CRD7410-HE User's Guide

CIRRUS LOGIC®

Release 1.2

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Chapter 1

Board Architecture

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1.1 Overview

This document describes a reference design platform for the Cirrus Logic CS7410, known as the CRD7410-HE. It is an evaluation platform for a high-end portable CD player. The CRD7410-HE platform provides a low-cost yet powerful solution for today's popular digital music formats (CDDA, MP3, WMA, VCD, AVCD, and SVCD). The platform also provides support for today's popular music playlist formats such as MP3, M4U, PLS, B4S, and RMP. An integrated single-chip stereo FM tuner provides yet another attractive feature for the portable audio market. The system's small size, light weight, and low power consumption allow designers to integrate powerful features into a portable device. The design is also easily adapted to small bookshelf systems.

The CRD7410-HE is composed of the main board and the remote control unit. All components necessary for a portable CD/MP3/WMA/VCD/AVCD/SVCD/FM application except the LCD display are incorporated into the main board. The remote control unit contains an LCD display and all switches necessary to control the player. Refer to Figure 1-1.

Debug capability is provided adjacent to the main circuitry. In a final design, the I2C debug and Romulator ports could easily be eliminated, leaving only the circuitry required for the application.

In addition, the LCD display and control buttons on the remote control are laid out in a manner which allows that circuitry to be moved easily to a separate front panel PCB. Refer to Figure 1-1.

Cirrus Logic provides the system as a complete solution. Schematics and Gerber data files for the PCB are available.

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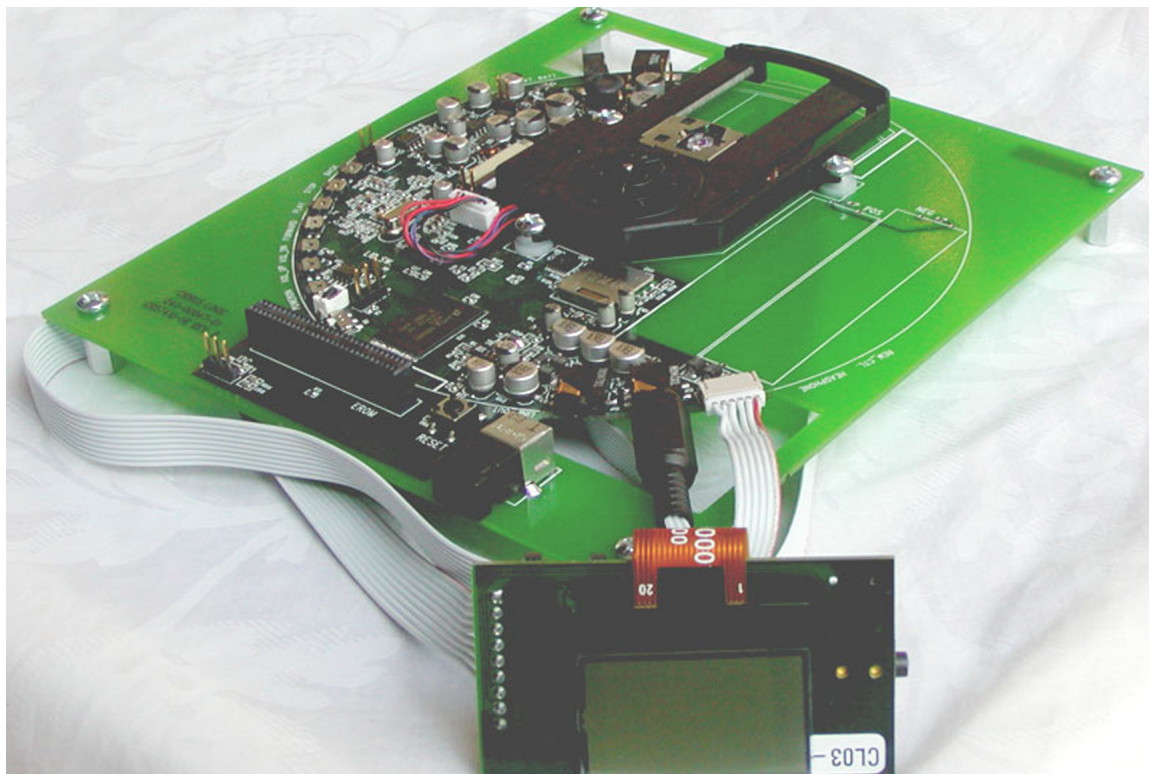
Figure 1-1. CRD7410-HE System

The CRD7410-HE system contains three Cirrus Logic devices:

- CS7410 Compressed Audio Decoder
- CS43L42 Low-voltage Stereo D/A Converter with Headphone Amp
- CS5333 24-Bit, 96 kHz, Stereo A/D Converter

User interface control and digital audio decoding are provided by the CS7410. The CS7410 receives data from the CD loader subsystem, decodes the CDDA/MP3/WMA/VCD/AVCD/SVCD data, processes it for EQ and 3D sound effects and delivers digital audio outputs to the on-board CS43L42 digital-to-analog converter (DAC).

The CS43L42 DAC can deliver the analog audio to an external amplifier via a line-level output jack or, using its integrated headphones amplifier, power a set of headphones.

The CS5333 ADC converts analog input from the on-board world-wide-capable FM tuner or the auxiliary line-level input jack. The analog data is converted and delivered to the CS7410 for EQ and 3D sound effects processing. The processed digital data is then passed to theCS43L42 stereo DAC and output to both the integrated headphones amplifier and the auxiliary line-out jack.

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1.2   Main Subsystems

The CRD7410-HE has seven main subsystems. They are:

- Decoder
- Audio
- User Interface Subsystem
- CD Loader
- Power
- Debug Interface
- Jumpers and Switches

The subsystems are detailed in the following sections.

1.2.1   Decoder Subsystem

This system uses the Cirrus Logic CS7410 for main control and audio decode. See U6 in Figure 1-2.

A Flash EEPROM is used for application code. See U3 in Figure 1-3.

An SDRAM is provided for Electronic Shock Protection (ESP). See U8 in Figure 1-2.
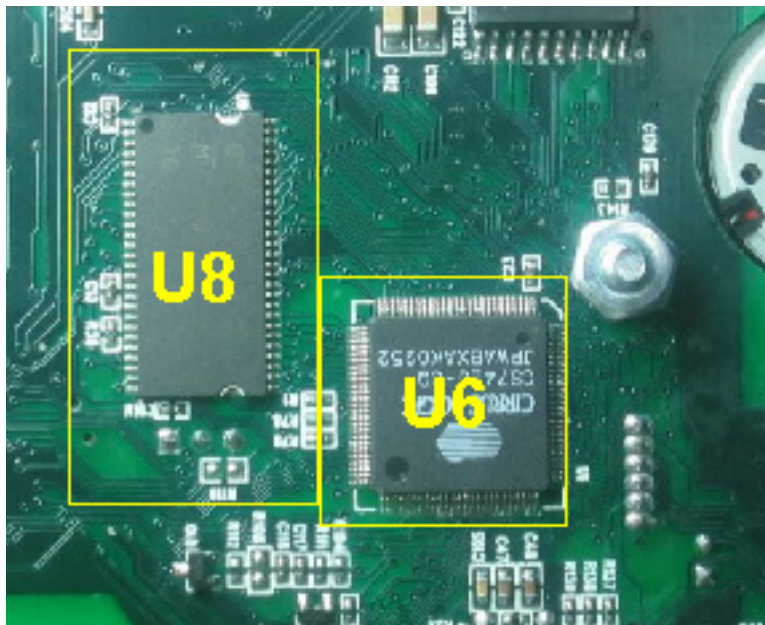
Figure 1-2.   CS7410 (U6) and SDRAM (U8)

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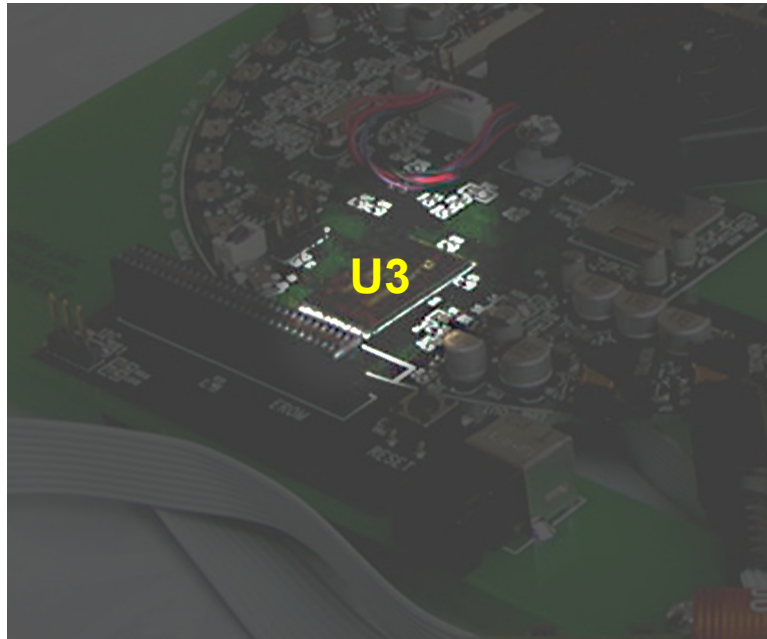
Figure 1-3. Flash EEPROM (U3)

1.2.2   Audio Subsystem

The CS7410 receives data from the CD loader subsystem, decodes the CDDA/MP3/WMA/VCD/AVCD/SVCD data (supporting M3U/M4U/PLS/B4S/RMP playlist formats), processes it for EQ and 3D sound effects and delivers digital audio outputs to the on-board CS43L42 digital-to-analog converter (DAC).

The CS43L42 DAC can deliver the analog audio to an external amplifier via a line-level output jack or, using its integrated headphones amplifier, power a set of headphones.

The CS5333 ADC converts analog input from the on-board world-wide-capable FM tuner or the auxiliary line-level input jack. The analog data is converted and delivered to the CS7410 for EQ and 3D sound effects processing. The processed digital data is then passed to the CS43L42 stereo DAC and output to both the integrated headphones amplifier and the auxiliary line-out jack.

1.2.2.1   On-board DAC

The CS43L42 is an integrated Sigma-Delta-based Digital-to-Analog Converter. This allows the designer to build a low-cost DAC with a simple RC integration circuit. In such a design, proper layout permits greater than 80 dB SNR.

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1.2.2.2 SPDIF Digital Audio Output

This system also provides audio data in serial format, to support the use of an external DAC. An optical SPDIF connector is available adjacent to the Romulator and I2C debug ports.

1.2.2.3 Subsystem Design Details

The flowering three figures show the details of the implementation of this subsystem design. This list below defines the semiconductor devices and connectors used in this subsystem, and the function of each.

