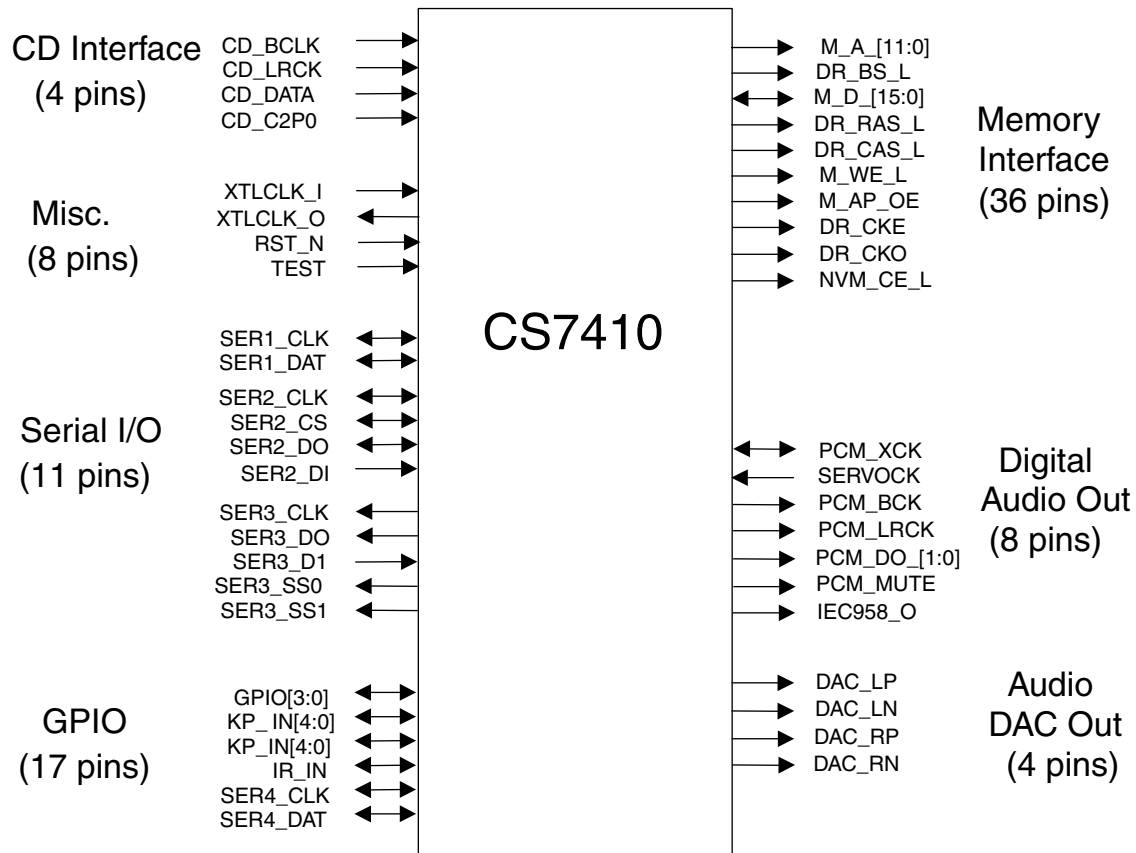


Figure 17. CS7410 Pin Identification

Table 6 lists the conventions used to identify the pin type and direction. pin assignments.

| |
|---|
| I: Input |
| S: Schmitt trigger on input |
| U: Pull up resistor |
| O: Output |
| O4: Output – 4mA drive |
| T4: High Z output – 4mA drive |
| B: Bi-direction |
| B4: Bi-direction – 4mA drive |
| D4: Bi-direction with 4mA open drain output |

Table 6. Pin Type and Direction Legend

| |
|--|
| Pwr: +2.5V or +3.3V power supply voltage |
| Gnd: Power supply ground |
| Name_N: Low active |
| Name_L: Low active |

Table 6. Pin Type and Direction Legend (Continued)

Table 7 lists the pin number, pin name, and pin type for the 100-pin CS7410 package. For signal pins, the pin direction after reset is shown. The primary function and pin direction is shown for all signal pins. For some signal pins, a secondary function and direction are also shown.

