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ADSP-BF535 Blackfin® EZ-KIT Lite™ CompactFlash® Interface

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Introduction

CompactFlash® storage cards provide the capability to easily transfer/store all types of digital information, such as data, audio, and images, between large varieties of digital systems. CompactFlash cards are high density (up to 1Gbytes of nonvolatile storage memory!), removable (i.e. hot-swappable), and very compact in size. CF™ cards can be used as memory storage devices for digital imaging, video, audio, PDAs, etc. but they can also be extended for I/O communications applications such as modems, Ethernet controllers, laser scanners, BlueTooth Wireless, 802.11 WiFi LAN, wireless digital cell phone cards, and GPS nodes.

This note describes one way to interface a CompactFlash Storage Card to the ADSP-BF535 EZ-KIT Lite™ Evaluation Board. The interface consists of a hardware and software implementation, both of which will be discussed in this application note. In this example, the interface will demonstrate the playing of MP3 tracks (stored on the CompactFlash card) by the ADSP-BF535 Blackfin® processor.

Overview

CompactFlash Cards conform to the CF and CF+ standard published by the CompactFlash Association (CFA). There is an on-card intelligent controller that manages interface protocols, data storage and retrieval (see Figure 1). Once the CompactFlash card has been configured/formatted by a Windows host PC, it appears to the host as a standard ATA (IDE) disk drive.

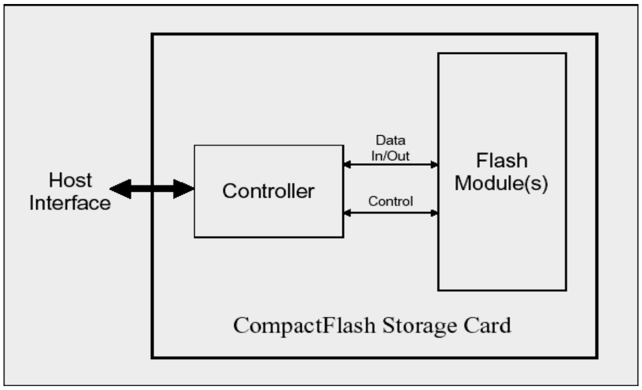


Figure 1. CompactFlash Storage Card Block Diagram

Because of this, CompactFlash cards can be easily interfaced to the ADSP-BF535 Blackfiin processor's Asynchronous Memory through the External Bus Interface Unit (EBIU). The EBIU provides glueless interfaces to external memories.

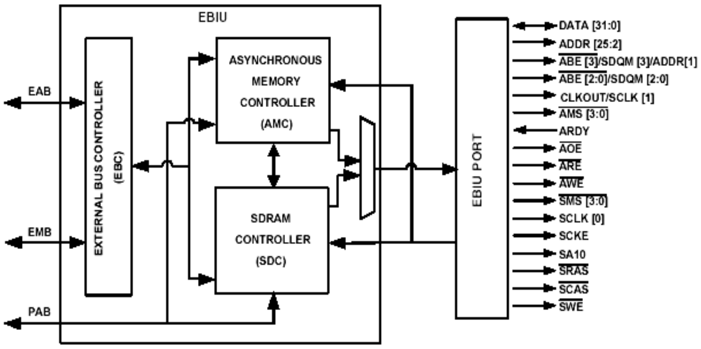


Figure 2. External Bus Interface Unit (EBIU)

The EBIU is clocked by the system clock (SCLK) of the ADSP-BF535 Blackfin processor. On the ADSP-BF535 Blackfin EZ-KIT Lite, SCLK is set to 120MHz, which will be more than sufficient for accesses to CompactFlash cards. Read/Write access times on CompactFlash cards are defined between 250ns – 300ns (~ 3 – 4 MHz). To find interface/bus timing, please refer to the CF/CF+ standard.

CompactFlash cards function in three basic modes:

- PC Card ATA using Common Memory Mode.
- PC Card ATA using I/O Mode.
- True IDE Mode.

This EE-Note will only deal with 16 bit transfers using Common Memory Mode.

ADSP-BF535 CompactFlash Interface Pin Mapping

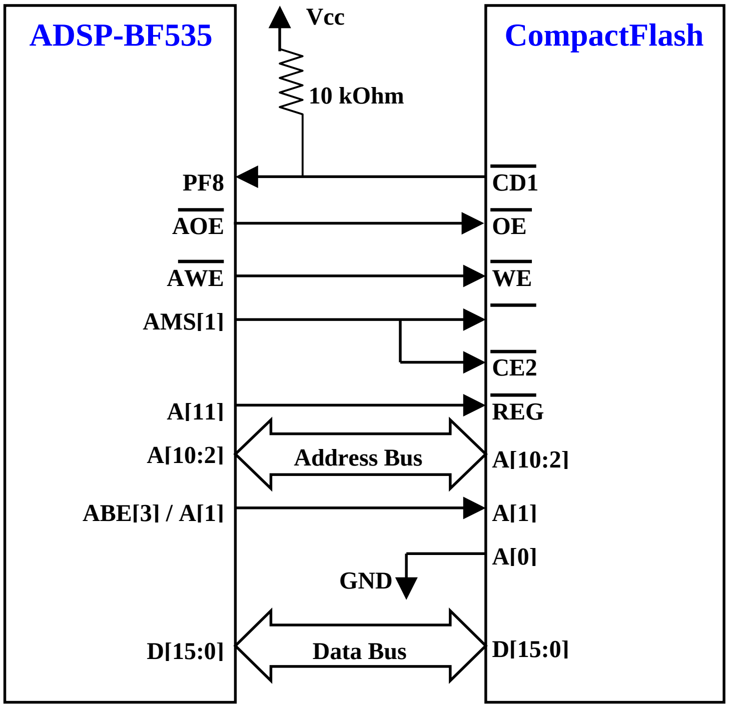


Figure 3: CF Interface Pin Mapping

Figure 3 shows the main pin-to-pin connections between the ADSP-BF535 and the CompactFlash card.

CompactFlash Signal Descriptions – Common Memory Mode

- A[10:1]: Address Lines
- D[15:0]: Data Lines
- /WE (Write Enable): This signal is driven by the ADSP-BF535 and used for strobing memory write data to the registers of the CompactFlash.
- /OE (Output Enable): This strobe is generated by the ADSP-BF535 and used to read data from the CompactFlash.
- REG (Attribute Memory Select): This signal is to distinguish between Common Memory and Register (Attribute) Memory accesses. High for Common Memory, Low for Attribute Memory.
- /CE1, /CE2 (Card Enable): These signals are used both to select the card and to indicate to the card whether a byte or a word operation is being performed. Since both of these signals are tied to AMS[1] of the ADSP-BF535, we will be doing word (16-bit) accesses only.
- /CD1 (Card Detect): This signal is used by the ADSP-BF535 to determine that the CompactFlash is fully inserted into its socket.
- A[0]: Address line 0 is connected to ground since this interface supports word accesses only.