- D-to-A Converter - CS43L42
- A-to-D Converter - CS5333
- J12 - Headphones Out and Line Controller Headphones Jack
- J15 - Line Out Jack
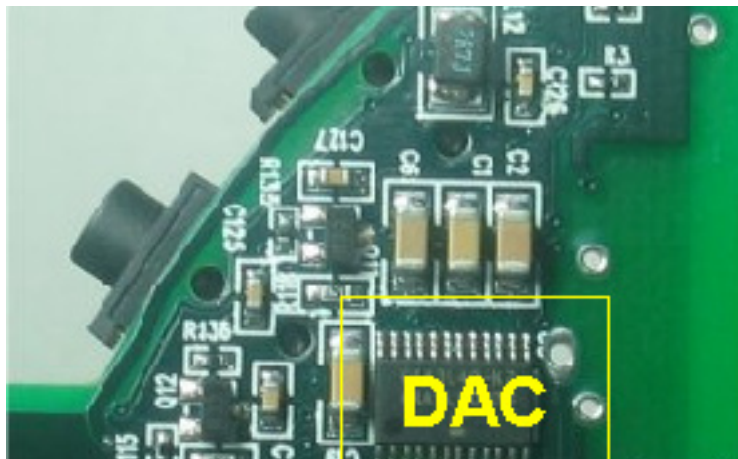
Figure 1-4. CS43L42 DAC
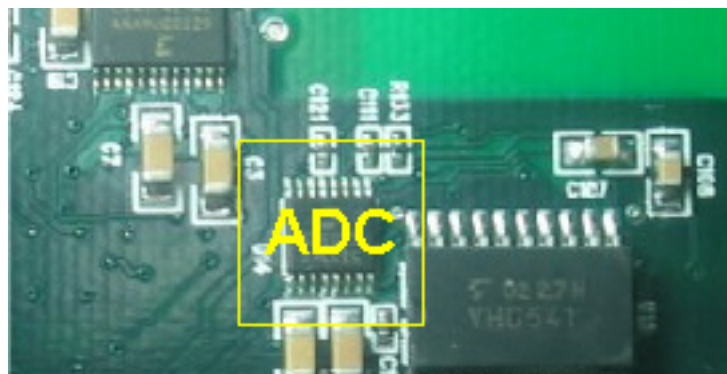
Figure 1-5. CS5333 ADC
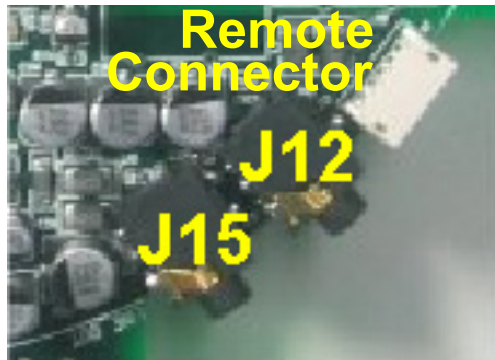
Figure 1-6. Headphones and Line Out Jacks

1.2.3 Tuner Subsystem

The tuner subsystem incorporates an single-chip electronically-tuned FM stereo radio with fully integrated IF selectivity and demodulation.

The radio can be tuned to the European, US, and Japanese FM bands.

The tuner's analog outputs are sampled and converted to digital data by the CS5333 and delivered to the CS7410 for EQ and 3D sound effects processing. The data is then passed to the optical SPDIF connector and the CS43L42 DAC. The CS43L42 integrates both a headphones amplifier and line-level amplifier.
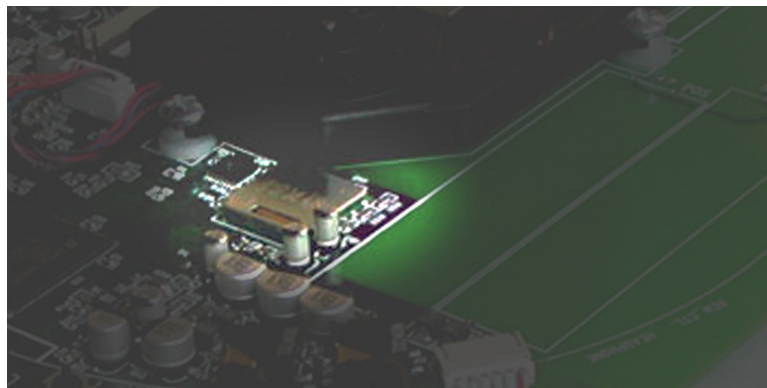
Figure 1-7. FM Tuner

1.2.4   User Interface Subsystem

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The User Interface Subsystem has three sections: the LCD (Liquid Crystal Display), the Button Matrix, and the wired remote controller. The LCD is integrated into the remote controller.

1.2.4.1   LCD Display

Figure 1-8 shows a close-up view of the LCD, which is part of the User Interface Subsystem.

The LCD display (reference designator - DSP1) is a 128 x 64 pixel display. For a dot matrix character size of 8 x 6, this gives 21 characters per line, by 8 lines per display.

Figure 1-8. LCD

1.2.4.2 System Control Buttons

Figure 1-9 shows a close-up view of the control buttons located on the main board, which are part of the User Interface Subsystem. The *Lid Open* switch works as an interlock preventing the unit from being powered on while the lid/door is open. If the lid/door is opened while the unit is playing, the power will be switched off.

User inputs are implemented with 8 push buttons on the main board and 12 buttons on the remote control.

Table 1-1 shows the functions of the push buttons shown in Figure 1-9.
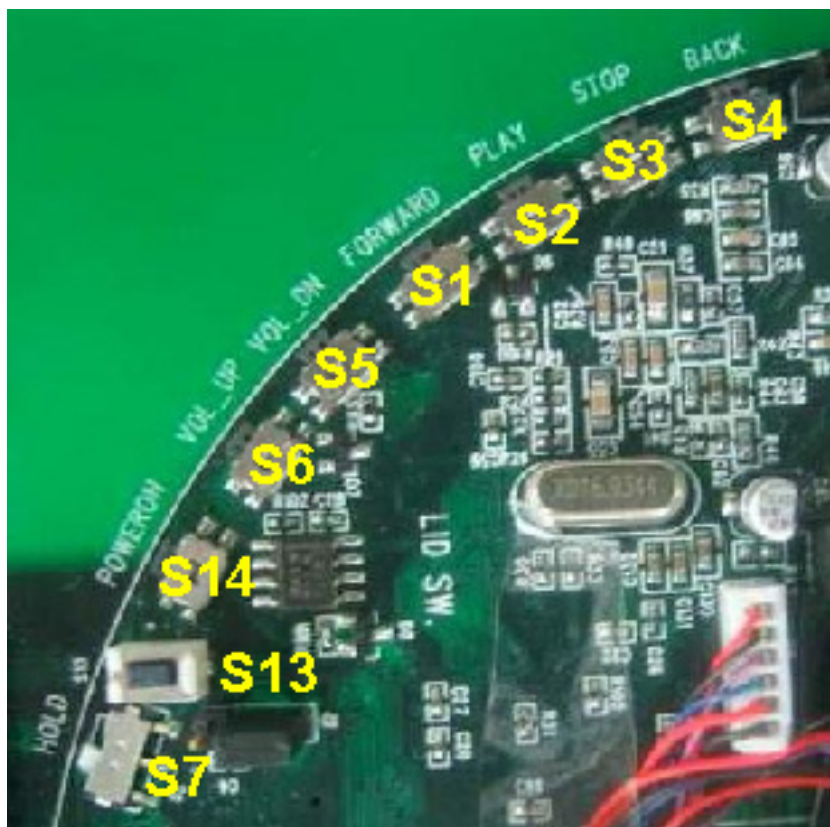
Figure 1-9. Detail View of the Control Buttons

Note: When the power is on, push button S2 must be pressed to activate the system.

Table 1-1: Main Board Buttons

S1: Next/Right/Select	S2: Play/Pause/Up	S3: Stop/Down	S4: Previous/Left/Delete
S5: Vol-	S6: Vol+	S7: Hold	S14: Power On
S13: Lid Open			

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1.2.4.3 Remote Controller

Figure 1-10 shows a close-up view of the remote controller, which is part of the User Interface Subsystem.

User inputs are implemented with 8 push buttons, one switch (*Hold*) and one headphone output.

The *Hold* button prevents inadvertent button presses while it is engaged. This allows the unit for instance, to be worn while jogging or other activity without unwanted button activity.

Table 1-2 shows the functions of the push buttons and switch shown in Figure 1-10.
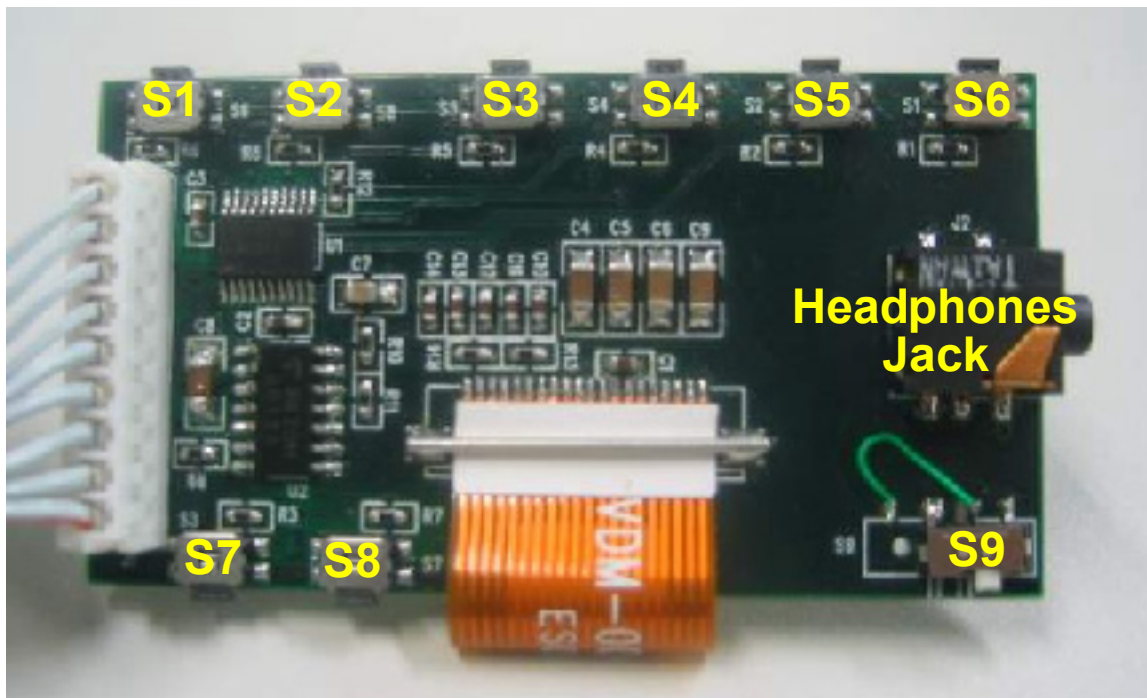
Figure 1-10. Remote Control Buttons

Note: When the power is on, push button S5 must be pressed to activate the system.

Table 1-2: Remote Controller Buttons

S1: *Next/Right*	S2: *Vol-*	S3: *Stop/Down*	S4: *Select/AB Repeat/Program*
S5: *Play/Pause/Up*	S6: *Vol+*	S7: *Previous/Left/Delete*	S8: *Navigator/Menu*
S9: *Hold* Switch			

1.2.4.4 CD Loader Subsystem

The CRD7410-HE provides direct support for common servo chipsets. The devices incorporated into the CRD7410-HE servo system are:

• SAA7824HL - (U301) CD audio decoder, digital servo and filterless DAC with integrated pre-amp and laser control. Refer to Figure 1-11.