| Pin | Name | Type | Reset | Function #1 | Dir | Function #2 | Dir | Note |
|-----|----------|------|-------|----------------|-----|-------------------|-----|------|
| 1 | PLL_GND | Gnd | | PLL Ground | | | | |
| 2 | PLL_1V8 | Pwr | | PLL Power | | | | |
| 3 | M_D_15 | B4 | I | DRAM Data[15] | B | NVMem Address[19] | O | |
| 4 | M_D_14 | B4 | I | DRAM Data[14] | B | NVMem Address[18] | O | |
| 5 | M_D_13 | B4 | I | DRAM Data[13] | B | NVMem Address[17] | O | |
| 6 | M_D_12 | B4 | I | DRAM Data[12] | B | NVMem Address[16] | O | |
| 7 | M_D_11 | B4 | I | DRAM Data[11] | B | NVMem Address[15] | O | |
| 8 | M_D_10 | B4 | I | DRAM Data[10] | B | NVMem Address[14] | O | |
| 9 | M_D_9 | B4 | I | DRAM Data[9] | B | NVMem Address[13] | O | |
| 10 | M_D_8 | B4 | I | DRAM Data[8] | B | NVMem Address[12] | O | |
| 11 | M_D_7 | B4 | I | DRAM Data[7] | B | NVMem Data[7] | B | |
| 12 | CORE_1V8 | Pwr | | Core Power | | | | |
| 13 | M_D_6 | B4 | I | DRAM Data[6] | B | NVMem Data[6] | B | |
| 14 | CORE_GND | Gnd | | Core Ground | | | | |
| 15 | M_D_5 | B4 | I | DRAM Data[5] | B | NVMem Data[5] | B | |
| 16 | IO_3V3 | Pwr | | I/O Power | | | | |
| 17 | XTLCLK_O | O | O | Oscillator Out | O | | | |

Table 7. Pin Assignments

| Pin | Name | Type | Reset | Function #1 | Dir | Function #2 | Dir | Note |
|-----|----------|------|-------|------------------|-----|-------------------|-----|------|
| 18 | XTLCLK_I | I | I | Oscillator In | I | | | |
| 19 | IO_GND | Gnd | | I/O Ground | | | | |
| 20 | M_D_4 | B4 | I | DRAM Data[4] | B | NVMem Data[4] | B | |
| 21 | M_D_3 | B4 | I | DRAM Data[3] | B | NVMem Data[3] | B | |
| 22 | M_D_2 | B4 | I | DRAM Data[2] | B | NVMem Data[2] | B | |
| 23 | M_D_1 | B4 | I | DRAM Data[1] | B | NVMem Data[1] | B | |
| 24 | M_D_0 | B4 | I | DRAM Data[0] | B | NVMem Data[0] | B | |
| 25 | M_A_11 | B4 | I | DRAM Address[11] | O | NVMem Address[11] | O | 1 |
| 26 | M_A_10 | B4 | I | DRAM Address[10] | O | NVMem Address[10] | O | 1 |
| 27 | M_A_9 | B4 | I | DRAM Address[9] | O | NVMem Address[9] | O | 1 |
| 28 | M_A_8 | B4 | I | DRAM Address[8] | O | NVMem Address[8] | O | 1 |
| 29 | M_A_7 | B4 | I | DRAM Address[7] | O | NVMem Address[7] | O | 1, 3 |
| 30 | M_A_6 | B4 | I | DRAM Address[6] | O | NVMem Address[6] | O | 1, 3 |
| 31 | M_A_5 | B4 | I | DRAM Address[5] | O | NVMem Address[5] | O | 1, 3 |
| 32 | M_A_4 | B4 | I | DRAM Address[4] | O | NVMem Address[4] | O | 1, 3 |
| 33 | M_A_3 | B4 | I | DRAM Address[3] | O | NVMem Address[3] | O | 1, 3 |
| 34 | M_A_2 | T4 | I | DRAM Address[2] | O | NVMem Address[2] | O | 3 |
| 35 | M_A_1 | T4 | I | DRAM Address[1] | O | NVMem Address[1] | O | 3 |
| 36 | M_A_0 | T4 | I | DRAM Address[0] | O | NVMem Address[0] | O | 3 |
| 37 | DR_RAS_L | T4 | I | DRAM RAS_L | O | | | |
| 38 | CORE_1V8 | Pwr | | Core Power | | | | |
| 39 | DR_CAS_L | T4 | I | DRAM CAS_L | O | | | |

Table 7. Pin Assignments (Continued)