Software Implementation

Since we are using the CompactFlash as a PC card ATA using memory mode, it will be seen by the ADSP-BF535 as a standard ATA disk drive. The following gives a brief explanation of the file system used on standard disk drives.

FAT file system

Standard disk drives use the FAT (File Allocation Table) file system. Currently there are three types of FAT file systems: FAT12, FAT16, and FAT32. In a FAT*nn* file system, *nn* represents the size, in bits, of the entries in the actual FAT structure on the disk. There are 12 bits in a FAT12 FAT entry, 16 bits in a FAT16 FAT entry and 32 bits in a FAT32 FAT entry. Currently, this interface supports FAT16 only but other FAT systems could be implemented.

There are 4 basic regions on a FAT volume:

- Reserved Region
- FAT Region
- Root Directory Region (non FAT32)
- File and Directory Data Region

Disk Structure	Sector Offset
Boot Sector	0
FAT 1	1
FAT 2	(# of Sectors per FAT) + 1
Root Directory	2*(# of Sectors per FAT)+1
File Clusters (Data Region)	2*(# of Sectors per FAT)+1+(# of Root Directory Sectors)

Table 2. Disk Structure

Reserved Region

The Reserved Region contains the Boot Sector which is the first sector of the volume. A summary of the FAT16 structure of the Boot Sector is provide below, starting with the first word at byte offset 0 (also applies to FAT12):

The Boot Sector contains all the information about the physical structure of the CompactFlash. This information is needed to determine where data is stored on the CompactFlash for retrieval.

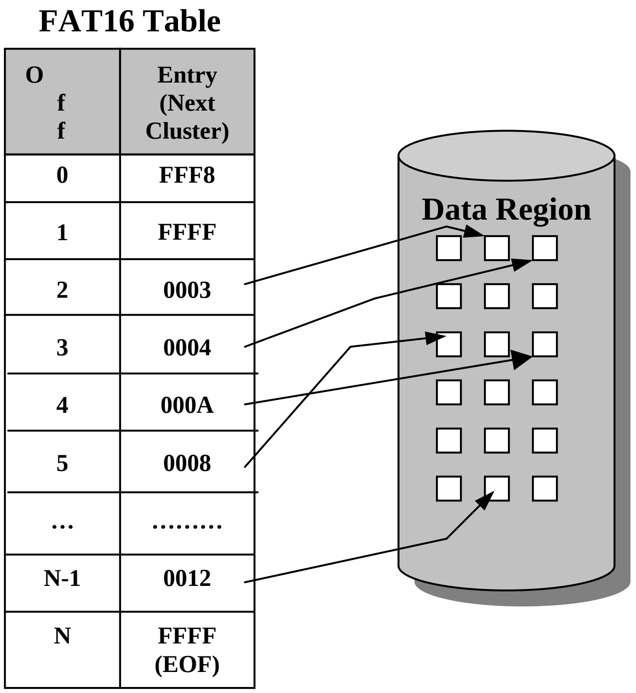
Name	Size (in bytes)	Description
JumpBoot	3	Jump Instruction to boot code.
OEMName	8	Name string – MSWIN4.1.
BytesPerSector	2	**512**, 1024, 2048, 4096.
SectorsPerCluster	1	1, 2, 4, 8, 16, 32, 64, 128.
ReservedSectors	2	1 for FAT12 and FAT16.
FATCount	1	2 FAT data structures.
RootEntCount	2	# of 32-byte entries in root directory.
TotalSectors1	2	Total # of sectors on volume Bits[15:0].
MediaDescriptor	1	0xF8 for fixed media. 0xF0 for removable media.
SectorsPerFAT	2	# of sectors in one FAT.
SectorsPerTrack	2	Tracks are broken down into heads and cylinders.
HeadCount	2	Relevant for previous field.
HiddenSectors	4	Count of hidden sectors preceding FAT volume.
TotalSectors2	4	Total # of sectors on volume Bits[47:16].
DriveNumber	1	This field is OS specific.
Reserved	1	Reserved.
BootSignature	1	Extended Boot Sig. (0x29).
VolumeID	4	Volume serial number.
VolumeLabel	11	Volume label.
Reserved	8	Reserved.

Table 3. Boot Sector

FAT Region

There are two FAT data structures on the volume. The reason there are two is to provide redundancy for the FAT data structure so that if a sector goes bad in one of the FATs, the data is not lost because it is duplicated in the other FAT.

Each FAT is a single linked list of the clusters of a file. These clusters map to the data region of the volume. The first 2 entries in the FAT are reserved so logical cluster numbers begin at 2.



FAT16 Table

Off	Entry (Next Cluster)
0	FFF8
1	FFFF
2	0003
3	0004
4	000A
5	0008
…	………
N-1	0012
N	FFFF (EOF)

Figure 4. FAT File System

FAT16 entry values:

0x0000:	Unused Cluster
0xFFF0 – 0xFFF6:	Reserved Cluster
0xFFF7:	Bad Cluster
0xFFF8 – 0xFFFF:	End of Cluster/File
Other:	Next Cluster in File

The first sector is of cluster 2 and is calculated as:

FirstDataSector = ReservedSectors + (FATCount * SectorsPerFAT) + RootDirSectors

Where

RootDirSectors = ((RootEntCount * 32) + (BytesPerSector – 1)) / BytesPerSector

The first sector of any cluster N is calculated as:

FirstSectorofCluster = ((N – 2) * SectorsPerCluster) + FirstDataSector

Root Directory

The Root Directory is composed of a linear list of 32-byte structures which represent files stored on the disk. The following table describes the different fields of a 32-byte structure within the Root directory:

Name	Size (in bytes)	Description
Name	11	Short name. (see note below)
Attr	1	Bit 0: READ_ONLY Bit 1: HIDDEN Bit 2: SYSTEM Bit 3: VOLUME_ID Bit 4: DIRECTORY Bit 5: ARCHIVE Bit 6: LONG_NAME Bits 7 and 8: RESERVED
NTRes	1	Reserved for Windows NT use.
CrtTimeTenth	1	File creation time. Millisecond granularity.
CrtTime	2	File creation time. 2 second granularity.
CrtDate	2	File creation date.
LstAccDate	2	Last read/write date of file.
FstClusHI	2	File's first cluster number; bits[31:16]. This is 0 for FAT12 and FAT16 volume.
WrtTime	2	Time of last write.
WrtDate	2	Date of last write.
FstClusLO	2	File's first cluster number; bits[15:0].
FileSize	4	File size in bytes.