• MM1538XQ - (U201) 4-channel Motor Driver and DC-DC control. Refer to Figure 1-12.

• TPP381 - CD Loader Mechanism. Refer to Figure 1-12.

This design implements a power-save-mode circuit to maximize battery life.

Because of the capabilities built into the CS7410, no separate microcontroller is needed.
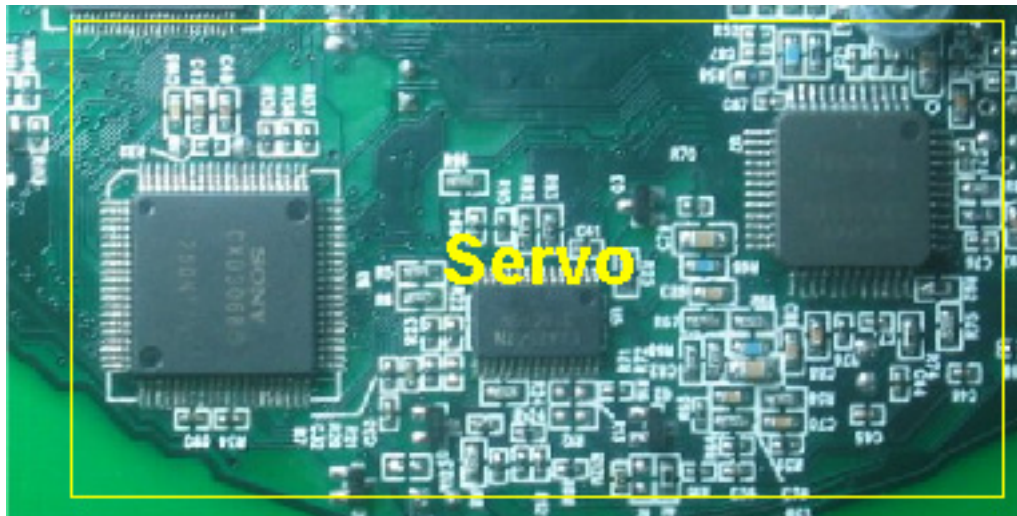
Figure 1-11. Servo Subsystem
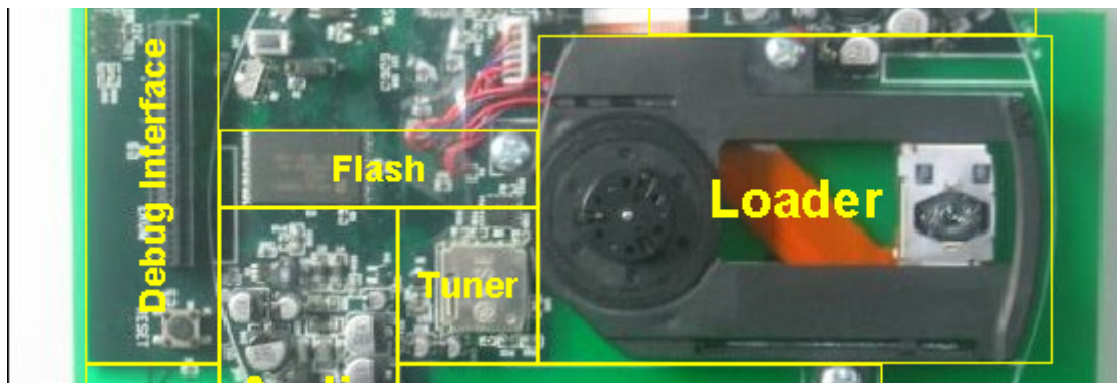
Figure 1-12. CD Loader

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1.2.4.5 Power Subsystem

The Power Subsystem provides power to all system components. It consists of:

• The 5 Volt power input connector (J2).

• The AA battery supply mounts (J1) and Battery Supply On/Off switch (SW3).

• A MM1538XQ DC-to-DC converter, to generate the main system voltage (3.0 V).

• The potentiometer and a comparator circuit for Power Subsystem battery monitoring (U1 - Dual Comparator - BA4510).

• Voltage regulators to generate the 1.8 V levels needed for the CS7410 core (U10 - Voltage Regulator - LM393M).
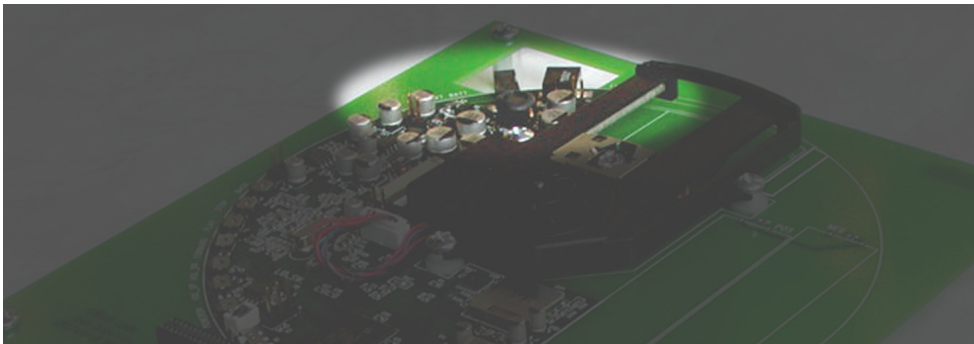
Figure 1-13. Power Subsystem

1.2.4.6 Debug Interface

There is a debug interface and Romulator connector to provide test and debug facilities.

The following connectors are provided (see Figure 1-14, below):

• J11 - I2C debug (be sure to match pin 1 to pin 1 when connecting the I2C debug cable from the Romulator to J12).

• J401 - Romulator connector (be sure to match pin 1 to pin 1 (as marked on the connectors) when connecting the buffer card connector from the Romulator to J401).

• J402 - Romulator select (install a jumper between pin 1 and pin 2 to select Flash mode, or install a jumper between pin 2 and pin 3 to select Romulator mode)
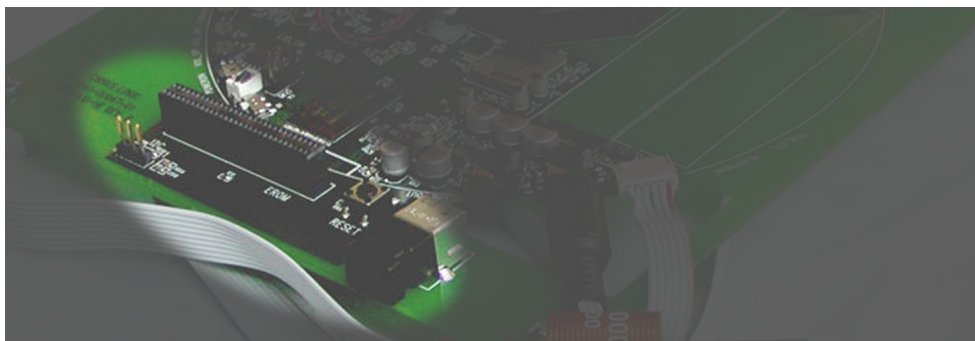
Figure 1-14. Debug Subsystem

1.2.4.7 Jumpers and Switches

Switches

- S13 - Button Hold
- S14 - Lid Open
- S15 - Not Used
- S16 - Reset

Jumpers

- JP1 – When closed, the power supply will be enabled.
- JP2:JP3 – When closed, the system power will be 3.1v;when open the system power will be 2.6-2.8v.
- JP4 – When closed, the system does not check the status of the *Lid Open* switch (S13).
- JP5, – when closed, S13 will be disabled.
- JP6, – when closed, S14 will be disabled.
- JP7, – when closed, S15 will be disabled.
- JP8, – when closed, S16 will be disabled.

Chapter 2

User Menu Selections

2

2.1 User Interface

This document describes the reference user interface for the CS7410-HE firmware. The user interface supplies the required UI APIs as specified in the *"CS7410HE Firmware Architecture Specification"* and relies upon the services provided by that architecture. It is easy to understand, easy to customize, and easy to expand.

The hardware available for use by the user interface consists of six push buttons (*Play/Pause/Up*, *Stop/Down*, *Previous/Left*, *Next/Right*, *Vol+*, *Vol-*) and two switches (*Lid Open*, *Hold*) on the HE board, and eight push buttons (*Play/Pause/Up*, *Stop/Down*, *Previous/Left*, *Next/Right*, *Navigator/Menu*, *Select*, *Vol+*, *Vol-*), one switch (*Hold*) on the remote control, an LCD (which is twenty columns by four rows of text, 8X6 characters) in Remote CTL. These buttons and switches on the HE board and remote control are independent.

The CS7410 version 6.0 firmware assumes availability of eight push buttons, two switches, and an LCD (which is twenty columns by eight rows of text). The eight push buttons are used for the following functions:

Play/Pause/Up:

- This button is used to start or pause playback of the current track. When displaying a menu, this button is used to move up. When the player is in *Soft Power Down* mode, pressing this button will power on the player and commence playback.

Stop/Down:

- This button is used to stop playback of the current track. When displaying a menu, this button is used to move down. When held, this button will put the player into *Soft Power Down* mode.

Previous/Left/Delete:

- This button is used to skip to the beginning of the current track, or to the beginning of the previous track if already at the beginning of the current track. Holding this button while playing will seek backwards within the track. Holding this button while stopped will repeatedly skip to the previous track. When displaying a menu, this button is used to move left.

- In radio mode, this button deletes previously created pre-sets.

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Next/Right:

- This button is used to skip to the beginning of the next track. Holding this button while playing will seek forward within the track. Holding this button while stopped will repeatedly skip to the next track. When displaying a menu, this button is used to move right.

Select/ A→B Repeat/Program:

- This button is used to select items when displaying a menu.

- Pressing this button while playing sets the *A* point for the *A→B Repeat* mode. Pressing it again will set the B point and enable the *A→B Repeat* mode. Pressing it a third time will cancel the *A→B Repeat* mode.

- Pressing this button while stopped will enter the playlist menu.

Navigator/Menu:

- Pressing this button will enter/leave the file system *Navigator* menu.

- Holding this button will enter/leave the *Main* menu.

- Pressing this button while stopped will leave the *Playlist* menu.

Vol+:

- Pressing this button will turn the volume up by one. Holding this button will repeatedly turn the volume up.

Vol-:

- Pressing this button will turn the volume down by one. Holding this button will repeatedly turn the volume down.

The two switches are used for the following functions:

Lid Open:

- This switch is used to detect whether the lid of the CD player is opened or closed.

Hold:

- This switch is used to disable the buttons. When enabled, the player will ignore all buttons except the *Hold* button.

The LCD is used to provide status information to the user. Normally, the LCD will display information about the track currently being played. Various menu modes exist which will overlay the status information with a menu, allowing settings to be changed, playlists to be loaded, etc. Additionally, these menu modes change the functions of some of the buttons.

