ARM® CORTEX®-M4

32-BIT MICROCONTROLLER

NuMicro® Family
N9H26
Non-OS Library Reference Guid

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1. AAC Library

1.1. AAC Library Overview

This library is designed to make user application to use N9H26 AAC IMDCT/MDCT more easily.
The AAC library has the following features:

- AAC IMDCT for decoder.
- AAC MDCT for encoder.

SDK Non-OS provide one library and one sample code to test AAC IMDCT/MDCT function. User could use them to verify hardware IP.

1.2. AAC API

DrvAAC_Open

Synopsis

VOID DrvAAC_Open(VOID)

Description

This function enables the AAC engine clock.

Parameter

None

Return Value

None

Example

```
DrvAAC_Open ();
```

DrvAAC_Close

Synopsis

VOID DrvAAC_Close (VOID)

Description

This function disables the AAC engine clock.

Parameter

None

Return Value

None

Example

```
DrvAAC_Close ();
```

DrvAAC_Decoder

Synopsis

INT32

DrvAAC_Decoder(

INT32   i32Size,

INT32 *pi32inbuf,

INT32 *pi32outbuf

)

Description

Set the parameters for AAC IMDCT of decoder, it will return the size of output buffer and the output buffer for the result of IMDCT.

Parameter

i32Size	2048 or 256
pi32inbuf	The input encoded data.
Pi32outbuf	The output data by running AAC IMDCT of decoder.

Return Value

The size of output buffer. Its bytes is the size x 4.

Example

```
DrvAAC_Open();
```

```
DrvAAC_Decoder(128*2, pi32inptr,pi32resultptr);

DrvAAC_Close();
```

DrvAAC_Encoder

Synopsis

INT32

DrvAAC_Encoder(

INT32 *pi32inbuf,

INT32 *pi32outbuf,

INT32 i32Size

)

Description

Set the parameters for AAC MDCT of encoder, it will return the size of output buffer and the output buffer for the result of IMDCT.

Parameter

pi32inbuf	The input encoded data.
Pi32outbuf	The output data by running AAC MDCT of encoder.
i32Size	2048 or 256

Return Value

The size of output buffer , its bytes is the size x 4.

Example

```
DrvAAC_Open();

DrvAAC_Encoder(pi32inptr,pi32resultptr,256);

DrvAAC_Close();
```

1.3. Example code

This demo code includes sample code and library code. Please refer to AAC sample codes of SDK Non-OS.

2. AES Library Introduction

The AES accelerator is a fully compliant implementation of the AES algorithm. Such accelerator supports both encryption and decryption. The AES accelerator can be used in different data security applications, such as secure communications, which need to provide cryptographic protection.

2.1. Feature

- Supports both encryption and decryption.
- Supports only CBC (Cipher Block Chaining) mode.
- All three kinds of key lengths, 128, 192, and 256 bits, are supported.

2.2. API Data Structure

KEYSIZE

Key size..

Name	Value	Description
KEY_128	0	128-bit key size
KEY_192	1	192-bit key size
KEY_256	2	256-bit key size

2.3. API Function

AES_Initial

Synopsis

VOID AES_Initial(VOID);

Description

Initialize AES engine and install interrupt service routine.

Parameter

None

Return Value

None

AES_Final

Synopsis

VOID AES_Final(VOID);

Description

Tear down AES engine.

Parameter

None

Return Value

None

AES_Encrypt

Synopsis

int AES_Encrypt(UINT8 *input_buf, UINT8 *output_buf, UINT32 input_len, UINT8 *iv, UINT8 *key, KEYSIZE key_size);

Description

Start to encrypt in AES CBC mode and wait for its finish.