Table 4. 32-Byte Directory Entry Structure.

Note, if the first byte of the Name field =

- 0xE5: then the entry is free.
- 0x00: then the entry is free; there are no more allocated entries after this one.
- Values less than 0x20: Not Valid (except 0x05 ← used in Japan).

Long file names are not supported in this software interface.

For FAT12 and FAT16 file systems, the root directory immediately follows the last FAT and has a fixed location and fixed size on the disk. The first sector of the Root Directory is computed as:

FirstRootDirSec = ReservedSectors + (FATCount * SectorsPerFAT)

For FAT32 file systems, the root directory can be of variable size and is a cluster chain.

Software Accesses to the CompactFlash

In Common Memory Mode, accesses to the CompactFlash are done through a set of memory-mapped registers. The following lists them out (last two columns of Table 5) as well as the state of the pins required to access them:

Blackfin External Memory Address	ASM[1]		A[11]	A[10]	A[9:4]	A[3:0] (HEX)	$\overline{\text{AOE}}$ [$\overline{\text{OE}}$] = 0 ATA Read Register	$\overline{\text{AWE}}$ [$\overline{\text{WE}}$] = 0 ATA Write Register
	[$\overline{\text{CE2}}$]	[$\overline{\text{CE1}}$]	[$\overline{\text{REG}}$]					
0x2400 0800 D[7:0]	0	0	1	0	XX	0	Even RD Data	Even WR Data
0x2400 0800 D[15:8]	0	0	1	0	XX	0	Error	Feature
0x2400 0802 D[7:0]	0	0	1	0	XX	2	Sector Count	Sector Count
0x2400 0802 D[15:8]	0	0	1	0	XX	2	Sector Number	Sector Number
0x2400 0804 D[7:0]	0	0	1	0	XX	4	Cylinder Low	Cylinder Low
0x2400 0804 D[15:8]	0	0	1	0	XX	4	Cylinder High	Cylinder High
0x2400 0806 D[7:0]	0	0	1	0	XX	6	Select Card / Head	Select Card / Head
0x2400 0806 D[15:8]	0	0	1	0	XX	6	Status	Command
0x2400 0808 D[7:0]	0	0	1	0	XX	8	Dup. Even RD Data	Dup. Even WR Data
0x2400 0808 D[15:8]	0	0	1	0	XX	8	Dup. Odd RD Data	Dup. Odd WR Data
0x2400 080C D[15:8]	0	0	1	0	XX	C	Dup. Error	Dup. Features
0x2400 080E D[7:0]	0	0	1	0	XX	E	Alt. Status	Device Control
0x2400 080E D[15:8]	0	0	1	0	XX	E	Drive Address	Reserved
0x2400 0C08 D[7:0]	0	0	1	1	XX	8	Even RD Data	Even WR Data
0x2400 0C08 D[15:8]	0	0	1	1	XX	8	Odd RD Data	Odd WR Data

Table 5. Memory Mapped Decoding

PLEASE NOTE – Since we have A[0] tied to ground, we can only do 16-bit accesses to the CompactFlash with this interface.

Detailed information of these registers can be found in the CF and CF+ standard.

The ADSP-BF535 is connected to the CF via Asynchronous Bank 1 (ASYNC Bank 1) of the External Bus Interface Unit (EBIU). The starting location of ASYNC Bank 1 is memory mapped to address 0x2400 0000 and uses AMS[1] as the memory bank select line.

From Table 5, we can see that each read/write access on the ADSP-BF535 will affect two CF registers. For example, the following piece of code shows how to set up the Cylinder registers

(Cylinder Low and Cylinder High) using Blackfin assembly language:

```
/* Set up Data */
R0.L = 0xABCD;      //Cylinder Low = 0xCD
                    //Cylinder High = 0xAB

/* Set up Address */
P0.H = 0x2400;      //P0 points to the CF’s
P0.L = 0x0804;      //Mem. Mapped Cylinder
                    //Registers

/* Set up CF Cylinder Registers */
W[P0] = R0.L;       //Write to Cylinder High
                    //and Cylinder Low
                    //registers of the CF.
```

Code Listing 1. CF Register Access

The code above will access the two Cylinder Registers (at offset = A[3:0] = 0x4) within the Common Memory (/REG = A[11] = 1) of the CF which is connected to ASYNC Bank 1 (AMS[1] = /CE2 = /CE1 = 0) of the ADSP-BF535.

Data regions on the CompactFlash card are accessed via Clusters and each Cluster maps to a Sector Number. Each sector number is considered a 28-bit Logical Block Address, LBA[27:0]. To access sector *N* on the CompactFlash, the following six registers need to be set:

- Sector Count - number of sectors to access. If set to 0, a count of 256 sectors is specified.
- Sector No – LBA[7:0]
- Cylinder Low – LBA[15:8]
- Cylinder High – LBA[23:16]
- Select Card / Head – 0xE0 | LBA[27:24]
- Command – 0x20 (read sector(s) command)

Once all of above registers are set, the on-card CF controller retrieves the specified sector(s) from the data region and places it into an internal buffer. We can access this internal buffer via repeated reads from the Dup. Even RD Data and the Dup. Odd RD Data registers.

The following code shows how to read the first sector within the data region of the CF using Blackfin assembly language:

```
/* Set up Pointer to Mem. Mapped Address */
P0.H = 0x2400;      //P0 points to the CF
P0.L = 0x0800;      //Mem. Mapped Registers

/* Set up Sector Count & Sector Number */
R0.L = 0x6701;      //Sector Count = 0x01
                    //Sector Number =
                    //LBA[7:0] = 0x67
W[P0+2] = R0.L;

/* Set up CF Cylinder Registers */
R0.L = 0x2345;      //Cylinder Low =
                    //LBA[15:8] = 0x45
                    //Cylinder High =
                    //LBA[23:16] = 0x23
W[P0+4] = R0.L;

/* Set up Select Card/Head and Command */
R0.L = 0x20E1;      //Select Card/Head =
                    //0xE1
                    //Command = 0x20
W[P0+6] = R0.L;

/* We have written to the six CF registers.
Now we’ll read the specified sector */
I0.H = Sector_Buffer;
I0.L = Sector_Buffer;
P1.H = 0x0000;
P1.L = 0x0100;      //Loop Count = 256
                    //Each loop iteration,
                    //we read in 2 bytes
                    //for a total of
                    //512 bytes/sector
LSETUP(Read_BEGIN, Read_END) LC1 = P1;
//Read Even Byte and Odd Byte
Read_BEGIN:  R0.L = W[P0+8];
//Store 16-bit word into internal memory
Read_END:  W[I0++] = R0.L;
```

Code Listing 2. CF Sector Read

File Detection & Retrieval

Now that we have an understanding of the CompactFlash file system and how to access different sectors on the disk, we are ready to read full files off the CompactFlash card.