| Pin | Name | Type | Reset | Function #1 | Dir | Function #2 | Dir | Note |
|-----|----------|------|-------|----------------------------|-----|----------------------|-----|------|
| 40 | CORE_GND | Gnd | | Core Ground | | | | |
| 41 | M_WE_L | T4 | I | DRAM WE_L | O | NVM_WE_L | | |
| 42 | IO_GND | Gnd | | I/O Ground | | | | |
| 43 | DR_CKO | T4 | I | SDRAM CKO | O | | | |
| 44 | IO_3V3 | Pwr | | I/O Power | | | | |
| 45 | DR_CKE | T4 | I | SDRAM CKE | O | | | |
| 46 | DR_BS_L | B4 | I | SDRAM BS_L | O | NVMem Address[20] | | 1 |
| 47 | M_AP_OE | B4 | I | SDRAM AP, EDO DRAM OE_L | O | NVM_ OE_L | | 1 |
| 48 | NVM_CE_L | T4 | I | NVM_CE_L | O | | | |
| 49 | KP_IN_0 | B4U | I | GPIO[19] | B | | | |
| 50 | KP_IN_1 | B4U | I | GPIO[20] | B | | | |
| 51 | KP_IN_2 | B4U | I | GPIO[21] | B | | | |
| 52 | KP_IN_3 | B4U | I | GPIO[22] | B | | | |
| 53 | KP_IN_4 | B4U | I | GPIO[23] | B | | | |
| 54 | KP_OUT_0 | B4 | I | GPIO[24] | B | | | |
| 55 | KP_OUT_1 | B4 | I | GPIO[25] | B | | | |
| 56 | KP_OUT_2 | B4 | I | GPIO[26] | B | | | |
| 57 | KP_OUT_3 | B4 | I | GPIO[27] | B | | | |
| 58 | KP_OUT_4 | B4 | I | GPIO[28] | B | | | |
| 59 | IR_IN | B4S | I | GPIO[4] | B | | | |
| 60 | SER1_CLK | D4S | I | Debug Port Clock | B | | | |
| 61 | SER1_DAT | D4S | I | Debug Port Data | B | | | |
| 62 | SER4_CLK | B4S | I | GPIO[5] | B | | | |
| 63 | SER4_DAT | B4S | I | GPIO[6] | B | | | |
| 64 | IO_GND | Gnd | | I/O Ground | | | | |
| 65 | SER2_CLK | B4 | I | Serial2 Clock | B | GPIO[7] | B | |
| 66 | SER2_DI | B4 | I | Serial2 Data In | B | GPIO[8] | B | |
| 67 | SER2_DO | B4 | I | Serial2 Data Out | B | GPIO[9] | B | |

Table 7. Pin Assignments (Continued)

| Pin | Name | Type | Reset | Function #1 | Dir | Function #2 | Dir | Note |
|-----|----------|------|-------|---------------------------------------|-----|-------------|-----|------|
| 68 | SER2_CS | B4 | I | Serial2 Chip Select | B | GPIO[10] | B | |
| 69 | SER3_CLK | B4 | I | Serial3 Clock | O | GPIO[11] | B | |
| 70 | SER3_DO | B4 | I | Serial3 Data Out | O | GPIO[12] | B | |
| 71 | CORE_1V8 | Pwr | | Core Power | | | | |
| 72 | SER3_DI | B4 | I | Serial3 Data In | I | GPIO[13] | B | |
| 73 | CORE_GND | Gnd | | Core Ground | | | | |
| 74 | SER3_SS0 | B4 | I | Serial3 Chip Select0 | O | GPIO[14] | B | |
| 75 | IO_3V3 | Pwr | | I/O Power | | | | |
| 76 | SER3_SS1 | B4 | I | Serial3 Chip Select1 | O | GPIO[15] | B | |
| 77 | SERVOCK | B4 | I | Servo Clock In | I | GPIO[17] | B | |
| 78 | PCM_XCK | B4 | I | PCM_XCK | B | | | |
| 79 | PCM_MUTE | B4 | I | PCM_MUTE | O | GPO[4] | O | 1 |
| 80 | CD_C2P0 | B4 | I | CD_C2P0 | I | GPIO[16] | B | |
| 81 | CD_BCLK | IS | I | CD_BCLK | I | | | |
| 82 | CD_LRCK | I | I | CD_LRCK | I | | | |
| 83 | CD_DATA | I | I | CD_DATA | I | | | |
| 84 | DAC_LP | O4 | O | $\Delta\Sigma$ DAC Left Positive Out | O | GPO[5] | O | |
| 85 | DAC_LN | O4 | O | $\Delta\Sigma$ DAC Left Negative Out | O | GPO[6] | O | |
| 86 | IO_GND | Gnd | | I/O Ground | | | | |
| 87 | DAC_RP | O4 | O | $\Delta\Sigma$ DAC Right Positive Out | O | GPO[7] | O | |
| 88 | DAC_3V3 | Pwr | | $\Delta\Sigma$ DAC I/O Power | | | | |
| 89 | DAC_RN | O4 | O | $\Delta\Sigma$ DAC Right Negative Out | O | GPO[8] | O | |
| 90 | RST_N | IS | I | Reset_L | I | | | |
| 91 | TEST | I | I | Manufacturing Test | I | | | |
| 92 | PCM_BCK | B4 | O | PCM_BCK | O | GPO[0] | O | 1 |
| 93 | PCM_LRCK | B4 | O | PCM_LRCK | O | GPO[1] | O | 1 |
| 94 | PCM_DO_0 | B4 | O | PCM_Dout[0] | O | GPO[2] | O | 2 |
| 95 | PCM_DO_1 | B4 | O | PCM_Dout[1] | O | GPO[3] | O | 1 |
| 96 | IEC958_O | B4 | I | IEC-958 Out | O | GPIO[18] | B | |
| 97 | GPIO_0 | B4 | I | GPIO[0] | B | | | |

