S3C6400/6410 HW Multimedia Codec (MFC)

User's Guide

S3C6400/6410

August 29, 2008

(Preliminary) REV 3.20

Important Notice

S3C6400/6410 RISC Microprocessor
User's Guide

Samsung Electronics Co., Ltd.
San #24 Nongseo-Dong, Giheung-Gu
Yongin-City Gyeonggi-Do, Korea
446-711

Home Page: http://www.samsungsemi.com/

E-Mail: mobilesol.cs@samsung.com

Printed in the Republic of Korea

Revision History

Revision No	Description of Change	Refer to	Author(s)	Date
1.00	Initial draft(refer to WinCE v5.4)	-	Simon Chun	Aug. 13, 2007
2.10	Linux version document		Jiun Yu	Aug. 31, 2007
2.11	Fig 2-3 is added		Jiun Yu	Sep. 1, 2007
2.20	Ioctl command is added		Jiun Yu	Oct. 15, 2007
2.21			Jiun Yu	Dec. 21, 2007
2.30	Rotation function is added		Jiun Yu	Jan. 24, 2008
2.40	Encoding options are added		JIun Yu	Mar. 31, 2008
3.00	Supporting S3C6400 and 6410		Jiun Yu	April 14, 2008
3.10	Supporting Hybrid divx decoder		Jiun Yu	July 5, 2008
3.20	Tested on s3c-linux-2.6.24 kernel		Jiun Yu	August 29, 2008

Contents

Figures

Tables

1 Introduction

1.1 Purpose

This document is prepared for the purpose of describing the S3C6400/6410 HW codec (MFCv1.0) device driver's API so that users can implement their multimedia application easily.

1.2 Scope

The scope of this document is to describe

- How to call the device driver's API to decode/encode.
- Usage example of Decoder

1.3 Intended Audience

Intended Audience	Tick whenever Applicable
Project Manager	Yes
Project Leader	Yes
Project Team Member	Yes
Test Engineer	Yes

1.4 Supported HW & SW

Intended Audience	Tick whenever Applicable
HW	Samsung S3C6400/6410 HW Multimedia Codec
OS	Linux 2.6.16 and 2.6.24

1.5 Definitions, Acronyms, and Abbreviations

Abbreviations	Description
MFC	Multi-Format Codec (HW codec in S3C6400/6410 Samsung AP)

1.6 References

Number	Reference	Description
1	S3C6400 Datasheet	S3C6400 Datasheet
2	S3C6400WM60MfcDriver_UserManual_REV5.60_20071228	UserManual of the MFC Windows Mobile device driver

2 Installation Guide

2.1 Directory Structure

FIMV_MFC_V1.0	
Doc	Documents(API specification, User's guide, release note)
Mfc_app/File_Operation	MFC test application using File I/O
Mfc_app/API	MFC test application using API made by Samsung
Mfc_drv	MFC Linux device driver source code

Table - Directory Structure of MFC Driver and Test application Source Code

2.1.1 Driver Source Code Structure

Mfc driver souce code was separated into three layers which is shown in .

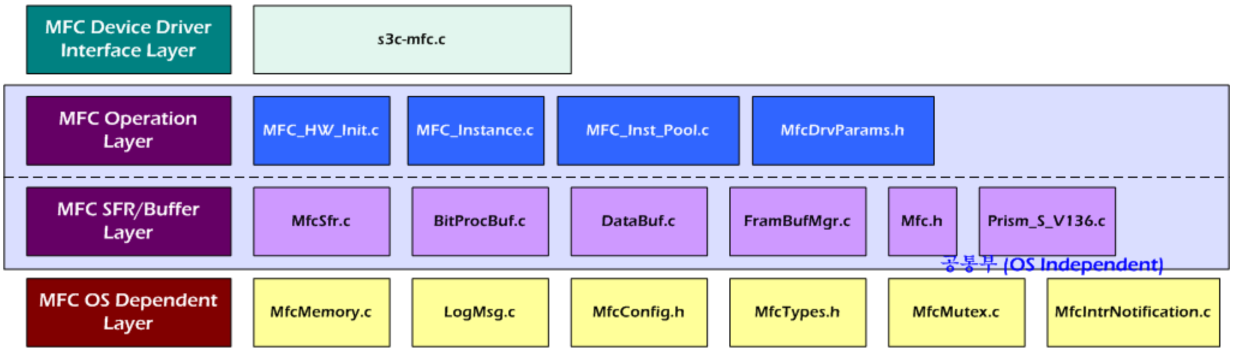


Fig - SW Layer of MFC Driver Source Code

[MFC Device Driver Interface Layer] It is the layer for the Linux OS device driver interface to be communicated with VFS. This layer is implementing the Linux character driver's API specification.

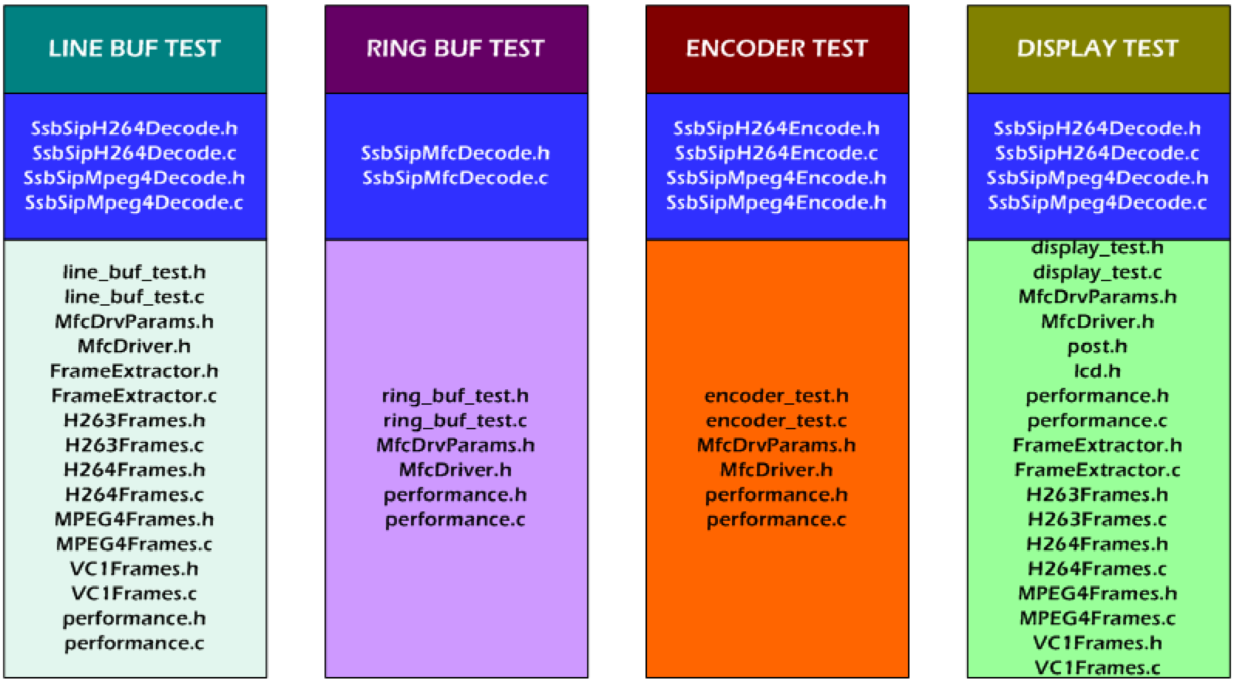
[MFC Operation Layer] It is implementing the operation logics for letting the MFC HW work.

[MFC SFR/Buffer Layer] This layer is for handling components such as MFC SFR, Bit Processor's buffer, etc.

[MFC OS System Layer] It is an abstraction layer for the OS system call.

2.1.2 API Test application Source Code Structure

Fig 2-3 shows source code structure of the MFC test application using API. Blue boxes are API Layer.



LINE BUF TEST

SsbSipH264Decode.h
SsbSipH264Decode.c
SsbSipMpeg4Decode.h
SsbSipMpeg4Decode.c

line_buf_test.h
line_buf_test.c
MfcDrvParams.h
MfcDriver.h
FrameExtractor.h
FrameExtractor.c
H263Frames.h
H263Frames.c
H264Frames.h
H264Frames.c
MPEG4Frames.h
MPEG4Frames.c
VC1Frames.h
VC1Frames.c
performance.h
performance.c

RING BUF TEST

SsbSipMfcDecode.h
SsbSipMfcDecode.c

ring_buf_test.h
ring_buf_test.c
MfcDrvParams.h
MfcDriver.h
performance.h
performance.c

ENCODER TEST

SsbSipH264Encode.h
SsbSipH264Encode.c
SsbSipMpeg4Encode.h
SsbSipMpeg4Encode.h

encoder_test.h
encoder_test.c
MfcDrvParams.h
MfcDriver.h
performance.h
performance.c