For this demo, we need to determine if there are any MP3 files on the CompactFlash. Using the configuration information provided by the Boot Sector and drive information, we search through the Root Directory for filenames with an MP3 extension.

The Root Directory consists of a list of 32-byte file structures. Each file that is saved on the CompactFlash card has it's own structure which contains the filename, attributes (read-only, hidden, etc), file creation / last modified times, file size, and starting cluster.

The demo software scans through each structure in the Root Directory for a valid file entry (first byte of the Name field ≠ 0xE5 or 0x00, see note after Table 4). If the entry is valid, the filename is checked for an MP3 extension, which is indicated by the last three bytes of the Name field within the file structure. If these three bytes are equal to 4D 50 33 (MP3), then the entry is a MP3 file and the starting cluster for this file is saved into a buffer called **MP3_Startclusters**.

After the whole Root Directory has been scanned, we are left with a set of starting clusters (stored in **MP3_Startclusters)** for each MP3 on the compact flash. The starting cluster is basically the starting point of a file. It would be mapped to the FAT table and the FAT table would, in turn, map the clusters to the Data Region (see Figure 4). The Data Region contains the contents of the MP3 file for that cluster. The demo software goes through the FAT table and retrieves the data for each cluster of the file. When we reach a cluster = 0xFFF8 or 0xFFFF, it would indicate that we are at the end of the cluster chain and thus, the end of the file (EOF).

Software Flow

The MP3 demo software performs the following sequence of subroutines:

1) Enable Asynchronous Bank 1
2) Reset Compact Flash Card if inserted
3) Read in Drive information and Boot Sector from CF card
4) Identify MP3s stored on CF by scanning through Root Directory and initialize **MP3_Startclusters** buffer
5) Set up Serial Port 0 and initialize AD1885 Codec for MP3 playback
6) Read MP3 Data from CF, Decode and Playback (see Figure 5)

After Blackfin, Codec, and CompactFlash initialization (steps 1 – 5 above), the software begins to read in MP3 sectors from the Compact Flash and stores the data in a 1024 x 32-bit buffer called **pack_buffer**. When enough data is read into the **pack_buffer**, the MP3 Decoder is called for processing.

The MP3 Decoder generates decoded PCM samples, which are stored in a 4608 x 32-bit buffer called **predac_buffer**. Finally, the decoded samples from this buffer are sent out to the AD1885 Codec for audio playback.

Each call to the MP3 Decoder produces 2304 samples (1152 left channel samples and 1152 right channel samples) of decoded PCM data. The 1152 left/right samples make up one frame of MP3 decoded data. The **predac_buffer** holds exactly two frames of data, which allows for ping-pong read/write accesses to this buffer. In other words, while the MP3 Decoder is filling one half of the buffer, the other half is sent out to the AD1885 Codec. Both the **pack_buffer** and **predac_buffer** operate in a circular buffer mode.

The PCM samples from the **predac_buffer** are sent to the AD1885 Codec via the Transmit Channel on SPORT0. The transmission rate is dependent on the sampling frequency of the AD1885 Codec (48KHz or 44.1KHz). The current version of the demo software enables SPORT0 Receive interrupts every 48KHz. Within each interrupt, one PCM sample (one left and one right sample) is sent out to the Codec for playback.

MP3 streams are sampled either at 44.1KHz or 48KHz. So playing one frame of MP3 decoded data will require 26.1ms at 44.1KHz or 24ms at

48KHz. Figure 5 shows an overview of the MP3 Decode and Playback system.

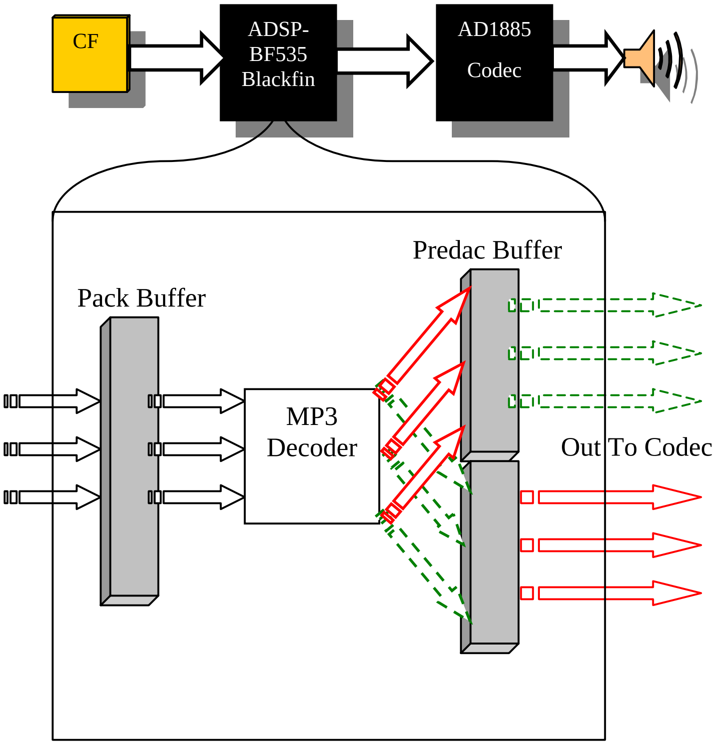


Figure 5. MP3 Playback System

Before the MP3 Decoder is called, the software checks whether there is enough MP3 data within the **pack_buffer** (at least half full) and whether there is enough empty space within the **predac_buffer** (at least half empty). Read and write pointers are assigned to each buffer that monitor the buffer's full/empty status:

- **pack_buffer_wrptr** – updated by software after sector reads from CompactFlash card.
- **pack_buffer_rdptr** – updated by MP3 Decoder.
- **predac_buffer_wrptr** – updated by MP3 Decoder.
- **predac_buffer_rdptr** – updated by software after each left/right sample is sent out within the interrupt service routine.