Table 7. Pin Assignments (Continued)

| Pin | Name | Type | Reset | Function #1 | Dir | Function #2 | Dir | Note |
|-----|--------|------|-------|-------------|-----|-------------|-----|------|
| 98 | GPIO_1 | B4 | I | GPIO[1] | B | PWM_Out | O | |
| 99 | GPIO_2 | B4 | I | GPIO[2] | B | | | |
| 100 | GPIO_3 | B4 | I | GPIO[3] | B | | | |

Table 7. Pin Assignments (Continued)

1. Optional pull up or pull down resistor may be connected to configure internal ROM program
2. Required external resistor required to select processor boot from internal ROM (pull down) or external ROM (pull up).
3. Drives for a short time after reset, then reverts to high impedance

4.2 Miscellaneous Pins

These pins described in Table 8 are used for used for basic functions such as clocking, reset and infrared receiver interface. The main system clock can be derived from an external crystal connected between the XTLCCLK_I and XTLCCLK_O pins, or can be received from the CD servo chip via the XTLCCLK_I pin. The CS7410 can accommodate a variety of input frequencies, such as 44.1 KHz x 256, x 384, or x 512.

| Pin | Signal Name | Type | Description |
|-----|-------------|------|--------------------------------------|
| 17 | XTLCCLK_O | O | Crystal output |
| 18 | XTLCCLK_I | I | Crystal input, or oscillator input |
| 90 | RST_N | I | Asynchronous reset input, active low |
| 91 | TEST | I | Manufacturing test, tie to ground |

Table 8. Miscellaneous Interface Pins

4.3 Serial Interface Pins

The CS7410 Serial Interface pins are described in Table 9. CS7410 has three dedicated serial ports, each with different protocols. The 2-wire serial port (SER1) supports industry standard protocols. This port is typically used for debug, with the CS7410 as the slave. The slave chip select address is programmable, and defaults to a 7-bit value of 0x1B. A second serial controller (SER2) supports industry standard 3-wire and 4-wire protocols. In master mode, this interface can control a front panel or a small non-volatile memory. In slave mode, it can operate under control of an external processor, for example, in a combination unit. The third serial port (SER3) is a 5-wire master device optimized for reading CD subcodes from the servo chip, and can also be used a general-purpose serial port.

| Pin | Signal Name | Type | Description |
|-----|-------------|------|---|
| 60 | SER1_CLK | B | Debug port serial clock |
| 61 | SER1_DAT | B | Debug port serial data |
| 65 | SER2_CLK | B | Clock for 4-wire serial port (output for master mode, input for slave mode) |
| 66 | SER2_DI | I | Input data for 4-wire serial port |
| 67 | SER2_DO | B | Output data for 4-wire serial port – may function as bidirectional data in 3-wire mode. |

Table 9. Serial Interface Pins

| | | | |
|----|----------|---|---|
| 68 | SER2_CS | B | Chip select for 4-wire serial port (output if master, input if slave mode). Can also be used as bidirectional ready line. |
| 69 | SER3_CLK | O | Clock output |
| 70 | SER3_DO | O | Data output – up to 32 bits per transfer. |
| 72 | SER3_DI | I | Data input – up to 96 bits per transfer. |
| 74 | SER3_SS0 | O | Slave select for first peripheral (programmable polarity) |
| 76 | SER3_SS1 | O | Slave select for second peripheral (programmable polarity) |

Table 9. Serial Interface Pins (Continued)

4.4 SDRAM / DRAM Interface

These pins are used to interface the CS7410 with external synchronous or EDO DRAMs. Data widths of 4 to 16 bits are supported. The CS7410 supports word or block transfers (partial word transfers are not required). Table 10 gives instructions on how to interface to any particular configuration of SDRAM. Table 11 gives pin definitions for interfacing to EDO DRAM.

| Pin | Signal Name | Type | Description |
|---|---------------------|------|--|
| 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 15, 20, 21, 22, 23, 24 | DRAM Data[15..0] | B | Memory Data Bus. |
| 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36 | DRAM Address[11..0] | O | Memory Address Bus. Connect in order starting with DR_Addr[0] to all RAM address pins not already connected to DR_BS_L or DR_AP. |
| 37 | DR_RAS_L | O | Memory Row Address Strobe |
| 39 | DR_CAS_L | O | Memory Column Address Strobe |
| 41 | M_WE_L | O | Memory Write Enable |
| 43 | DR_CKO | O | SDRAM Clock |
| 45 | DR_CKE | O | SDRAM Clock Enable |
| 46 | DR_BS_L | O | Bank Selection. Always connect to RAM BS or BS0 pin. |
| 47 | M_AP_OE | O | Memory Auto Pre-charge. Always connect to RAM AP pin. |