Parameter

input_buf	4-byte aligned address of input buffer
output_buf	4-byte aligned address of output buffer. If NULL, output_buf = input_buf
input_len	Length of input buffer in bytes
iv	16-byte initialization vector
key	16-, 24-, or 32-byte key buffer
key_size	key size as defined in KEYSIZE

Return Value

Success

AES_ERR_DATA_LEN	Data length is not 16-byte aligned
AES_ERR_DATA_BUF	Address of input buffer is NULL
AES_ERR_CIPHER_KEY	Key size not defined in KEYSIZE
AES_ERR_IV	NULL initialization vector

AES_Encrypt_Async

Synopsis

int AES_Encrypt_Async(UINT8 *input_buf, UINT8 *output_buf, UINT32 input_len, UINT8 *iv, UINT8 *key, KEYSIZE key_size);

Description

Start to encrypt in AES CBC mode but doesn't wait for its finish.

Parameter

input_buf	4-byte aligned address of input buffer
output_buf	4-byte aligned address of output buffer. If NULL, output_buf = input_buf
input_len	Length of input buffer in bytes
iv	16-byte initialization vector
key	16-, 24-, or 32-byte key buffer
key_size	key size as defined in KEYSIZE

Return Value

Success	
AES_ERR_DATA_LEN	Data length is not 16-byte aligned
AES_ERR_DATA_BUF	Address of input buffer is NULL
AES_ERR_CIPHER_KEY	Key size not defined in KEYSIZE
AES_ERR_IV	NULL initialization vector
AES_ERR_RUNNING	Operation is on-going. Wait by AES_Flush or Poll by AES_Check_Status

AES_Decrypt

Synopsis

int AES_Decrypt(UINT8 *input_buf, UINT8 *output_buf, UINT32 input_len, UINT8 *iv, UINT8 *key, KEYSIZE key_size);

Description

Start to decrypt in AES CBC mode and wait for its finish.

Parameter

input_buf	4-byte aligned address of input buffer
output_buf	4-byte aligned address of output buffer. If NULL, output_buf = input_buf
input_len	Length of input buffer in bytes
iv	16-byte initialization vector
key	16-, 24-, or 32-byte key buffer
key_size	key size as defined in KEYSIZE

Return Value

Success	
AES_ERR_DATA_LEN	Data length is not 16-byte aligned
AES_ERR_DATA_BUF	Address of input buffer is NULL
AES_ERR_CIPHER_KEY	Key size not defined in KEYSIZE
AES_ERR_IV	NULL initialization vector

AES_Decrypt_Async

Synopsis

int AES_Decrypt_Async(UINT8 *input_buf, UINT8 *output_buf, UINT32 input_len, UINT8 *iv, UINT8 *key, KEYSIZE key_size);

Description

Start to decrypt in AES CBC mode but doesn't wait for its finish.

Parameter

input_buf	4-byte aligned address of input buffer
output_buf	4-byte aligned address of output buffer. If NULL, output_buf = input_buf
input_len	Length of input buffer in bytes
iv	16-byte initialization vector
key	16-, 24-, or 32-byte key buffer
key_size	key size as defined in KEYSIZE

Return Value

Success	
AES_ERR_DATA_LEN	Data length is not 16-byte aligned
AES_ERR_DATA_BUF	Address of input buffer is NULL
AES_ERR_CIPHER_KEY	Key size not defined in KEYSIZE

AES_ERR_IV	NULL initialization vector
AES_ERR_RUNNING	Operation is on-going. Wait by AES_Flush or Poll by AES_Check_Status

AES_Flush

Synopsis

int AES_Flush(VOID);

Description

Wait for operation done

Parameter

None

Return Value

Success	Operation done
AES_ERR_BUS_ERROR	Encounter bus error

AES_Check_Status

Synopsis

int AES_Check_Status(VOID);

Description

Check operation status

Parameter

None

Return Value

Success	Operation done
AES_ERR_BUS_ERROR	Encounter bus error
AES_ERR_BUSY	Operation busy

AES_Enable_Interrupt

Synopsis

VOID AES_Enable_Interrupt(VOID);