Here's the flow diagram of the decoding process:

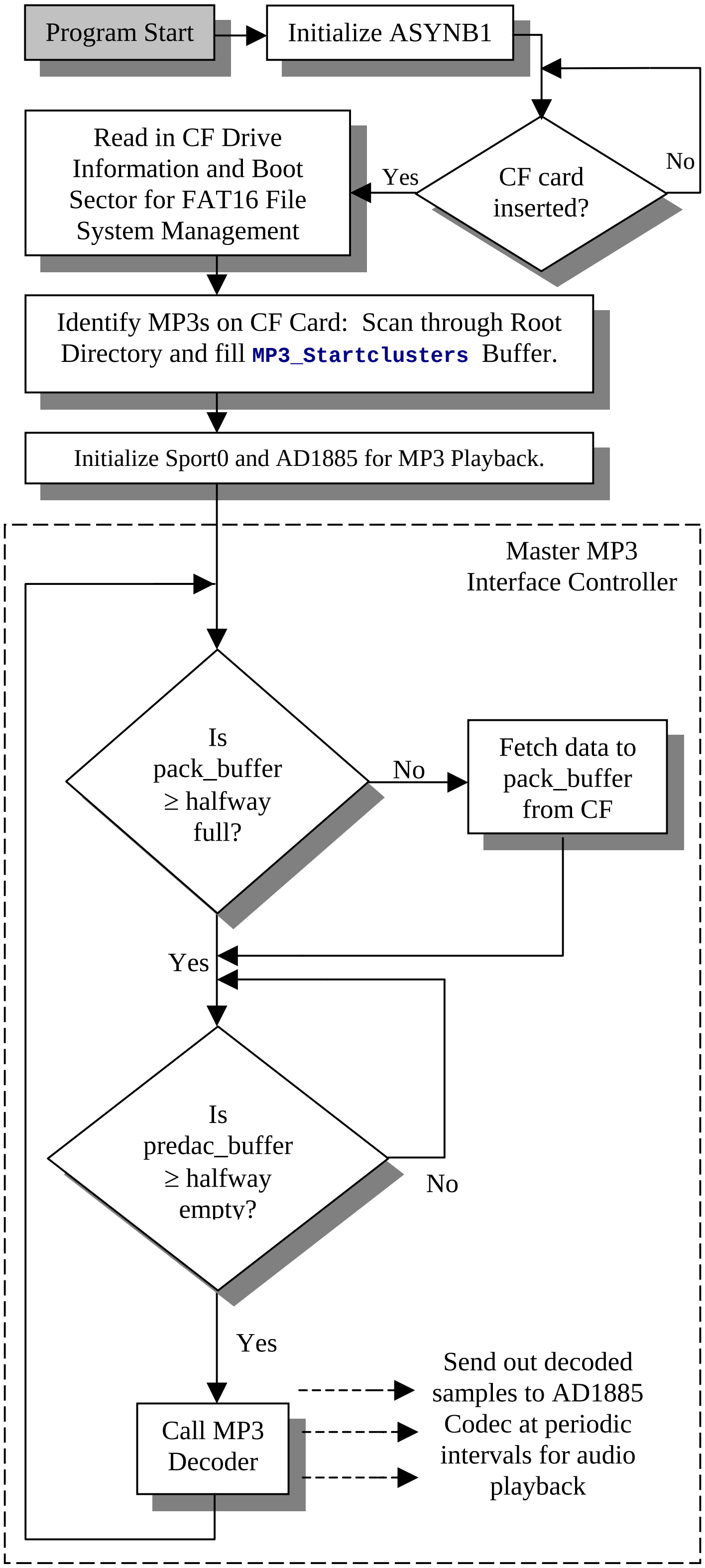

Program Start
Initialize ASYNB1
CF card inserted?
No
Yes
Read in CF Drive Information and Boot Sector for FAT16 File System Management
Identify MP3s on CF Card: Scan through Root Directory and fill MP3_Startclusters Buffer.
Initialize Sport0 and AD1885 for MP3 Playback.
Master MP3 Interface Controller
Is pack_buffer ≥ halfway full?
No
Fetch data to pack_buffer from CF
Yes
Is predac_buffer ≥ halfway empty?
No
Yes
Call MP3 Decoder
Send out decoded samples to AD1885 Codec at periodic intervals for audio playback

Figure 6. MP3 Software Flow

Benchmarks

Table 6 shows the benchmarks for the demo software.

Execution Range	Description	Cycles
Full Software Sequence	Full sequence of the code, from program start to one iteration of the Master MP3 Interface Controller (see Figure 6).	~1.37 x 10^9
System Initialization	Initialization of the system, which includes initializing the Blackfin (ASYNCB1, SPORT0, Interrupts, and PF pins), the AD1885 Codec, and the CompactFlash Card (FAT16 file system decode and detecting MP3 files).	~1.35 x 10^9
One MP3 Load/Decode Iteration	One iteration of the Master MP3 Interface Controller (see Figure 5). It includes filling the `pack_buffer` buffer with MP3 data, calling the MP3 Decoder, and filling the `predac_buffer` with decoded PCM samples.	~7.7 x 10^6
Single Sector Read	Read in one sector of data (512 bytes) from the CompactFlash card.	~150K

Table 6. Benchmarks

The demo software was written (not fully optimized), tested, and benchmarked using the VisualDSP++™ 3.0 Development Software. The demo was tested on CompactFlash cards with memory sizes: 32MB, 64MB, and a 1GB Microdrive. All software is available with this application note *excluding* the Blackfin® MP3 Decoder library. This library is available through the Software & Systems Technologies (SST) Division of Analog Devices: systems.solutions@analog.com (Phone: 781-461-3483, Fax: 781-461-4360).

Hardware Implementation

The hardware interface consists of an ADSP-BF535 EZ-KIT Lite board, an ADSP-BF535 CF interface daughter card (see Figure 6), a CF extend 180 Card Interface board from SYCARD Technology (see Figure 7), and a CompactFlash card.

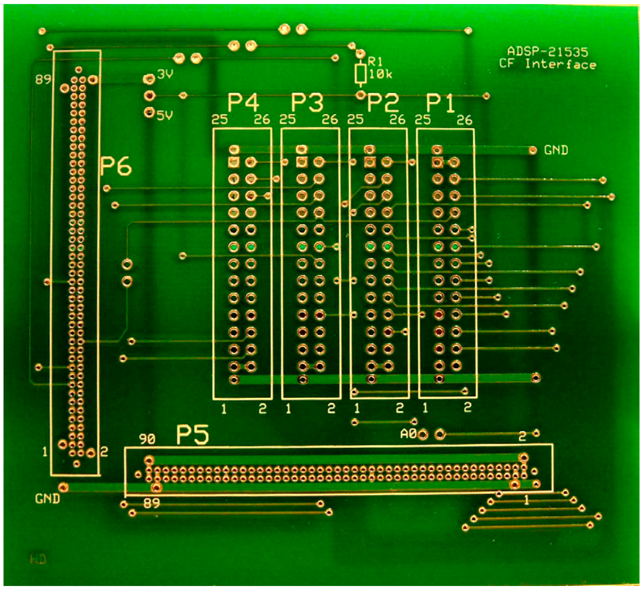


Figure 7. ADSP-BF535 CF Interface Daughter Card

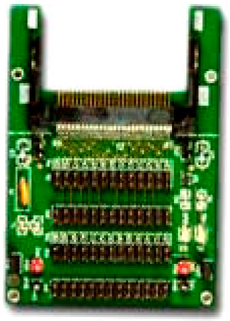


Figure 8. SYCARD CF extend 180 Card Interface Board

The daughter card is a two-layer board, which was manufactured by Express PCB (layout is included, CF interace PCB.pcb). It connects to the P1 and P2 expansion connectors of the ADSP-BF535 EZ-KIT Lite (via P5 and P6 of the daughter card). P1, P2, P3, and P4 connect to the SYCARD CIB board. The SYCARD CF extend 180 Card Interface Board allows full access to all

50 signal and power pins on the CompactFlash card. They SYCARD CIB board was used to quickly prototype a solution.