Table 10. SDRAM Interface

| Pin | Signal Name | Type | Description |
|---|---------------------|------|------------------------------|
| 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 15, 20, 21, 22, 23, 24 | DRAM Data[15..0] | B | Memory Data Bus. |
| 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36 | DRAM Address[11..0] | O | Memory Address Bus. |
| 37 | DR_RAS_L | O | Memory Row Address Strobe |
| 39 | DR_CAS_L | O | Memory Column Address Strobe |
| 41 | M_WE_L | O | Memory Write Enable |
| 47 | M_AP_OE | O | Memory Output Enable |

Table 11. EDO DRAM Interface

4.5 ROM/NVRAM Interface

The ROM/NVRAM Interface pins are described in Table 12. This interface connects to the non-volatile memory that contains the firmware. The memory could be ROM, NVRAM (FLASH), EEPROM, or any combination of these memory types. This interface can also connect to SRAM that would emulate a ROM on a development system. The bus width is always 8 bits. Most of these pins are shared with the DRAM interface, which operates simultaneously with the ROM/NVRAM interface. A number of pins are defined to accept configuration input at power-up (see Table 7), allowing different branches to be taken in the firmware. A configuration resistor is required on pin PCM_DO_0 to select whether the processor will boot from internal or external ROM.

| Pin | Signal Name | Type | Description |
|--|------------------|------|---|
| 11, 13, 15, 20, 21, 22, 23, 24 | NVMem Data[7..0] | B | Memory Data Bus (shared with bits [7:0] of DRAM data bus). |
| 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36 | NVM_Addr[11..0] | O | Memory Address Bus[11..0] (shared with DRAM address bus) |
| 3, 4, 5, 6, 7, 8, 9, 10 | NVM_Addr[19..12] | O | Memory Address Bus[19..12] (shared with bits [15..8] of DRAM data bus). |
| 46 | NVM_Addr[20] | O | Memory Address Bus[20] (DRAM BS_L pin). |
| 41 | NVM_WE_L | O | NVRAM Write Enable (shared with DRAM WE_L pin) |
| 47 | NVM_OE_L | O | NVRAM Write Enable (shared with DRAM WE_L pin) |
| 48 | NVM_CE_L | O | ROM/NVRAM Chip Enable. |

Table 12. ROM/NVRAM Interface

4.6 Digital Audio Output Interface

The Digital Audio Output Interface pins are described in Table 13. This is the audio PCM interface that connects to an audio PCM DAC. The sample rate and the size of the samples are programmable to accommodate any commercially available DAC. The CS7410 has two data output pins, for up to 4 channels of PCM output, and a separate output pin to simultaneously output IEC-958 encoded data (either compressed or uncompressed).

| Pin | Signal Name | Type | Description |
|-----|-------------|------|--|
| 78 | PCM_XCK | B | Audio 256x/384x/512x Clock input or output to Serial DAC. When output, it's generated from CS7410 internal PLL. |
| 77 | SERVOCK | I | Optional source of Audio 256x/384x/512x Audio Clock. May be used for CD direct audio to match input and output clocks. |
| 79 | PCM_MUTE | O | Audio Mute control to external DAC. Polarity is programmable and is three-stated at power up. |
| 92 | PCM_BCK | O | Audio Bit Clock output to serial DAC. Polarity is programmable. |
| 93 | PCM_LRCK | O | Audio Out Left/Right Clock to serial DAC. |
| 94 | PCM_DO_0 | O | Audio Serial PCM Data Out[0]. |
| 95 | PCM_DO_1 | O | Audio Serial PCM Data Out[1]. |
| 96 | IEC958_O | O | IEC-958 Output |

Table 13. Audio Output Interface

4.7 $\Delta\Sigma$ Modulator Interface

The $\Delta\Sigma$ Interface pins are described in Table 14. The CS7410 contains a stereo Delta-Sigma ($\Delta\Sigma$) modulator, which outputs two differential digital signals on four pins. These outputs are design to drive an external op-amp based integrator circuit (contact Cirrus Logic Applications Engineering for details).

| Pin | Signal Name | Type | Description |
|-----|-------------|------|---|
| 84 | DAC_LP | O | $\Delta\Sigma$ left channel, positive output |
| 85 | DAC_LN | O | $\Delta\Sigma$ left channel, negative output |
| 87 | DAC_RP | O | $\Delta\Sigma$ right channel, positive output |
| 89 | DAC_RN | O | $\Delta\Sigma$ right channel, positive output |