Description

Enable the only interrupt souce

Parameter

None

Return Value

None

AES_Disable_Interrupt

Synopsis

VOID AES_Disable_Interrupt(VOID);

Description

Disable the only interrupt souce

Parameter

None

Return Value

None

2.4. Error Code Table

Code Name	Value	Description
Successful	0	Success
AES_ERR_FAIL	AES_ERR_ID | 0x01	Internal
AES_ERR_DATA_LEN	AES_ERR_ID | 0x02	Not 16-byte aligned
AES_ERR_DATA_BUF	AES_ERR_ID | 0x03	NULL buffer
AES_ERR_CIPHER_KEY	AES_ERR_ID | 0x04	NULL key or invalid key size
AES_ERR_IV	AES_ERR_ID | 0x05	NULL initialization vector
AES_ERR_MODE	AES_ERR_ID | 0x06	Internal
AES_ERR_BUS_ERROR	AES_ERR_ID | 0x07	Encounter bus error
AES_ERR_RUNNING	AES_ERR_ID | 0x08	Operation is on-going. Need to flush.
AES_ERR_BUSY	AES_ERR_ID | 0x09	Operation is busy.
AES_ERR_CMPDAT	AES_ERR_ID | 0x0A	Internal

3. Audio ADC Library Overview

The N9H26 Audio ADC library provides a set of APIs to record audio data from input device. With these APIs, user can set sampling rate. Pre-gain and post gain control if AGC disable, Output target level if AGC enable and so on.

These libraries are created by using ARM Development Suite 1.2. Therefore, they only can be used in ADS environment.

3.1. Audio ADC Library APIs Specification

DrvAUR_Open

Synopsis

INT32 DrvAUR_Open(E_AUR_MIC_SEL eMIC, BOOL bIsCoworkEDMA)

Description

This function is used to open the Audio ADC library.

Parameter

eIntType	Input device type. Please refer Table 3-1:Input Device
bIsCoworkEDMA	Coporate with EDMA driver to receiver audio data TRUE: Enable corporation with EDMA. FALSE: Disable corporation with EDMA The parameter should be always equal to TRUE.

Table 3-1:Input Device

Field name	Value	Description
eAUR_MONO_LINE_IN	0	Mono Line In
eAUR_MONO_MIC_IN	1	Mono MIC In
eAUR_MONO_DIGITAL_MIC_IN	2	Mono Digital MIC In
eAUR_STEREO_DIGITAL_MIC_IN	3	Stereo Digital MIC In

Return Value

Successful

Example

/* Input device is Mono MIC and corporate with EDMA */

DrvAUR_Open(eAUR_MONO_MIC_IN, TRUE);

DrvAUR_Close

Synopsis

INT32 DrvAUR_Close(void)

Description

Close the Audio ADC library.

Parameter

None

Return Value

Successful

Example

```
/* Close Audio ADC library*/

DrvAUR_Close();
```

DrvAUR_InstallCallback

Synopsis

INT32 DrvAUR_InstallCallback (PFN_AUR_CALLBACK pfnCallback,

PFN_AUR_CALLBACK* pfnOldCallback);

Description

This function is used to install callback function that is used to notice the upper layer for specified auidio sample is done. The function will be useless if corporation with EDMA.

The specified audio sample is set in

Parameter

pfnCallback	The callback function want to register
pfnOldCallback	old callback function

Return Value

-1 or Successful.

Example

DrvAUR_EnableInt

Synopsis

void DrvAUR_EnableInt(void);

Description

This function was used to enable interrupt if converse audio sample done. The function will be useless if corporation with EDMA.

Parameter

None

Return Value

-1 or Successful.

Example

DrvAUR_DisableInt

Synopsis

void DrvAUR_DisableInt(void);

Description

This function was used to disable interrupt if converse audio sample done. The function will be useless if corporation with EDMA.

Parameter

None

Return Value

-1 or Successful.