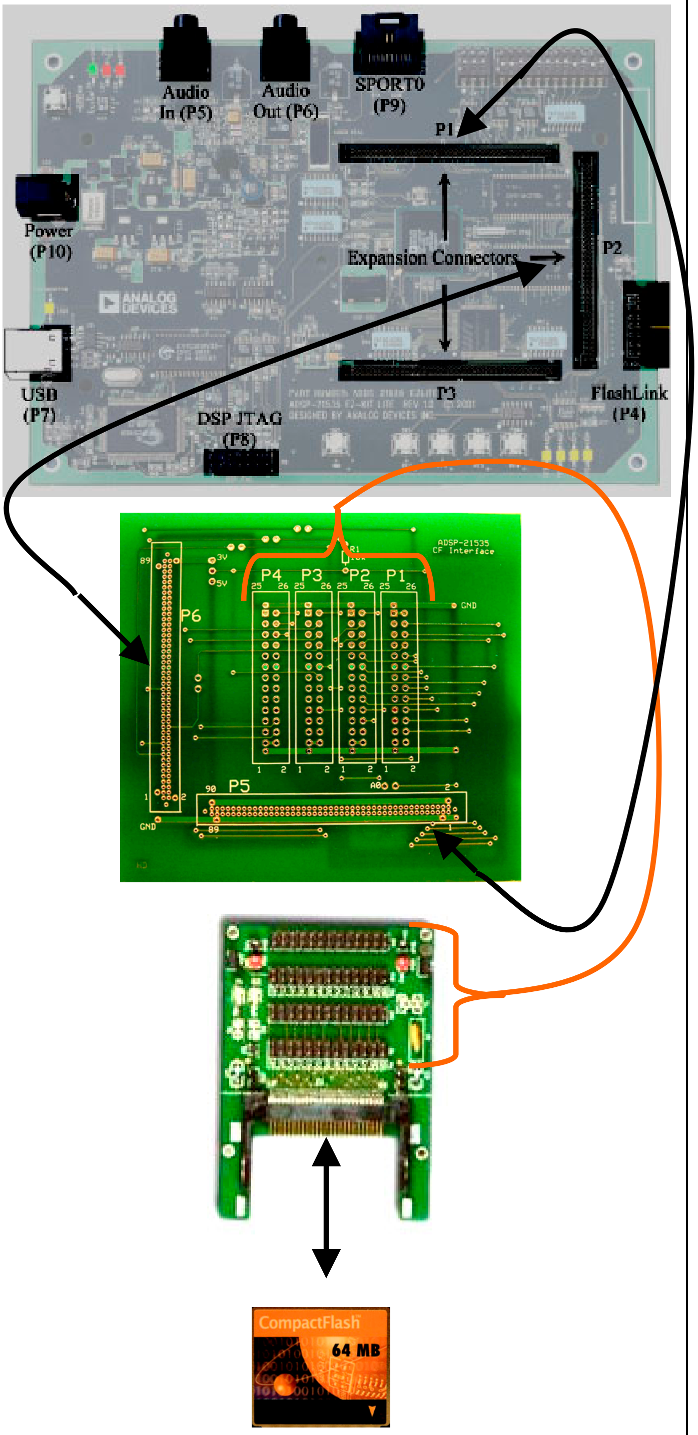


Figure 9. Physical Connections

Miscellaneous Hardware Information

The ADSP-BF535 EZ-KIT Lite and the daughter card are connected via 4 Samtec connectors:

- 2 female connectors: TFM-145-31-S-D (soldered to the ADSP-BF535 EZ-KIT Lite)
- 2 male connectors: SFM-145-01-S-D (soldered to the daughter card)

The daughter card and the SYCARD CIB board are connected via 4 standard 0.1 pitch connectors (male and female).

On the daughter card, there are six jumpers that need to be set. One of these jumpers sets the appropriate voltage for the CompactFlash card (3.3V or 5V). Also, a 10k resistor has to be connected as indicated in Figure 3.

The ADSP-BF535 CF Interface Daughter Card used in this application note can also be interfaced to the ADSP-BF533 EZ-KIT Lite as well (with a few wire wraps in place of the jumpers).