2.1.1 System Start-up

When the player is first powered on, it will initialize the LCD and display the following screen.
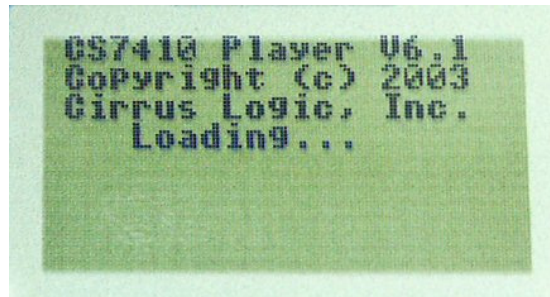
Figure 2-1. *Power On* Screen

The number at the end of the last line is the number of tracks currently read from the disc. Every 0.5 seconds, the number of tracks is updated.

Once the disc scan has completed, the player will check for update files. If any are found, it will display the following screen:
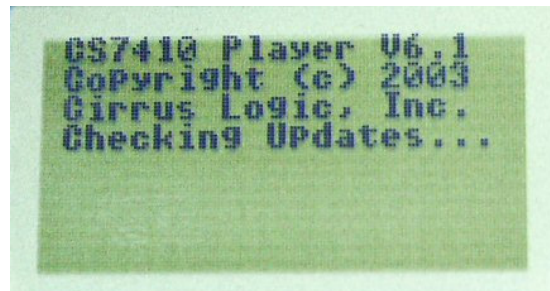
Figure 2-2. *Checking for Update Files* Screen

If an update file is found that is newer than the current firmware, the player will display the following screen:

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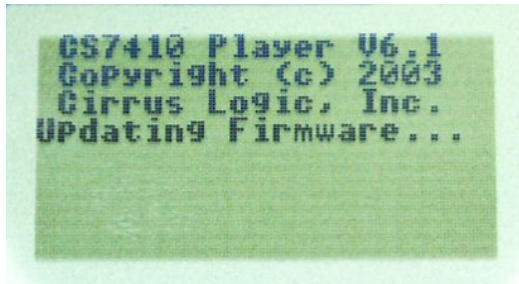
Figure 2-3. *Loading Updated Firmware* Screen

When the firmware has been updated, the player will restart and the new firmware will be run.

If there is a problem with the disc, the player will report that fact to the user interface. In this case, an appropriate message will be displayed on the LCD for five seconds, after which the player is powered off. The following is an example screen for the case where a bad disc is found:
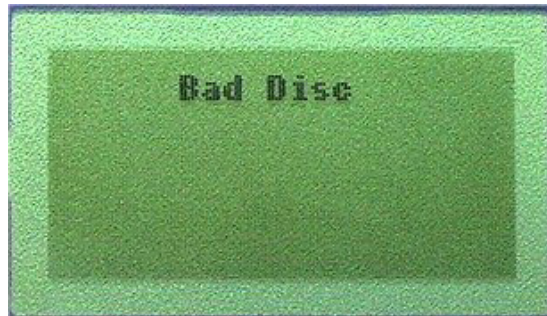
Figure 2-4. *Bad Disc* Screen

If the disc has been recognized and scanning has been completed, the *Normal* screen will then be displayed. The user interface will automatically start playback after the player finds a good disc.

Figure 2-5. *Normal Operation* Screen (*Play*)

When paused, the following screen will be displayed.

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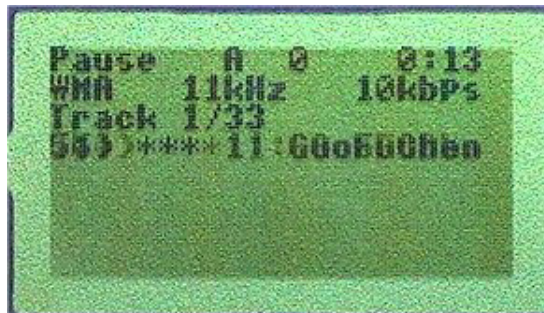
Figure 2-6. *Normal Operation* Screen (*Pause*)

2.1.2 *Normal* (Default) Start-up Mode

The default mode of the player at power on is *Play*. Refer to Figure 2-5 and Figure 2-6.

The *MMM* field corresponds to the current playback mode, which can be one of the following values:

Value	Meaning
A	All tracks on the disc are played in the order encountered. When the last track has been played, the player stops. This is the default playback mode.
1	Only the current track is played. When the track has been played, the player stops.
D	Only the tracks in the same directory as the current track are played. When the last track in the directory has been played, the player stops.
RA	All tracks on the disc are played in the order encountered. When the last track has been played, the player continues by playing the first track.
R1	Only the current track is played. When the track has been played, the player replays the current track.
RD	Only the tracks in the same directory as the current track are played. When the last track in the directory has been played, the player continues by playing the first track in the directory.
SA	All tracks on the disc are played in a random order. When all tracks have been played, the player stops.

S1   Only the current track is played. When the track has been played, the player stops. Skipping to the next or previous track will go to a random track.

SD   Only the tracks in the same directory as the current track are played, but in a random order. When all tracks in the directory have been played, the player stops.

RSA   All tracks on the disc are played in a random order. When all tracks have been played, they will all be played again in a different random order.

RS1   Only the current track is played. When the track has been played, the player replays the current track. Skipping to the next or previous track will go to a random track.

RSD   Only the tracks in the same directory as the current track are played, but in a random order. When all tracks in the directory have been played, they will all be played again in a different random order.

IA   The first portion of all tracks on the disc are played. When all tracks have been played, the player stops.

IS   The first portion of all tracks in the specified directory, and all its subdirectories, are played. When all tracks in the list have been played, the player stops.

HA   A portion from the middle of all tracks on the disc are played. When all tracks have been sampled, the player stops.

a   *A→B Repeat* mode is enabled, but only the *A* point is selected. During this time, the player is set to play all tracks on the disc in non-shuffled mode.

ab   The *B* point is selected and the player seeks back to the *A* point whenever the *B* point is encountered.

The *L* field is an indicator that is set to *L* when the player is using a custom playlist. The custom playlist can either be one loaded from a playlist file on the disc or one created by the user. When playing from the default playlist, this indicator will be blank.

The *K* field is an indicator that is set to *L* when the *Hold* switch is on, causing the buttons to be ignored by the user interface. When the *Hold* switch is off, this indicator will be blank.

The time in the upper right corner of the screen is the current playback time.

The second line contains the following items:

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Format

- This indicates the format of the audio on the disc. It will be *CDDA*, *MP1*, *MP2*, *MP3*, *WMA, VCD, AVCD, or SVCD*.

Sample Rate

- This indicates the sample rate of the PCM audio.

- It will be one of these ranges: 8kHz, 11kHz, 12kHz, 16kHz, 22kHz, 24kHz, 32kHz, 44kHz or 48kHz.

Bit Rate

- This indicates the bit rate of the audio on the disc. It will be specified as *XXXX kbps*, where *XXXX* is the bit rate specified in kilobits per second (kbps).

The third line displays the current track number and the total number of tracks available.

The fourth line contains a scrolling string providing track information. The complete format of this string is *TrackNum: Artist - Song (Length)*, where *TrackNum* is the number of the track on the disc, *Artist* is the name of the artist, *Song* is the name of the song, and *Length* is the length of the track in minutes and seconds (i.e. *xx:xx*). If the artist name is not known, just the song name will be used. If the song name is not known, the file name will be substituted for the song name. If neither is known, the file name will be used in place of the artist name and song name (i.e. *TrackNum: Filename (Length)*). This string will not be scrolled if it is short enough to fit on the display without scrolling.

During normal operation, these two variants of the screen (Figure 2-5 and Figure 2-6) are all that will be seen. When settings are changed though, the screen will be modified (or replaced) to provide feedback of that change.

When the volume is changed via the *Vol+* and *Vol-* buttons, the bottom line will be replaced with the volume indicator.
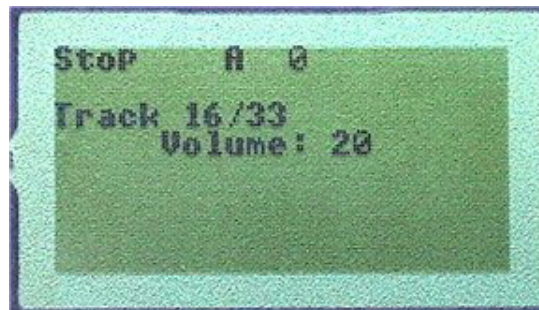
Figure 2-7. *Volume Adjust* Screen

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The top three lines will continue to operate as before, with the bottom line indicating the current volume setting. Once the volume has remained unchanged for a period of time, the volume indicator goes away and the *Normal* display returns.

Pressing the *Navigator/Menu* button will enter navigator mode and the following screen is displayed.

Figure 2-8. *Navigator Mode* Screen

The arrow buttons can be used to highlight a file, which is then selected by pressing the *Select* button. Selecting a file will cause it to be played back, and the playback mode set to *A*. Similarly, a directory can be highlighted and selected by pressing the *Select* button. Selecting a directory will cause its contents to be played back and the playback mode set to *S*. If in navigator mode with no button activity for a period of time, the screen reverts to *Normal* mode.

If the *Select/A→B Repeat/Program* button is pressed while the player is stopped, the playlist selection mode will be entered and the following screen displayed:

Figure 2-9. *Playlist Select* Menu

The arrow buttons can be used to highlight a playlist, which is then selected by pressing the *Select/A→B Repeat/Program* button. Selecting a playlist will cause the contents of that playlist to be loaded as a custom playlist, playback

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started, and the playback mode set to *A*. If in playlist selection mode with no button activity for a period of time, the screen reverts to normal mode.

When a playlist file is selected, the following screen is displayed while the contents of that file are being read and inserted into the custom playlist (with *<name>* replaced with the name of the playlist file).
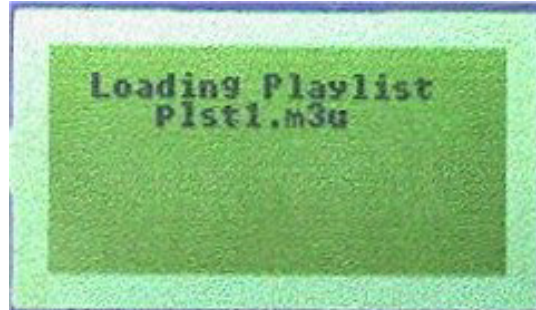
Figure 2-10. *Loading Playlist* Screen

After the playlist has been read from the playlist file, the playback mode is set to *A*, playback commenced, and the screen reverted to normal mode.

Selecting the *{new}* item enters the playlist creation mode, and the following screen is displayed.

Figure 2-11. *Create Playlist* Screen

The number on the first line is the playlist index of the track currently being programmed. Like in navigator mode, files are selected with the arrow buttons. Pressing the *Select/A→B Repeat/Program* button will add the file to the custom playlist. Pressing the *Navigator/Menu* button will complete the custom playlist, return the screen to normal mode, set the playback mode to *A*, and start playback of the custom playlist.

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2.2 *Main* Menu

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Control of the CRD7410-HE ia accomplished through a series of menus originating with the Main Menu. Refer to Figure 2-12.