Table 14. $\Delta\Sigma$ Output Interface

4.8 CD Interface

The CD Interface pins are described in Table 15. This interface is used to read serial CD data from a CD servo/read channel chip. The interface supports all standard formats, including 16 MHz, 24 MHz and 32 MHz clocks per container. Control of the CD servo chip is done by the RISC processor using GPIOs, and CD subcode data is read using the dedicated serial interface (SER3).

| Pin | Signal Name | Type | Description |
|-----|-------------|------|---|
| 81 | CD_BCLK | I | CD clock input – polarity is programmable |
| 82 | CD_LRCK | I | CD left-right clock input |
| 83 | CD_DATA | I | CD serial data input |
| 80 | CD_C2P0 | I | CD error signaling input |

Table 15. CD Interface

4.9 General Purpose Input/Output (GPIO)

The CS7410 provides a number of General Purpose Input/Output (GPIO) pins, each with individual output three-state controls, and a number of General Purpose Output (GPO) pins. Table 16 shows the 17 dedicated GPIO pins. A naming scheme for these pins was chosen to encourage system designers to adhere to standardized pin usage. Table 17 shows the GPIO and GPO pins that can be redefined from other functions. For redefined pins, mode control register bits select the normal function or GPIO/GPO function for the pins. Table 17 also indicates which mode bit controls each pin.

| Pin | Signal Name | Type | Description |
|--------------------|-------------|------|---|
| 100, 99, 98, 97 | GPIO[3:0] | B | 4 General purpose I/O on dedicated pins |
| 53, 52, 51, 50, 49 | KP_IN[4:0] | B | 5 General purpose I/O on dedicated pins |
| 58, 57, 56, 55, 54 | KP_OUT[4:0] | B | 5 General purpose I/O on dedicated pins |
| 59 | IR_IN | B | General purpose I/O on dedicated pin |
| 62 | SER4_CLK | B | General purpose I/O on dedicated pin |
| 63 | SER4_DAT | B | General purpose I/O on dedicated pin |

Table 16. Dedicated General Purpose I/O Pins

| Pin | Signal Name | Type | Description |
|-----|-------------|------|-------------------------------|
| 65 | SER2_CLK | B | GPIO controlled by Mode bit 2 |
| 67 | SER2_DO | B | GPIO controlled by Mode bit 2 |
| 68 | SER2_CS | B | GPIO controlled by Mode bit 2 |
| 66 | SER2_DI | B | GPIO controlled by Mode bit 3 |
| 69 | SER3_CLK | B | GPIO controlled by Mode bit 4 |
| 70 | SER3_DO | B | GPIO controlled by Mode bit 4 |
| 72 | SER3_DI | B | GPIO controlled by Mode bit 4 |
| 74 | SER3_SS0 | B | GPIO controlled by Mode bit 4 |
| 76 | SER3_SS1 | B | GPIO controlled by Mode bit 5 |
| 80 | CD_C2P0 | B | GPIO controlled by Mode bit 6 |
| 77 | SERVOCK | B | GPIO controlled by Mode bit 7 |
| 92 | PCM_BCK | O | GPO controlled by Mode bit 8 |
| 93 | PCM_LRCK | O | GPO controlled by Mode bit 9 |
| 94 | PCM_DO_0 | O | GPO controlled by Mode bit 10 |
| 95 | PCM_DO_1 | O | GPO controlled by Mode bit 11 |
| 79 | PCM_MUTE | O | GPO controlled by Mode bit 12 |
| 84 | DAC_LP | O | GPO controlled by Mode bit 13 |

Table 17. Redefined General Purpose Pins

| Pin | Signal Name | Type | Description |
|-----|-------------|------|--------------------------------|
| 85 | DAC_LN | O | GPO controlled by Mode bit 13 |
| 87 | DAC_RP | O | GPO controlled by Mode bit 13 |
| 89 | DAC_RN | O | GPO controlled by Mode bit 13 |
| 96 | IEC958_O | B | GPIO controlled by Mode bit 14 |