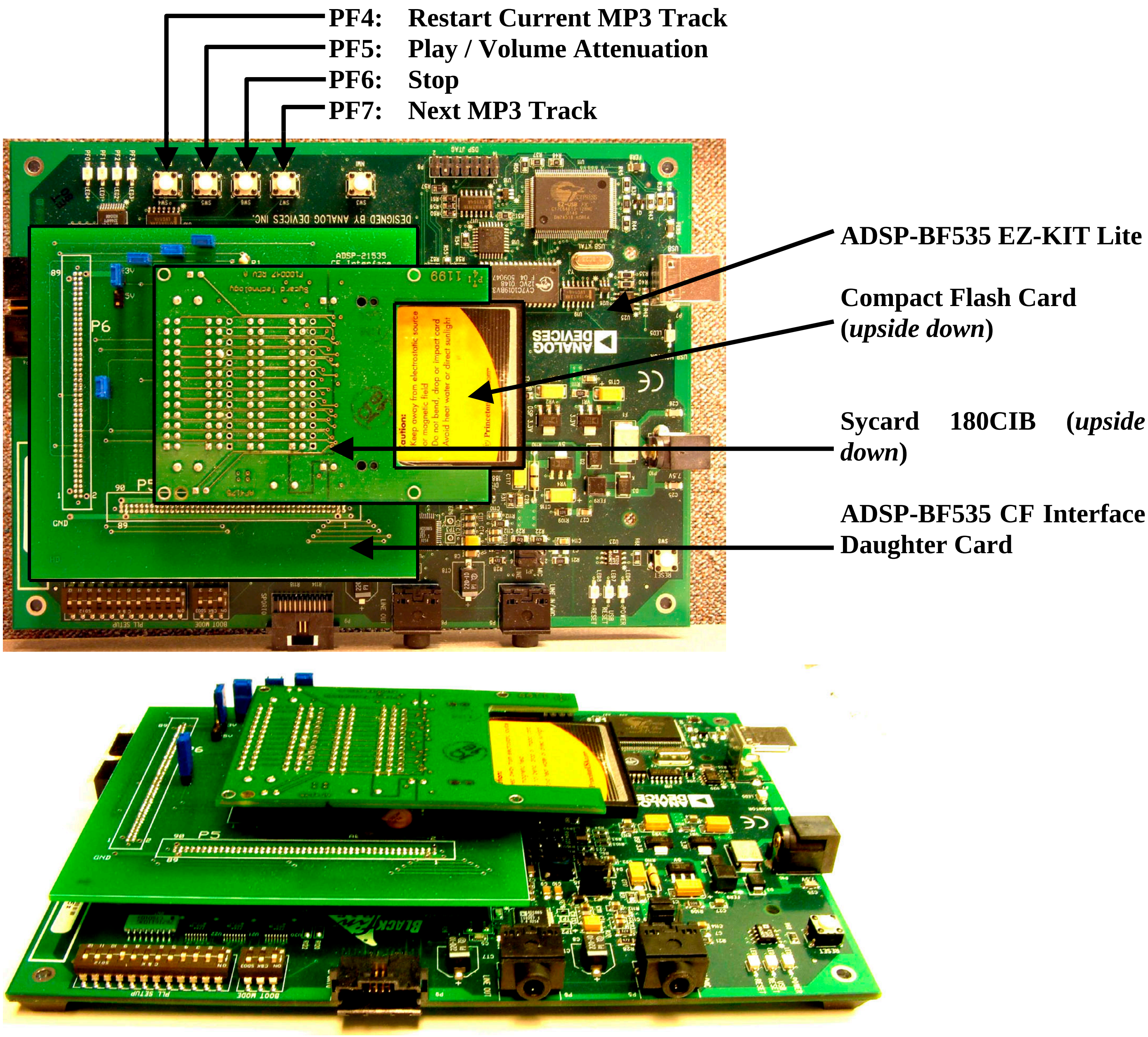

PF4: Restart Current MP3 Track
PF5: Play / Volume Attenuation
PF6: Stop
PF7: Next MP3 Track
ADSP-BF535 EZ-KIT Lite
Compact Flash Card (*upside down*)
Sycard 180CIB (*upside down*)
ADSP-BF535 CF Interface Daughter Card

Figure 10. ADSP-BF535 CompactFlash Interface

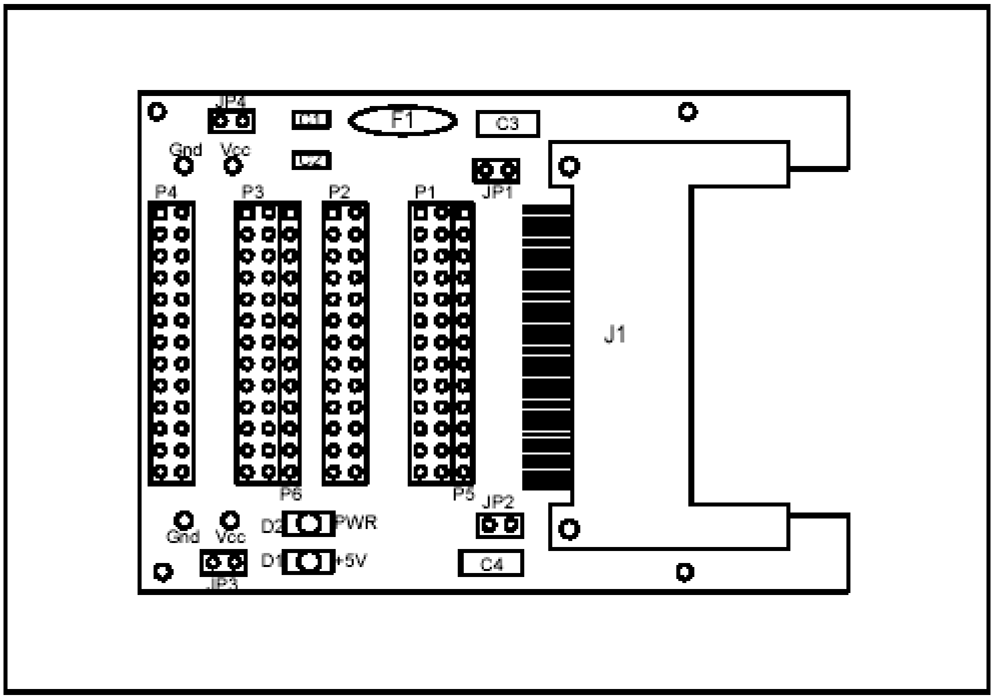


Figure 11. Layout Of SYCARD CF extend 180 Card Interface Board

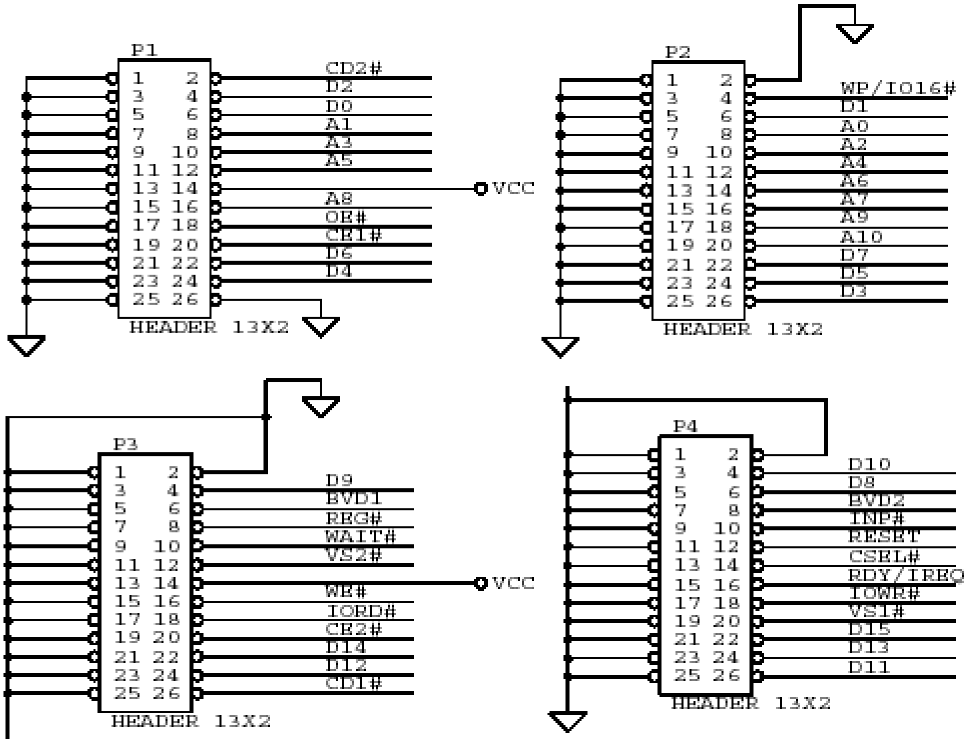


Figure 12. Pin Labels for SYCARD CIB180 board
(Pin Labels for Daughter Card As Well)