CRD7410-HE Menu Map

Figure 2-12. CRD7410-HE Menu Map

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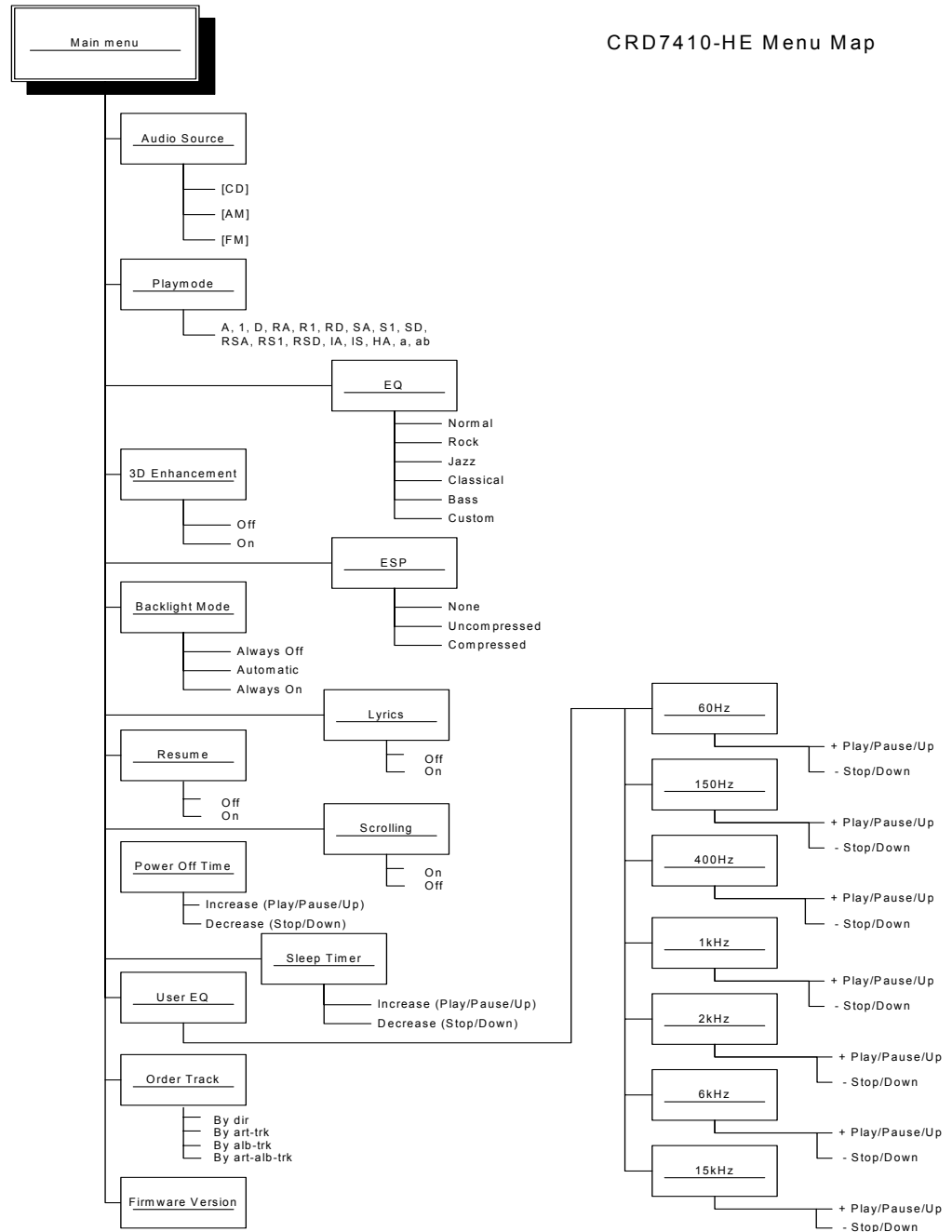
Holding the *Navigator/Menu* button will enter *Menu* mode and display the following screen.

Figure 2-13. *Main Menu* Screen

The *Up* and *Down* buttons will highlight a menu item. Pressing the *Select* button will enter the setting screen for that item. The asterisk (*) denotes the cursor position.

The following is a list of the items in the main menu:

Audio Source

- *CD*
- *AM* (Disabled in CRD7410-HE)
- *FM*

Play Mode

- *A*, *1*, *D*, *RA*, *R1*, *RD*, *SA*, *S1*, *SD*, *RSA*, *RS1*, *RSD*, *IA*, *IS*, *HA, a, ab*

EQ **(Preset)**

- *Normal*, *Rock*, *Jazz*, *Classical*, *Bass, Custom*

3D Enhancement

- *Off*
- *On*

Electronic Shock Protection (ESP)

- *None*
- *Uncompressed* (No ADPCM + ESP)
- *Compressed* (ADPCM + ESP)

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Backlight Mode

- *Always Off*
- *Automatic*
- *Always On*

Power off Time

- *0-15* minutes

Lyrics

- *Off*
- *On*

Resume

- *Off*
- *On*

Scrolling

- *On*
- *Off*

Sleep Timer

- *0-120 Minutes* in 15-minute increments

User EQ

- Displays the *User EQ* (user-defined EQ) menu screen

Order Tracks

- *Normal*
- *By dir*
- *By art-trk*
- *By alb-trk*
- *By art-alb-trk*

Firmware Version

- Displays the Firmware version

The order of the menu items can be changed, and items can be added or removed.

2.2.1 *ESP* Mode

Selecting the *ESP* item from the *Main* menu will display the following screen.

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Figure 2-14. *Electronic Shock Protection (ESP)* Screen

The *X* in the box indicates the current setting of the *ESP* item, the asterisk (*)
denotes the cursor position. Highlighting a different setting and pressing the
Right button will change the setting. Pressing the *Select* button will go back to
the parent menu. The actual values for the *Uncompressed* and *Compressed*
settings are based on the size of the ESP buffer. It will be ~45 and
~180 seconds if a 8 MB DRAM is used and ~11 and ~45 seconds if a 2 MB
DRAM is used.

2.2.2 *Backlight* Mode

Selecting the *Backlight* menu item displays this screen.

Figure 2-15. *Backlight* Screen

When the backlight setting is set to *Always Off*, the backlight is kept off at all
times. If it is set to *Always On*, it is kept on at all times. If it is set to *Automatic*,
it is turned on whenever a button is pressed. If no buttons are pressed for
5 seconds, the backlight is turned off. The asterisk (*) denotes the cursor
position.

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2.2.3 *Lyrics*

Selecting the *Lyrics* menu item displays this screen.
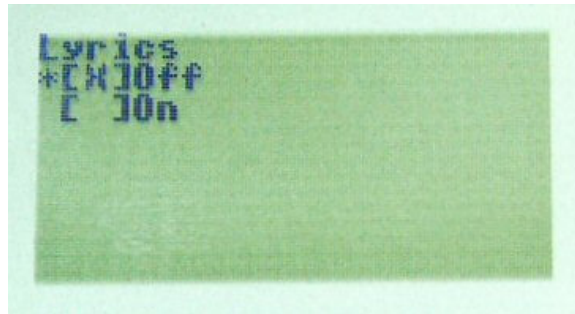
Figure 2-16. *Lyrics* Screen

The *X* in the box indicates the current setting of the *Lyrics* item. The asterisk (*) denotes the cursor position. Highlighting a different setting and pressing the *Right* button will change the setting. Pressing the *Select* button will go back to the parent menu.

When the *Lyrics* setting is set to *On*, if the track which is playing has lyrics on disc, the 4th line of LCD will display the lyrics of the track.

When the *Lyrics* setting is set to *Off*, if the track which is playing has lyrics on disc, the 4th line of LCD will only display the name of the track, not display the lyrics.

2.2.4 *Resume*

Selecting the *Resume* menu item displays this screen.
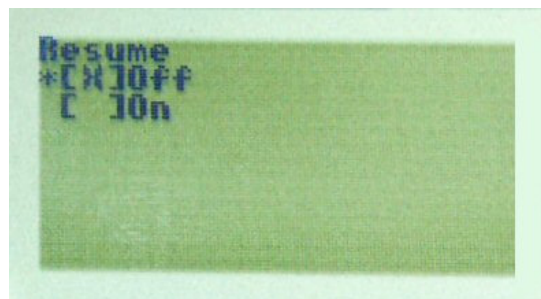
Figure 2-17. *Resume* Screen

The *X* in the box indicates the current setting of the *Resume* item. The asterisk (*) denotes the cursor position. Highlighting a different setting and pressing

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the *Right* button will change the setting. Pressing the *Select* button will go back to the parent menu.

When the *Resume* setting is set to *On* and the user opens the Lid, the CRD7410-HE will remember the current time of the current track on that disc. When the user replays that disc, the system will begin playing from the point on the disc when the lid was opened (for that disc). However the function only remembers the last five (5) discs that have been played. When the 6th disc is inserted, the information for the 1st disc is overwritten.

When the *Resume* setting is set to *Off*, the CRD7410-HE will not have the *Resume* function.

2.2.5 *Scrolling*

Selecting the *Scrolling* menu item displays this screen.
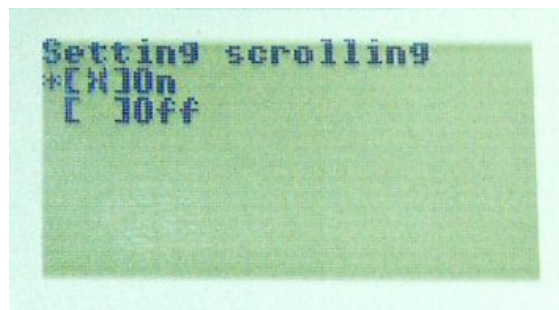
Figure 2-18. *Scrolling* Screen

The *X* in the box indicates the current setting of the *Scrolling* item. The asterisk (*) denotes the cursor position. Highlighting a different setting and pressing the *Right* button will change the setting. Pressing the *Select* button will go back to the parent menu.

When the *Scrolling* setting is set to *On* and the information that displays on 4th line of LCD (artist, album, or track name) is significantly longer than the length of the LCD's line, the information will scroll accross the 4th line of the LCD. Therefore, It will display the entire contents.

When the *Scrolling* setting is set to *Off* and the information that displays on 4th line of LCD (artist, album, or track name) is significantly longer than the length of the LCD's line, the 4th line of the LCD will only display the first 20 characters of the information.

2.2.6 *Power Off Time* Menu

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Selecting the *Power Off Time* menu item displays the following screen.
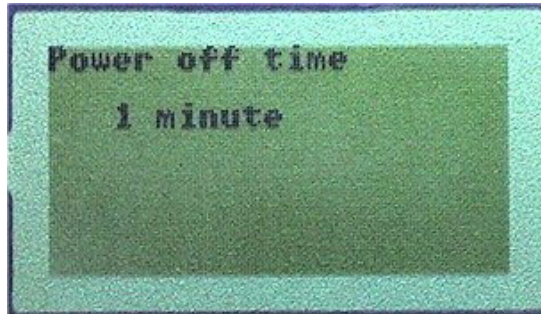
Figure 2-19. *Power Off Time* Screen

If the *Power Off Time* is not zero, the player will be put into *Soft Power Off* mode after the specified number of minutes of inactivity (i.e. no button presses while the player is in *Stop* mode).