DISPLAY TEST

SsbSipH264Decode.h
SsbSipH264Decode.c
SsbSipMpeg4Decode.h
SsbSipMpeg4Decode.c

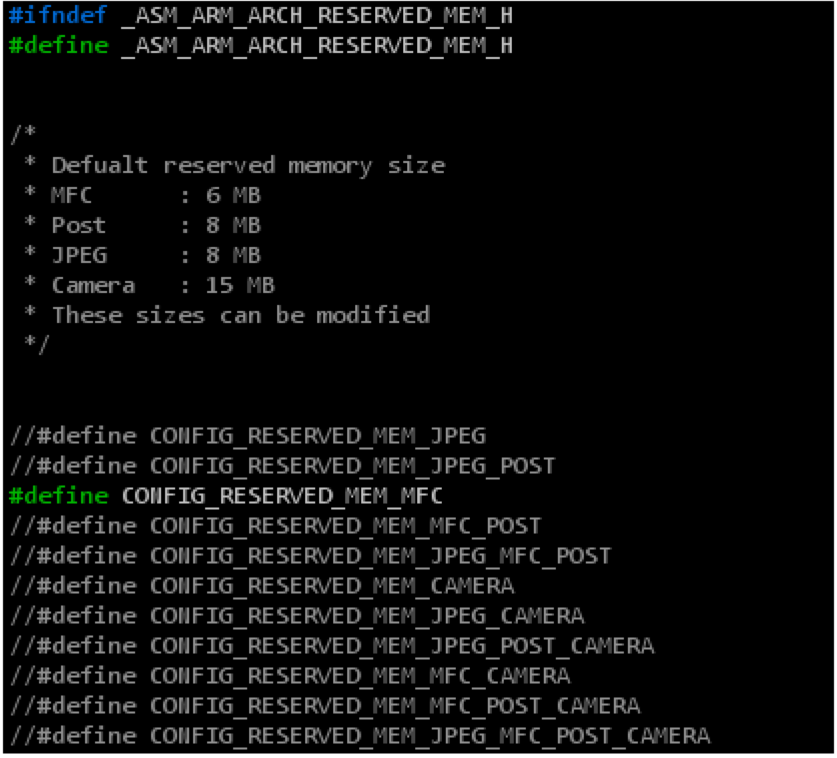
display_test.h
display_test.c
MfcDrvParams.h
MfcDriver.h
post.h
lcd.h
performance.h
performance.c
FrameExtractor.h
FrameExtractor.c
H263Frames.h
H263Frames.c
H264Frames.h
H264Frames.c
MPEG4Frames.h
MPEG4Frames.c
VC1Frames.h
VC1Frames.c

Fig - MFC Test application using API

2.2 Installation Step (Linux BSP)

2.2.1 Kernel configuration and building

Some devices need reserved memory because they have to allocate physically continuous memory. So You must setup reserved memory layout using below file named "reserved_mem.h" before kernel compilation.



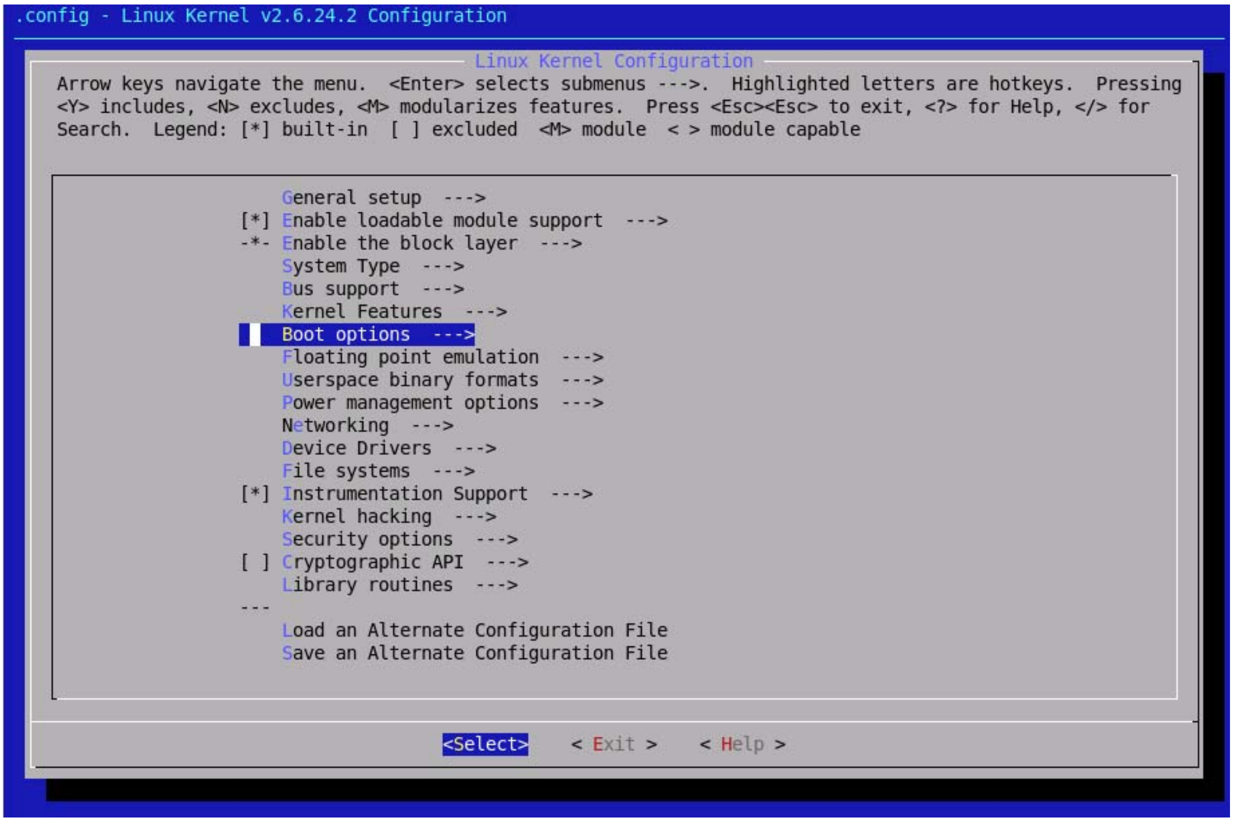
```
#ifndef _ASM_ARM_ARCH_RESERVED_MEM_H
#define _ASM_ARM_ARCH_RESERVED_MEM_H


/*
 * Defualt reserved memory size
 * MFC       : 6 MB
 * Post      : 8 MB
 * JPEG      : 8 MB
 * Camera    : 15 MB
 * These sizes can be modified
 */


//#define CONFIG_RESERVED_MEM_JPEG
//#define CONFIG_RESERVED_MEM_JPEG_POST
#define CONFIG_RESERVED_MEM_MFC
//#define CONFIG_RESERVED_MEM_MFC_POST
//#define CONFIG_RESERVED_MEM_JPEG_MFC_POST
//#define CONFIG_RESERVED_MEM_CAMERA
//#define CONFIG_RESERVED_MEM_JPEG_CAMERA
//#define CONFIG_RESERVED_MEM_JPEG_POST_CAMERA
//#define CONFIG_RESERVED_MEM_MFC_CAMERA
//#define CONFIG_RESERVED_MEM_MFC_POST_CAMERA
//#define CONFIG_RESERVED_MEM_JPEG_MFC_POST_CAMERA
```

Fig - Setup reserved memory layout

```
[NOTE]

This file is in
include/asm/arch-s3c64xx/reserved_mem.h (Linux2.6.16)
include/asm/arch-s3c2410/reserved mem.h (Linux2.6.21 and 2.6.24)
```