Example

DrvAUR_EnableInt(); /* Enable interrupt if specified audio length done */

DrvAUR_EnableInt

DrvAUR_AutoGainCtrl

Synopsis

INT32 DrvAUR_ AutoGainCtrl(BOOL bIsEnable, BOOL bIsChangeStep,

E_AUR_AGC_LEVEL eLevel);

Description

This function is used to enable or disable auto gain control-AGC function. And set output target level.

Parameter

bIsEnable	Enable AGC or not.
bIsChangeStep	To trace the output target level, AGC algorithm change gain for each step
eLevel	Output target level. Please refer Table 3-2:Output Target Level

Table 3-2:Output Target Level

Field name	Value	Description
eAUR_OTL_N3	0	-3 db
eAUR_OTL_N4P6	1	-4.6 db
eAUR_OTL_N6P2	2	-6.2 db
eAUR_OTL_N7P8	3	-7.8 db
eAUR_OTL_N9P4	4	-9.4 db
eAUR_OTL_N11	5	-11 db
eAUR_OTL_N12P6	6	-12.6 db
eAUR_OTL_N14P2	7	-14.2 db
eAUR_OTL_N15P8	8	-15.8 db
eAUR_OTL_N17P4	9	-17.4 db
eAUR_OTL_N19	10	-19 db
eAUR_OTL_N20P6	11	-20.6 db
eAUR_OTL_N22P2	12	-22.2 db
eAUR_OTL_N23P8	13	-23.8 db
eAUR_OTL_N25P4	14	-25.4 db
	15	Mute

Return Value

Successful

Example

DrvAUR_AutoClampingGain

Synopsis

INT32 DrvAUR_AutoClampingGain (UINT32 u32MaxGain, UINT32 u32MinGain)

Description

This function was used to clamp the maximum and minimum gain if enable AGC function. It will be useless if disable AGC.

Parameter

u32MaxGain	Maximun gain to clamp AGC. The value is from 0 ~15.
u32MinGain	Minimum gain to clamp AGC. The value is from 0 ~15.

Return Value

Successful

Example

DrvAUR_SetSampleRate

Synopsis

INT32 DrvAUR_SetSampleRate(E_AUR_SPS eSampleRate)

Description

This function is used to set sampling rate.

Parameter

eSampleRate	Sampling rate from 8K to 192K. Please refer Table 3-3: Sampling Rate

Table 3-3: Sampling Rate

Field name	Value	Description
eAUR_SPS_48000	48000	48K sampling rate
eAUR_SPS_44100	44100	44.1K sampling rate
eAUR_SPS_32000	32000	32K sampling rate
eAUR_SPS_24000	24000	24K sampling rate
eAUR_SPS_22050	22050	22K sampling rate
eAUR_SPS_16000	16000	16K sampling rate
eAUR_SPS_12000	12000	12K sampling rate
eAUR_SPS_11025	11025	11.025K sampling rate
eAUR_SPS_8000	8000	8K sampling rate

eAUR_SPS_96000	96000	96K sampling rate
eAUR_SPS_192000	192000	192K sampling rate

Return Value

Successful

Example

DrvAUR_AudioI2cRead

Synopsis

INT32 DrvAUR_AudioI2cRead(UINT32 u32Addr, UINT8* p8Data)

Description

This function is used to read back the internal register of sigma-delt ADC. Programmer can use the API to adjust pre-gain and post-gain if AGC is disable.

Parameter

u32Addr   Register address. Please refer Table 3-4: Sigme-Delta Register Address.

p8Data   Register content after read back.