2.2.7 *Audio Source* Menu

Selecting the *Audio Source* menu item displays the following screen.
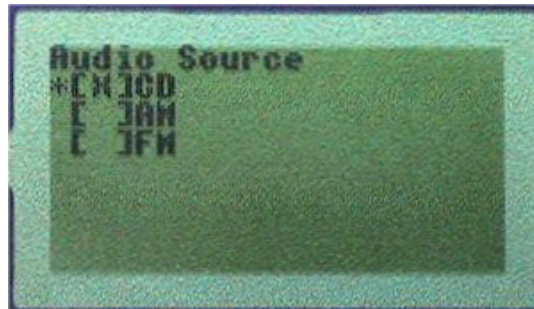
Figure 2-20. *Audio Source* Screen

The *X* in the box indicates the current setting of the *Audio Source* item. The asterisk (*) denotes the cursor position. Highlighting a different setting and pressing the *Right* button will change the setting. Pressing the *Select* button will go back to the parent menu. When the audio source setting is set to *CD*, the tuner will be disabled and the data from disc will be played - MP3/WMA/CDDA/VCD/AVCD/SVCD. If it is set to *AM* or *FM*, the tuner will be enabled. This selection can only be made when player is in *Stop* mode. The default setting of the *Audio Source* item is *CD*.

Note: While the CRD7410-HE firmware supports an AM/FM tuner, the

current hardware only supports *FM* mode. This menu item appears in the *Audio Source* menu but is inactive. Selecting it will do nothing.

2.2.8 *Playback Mode* Menu

Selecting the *Playback Mode* menu item displays the following screen.
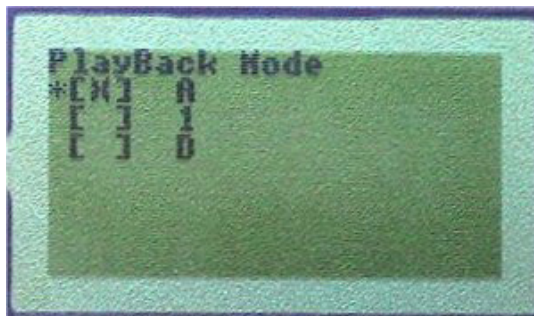
Figure 2-21. *Playback Mode* Screen

The *MMM* field corresponds to the current playback mode, which can be one of the following values:

Value	Meaning
A	All tracks on the disc are played in the order encountered. When the last track has been played, the player stops. This is the default playback mode.
1	Only the current track is played. When the track has been played, the player stops.
D	Only the tracks in the same directory as the current track are played. When the last track in the directory has been played, the player stops.
RA	All tracks on the disc are played in the order encountered. When the last track has been played, the player continues by playing the first track.
R1	Only the current track is played. When the track has been played, the player replays the current track.
RD	Only the tracks in the same directory as the current track are played. When the last track in the directory has been played, the player continues by playing the first track in the directory.
SA	All tracks on the disc are played in a random order. When all tracks have been played, the player stops.

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S1	Only the current track is played. When the track has been played, the player stops. Skipping to the next or previous track will go to a random track.
SD	Only the tracks in the same directory as the current track are played, but in a random order. When all tracks in the directory have been played, the player stops.
RSA	All tracks on the disc are played in a random order. When all tracks have been played, they will all be played again in a different random order.
RS1	Only the current track is played. When the track has been played, the player replays the current track. Skipping to the next or previous track will go to a random track.
RSD	Only the tracks in the same directory as the current track are played, but in a random order. When all tracks in the directory have been played, they will all be played again in a different random order.
IA	The first portion of all tracks on the disc are played. When all tracks have been played, the player stops.
IS	The first portion of all tracks in the specified directory, and all its subdirectories, are played. When all tracks in the list have been played, the player stops.
HA	A portion from the middle of all tracks on the disc are played. When all tracks have been sampled, the player stops.
a	*A→B Repeat* mode is enabled, but only the *A* point is selected. During this time, the player is set to play all tracks on the disc in non-shuffled mode.
ab	The *B* point is selected and the player seeks back to the *A* point whenever the *B* point is encountered.

2.2.9 *EQ* (Preset) Menu

Selecting the *EQ* item will display the following screen. The asterisk (*) denotes the cursor position. Note that if Vol- is pressed, the asterisk will move down and cause the screen to scroll, showing more selections (*Classical*, *Bass*).

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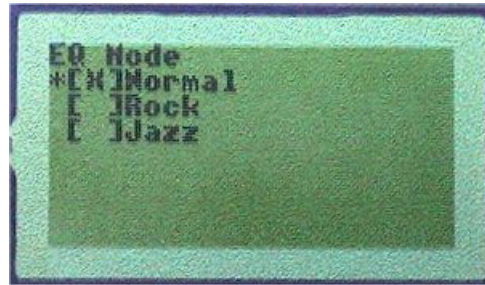
Figure 2-22. *EQ* (Preset) Screen

2.2.10 *User EQ* Menus

The *User EQ* is selected from the scrolling list in the *Main* menu. Refer to Figure 2-23. When *User EQ* is selected, the bottom three lines will be replaced with the current equalizer setting indicator. Refer to Figure 2-24.
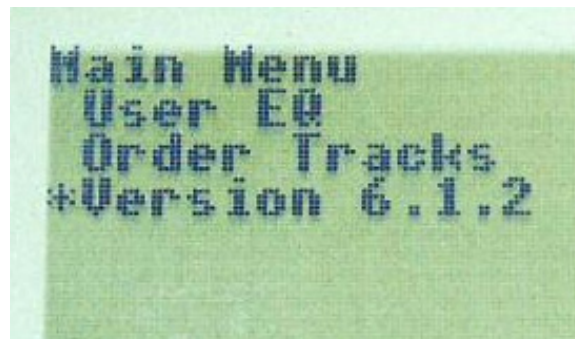
Figure 2-23. *User EQ* Select

The first time the *User EQ* is selected, the current equalizer setting will be displayed. Subsequent presses of the *Select/A→B Repeat/Program* button while the equalizer is displayed will cycle through the various equalizer settings.

The first line indicates the frequency band of the equalizer setting. The bottom two lines provide a graphical representation of the equalizer setting.

A setting of *0dB* for a band is displayed with the top character being blank and the bottom character being solid (i.e. like the first column in Figure 2-24). A setting of *+12dB* for a band is displayed as both the top and bottom characters being solid, and *-12dB* as both characters being blank.

Once the equalizer has remained unchanged for a period of time, the *EQ* indicator goes away and the *Normal* display returns.

The equalizer is automatically set to *User Defined* when the *Main* menu *User EQ* item is selected. The frequency band is displayed, as well as the current decibel setting of that band. The three asterisks (***) denote the currently

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selected band. The *Left* and *Right* buttons select the band and the *Up* and *Down* buttons change the decibel setting of that band. Pressing *Select* saves the settings for the equalizer and returns to *Normal* mode.

2.2.10.1   *60Hz* EQ Menu

The *User EQ* menu for the *60Hz* band displays the following screen.
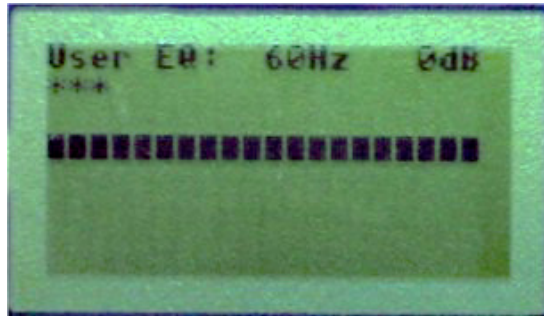
Figure 2-24.   *User EQ 60 Hz* Submenu Screen

2.2.10.2   *150Hz* EQ Menu

The *User EQ* menu for the *150Hz* band displays the following screen.

Figure 2-25.   *User EQ 150 Hz* Submenu Screen

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2.2.10.3 *400Hz* EQ Menu

The *User EQ* menu for the *400Hz* band displays the following screen.
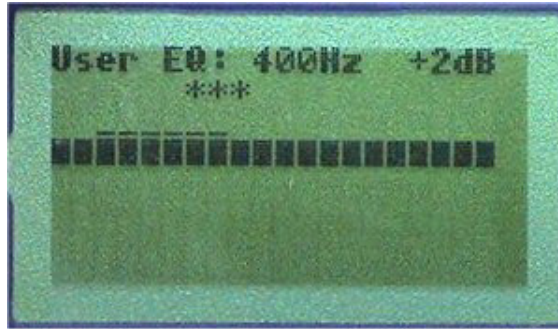
Figure 2-26. *User EQ 400 Hz* Submenu Screen

2.2.10.4 *1kHz* EQ Menu

The *User EQ* menu for the *1kHz* band displays the following screen.

Figure 2-27. *User EQ 1 kHz* Submenu Screen

2.2.10.5 *2kHz* EQ Menu

The *User EQ* menu for the *2kHz* band displays the following screen.

Figure 2-28. *User EQ 2 kHz* Submenu Screen

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2.2.10.6 *6kHz* EQ Menu

The *User EQ* menu for the *6kHz* band displays the following screen.
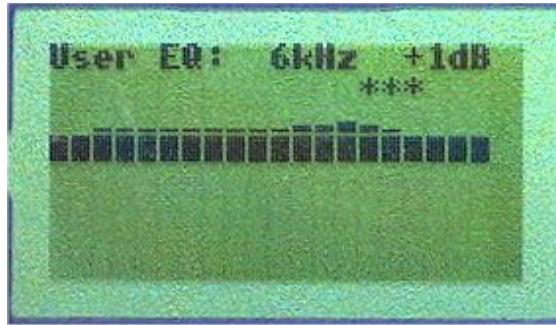
Figure 2-29.   *User EQ 6 kHz* Submenu Screen

2.2.10.7 *15kHz* EQ Menu

The *User EQ* menu for the *15kHz* band displays the following screen.
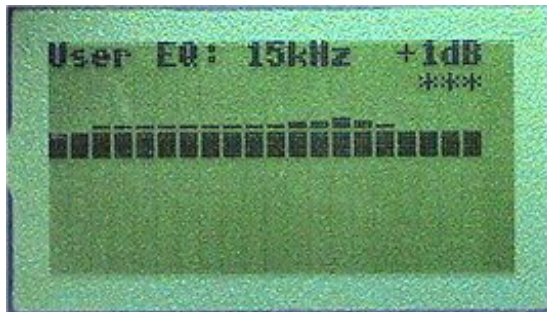
Figure 2-30.   *User EQ 15 kHz* Submenu Screen

2.2.11 *3D Enhancement* Menu

Selecting the *3D Enhancement menu* item will display the following screen.

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Figure 2-31. *3D Enhancement* Screen

If *3D Enhancement* is set to *Off*, the 3D effect will be disabled. If *3D Enhancement* is set to *On*, the 3D effect will be enabled.