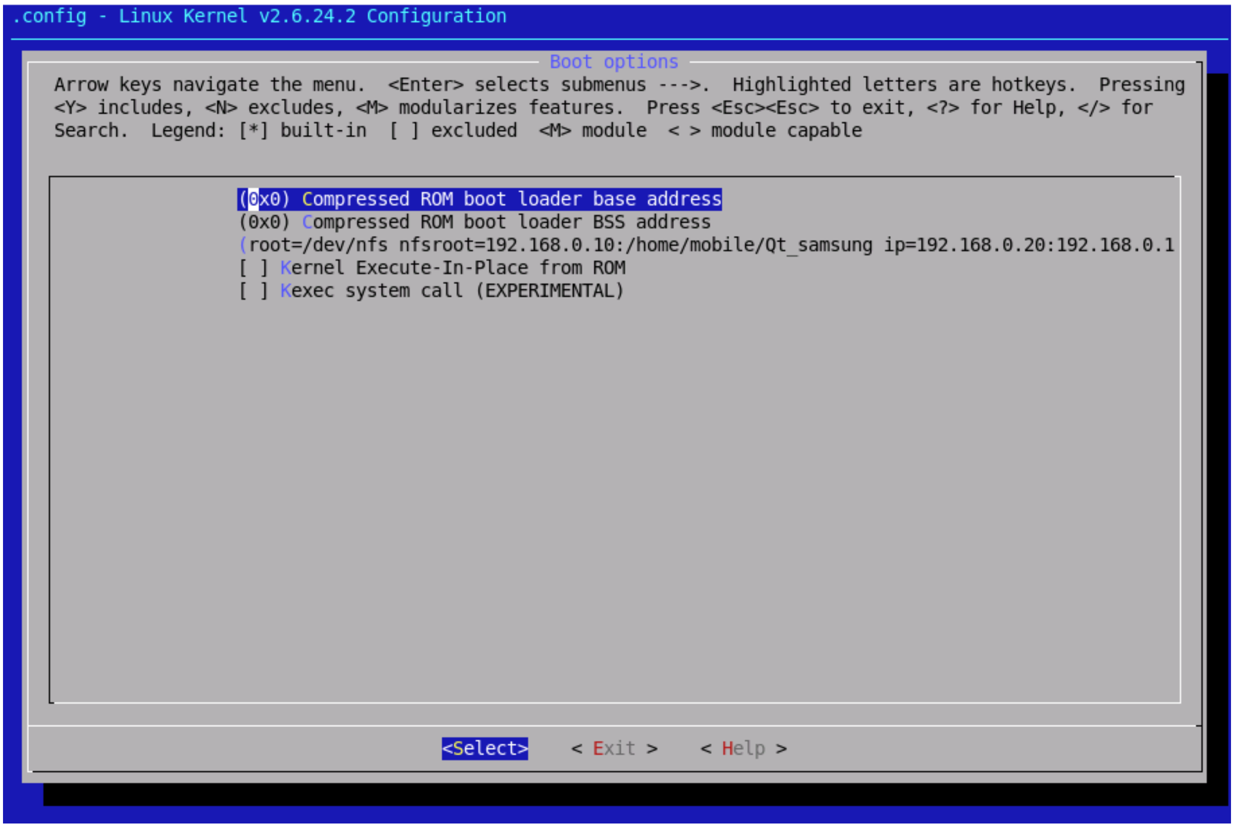
And then you must confirm "Boot option" in menuconfig using below procedure.

```
#cd [installed directory]/s3c-linux-2.6.24

[root@localhost s3c-linux-2.6.24]# make smdk6410mtd_defconfig

[root@localhost s3c-linux-2.6.24]# make menuconfig
```



```
.config - Linux Kernel v2.6.24.2 Configuration
                        Linux Kernel Configuration
 Arrow keys navigate the menu.  <Enter> selects submenus --->.  Highlighted letters are hotkeys.  Pressing
 <Y> includes, <N> excludes, <M> modularizes features.  Press <Esc><Esc> to exit, <?> for Help, </> for
 Search.  Legend: [*] built-in  [ ] excluded  <M> module  < > module capable

                     General setup  --->
                 [*] Enable loadable module support  --->
                 -*- Enable the block layer  --->
                     System Type  --->
                     Bus support  --->
                     Kernel Features  --->
                     Boot options  --->
                     Floating point emulation  --->
                     Userspace binary formats  --->
                     Power management options  --->
                     Networking  --->
                     Device Drivers  --->
                     File systems  --->
                 [*] Instrumentation Support  --->
                     Kernel hacking  --->
                     Security options  --->
                 [ ] Cryptographic API  --->
                     Library routines  --->
                 ---
                     Load an Alternate Configuration File
                     Save an Alternate Configuration File

                       <Select>    < Exit >    < Help >
```

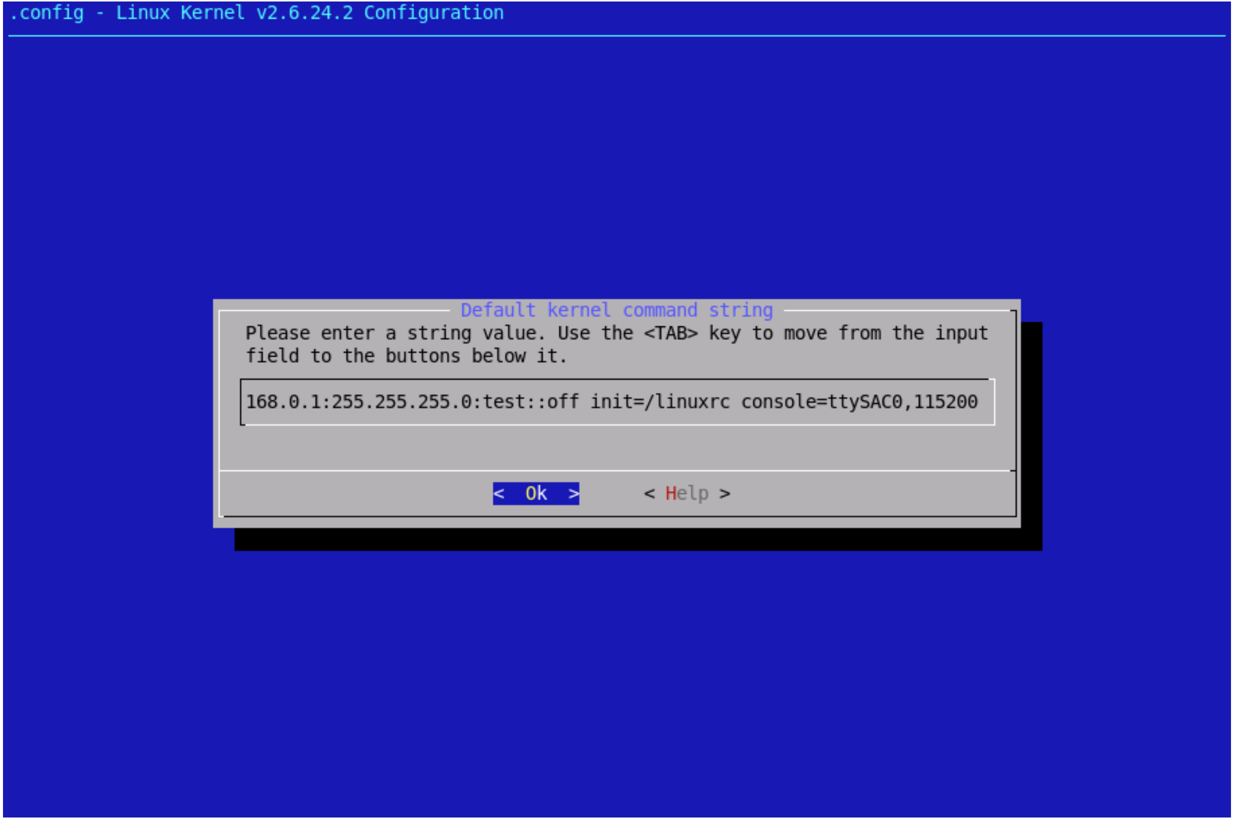
Fig - Select "Boot option"



```
.config - Linux Kernel v2.6.24.2 Configuration
                              Boot options
 Arrow keys navigate the menu.  <Enter> selects submenus --->.  Highlighted letters are hotkeys.  Pressing
 <Y> includes, <N> excludes, <M> modularizes features.  Press <Esc><Esc> to exit, <?> for Help, </> for
 Search.  Legend: [*] built-in  [ ] excluded  <M> module  < > module capable

                  (0x0) Compressed ROM boot loader base address
                  (0x0) Compressed ROM boot loader BSS address
                  (root=/dev/nfs nfsroot=192.168.0.10:/home/mobile/Qt_samsung ip=192.168.0.20:192.168.0.1
                  [ ] Kernel Execute-In-Place from ROM
                  [ ] Kexec system call (EXPERIMENTAL)

                        <Select>    < Exit >    < Help >
```

Fig - Select 3rd line

If there is "mem=128M" in "Default kernel command string", please erase because you already modify reserved memory layout previous step.



```
.config - Linux Kernel v2.6.24.2 Configuration

                      Default kernel command string
  Please enter a string value. Use the <TAB> key to move from the input
  field to the buttons below it.

  168.0.1:255.255.255.0:test::off init=/linuxrc console=ttySAC0,115200

                      <  Ok  >      < Help >
```

Fig - Confirm "Default kernel command string"

Save and exit in “menuconfig”

```
[root@localhost s3c-linux-2.6.24]# make clean

[root@localhost s3c-linux-2.6.24]# make

[root@localhost s3c-linux-2.6.24]# cp arch/arm/boot/zImage /tftpboot
```

When “zImage” is ready in the directory “/tftpboot”, then you can run “minicom” to download it to the target board.

[NOTE]

For detailed information about how to build Linux kernel and how to download kernel image and cramfs, please refer to related porting guide documents.

2.2.2 Module compilation

MFC device driver should be compiled as a kernel module.

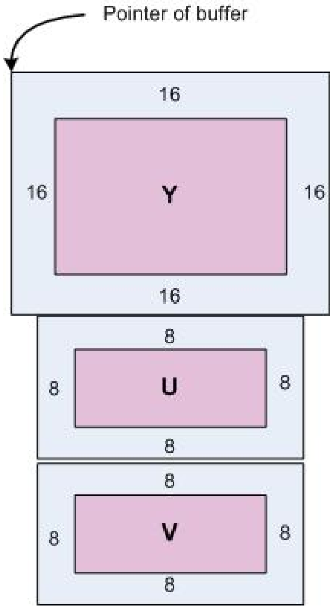
2.2.2.1 Makefile

You should modify “Makefile” to set configuration according to your environment.

```
[root@localhost s3c-linux-2.6.24]# cd [module directory]/Multimedia_DD/FIMV_MFC_V1.0/mfc_drv

[root@localhost mfc_drv]# vi Makefile
```

```
##################################################
# Makefile for MFC Driver
# 2007 (C) Samsung Electronics
# Author : Jiun. Yu <jiun.yu@samsung.com>
##################################################

#where the kernel sources are located
KERNEL_DIR := ../../../ s3c-linux-2.6.24

CFLAGS_MODULE += -DLINUX
CFLAGS_MODULE += -DDIVX_ENABLE

obj-m           := s3c_mfc.o

s3c_mfc-y := Prism_0503.o BitProcBuf.o DataBuf.o FramBufMgr.o \
                      LogMsg.o MFC_HW_Init.o MFC_Inst_Pool.o MFC_Instance.o MfcMemory.o
MfcMutex.o MfcSfr.o    \
                      s3c-mfc.o MfcIntrNotification.o MfcSetConfig.o

PWD                   := $(shell pwd)

here:
        (cd $(KERNEL_DIR); make SUBDIRS=$(PWD) modules)

clean:
        rm -rf *.ko
        rm -rf *.mod.*
        rm -rf .*.cmd
        rm -rf *.o
        rm -rf Module.*
```

In case of enabling DIVX_TEST macro, MFC's output buffer's scheme is changed like below. Below buffer scheme is used for Hybrid divx decoder.