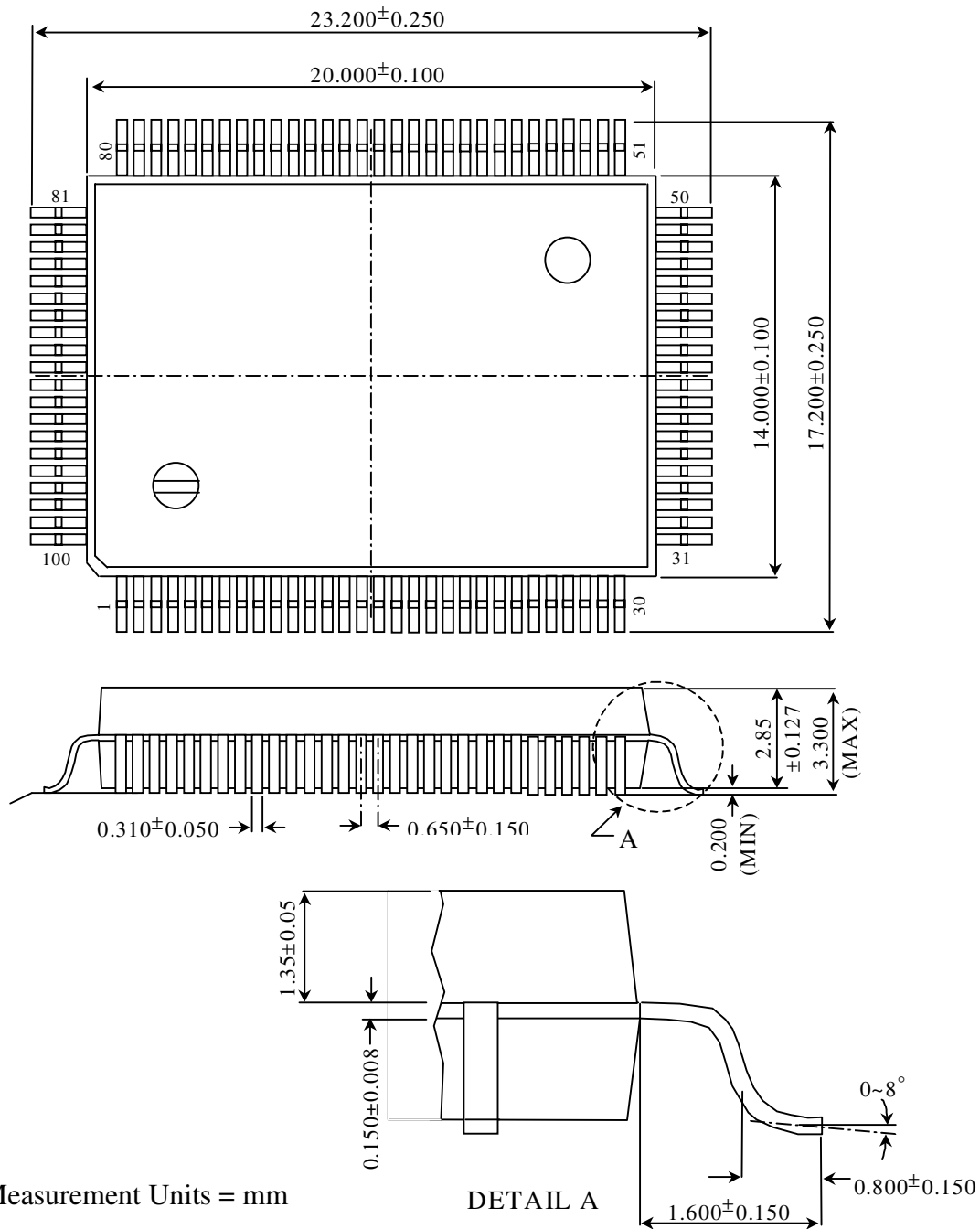
Table 17. Redefined General Purpose Pins (Continued)