2.2.12 *Sleep Timer* Menu

Selecting the *Sleep Timer* menu item displays the following screen.
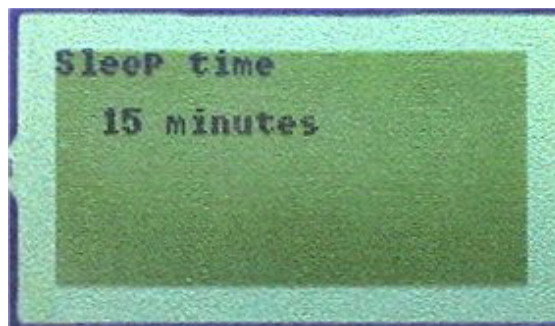
Figure 2-32. *Sleep Timer* Screen

If the *Sleep Timer* setting is not zero, the player will be put into *Soft Power Off* mode after the specified number of minutes, regardless of activity.

2.2.13 *Order Tracks* Menu

Selecting the *Order Tracks* menu item displays the following screen.
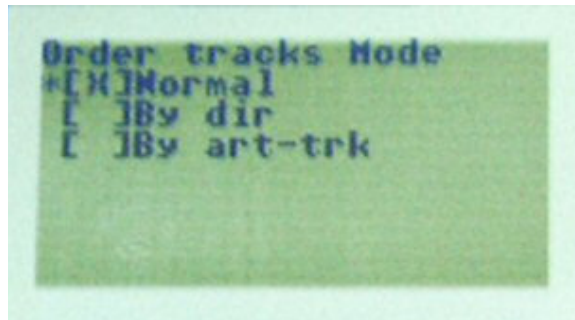
Figure 2-33.   *Order Tracks* Screen 1
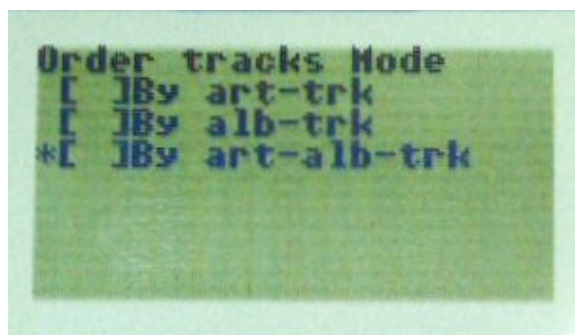
Figure 2-34.   *Order Tracks* Screen 2

The *Order Tracks* option is selected from the scrolling list in the *Main* menu. Selecting the *Audio Source* menu item displays the screens shown in Figure 2-33 and Figure 2-34. The *X* in the box indicates the current setting of the *Order Tracks* item. The asterisk (*) denotes the cursor position. Highlighting a different setting and pressing the *Right* button will change the setting. Pressing the *Select* button will go back to the parent menu.

- *By Dir:* This mode is similar to the original mode when the system boots. Files are kept in directory and sorted by filename.

- *By Artist and Track:* This mode is Sort by Artist, if the Artist fields are the same for several songs, they will be sorted by filename. All files listed appear as *Artist.Filename*.

- *By Album and Track:* This mode is Sort by Album, if the Album fields are the same for several songs, they will be sorted by filename. All files listed appear as *Album.Filename*.

- *By Artist, Album and Track:* This mode is Sort by Artist, if the Artist fields are the same for several songs, they will be sorted by Album, if the Album

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fields are the same for several songs, they will be sorted by filename. All files here appear as *Artist.Album.Filename*.

2.2.14 *Firmware Version*

The following screen shows the version of firmware loaded.
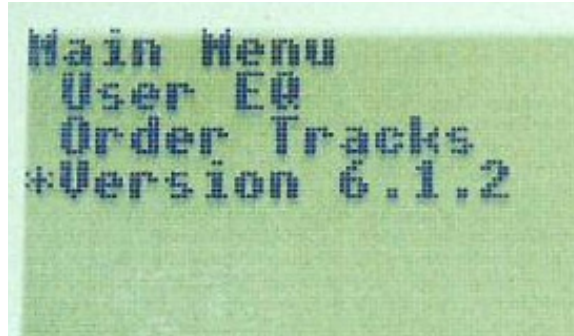
Figure 2-35. *Firmware Version* Screen

Ver x.x.x represents the version of the firmware.

2.3   Menu Options

Many of the buttons in the user interface have modified/different functions if they are pressed and released or if they are pressed and held. Some buttons continue to perform their function so long as the button is held.

The following is a complete list of the functions of the buttons by player mode.

2.3.1 *Power Off* Mode

Play/Pause/Up

• Pressing this button when the lid is closed will power on the player and start playback of the first track. The player will then be in *Normal* mode.

• All other buttons are ignored in this mode.

2.3.2 *Normal* Mode

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Play/Pause/Up

• If the player is stopped, pressing this button will commence playback of the current track.

• If the player is playing, pressing this button will pause playback of the current track.

• If the player is paused, pressing this button will resume playback of the current track.

Stop/Down

• If the player is not stopped, pressing this button will stop playback of the current track and set the playback position to the beginning of the track.

• If the player is stopped and a custom playlist is loaded, pressing this button will cancel the custom playlist and revert to the default playlist.

• Holding this button for 1 second will put the player into power off mode, stopping playback and reducing power consumption as much as possible.

Previous/Left/Delete

• Pressing this button when the player is not stopped and the playback position is less than 3 seconds into the current track will skip to the previous track, maintaining the current playback mode.

• Pressing this button when the player is not stopped and the playback position is greater than or equal to 3000 ms into the current track will seek back to the beginning of the current track, maintaining the current playback mode.

• Holding this button for 500 ms when the player is not stopped will start seeking backward within the track. Every 250 ms afterwards, another backward seek will occur.

• Holding the button for 500 ms when the player is stopped will skip to the previous track when the button is first pressed, at the 500 ms point, and then every 250 ms afterwards until the button is released.

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Next/Right

• Pressing this button when the player is not stopped will skip to the next track, maintaining the current playback mode.

• Holding this button for 500 ms when the player is not stopped will start seeking forward within the track. Every 250 ms afterwards, another forward seek will occur.

• Holding this button for 500 ms when the player is stopped will skip to the next track when the button is first pressed, at the 500 ms point, and then every 250 ms afterwards until the button is released.

Select/A→B Repeat/Program

• If playing, pressing this button will set the *A* point for the *A→B Repeat*. Pressing it again will set the *B* point and restart playback from the *A* point. Pressing it again will cancel *A→B Repeat* mode.

• If the player is stopped, pressing this button will enter the *Playlist Selection* mode.

Navigator/Menu

• Pressing this button will enter *Menu* mode.

• Holding this button for 500 ms will enter *Navigator* mode.

• If the player is stopped and a playlist is created, pressing this button will leave the *Playlist Selection* mode.

Vol+

• Pressing this button will turn the volume up by one setting.

• Holding this button for 500 ms will turn up the volume by one setting when the button is first pressed, at the 500 ms point, and then every 100 ms afterwards until the button is released.

• The behavior of this button is not affected by the other modes, other than the fact that the volume indicator is only displayed when in *Normal* mode.

Vol-

• Pressing this button will turn the volume down by one setting.

• Holding this button for 500 ms will turn down the volume by one setting when the button is first pressed, at the 500 ms point, and then every 100 ms afterwards until the button is released.

• The behavior of this button is not affected by the other modes, other than the fact that the volume indicator is only displayed when in *Normal* mode.

2.3.3 *Navigator/Menu* Mode

2

Play/Pause/Up

• Pressing this button will move the cursor up the current directory list by one entry. If already at the top of the directory list, pressing this button does nothing.

• Holding this button for 500 ms will move the cursor up the current directory list by one entry when the button is first pressed, at the 500 ms point, and then every 125 ms afterwards until the button is released or the top of the directory list is reached.

Stop/Down

• Pressing this button will move the cursor down the current directory list by one entry. If already at the bottom of the directory list, pressing this button does nothing.

• Holding this button for 500 ms will move the cursor down the current directory list by one entry when the button is first pressed, at the 500 ms point, and then every 125 ms afterwards until the button is released or the bottom of the directory list is reached.

Previous/Left/Delete

• Pressing this button will move up one level in the directory hierarchy. If already at the root directory, pressing this button does nothing.

• Holding this button for 500 ms will move up one level in the directory hierarchy when the button is first pressed, at the 500 ms point, and then every 250 ms afterwards until the button is released or the root directory is reached.

Next/Right

• If the cursor is currently on a directory in the list, pressing this button will move into the specified directory.

• While the cursor is on a directory in the list, holding this button for 500 ms will move down the directory hierarchy when the button is first pressed, at the 500 ms point, and then every 125 ms afterwards until the button is released or the current entry is no longer a directory.

• If the cursor is currently on a file in the list, pressing this button will do nothing.

Navigator/Menu

• Pressing this button will exit *Navigator* mode and return to the *Normal* mode.

Select/A→B Repeat/Program

• If the cursor is currently on a file in the list, pressing this button will commence playback of the currently selected file and return to *Normal* mode.

• If the cursor is currently on a directory in the list, pressing this button will commence playback of the directory in subdirs mode and return to *Normal* mode.

2.3.4 *Playlist Selection* Mode

Play/Pause/Up

• Pressing this button will move the cursor up the list of playlists by one entry. If already at the top of the list, pressing this button does nothing.

• Holding this button for 500 ms will move the cursor up the list of playlists by one entry when the button is first pressed, at the 500 ms point, and then every 125 ms afterwards until the button is released or the top of the list is reached.

Stop/Down

• Pressing this button will move the cursor up the list of playlists by one entry. If already at the bottom of the list, pressing this button does nothing.

• Holding this button for 500 ms will move the cursor down the list of playlists by one entry when the button is first pressed, at the 500 ms point, and then every 125 ms afterwards until the button is released or the bottom of the list is reached.

Previous/Left/Delete

• This button is ignored.

Next/Right

• This button is ignored.

Select

• If the cursor is on the *{new}* entry, pressing this button will enter *Playlist Creation* mode.

• If the cursor is on one of the playlist entries, pressing this button will load the selected playlist, commence playback of the first track, and return to *Normal* mode.

Navigator/Menu

• Pressing this button will exit *Playlist Selection* mode and return to *Normal* mode.

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2.3.5 *Playlist Creation* Mode

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Play/Pause/Up

• Pressing this button will move the cursor up the current directory list by one entry. If already at the top of the directory list, pressing this button does nothing.

• Holding this button for 500 ms will move the cursor up the current directory list by one entry when the button is first pressed, at the 500 ms point, and then every 125 ms afterwards until the button is released or the top of the directory list is reached.

Stop/Down

• Pressing this button will move the cursor down the current directory list by one entry. If already at the bottom of the directory list, pressing this button does nothing.

• Holding this button for 500 ms will move the cursor down the current directory list by one entry when the button is first pressed, at the 500 ms point, and then every 125 ms afterwards until the button is released or the bottom of the directory list is reached.

Previous/Left/Delete

• Pressing this button will move up one level in the directory hierarchy. If already at the root directory, pressing this button does nothing.

• Holding this button for 500 ms will move up one level in the directory hierarchy when the button is first pressed, at the 500 ms point, and then every 125 ms afterwards until the button is released or the root directory is reached.