2.2.2.2 Compile

After compilation, you can find newly created files. "s3c_mfc.ko" file is module of MFC device driver.

```
[root@localhost mfc_drv]# make
```

2.2.3 Test application compilation

In this sub chapter, you should know how to compile and how to use test application. It is included encoder and decoder test

First, you should modify the "Makefile". There are several macro. you should enable macro accoding to your development environment.

```
[root@localhost mfc_drv]# cd ../mfc_app/API

[root@localhost API]# vi Makefile
```

```
CC = /usr/local/arm/4.2.2-eabi/usr/bin/arm-linux-gcc

#[Definitions]
#FPS : performance measurement. It doesn't make the output file
#ROTATE_ENABLE : Rotation mode enable when testing line buffer and ring buffer.
#               and if you want to test rotation, you must modify definition as "#define
#               MFC_ROTATE_ENABLE 1" in MfcConfig.h file
#RGB24BPP : display as 24bpp. default is 16bpp
#DIVX_ENABLE : test for hybrid divx decoder

CFLAGS =  -Wall -Os

CSRCS = ./MPEG4Frames.c             \
            ./H264Frames.c                      \
            ./VC1Frames.c               \
            ./H263Frames.c                      \
            ./FrameExtractor.c              \
            ./line_buf_test.c               \
            ./ring_buf_test.c               \
            ./display_test.c        \
            ./display_optimization1.c       \
            ./display_optimization2.c       \
            ./encoder_test.c                \
            ./SsbSipH264Decode.c    \
            ./SsbSipMpeg4Decode.c           \
            ./SsbSipVC1Decode.c     \
            ./SsbSipMfcDecode.c             \
            ./SsbSipH264Encode.c    \
            ./SsbSipMpeg4Encode.c \
            ./SsbSipLogMsg.c                \
            ./performance.c                 \
            ./FileRead.c                    \
            ./demo.c                                        \
            ./test.c

OBJS = $(CSRCS:.c=.o)

.SUFFIXES:.c.o

all:        mfc

mfc: $(OBJS)
            $(CC) $(CFLAGS) -g -o $@ $(OBJS) -lpthread

.c.o:
            $(CC) $(CFLAGS) -g -c -o $@ $<

clean:
            rm -f mfc $(OBJS)
```

Second, you should decide to test encoder or decoder.

```
 [root@localhost mfc_drv]# cd ../mfc_app/API

[root@localhost API]# vi test.c
```

Modify "test.c" file. You can select encoder or decoder test

```
#include "line_buf_test.h"
#include "ring_buf_test.h"
#include "encoder_test.h"
#include "display_test.h"
#include "demo.h"
#include "display_optimization1.h"
#include "display_optimization2.h"

int main(int argc, char **argv)
{
            Test_H263_Decoder_Line_Buffer(argc, argv);
            //Test_H264_Decoder_Line_Buffer(argc, argv);
            //Test_MPEG4_Decoder_Line_Buffer(argc, argv);
            //Test_VC1_Decoder_Line_Buffer(argc, argv);
            //Test_Decoder_Ring_Buffer(argc, argv);
            //Test_Display_H264(argc, argv);
            //Test_Display_MPEG4(argc, argv);
            //Test_Display_H263(argc, argv);
```

```
        //Test_Display_VC1(argc, argv);
        //Test_H264_Encoder(argc, argv);
        //Test_MPEG4_Encoder(argc, argv);
        //Test_H263_Encoder(argc, argv);
        //Demo(argc, argv);
        //Test_Display_Optimization1(argc, argv);
        //Test_Display_Optimization2(argc, argv);

        return 0;
}
```

Third, you should compile the test application.

```
[root@localhost mfc_app]# make
```

After compilation, you can find newly created files. "mfc" is executable file.

2.2.4 Download module and test application(At target side)

Use "rz" command in root file system. This command enables you can transfer test application from host PC to target board through uart console by zmodem.

```
/tmp $ rz <ENTER>
```

After downloading completely, you need to change access right of this application. Use "chmod" command. If you are using NFS root file system, you just copy these created files to your NFS root directory.

2.2.5 Loading module and executing test applicatioin

```
/ $ insmod s3c_mfc.ko

S3C6400 MFC Driver, (c) 2007 Samsung Electronics

S3C6400 MFC driver module init OK.

./mfc [input filename] [output filename]
```

2.3 Memory Configuration

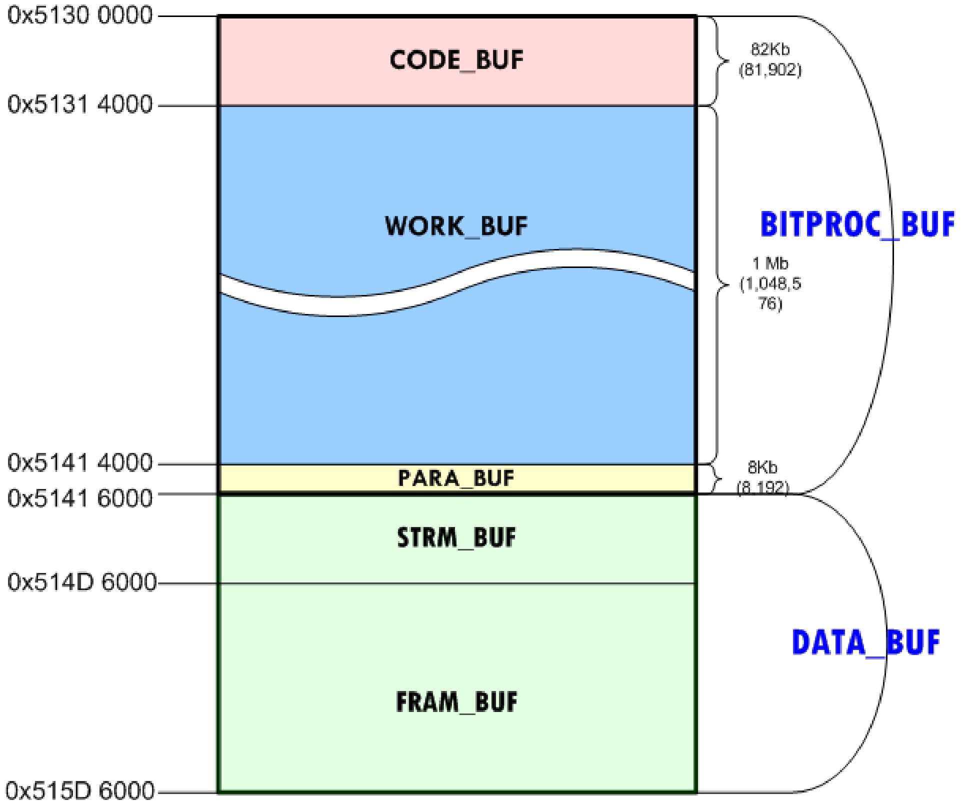


Fig - Memory Layout in RAM for MFC

There are two memory region to be reserved for the MFC to operate. One is BITPROC_BUF and its size is fixed as 1,138,688 bytes. The other is DATA_BUF, the size for this buffer is application-dependent.

BUF name	Description		BUF size (Bytes)
BITPROC_BUF	Reserved area for the BITPROCESSOR(MFC's internal processor) Once the MFC is started, the address cannot be changed.		**1,138,688**
	CODE_BUF	BITPROCESSOR's F/W code	81,902
	WORK_BUF	BITPROCESSOR's working buffer	1,048,576
	PARA_BUF	Parameters on issuing command to MFC	8,192
DATA_BUF	Input/Output buffer for encoding and decoding		
	STRM_BUF	Buffer for the compressed video stream.	❶
	FRAM_BUF	Buffer for the YUV420 frame	❷

Table - MFC's Buffer Description

BITPROC_BUF is reserved for the BITPROCESSOR and the size is fixed as 1,138,688 bytes.
DATA_BUF consists of STRM_BUF and FRAM_BUF for input and output buffer. In the STRM_BUF area, we allocates the LINE_BUF

2.3.1 Configuring the MFC Buffer Address

FIMV_MFC_V1.0/mfc_drv/MfcConfig.h

DEFINE	Description
S3C6400_BASEADDR_MFC_SFR	• Base address of MFC SFR • [Value = 0x7e002000] is fixed. (Refer to S3C6400 Datasheet.)
S3C6400_BASEADDR_MFC_BITPROC_BUF	• Base address of MFC BITPROC_BUF • Value is in RAM region
S3C6400_BASEADDR_MFC_DATA_BUF	• Base address of MFC DATA_BUF • Value is in RAM region (Better if it is consecutive to BITPROC_BUF.)