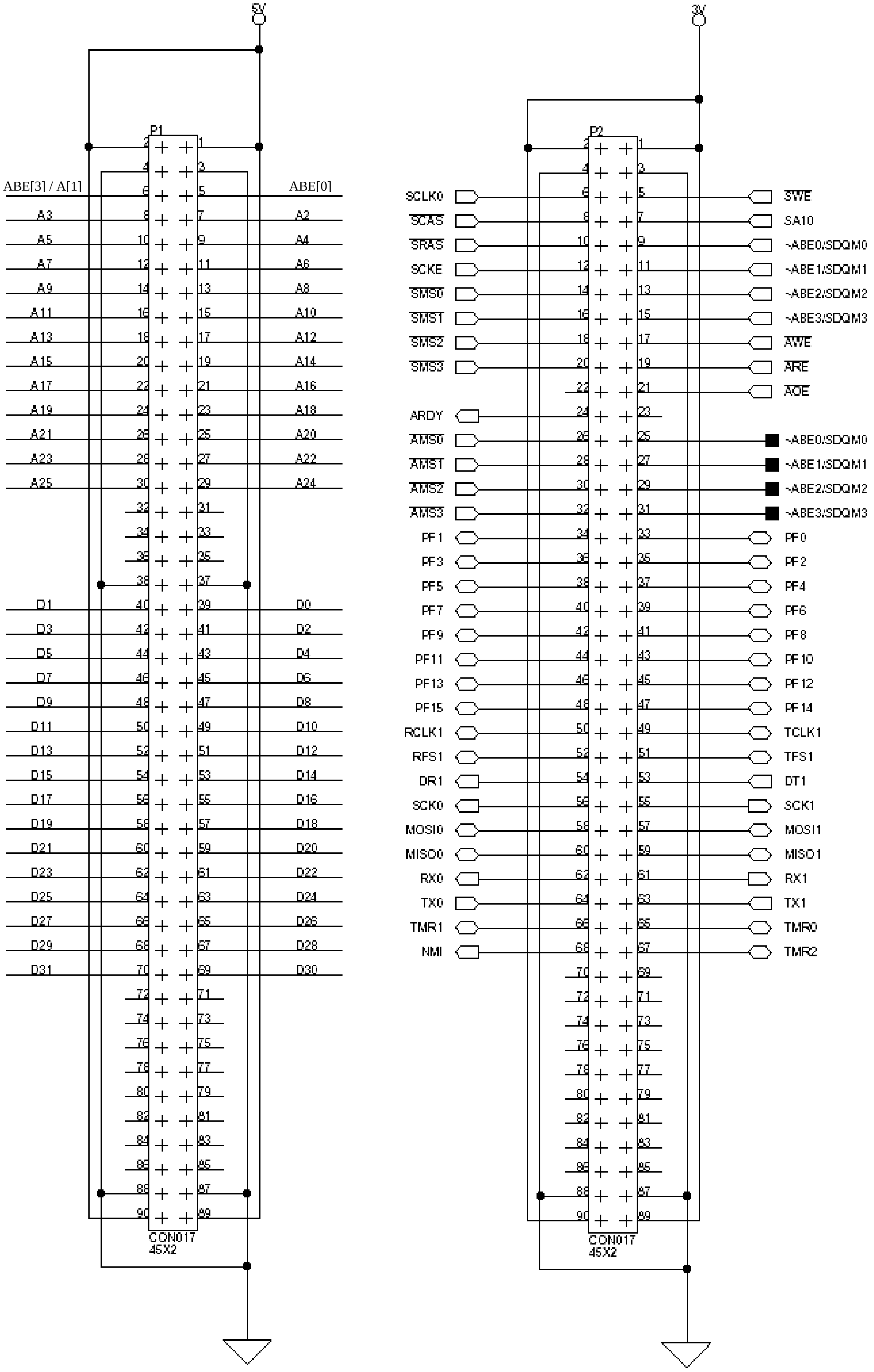


Figure 13. P1 and P2 Expansion Connectors on ADSP-BF535 EZ-KIT Lite (P5 and P6 Connectors on the Daughter Card As Well)

	ADSP-BF535 EZ-KIT Lite Connector P1 (P5 Connector on Daughter Card)	ADSP-BF535 EZ-KIT Lite Connector P2 (P6 Connector on Daughter Card)	Signal
SYCARD P1 Connector			
4	41		D2
6	39		D0
8	6		A1
10	8		A3
12	10		A5
14	1,2,89,90 (5V)	1,2,89,90 (3V)	VCC
16	13		A8
18		21 (/AOE)	/OE
20		28 (/AMS[1])	/CE1
22	45		D6
24	43		D4
1,3,5,7,9,11,13,15,17,19,21,23,25,26	3,4,37,38,87,88	3,4,87,88	GND
SYCARD P2 Connector			
6	40		D1
10	7		A2
12	9		A4
14	11		A6
16	12		A7
18	14		A9
20	15		A10
22	48		D7
24	44		D5
26	42		D3
1,2,3,5,7,8,9,11,13,15,17,19,21,23,25	3,4,37,38,87,88	3,4,87,88	GND
SYCARD P3 Connector			
4	48		D9
8	16 (A[11])		/REG
14	1,2,89,90 (5V)	1,2,89,90 (3V)	VCC
16		17 (/AWE)	/WE
20		28 (/AMS[1])	/CE2
22	53		D14
24	51		D12
26		41 (PF8)	/CD1
1,2,3,5,7,8,9,11,13,15,17,19,21,23,25	3,4,37,38,87,88	3,4,87,88	GND
SYCARD P4 Connector			
4	49		D10
6	47		D8
22	54		D15
24	52		D13
26	50		D11
1,2,3,5,7,8,9,11,13,15,17,19,21,23,25	3,4,37,38,87,88	3,4,87,88	GND

Table 6. Pin-to-Pin Connections

Document History

Version	Description
June 04, 2003 by H. Desai	Initial Release

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