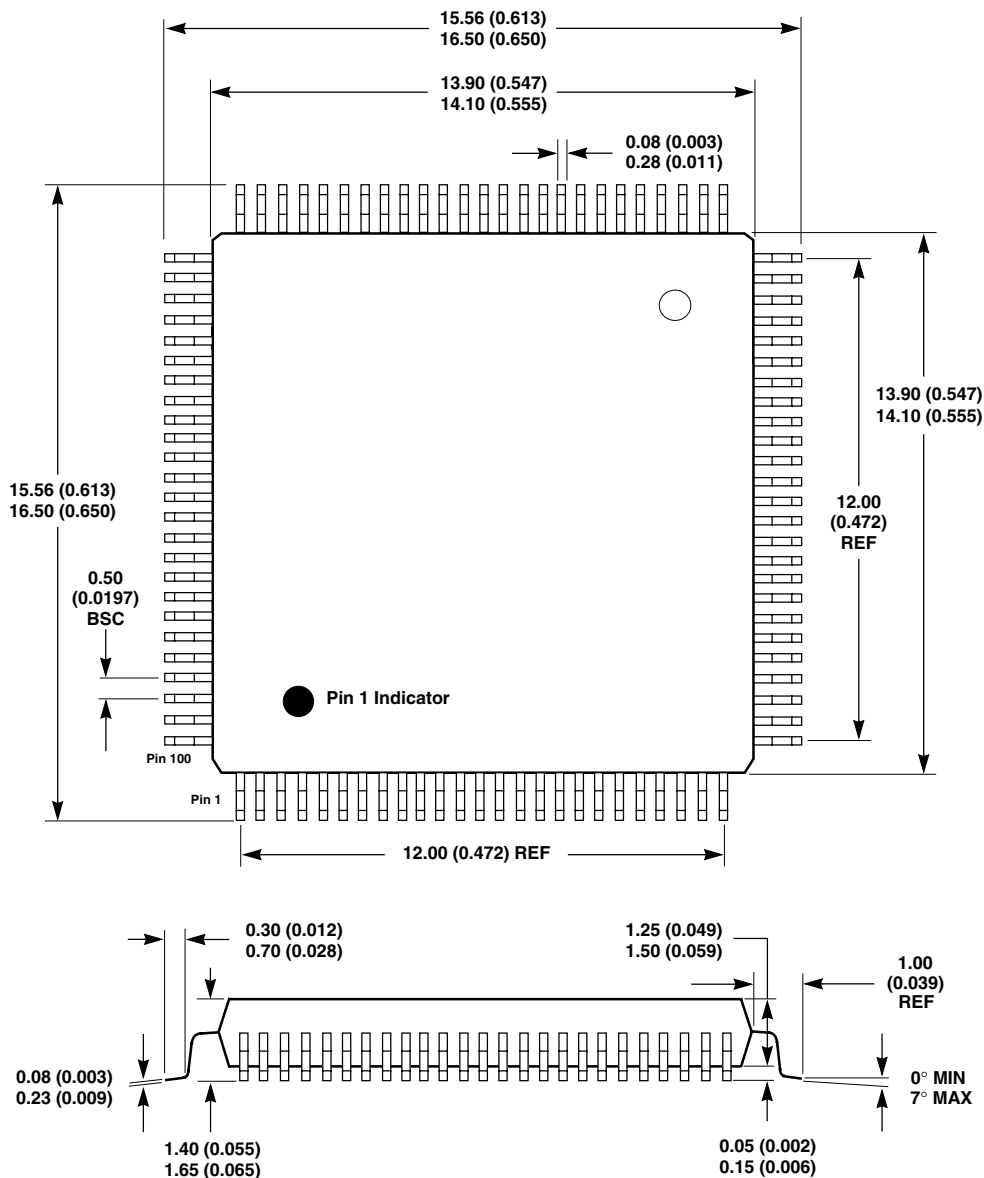
4.10 Power and Ground

Table 18 describes the power and ground pins. The CS7410 requires 3 different types of power supplies for the PLLs, internal logic, and IO pins. The PLLs and internal logic use 1.8 V supply voltage. The IO pins use 3.3 V supply voltage. An optional separate supply can be used to provide clean 3.3 V to the Sigma-Delta DACs digital output pads. It is recommended that you use good layout techniques to provide isolation between the supply types on the board. Contact Cirrus Logic applications engineering for layout guidelines.

| Pin | Signal Name | Type | Description |
|----------------|-------------|------|---------------------------------------|
| 1 | PLL_GND | | Ground for internal PLLs |
| 2 | PLL_1V8 | | 1.8V for internal PLLs |
| 14, 40, 73 | CORE_GND | | Ground for internal core logic |
| 12, 38, 71 | CORE_1V8 | | 1.8V for internal core logic |
| 19, 42, 64, 86 | IO_GND | | Ground for Digital I/Os |
| 16, 44, 75 | IO_3V3 | | 3.3V for Digital I/Os |
| 88 | DAC_3V3 | | 3.3V for Sigma Delta DAC Digital I/Os |

Table 18. Power and Ground

5. 100-PIN MQFP PACKAGE SPECIFICATIONS (20X14X2.85mm)

Figure 18. 100-Pin MQFP Package (20x14x2.85mm)

6. 100-PIN LQFP PACKAGE SPECIFICATIONS (14X14X1.4mm)

NOTES:

- 1) Dimensions are in millimeters (inches), and controlling dimension is millimeter.
- 2) Package body dimensions do not include mold protrusion, which is 0.25 mm (0.010 in).
- 3) Pin 1 identification may be either ink dot or dimple .
- 4) Package top dimensions can be smaller than bottom dimensions by 0.20 mm (0.008 in).
- 5) The "lead width with plating" dimension does not include a total allowable dambar protrusion of 0.08 mm (at maximum material condition).
- 6) Ejector pin marks in molding are present on every package.

Figure 19. 100-Pin LQFP Package (14X14X1.4mm)

Contacting Cirrus Logic Support

For all product questions and inquiries contact a Cirrus Logic Sales Representative.
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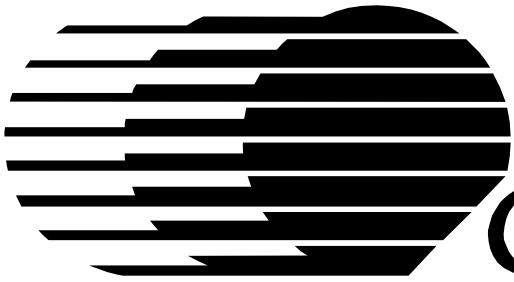
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• **Notes** •



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