DEFINE	Description
MFC_CODE_BUF_SIZE	• Size of CODE_BUF • [Value = 81920] is fixed.
MFC_WORK_BUF_SIZE	• Size of WORK_BUF • [Value = 1048576] is fixed.
MFC_PARA_BUF_SIZE	• Size of PARA_BUF • [Value = 8192] is fixed.
MFC_BITPROC_BUF_SIZE	• Total size of BITPROC_BUF • Value = MFC_CODE_BUF_SIZE + MFC_WORK_BUF_SIZE + MFC_PARA_BUF_SIZE

DEFINE	Description
MFC_NUM_INSTANCES_MAX	• Maximum number of MFC instances • Value = 1 ~ 8
MFC_LINE_RING_SHARE	• LINE_BUF & RING_BUF are shared? • Value = 0 or 1

DEFINE	Description
MFC_LINE_BUF_SIZE_PER_INSTANCE	• Size of LINE_BUF per instance • [Recommended Value for VGA = 200 * 1024] • [Recommended Value for QVGA = 100 * 1024]
MFC_LINE_BUF_SIZE	• MFC_LINE_BUF_SIZE_PER_INSTANCE * MFC_NUM_INSTANCES_MAX
MFC_RING_BUF_SIZE	• Size of RING_BUF • [Recommended Value = 256000 * 3]
MFC_FRAM_BUF_SIZE	• Size of FRAM_BUF • [Recommended Value = 720*480*3*4]

MFC_RING_BUF_PARTUNIT_SIZE	• Size of one PART of RING_BUF • MFC_RING_BUF_SIZE / 3
MFC_STRM_BUF_SIZE	• MFC_LINE_BUF_SIZE + MFC_RING_BUF_SIZE
MFC_DATA_BUF_SIZE	• MFC_STRM_BUF_SIZE + MFC_FRAM_BUF_SIZE

2.3.2 Required Memory Sized Calculation

In this section, how to calculate the memory will be explained step by step.

① BITPROC_BUF size is fixed. (size = 1,138,688 bytes)

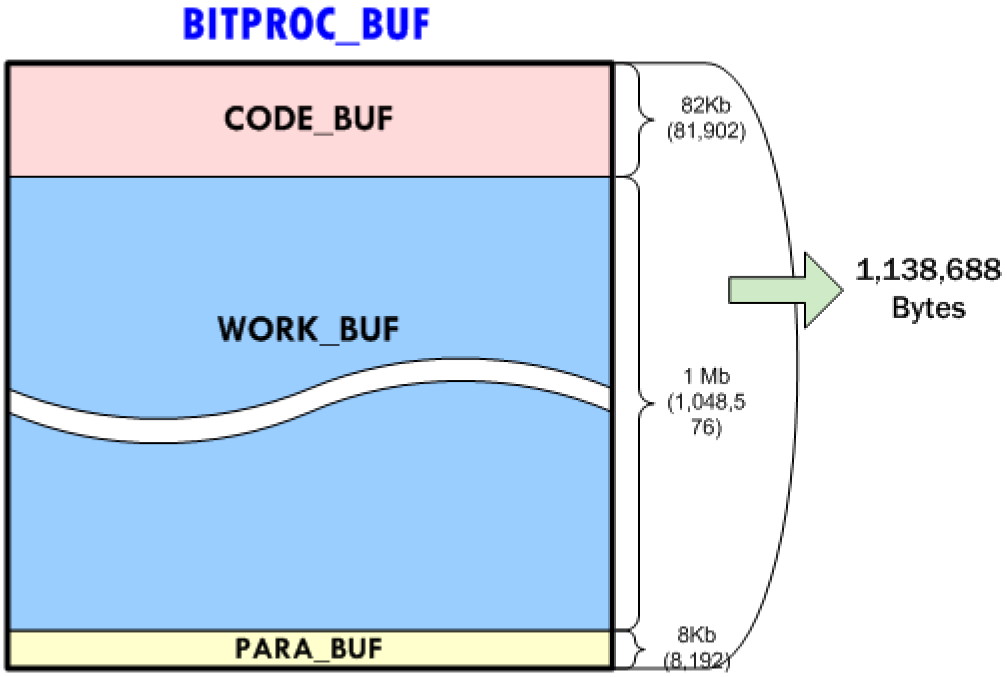


Fig - Size of BITPROC_BUF

② STRM_BUF size calculation.

STRM_BUF has LINE_BUF and RING_BUF. They can be separated or shared.

LINE_BUF & RING_BUF are in separate mode.
As shown in , LINE_BUF and RING_BUF consume memory spaces respectively. For the 720x576-sized video, the possible maximum length of frame is 622,080 (720x576x1.5) bytes that is when it is not totally compressed. By assuming that it can be compressed to 30%, 204,800 bytes is the proper value for the maximum length of compressed frame.

Therefore, we can assume that the maximum length of compressed frame for different video size is

- SD image : 204,800 bytes or less
- CIF image : 102,400 bytes or less

LINE_BUF & RING_BUF are in shared mode.
As shown in , LINE_BUF and RING_BUF are shared so that the required size of STRM_BUF is larger one. Typically, the RING_BUF size is equal to three times of LINE_BUF_PER_INSTANCE, the size for STRM_BUF can be set 614,400 bytes for SD-sized image.

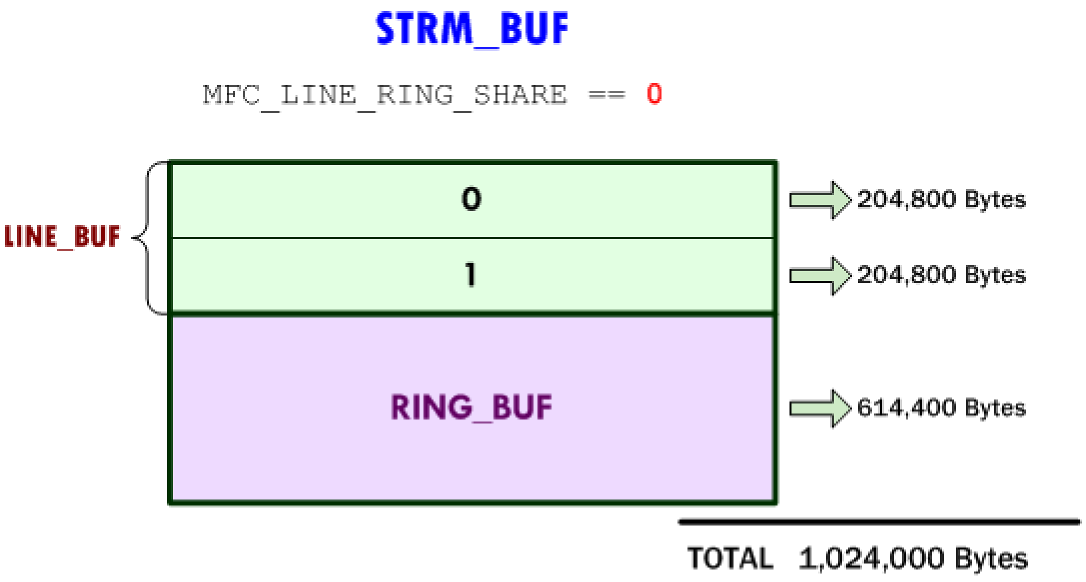


Fig - Size of STRM_BUF with LINE_BUF and RING_BUF not-shared (Example)

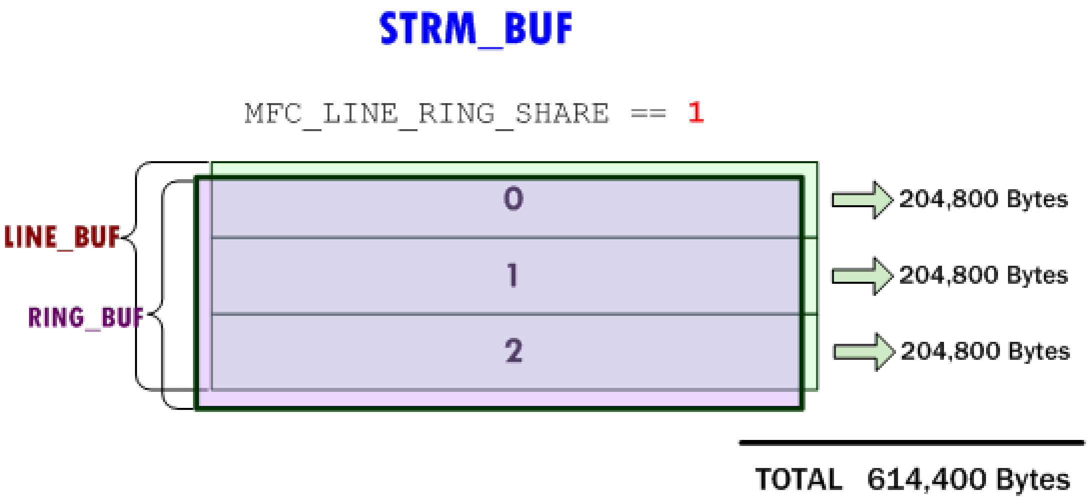


Fig - Size of STRM_BUF with LINE_BUF and RING_BUF shared (Example)

③ FRAM_BUF size calculation.