Next/Right

• If the cursor is currently on a directory in the list, pressing this button will move into the specified directory.

• While the cursor is on a directory in the list, holding this button for 500 ms will move down the directory hierarchy when the button is first pressed, at the 500 ms point, and then every 125 ms afterwards until the button is released or the current entry is no longer a directory.

• If the cursor is currently on a file in the list, pressing this button will do nothing.

Select/A→B Repeat/Program

• If the cursor is currently on a file in the list, pressing this button will add the selected file to the playlist.

• If the cursor is currently on a directory in the list, this button is ignored.

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Navigator/Menu

- Pressing this button will commence playback of the created playlist and return to *Normal* mode.

2.3.6 *Menu* Mode, in a Menu List

Play/Pause/Up

- Pressing this button will move the cursor up the current menu by one entry. If already at the top of the menu, pressing this button does nothing.

- Holding this button for 500 ms will move the cursor up the current menu by one entry when the button is first pressed, at the 500 ms point, and then every 125 ms afterwards until the button is released or the top of the menu is reached.

Stop/Down

- Pressing this button will move the cursor down the current menu by one entry. If already at the bottom of the menu, pressing this button does nothing.

- Holding this button for 500 ms will move the cursor down the current menu by one entry when the button is first pressed, at the 500 ms point, and then every 125 ms afterwards until the button is released or the bottom of the menu is reached.

Previous/Left/Delete

- This button is ignored.

Next/Right

- This button is ignored.

Select/A→B Repeat/Program

- Pressing this button will display the selected setting screen.

Navigator/Menu

- Pressing this button will return to *Normal* mode.

2.3.7 *Menu* Mode, in a Settings Screen

Play/Pause/Up

- Pressing this button will move the cursor up the list of settings. If already at the first setting, pressing this button does nothing.

- Holding this button for 500 ms will move the cursor up the list of settings when the button is first pressed, at the 500 ms point, and then

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every 125 ms afterwards until the button is released or the first setting is reached.

Stop/Down

• Pressing this button will move the cursor down the list of settings. If already at the last setting, pressing this button does nothing.

• Holding this button for 500 ms will move the cursor down the list of settings when the button is first pressed, at the 500 ms point, and then every 125 ms afterwards until the button is released or the last setting is reached.

Previous/Left/Delete

• This button is ignored.

Next/Right

• Pressing this button will change the setting to the currently selected value.

Select/A→B Repeat/Program

• Pressing this button will return to the menu containing the current setting.

Navigator/Menu

• Pressing this button will return to *Normal* mode.

2.3.8 *Menu* Mode, in the *User EQ* Setting Screen

play/Pause/Up

• Pressing this button will increase the gain for the currently selected band by 1dB.

• Holding this button for 500 ms will increase the gain for the currently selected band by 1dB when the button is first pressed, at the 500 ms point, and then every 125 ms afterwards until the button is released or +12dB is reached.

Stop/Down

• Pressing this button will decrease the gain for the currently selected band by 1dB.

• Holding this button for 500 ms will decrease the gain for the currently selected band by 1dB when the button is first pressed, at the 500 ms point, and then every 125 ms afterwards until the button is released or -12dB is reached.

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Previous/Left/Delete

- Pressing this button will select the next lower band.

- Holding this button for 500 ms will select the next lower band when the button is first pressed, at the 500 ms point, and then every 250 ms afterwards until the button is released or the first band is selected.

Next/Right

- Pressing this button will select the next higher band.

- Holding this button for 500 ms will select the next higher band when the button is first pressed, at the 500 ms point, and then every 250 ms afterwards until the button is released or the last band is selected.

Select/A→B Repeat/Program

- Pressing this button will return to the menu containing the user EQ setting.

Navigator/Menu

- Pressing this button will return to *Normal* mode.

The following playback modes are available when playing from the default playlist:
A, 1, D, RA, R1, RD, SA, S1, SD, RSA, RS1, RSD, IA, IS, HA - in that order.

If a custom playlist has been loaded, the playback modes available are:
A, 1, RA, R1, SA, S1, RSA, RS1, IA, HA - in that order.

If subdirectory playback mode has been selected from the navigator, these playback modes are available:
S, RS, SS, RSS, IS, HS - in that order.

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CIRRUS LOGIC®

Chapter 3

FM Tuner   **3**

3.1   Tuner Subsystem

3.1.1   Integrated Stereo FM Tuner

The CRD7410-HE system incorporates a single-chip, electronically tuned FM stereo radio with fully integrated IF selectivity and demodulation.

The radio can be tuned to the European, US, and Japanese FM bands.

3.1.2   CS5333 ADC

This system provides support for the tuner's analog audio output through an ADC (Analog-to-Digital Converter). A multiplexer on the CRD7410-HE main board switches between sources, selecting analog input from the CD or the tuner.

The tuner's analog outputs are sampled and converted to digital data by the CS5333 and delivered to the CS7410 for EQ and 3D sound effects processing.

3.1.3   CS43L42 DAC

The digital signal from the CDS7410 is sent to the CS43L42 DAC. The digital data is converted to an analog signal and delivered the headphones amplifier and line-level amplifier on board the CS43L42.

The CS43L42 headphones amplifier output is sent to the headphones jack. The CS43L42 line-level analog output is sent to the line out jack.

3.1.4   Tuner Mode Main Menu

The *X* in the box indicates the current setting of the *Audio Source* item. Highlighting a different item and pressing the *Right* button will change the setting.

Pressing the *Select* button will go back to the parent menu. Refer to Figure 3-1.

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Figure 3-1. *Audio Source* **Menu**

When the audio source setting is set to *CD*, the tuner will be disabled and the data from disc will be played - MP3/WMA/CDDA etc. If it is set to *FM*, the tuner will be enabled. This selection can only be made when the player is in *Stop* mode. The default setting of the *Audio Source* item is *CD*.

Figure 3-2. Navigator Mode Screen (Tuner Mode)

The arrow buttons can be used to highlight a preset slot, which is then selected by pressing the *Select* button. Selecting a preset while listening to the tuner will cause that preset to be tuned. Selecting a preset while in preset edit mode will cause that preset slot to be loaded with the current tuner frequency.

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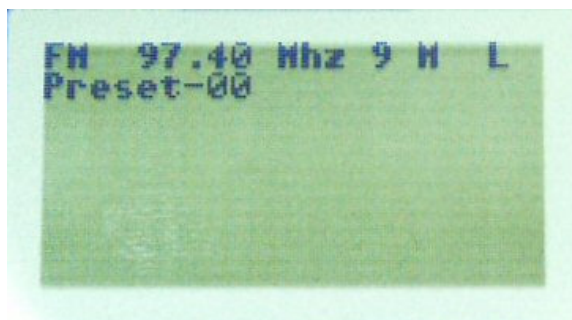
Figure 3-3. Tuner Playback Screen

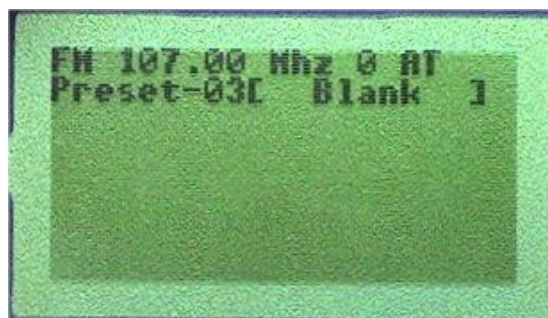In this example, the current band (*FM*), frequency (*99.90 MHz*), battery life (*0*), and tuning mode (*Automatic - A*) are displayed in the first line of the LCD display. The preset slots and their frequency settings (if any) are displayed in the second, third, and fourth lines of the LCD display. This list will scroll if there are too many presets to display at once (more than three).

Figure 3-4. Tuner Tuning Screen

When the system is in *FM* mode, pressing the *Select* button toggles between *Automatic* (*A*) or *Manual* (*M*) tuning mode.

Pressing the *Up* or *Down* buttons will begin either and upward or downward search for an FM station.

The *Next* and *Previous* buttons select an FM preset slot (location). Pressing the *Select* button will load the current preset slot with the current tuner frequency.

When in manual or automatic tuning mode, and tuning is in progress, the tuning indicator, *T* will be displayed after the tuning mode (in this example, *A* for automatic tuning mode). Refer to Figure 3-4. All tuning commands will be ignored until the current tuning is complete.

Figure 3-5. Tuner Edit Screen

In this example, the current band (*FM*), frequency (*97.4 MHz*), battery life (*0*), and tuning mode (*Automatic - A*) are displayed in the first line of the LCD display. The preset slot to save the current frequency and its contents (if any) are displayed in the second line of the LCD display.

3.1.5 Tuner Mode Button Functions

The following is a complete list of the functions of the buttons based on the tuner mode.

play/pause/up

- If the tuning mode is set to manual, pressing this button will increase the current frequency by one step and the system enters preset edit mode. The step grid is 100kHz.

- Holding this button for 500 ms will increase the current frequency by one step when the button is first pressed, at the 500 ms point, and then every 125 ms afterwards until the button is released or the maximum frequency is reached.

- If the tuning mode is set to automatic, pressing this button will search the for the next higher-frequency station, and enter preset edit mode.

stop/down

- If the tuning mode is set to manual, pressing this button will decrease the current frequency by one step and the system enters preset edit mode. The step grid is 100kHz.

- Holding this button for 500 ms will decrease the current frequency by one step when the button is first pressed, at the 500 ms point, and then every 125 ms afterwards until the button is released or the minimum frequency is reached.

- If the tuning mode is set to automatic, pressing this button will search the for the next lower-frequency station, and enter preset edit mode.

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previous/left

- When listening to the FM source, pressing this button will switch to the next lower-numbered preset slot, the frequency in that slot will be tuned.

- When editing presets, pressing this button will switch to the next lower-numbered preset slot.

- When in *Tuner Navigator* mode, pressing this button will erase the currently selected preset slot contents.

next/right

- When listening to the FM source, pressing this button will select the next higher-numbered preset slot, the frequency in that slot will be tuned.

- When editing presets, pressing this button will switch to the next higher-numbered preset slot.

select

- When listening to the FM source, pressing this button will switch the tuning mode between automatic and manual.

- When editing presets, pressing this button will save the current tuner frequency into the current slot, and the system returns to listening mode.

navigator/menu

- Pressing this button will enter menu mode.

- Holding this button for 500 ms will enter navigator mode.

vol+

- Pressing this button will turn the volume up by one setting.

- Holding this button for 500 ms will turn up the volume by one setting when the button is first pressed, at the 500 ms point, and then every 100 ms afterwards until the button is released, or the highest volume setting is reached.

- The behavior of this button is not affected by the other modes, other than the fact that the volume indicator is only displayed when in tuner mode.

vol-

- Pressing this button will turn the volume down by one setting.

- Holding this button for 500 ms will turn up the volume by one setting when the button is first pressed, at the 500 ms point, and then every

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100 ms afterwards until the button is released, or the lowest volume setting is reached.

• The behavior of this button is not affected by the other modes, other than the fact that the volume indicator is only displayed when in tuner mode.