MFC requires that the output buffer size is three or four times bigger than the YUV frame size. The number is determined by the return value (frame count in MFC DEC_PIC_RUN command.) The number is commonly 3 (three times bigger).
For the SD-sized image, the required size of FRAM_BUF is shown in .

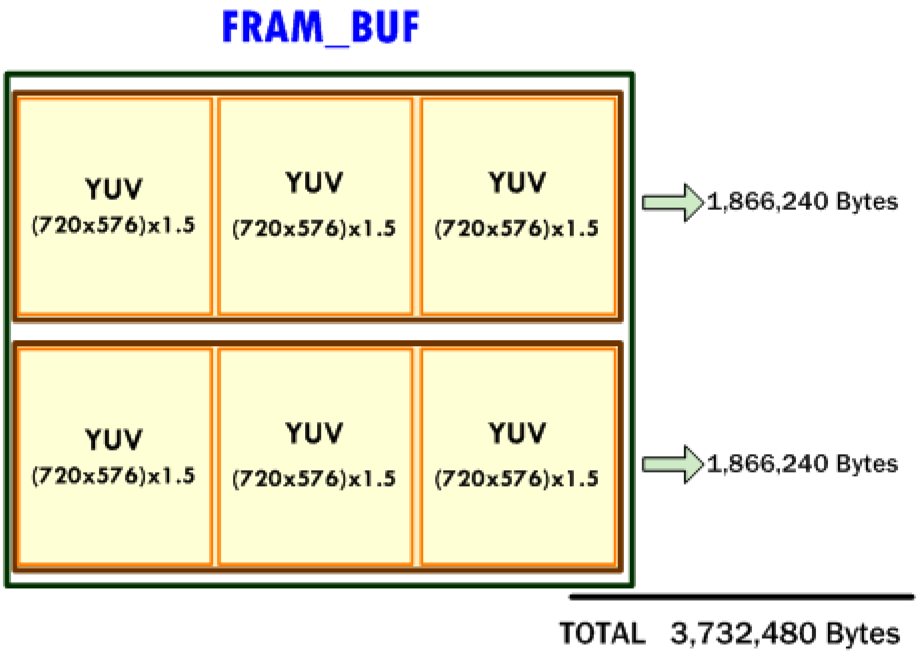


Fig - Size of FRAM_BUF (Example)

The following tables, Table 2-3 and Table 2-4, are showing required memory size examples for common situations. If we set the MFC to support 1 SD image, it requires 3.3 MB. Since it is greater than the case of 2 CIF images, 1 SD image setting is supporting the 2CIF image setting as well.

(Unit : Bytes)

	2 SD images		1 SD image	
	LINE_RING split	LINE_RING share	LINE_RING split	LINE_RING share
BITPROC_BUF	1,138,688	1,138,688	1,138,688	1,138,688
STRM_BUF	1,024,000	614,400	512,000	307,200
FRAM_BUF	3,732,480	3,732,480	1,866,240	1,866,240
TOTAL	**5,895,168** 0x0059 F400	**5,485,568** 0x0053 B400	**3,516,928** 0x0035 AA00	**3,312,128** 0x0032 8A00

Table - Required Memory Size (1 or 2 SD images)

(Unit : Bytes)

	2 CIF images		1 CIF image	
	LINE_RING split	LINE_RING share	LINE_RING split	LINE_RING share
BITPROC_BUF	1,138,688	1,138,688	1,138,688	1,138,688
STRM_BUF	512,000	307,200	512,000	307,200
FRAM_BUF	912,384	912,384	912,384	912,384
TOTAL	**2,563,072** 0x0027 1C00	**2,358,272** 0x0023 FC00	**2,563,072** 0x0027 1C00	**2,358,272** 0x0023 FC00

Table - Required Memory Size (1 or 2 CIF images)

3 File I/O Operatioin

3.1 Linux Device Driver's File I/O Operation

API Functions	Description
open	Create the 6400 MFC instance.
ioctl	IOCTL_MFC_MPEG4_DEC_INIT IOCTL_MFC_MPEG4_ENC_INIT IOCTL_MFC_MPEG4_DEC_EXE IOCTL_MFC_MPEG4_ENC_EXE IOCTL_MFC_H264_DEC_INIT IOCTL_MFC_H264_ENC_INIT IOCTL_MFC_H264_DEC_EXE IOCTL_MFC_H264_ENC_EXE IOCTL_MFC_H263_DEC_INIT IOCTL_MFC_H263_ENC_INIT IOCTL_MFC_H263_DEC_EXE IOCTL_MFC_H263_ENC_EXE IOCTL_MFC_VC1_DEC_INIT IOCTL_MFC_VC1_DEC_EXE IOCTL_MFC_GET_LINE_BUF_ADDR IOCTL_MFC_GET_RING_BUF_ADDR IOCTL_MFC_GET_FRAM_BUF_ADDR IOCTL_MFC_GET_PHY_FRAM_BUF_ADDR IOCTL_MFC_GET_CONFIG IOCTL_MFC_SET_CONFIG IOCTL_MFC_SET_H263_MULTIPLE_SLICE
mmap	Map reserved memory for application
close	Close the 6400 MFC instance.

3.1.1 open

open	
Syntax	int open(const char * path, int oflag);
Description	This function creates the 6400 MFC instance. Several MFC instance can be made simultaneously. This means that open function can be called several times in a process(task).
Parameters	path [IN] : path of the MFC device driver's node oflag[IN] : flags of MFC.
Returns	HANDLE(file descriptor) of the MFC instance. If it fails, it returns INVALID_HANDLE_VALUE.

3.1.2 ioctl

ioctl	
Syntax	int ioctl(int fd, int cmd, int arg);
Description	Most of functions are developed in ioctl. This system call has many functions which is separated by cmd
Parameters	fd [IN] : HANDLE returned by open() function. cmd [IN] : Control codes for the operation. Detailed information of cmd will explain below. arg[IN] : Structure of the MFC argument.
Returns	If the operation completes successfully, the return value is nonzero. If the operation fails or is pending, the return value is zero.

3.1.3 mmap

mmap	
Syntax	Void *mmap(void *addr, size_t len, int prot, int flags, int fd, off_t off);
Description	This function maps physically continuous memory. This memory can share user and device driver. It is used as Stream buffer and frame buffer of the MFC
Parameters	addr[IN] : none len[IN] : mapped memory size prot[IN] : memory access permission(PROT_READ, PROT_WRITE, etc) flag[IN] : attribute of memory (MAP_SHARED, etc) fd [IN] : HANDLE of the MFC off[IN] : none
Returns	Base address of stream buffer. This address can use in user application.

3.1.4 close

Close	
Syntax	int close(int fd);
Description	Closes an open MFC's handle.
Parameters	fd [IN] : HANDLE returned by open() function
Returns	If the function succeeds, the return value is nonzero. If the function fails, the return value is zero

3.2 Control Codes for ioctl()

IOCTL_MFC_MPEG4_DEC_INIT **IOCTL_MFC_H263_DEC_INIT** **IOCTL_MFC_H264_DEC_INIT** **IOCTL_MFC_VC1_DEC_INIT**	
Syntax	See 3.1.2
Description	It initializes the MFC's instance with the configure stream.
Parameters	fd [IN] : HANDLE returned by open() function cmd [IN] : IOCTL_MFC_MPEG4_DEC_INIT, IOCTL_MFC_H263_DEC_INIT, IOCTL_MFC_H264_DEC_INIT, IOCTL_MFC_VC1_DEC_INIT arg [IN/OUT] : Pointer to MFC_DEC_INIT_ARG structure.
Returns	If the operation completes successfully, the return value is nonzero. If the operation fails or is pending, the return value is zero.

IOCTL_MFC_MPEG4_DEC_EXE **IOCTL_MFC_H263_DEC_EXE** **IOCTL_MFC_H264_DEC_EXE** **IOCTL_MFC_VC1_DEC_EXE**	
Syntax	See 3.1.2
Description	It decodes the stream in the LINE_BUF or RING_BUF.
Parameters	fd [IN] : HANDLE returned by open() function cmd [IN] : IOCTL_MFC_MPEG4_DEC_EXE, IOCTL_MFC_H263_DEC_EXE, IOCTL_MFC_H264_DEC_EXE, IOCTL_MFC_VC1_DEC_EXE arg [IN/OUT] : Pointer to MFC_DEC_EXE_ARG structure.
Returns	If the operation completes successfully, the return value is nonzero. If the operation fails or is pending, the return value is zero.

IOCTL_MFC_MPEG4_ENC_INIT **IOCTL_MFC_H263_ENC_INIT** **IOCTL_MFC_H264_ENC_INIT** **IOCTL_MFC_VC1_ENC_INIT**	
Syntax	See 3.1.2
Description	It initializes the MFC's encoding information.

Parameters	fd [IN] : HANDLE returned by open() function cmd [IN] : IOCTL_MFC_MPEG4_ENC_INIT, IOCTL_MFC_H263_ENC_INIT, IOCTL_MFC_H264_ENC_INIT, IOCTL_MFC_VC1_ENC_INIT arg [IN/OUT] : Pointer to MFC_ENC_INIT_ARG structure.
Returns	If the operation completes successfully, the return value is nonzero. If the operation fails or is pending, the return value is zero.

IOCTL_MFC_MPEG4_ENC_EXE **IOCTL_MFC_H263_ENC_EXE** **IOCTL_MFC_H264_ENC_EXE** **IOCTL_MFC_VC1_ENC_EXE**	
Syntax	See 3.1.2
Description	It encodes the stream in the FRAM_BUF.
Parameters	fd [IN] : HANDLE returned by open() function cmd [IN] : IOCTL_MFC_MPEG4_ENC_EXE, IOCTL_MFC_H263_ENC_EXE, IOCTL_MFC_H264_ENC_EXE, IOCTL_MFC_VC1_ENC_EXE arg [IN/OUT] : Pointer to MFC_ENC_EXE_ARG structure.
Returns	If the operation completes successfully, the return value is nonzero. If the operation fails or is pending, the return value is zero.

IOCTL_MFC_GET_LINE_BUF_ADDR **IOCTL_MFC_GET_RING_BUF_ADDR** **IOCTL_MFC_GET_FRAM_BUF_ADDR**	
Syntax	See 3.1.2
Description	It obtains the address of the LINE_BUF, RING_BUF or FRAM_BUF.
Parameters	fd [IN] : HANDLE returned by open() function cmd [IN] : IOCTL_MFC_GET_LINE_BUF_ADDR, IOCTL_MFC_GET_RING_BUF_ADDR, IOCTL_MFC_GET_FRAM_BUF_ADDR arg [IN/OUT] : Pointer to MFC_GET_BUF_ADDR_ARG structure.
Returns	If the operation completes successfully, the return value is nonzero. If the operation fails or is pending, the return value is zero.

IOCTL_MFC_GET_PHY_FRAM_BUF_ADDR	
Syntax	See 3.1.2
Description	It obtains the physical address of the FRAM_BUF.

Parameters	fd [IN] : HANDLE returned by open() function cmd [IN] : IOCTL_MFC_GET_PHY_FRAM_BUF_ADDR arg [IN/OUT] : Pointer to MFC_GET_BUF_ADDR_ARG structure.
Returns	If the operation completes successfully, the return value is nonzero. If the operation fails or is pending, the return value is zero.

IOCTL_MFC_GET_CONFIG	
Syntax	See 3.1.2
Description	It get the configurable parameters. The list of configurable parameters is described below.
Parameters	fd [IN] : HANDLE returned by open() function cmd [IN] : IOCTL_MFC_GET_CONFIG arg [IN/OUT] : Pointer to MFC_GET_CONFIG_ARG structure.
Returns	If the operation completes successfully, the return value is nonzero. If the operation fails or is pending, the return value is zero.

IOCTL_MFC_SET_CONFIG	
Syntax	See 3.1.2
Description	It set the configurable parameters with new value. The list of configurable parameters is described below.
Parameters	fd [IN] : HANDLE returned by open() function cmd [IN] : IOCTL_MFC_SET_CONFIG arg [IN/OUT] : Pointer to MFC_SET_CONFIG_ARG structure.
Returns	If the operation completes successfully, the return value is nonzero. If the operation fails or is pending, the return value is zero.

IOCTL_MFC_SET_H263_MULTIPLE_SLICE	
Syntax	See 3.1.2
Description	This command supports multiple slice mode in H.263 encoding case
Parameters	fd [IN] : HANDLE returned by open() function cmd [IN] : IOCTL_MFC_SET_H263_MULTIPLE_SLICE
Returns	None

3.3 Data Structure for Passing the IOCTL Arguments

3.3.1 MFC_ENC_INIT_ARG

MFC_ENC_INIT_ARG

int ret_code	[OUT] Return code
int in_width	[IN] width of YUV420 frame to be encoded
int in_height	[IN] height of YUV420 frame to be encoded
int in_bitrate	[IN] Encoding parameter: Bitrate (kbps)
int in_gopNum	[IN] Encoding parameter: GOP Number (interval of I-frame)
int in_frameRateRes	[IN] Encoding parameter: Frame rate (Res)
int in_frameRateDiv	[IN] Encoding parameter: Frame rate (Divider)

3.3.2 MFC_ENC_EXE_ARG

MFC_ENC_EXE_ARG	
int ret_code	[OUT] Return code
int out_encoded_size	[OUT] Length of Encoded video stream
Int out_header_size	[OUT] Length of Encoded header size

3.3.3 MFC_DEC_INIT_ARG

MFC_DEC_INIT_ARG	
int ret_code	[OUT] Return code
int in_strmSize	[IN] Size of video stream filled in STRM_BUF
int out_width	[OUT] width of YUV420 frame
int out_height	[OUT] height of YUV420 frame

3.3.4 MFC_DEC_EXE_ARG

MFC_DEC_EXE_ARG	
int ret_code	[OUT] Return code
int in_strmSize	[IN] Size of video stream filled in STRM_BUF

3.3.5 MFC_GET_BUF_ADDR_ARG

MFC_GET_BUF_ADDR_ARG	
int ret_code	[OUT] Return code

int in_usr_data	[IN] address returned by mmap() function
int out_buf_addr	[OUT] Buffer address
int out_buf_size	[OUT] Size of buffer address

3.3.6 MFC_GET_CONFIG_ARG

MFC_GET_CONFIG_ARG	
int ret_code	[OUT] Return code
int in_config_param	[IN] Configurable parameter type
int out_config_value[2]	[IN] Values to get for the configurable parameter. Maximum two integer values can be obtained.

3.3.7 MFC_SET_CONFIG_ARG

MFC_SET_CONFIG_ARG	
int ret_code	[OUT] Return code
int in_config_param	[IN] Configurable parameter type
int in_config_value[2]	[IN] Values to be set for the configurable parameter. Maximum two integer values can be set
int out_config_value_old[2]	[OUT] Old values of the configurable parameter.

3.4 Obtainable Parameters for MFC

In this section, the obtainable parameters for MFC are explained. They are 'obtainable parameter types' which are obtained to out_config_param in MFC_GET_CONFIG_ARG that is an argument of IOCTL_MFC_GET_CONFIG command

Obtainable Paramter		Parameter Value	
MFC_GET_CONFIG_DEC_FRAME_NEED_COUNT		out_config_value_old[0]	Count of frame buffers
		out_config_value_old[1]	Not Used

3.5 Configurable Parameters for MFC

In this section, the configurable parameters for MFC are explained. They are 'configurable parameter types' which are assigned to in_config_param in MFC_SET_CONFIG_ARG that is an argument of IOCTL_MFC_SET_CONFIG command

Configurable Paramter		Parameter Value	
MFC_SET_CONFIG_DEC_ROTATE	'Post rotation mode' configurables the MFC to rotate and/or mirror the output YUV image	in_config_value[0]	PostRotMode
		in_config_value[1]	Not Used
		out_config_value_old[0]	Old value of PostRotMode

	during the decoding.	out_config_value_old[1]	Not Used
MFC_SET_CONFIG_DEC_ H264_REORDER (Not implemented)		In_config_value[0]	ReorderEn
		In_config_value[1]	Not used
		Out_config_value_old[0]	Old value of ReorderEn
		Out_config_value_old[1]	Not Used
MFC_SET_CONFIG_ENC_ H263_PARAM	'H.263 Encode Parameters'	In_config_value[0]	H.263 EncParam
		In_config_value[1]	Not Used
		Out_config_value_old[0]	Old value of H.263 EncParam
		Out_config_value_old[1]	Not Used
MFC_SET_CONFIG_ENC_ SLICE_MODE	MFC 'EncSliceMode'	In_config_value[0]	0: Single, 1: Multi
		In_config_value[1]	Number of Slices
		Out_config_value_old[0]	Old value of Single/Multi
		Out_config_value_old[1]	Old value of Number Of Slices
MFC_SET_CONFIG_ENC_ PARAM_CHANGE	'EncParamChange' for Changing encode Parameter during the Encoding	In_config_value[0]	Parameter to be Changed
		In_config_value[1]	New value of the Parameter
		Out_config_value_old[0]	Parameter to be Changed
		Out_config_value_old[1]	Old value of the Parameter
MFC_SET_CONFIG_ENC_ CUR_PIC_OPT		In_config_value[0]	Option Name
		In_config_value[1]	Option Value
		Out_config_value_old[0]	Not used
		Out_config_value_old[1]	Not used

Table - Configurable parameter types for IOCTL_MFC_SET_CONFIG

3.5.1 MFC_SET_CONFIG_DEC_ROTATE

'Post rotation mode' configures the MFC to rotate and/or mirror the output YUV image during the decoding.

in_config_value[0] = {HorMir, VerMir, RotAng[1:0]}
HorMir : Horizontal mirroring
VerMir : Vertical mirroring
RotAng[1:0]
0 : 0 degree counterclockwise rotate
1 : 90 degree counterclockwise rotate
2 : 180 degree counterclockwise rotate
3 : 270 degree counterclockwise rotate

in_config_value[1] = Not Used
out_config_value[0] = Old value of PostRotMode
out_config_value[1] = Not Used

In_config_value[0]	HorMir	VerMir	RotAng
0x0000	X	X	X
0x0010	X	X	X
0x0011	X	X	90° rotate
0x0012	X	X	180° rotate
0x0013	X	X	270° rotate
0x0014	X	O	X
0x0015	X	O	90° rotate

0x0016	X	O	180° rotate
0x0017	X	O	270° rotate
0x0018	O	X	X
0x0019	O	X	90° rotate
0x001A	O	X	180° rotate
0x001B	O	X	270° rotate
0x001C	O	O	X
0x001D	O	O	90° rotate
0x001E	O	O	180° rotate
0x001F	O	O	270° rotate

3.5.2 MFC_SET_CONFIG_ENC_H263_PARAM

‘H.263 Encode Annex’ sets the MFC to produce H.263 stream with the PLUSTYPE features as defined in H.263 standard specification document. The S3C6400 MFC supports four Annexes, Annex T, Annex J, Annex K and Annex I. They are enabled by bitwise-OR operation.

in_config_value[0] = {ANNEX_T_ON/OFF | ANNEX_K_ON/OFF | ANNEX_J_ON/OFF }
ANNEX_T_ON, ANNEX_T_OFF: Modified Quantization mode
ANNEX_K_ON, ANNEX_K_OFF : Slice Structured mode
ANNEX_J_ON, ANNEX_J_OFF : Deblocking Filter mode

in_config_value[1] = Not Used
out_config_value[0] = Old value of H.263 Annex Setting
out_config_value[1] = Not Used

in_config_value[0]	**Annex T**	**Annex K**	**Annex J**
0x0000	X	X	X
0x0001	O	X	X
0x0002	X	O	X
0x0003	O	O	X
0x0004	X	X	O
0x0005	O	X	O
0x0006	X	O	O
0x0007	O	O	O

3.5.3 MFC_SET_CONFIG_ENC_SLICE_MODE

‘EncSliceMode’ determines the encoded output stream format to be single or multiple slices.

in_config_value[0] = {0: single slice, 1: multiple slice}
in_config_value[1] = Number of slices per picture
out_config_value[0] = Old value of Single/Multiple
out_config_value[1] = Old value of NumSlices

in_config_value[0]	**in_config_value[1]**	**Description**
0	ignored	Single slice
1	1 ~ 256	Number of multiple slices

		per picture

3.5.4 MFC_SET_CONFIG_ENC_PARAM_CHANGE

'EncParamChange' changes the encoding parameter during the encoding.
The encoding parameters such as frame rate and bitrate are set at the encoder initialization stage.
Once the encoder is initialized, the parameters can be changed dynamically

in_config_value[0] = Encoding Parameter to be changed
in_config_value[1] = Parameter value to be set
out_config_value[0] = Encoding Parameter to be changed
out_config_value[1] = Old value of parameter

in_config_value[0]	in_config_value[1]	Description
ENC_PARAM_GOP_NUM	0~60	0 – I, P, P, P, … 1 – I, I, I, I, … 2 – I, P, I, P, … 3 – I, P, P, I, P, P, I, …
ENC_PARAM_INTRA_QP	1 ~ 31 (MPEG4/H.263), 0 ~ 51 (H.264)	Intra frame picture quantized step parameter
ENC_PARAM_BITRATE	1 ~ 32767	Target bitrate in kbps
ENC_PARAM_F_RATE	[FrameRateDiv-1] [FrameRateRes]	Bits 31~16 : FrameRateDiv-1 Bits 15~0 : FrameRateRes F_RATE = [FrameRateRes] / [FrameRateDiv-1]
ENC_PARAM_INTRA_REF	0 ~ N	Intra MB refresh number. 0 – Intra MB refresh is not used N – At least N number of MBs are encoded as intra mode at every picture
ENC_PARAM_SLICE_MODE	0 ~ 256	Number of multiple slices per picture 0 – Single slice 1 ~ 256 – Multiple slices

3.5.5 MFC_SET_CONFIG_ENC_CUR_PIC_OPT

in_config_value[0] = Encoding Parameter to be changed
in_config_value[1] = Parameter value to be set
out_config_value[0] = Encoding Parameter to be changed
out_config_value[1] = Old value of parameter

in_config_value[0]	in_config_value[1]	Description
ENC_PIC_OPT_IDR	1	The current source image is encoded as H.264 – IDR picture MPEG4/H263 – I picture
ENC_PIC_OPT_SKIP	1	The current source image is ignored. (Encoding is

		skipped.)
ENC_PIC_OPT_RECOVERY	1	The current and several following images will be encoded as multiple slice for the gradual recovery. The SEI message which is containing the recovery point is generated. **H.264 only.**

4 Annex A (H.264 Decoder Usage)

H.264 Decoding Example

```
#include “test.h”
#include “MfcDrvParams.h”

#define DEVICE_FILENAME                  "/dev/misc/s3c-mfc"
#define BUF_SIZE                         0x459000

int Test_Decoder_Ring_Buffer(int argc, char **argv)
{
        int             dev_fd, in_fd, out_fd;
        char            *addr, *in_addr;
        int             cnt = 1;
        int             file_size;
        int             remain;
        struct stat     s;

        // arguments of ioctl
        MFC_DEC_INIT_ARG                 dec_init;
        MFC_DEC_EXE_ARG                  dec_exe;
        MFC_GET_BUF_ADDR_ARG             get_buf_addr;

        if (argc != 3) {
                printf("Usage : mfc <input file name> <output filename>\n");
                return -1;
        }

      //////////////////////
        // In/Out file open //
      //////////////////////
        in_fd   = open(argv[1], O_RDONLY);
        out_fd  = open(argv[2], O_RDWR | O_CREAT | O_TRUNC, 0644);
        if( (in_fd < 0) || (out_fd < 0) ) {
                printf("input/output file open error\n");
                return -1;
        }

         // get input file size
        fstat(in_fd, &s);
        file_size = s.st_size;

         // mapping input file to memory
        in_addr = (char *)mmap(0, file_size, PROT_READ, MAP_SHARED, in_fd, 0);
        if(in_addr == NULL) {
                printf("input file memory mapping failed\n");
                return -1;
}

         ////////////////////////////
        // MFC device driver open //
      ////////////////////////////
        dev_fd = open(DEVICE_FILENAME, O_RDWR|O_NDELAY);
        if (dev_fd < 0) {
                printf("MFC open error : %d\n", dev_fd);
                return -1;
        }
      ///////////////////////////////////////////////////////
        // mapping shared in/out buffer between App and D/D //
      ///////////////////////////////////////////////////////
        addr = (char *) mmap(0,
                             BUF_SIZE,
                             PROT_READ | PROT_WRITE,
                             MAP_SHARED,
                             dev_fd,
                             0
                             );
        if (addr == NULL) {
                printf("MFC mmap failed\n");
                return -1;
        }

         // Get input buffer address in ring buffer mode //
        // When below ioctl function is called for the first time, It returns double buffer size.
        // So, Input buffer will be filled as 2 part unit size
        get_buf_addr.in_usr_data = (int)addr;
         ioctl(dev_fd, IOCTL_MFC_GET_RING_BUF_ADDR, &get_buf_addr);

        remain = file_size;

        // copy input stream to input buffer
        memcpy((char *)get_buf_addr.out_buf_addr, in_addr, get_buf_addr.out_buf_size);
        remain -= get_buf_addr.out_buf_size;
        printf("remain : %d\n", remain);

      ////////////////////////////////
        // MFC decoder initialization //
      ////////////////////////////////
        dec_init.in_strmSize = get_buf_addr.out_buf_size;
         ioctl(dev_fd, IOCTL_MFC_H264_DEC_INIT, &dec_init);
        printf("out_width : %d, out_height : %d\n", dec_init.out_width, dec_init.out_height);

         while(1)
        {
           /////////////////////////////////////
                // Get input stream buffer address //
           /////////////////////////////////////
                ioctl(dev_fd, IOCTL_MFC_GET_RING_BUF_ADDR, &get_buf_addr);

                if(get_buf_addr.out_buf_size > 0) {
                        if(remain >= get_buf_addr.out_buf_size) {
                                cnt++;
                                memcpy((char *)get_buf_addr.out_buf_addr, in_addr + (cnt *
(get_buf_addr.out_buf_size)), get_buf_addr.out_buf_size);

remain -= get_buf_addr.out_buf_size;
                                dec_exe.in_strmSize = get_buf_addr.out_buf_size;
                        } else {
                                cnt++;
                                memcpy((char *)get_buf_addr.out_buf_addr, in_addr + (cnt *
(get_buf_addr.out_buf_size)), remain);
                                dec_exe.in_strmSize = remain;
                                remain = 0;
                        }
                        printf("remain : %d\n", remain);
                }
```

```
                else {
                        dec_exe.in_strmSize = 0;
                }

           //////////////////
                // MFC decoding //
           //////////////////
                ioctl(dev_fd, IOCTL_MFC_H264_DEC_EXE, &dec_exe);
                if(dec_exe.ret_code < 0) {
                        printf("ret code : %d\n", dec_exe.ret_code);
                        break;
                }

           ///////////////////////////////
                // Get output buffer address //
           ///////////////////////////////
                ioctl(dev_fd, IOCTL_MFC_GET_FRAM_BUF_ADDR, &get_buf_addr);
             write(out_fd, (char *)get_buf_addr.out_buf_addr, get_buf_addr.out_buf_size);
        }

        close(dev_fd);
        close(in_fd);
        close(out_fd);

        return 0;
}
```