Table 3-4: Sigme-Delta Register Address

Field name	Value	Description
eAUR_ADC_H20	0x20	Please refer IP programming guide
eAUR_ADC_H21	0x21	Please refer IP programming guide
eAUR_ADC_H22	0x22	Please refer IP programming guide
eAUR_ADC_H23	0x23	Please refer IP programming guide
eAUR_ADC_H24	0x24	Please refer IP programming guide
eAUR_ADC_H25	0x25	Please refer IP programming guide
eAUR_ADC_H26	0x26	Please refer IP programming guide
eAUR_ADC_H29	0x29	Please refer IP programming guide

Return Value

Successful

Example

```
DrvAUR_AudioI2cWrite(0x22, 0x1E);    /* Adjust Pre-gain */

DrvAUR_AudioI2cWrite(0x23, 0x0E);    /* Adjust Post-gain*/
```

DrvAUR_AudioI2cWrite

Synopsis

INT32 DrvAUR_AudioI2cWrite(UINT32 u32Addr, UINT32 u32Data);

Description

This function is used to program the internal register of sigma-delt ADC. Programmer can use the API to adjust pre-gain and post-gain if AGC is disable.

Parameter

u32Addr	Register address. Please refer Table 3-4: Sigme-Delta Register Address.
u32Data	The content want to program sigma-delta

Return Value

Successful

Example

```
DrvAUR_AudioI2cWrite(0x22, 0x1E);        /* Adjust Pre-gain */

DrvAUR_AudioI2cWrite(0x23, 0x0E);        /* Adjust Post-gain*/
```

DrvAUR_SetDigiMicGain

Synopsis

VOID DrvAUR_SetDigiMicGain(BOOL bIsEnable,
E_AUR_DIGI_MIC_GAIN eDigiGain)

Description

This function is used to set digital gain if input device is digital MIC. It is only for input device is Mono Digital MIC In or Stereo Digital MIC In. Please refer Table 3-1:Input Device

Parameter

bIsEnable	Enable digital gain for digital MIC.
eDigiGain	Digital gain. Please refer Table 3-5:Digital Gain

Table 3-5:Digital Gain

Field name	Value	Description
eAUR_DIGI_MIC_GAIN_P0	0	+0db
eAUR_DIGI_MIC_GAIN_P1P6	1	+1.6db
eAUR_DIGI_MIC_GAIN_P3P2	2	+3.2db
eAUR_DIGI_MIC_GAIN_P4P8	3	+4.8db
eAUR_DIGI_MIC_GAIN_P6P4	4	+6.4db

eAUR_DIGI_MIC_GAIN_P8	5	+8db
eAUR_DIGI_MIC_GAIN_P9P6	6	+9.6db
eAUR_DIGI_MIC_GAIN_P11P2	7	+11.2db
eAUR_DIGI_MIC_GAIN_P12P8	8	+12.8db
eAUR_DIGI_MIC_GAIN_P14P4	9	+14.4db
eAUR_DIGI_MIC_GAIN_P16	10	+16db
eAUR_DIGI_MIC_GAIN_P17P6	11	+17.6db
eAUR_DIGI_MIC_GAIN_P19P2	12	+19.2db
eAUR_DIGI_MIC_GAIN_P20P8	13	+20.8db
eAUR_DIGI_MIC_GAIN_P22P4	14	+22.4db
eAUR_DIGI_MIC_GAIN_P24	15	+24db

Return Value

Successful

Example

DrvAUR_SetDigiMicGain(TRUE, eAUR_DIGI_MIC_GAIN_P19P2);

DrvAUR_StartRecord

Synopsis

VOID DrvAUR_StartRecord(E_AUR_MODE eMode);

Description

Start up sigma-delta ADC to converse audio data.

Parameter

eMode Only eAUR_MODE_1 can be set if corporate with EDMA

Please refer Table 3-6:Interface Between Audio ADC and EDMA

Table 3-6:Interface Between Audio ADC and EDMA

Field name	Value	Description
eAUR_MODE_0	0	1 sample
eAUR_MODE_1	1	2 Samples
eAUR_MODE_2	2	4 Samples
eAUR_MODE_3	3	8 Samples

Return Value

Successful

Example

DrvAUR_StartRecord(eAUR_MODE_1);

DrvAUR_StopRecord

Synopsis

VOID DrvAUR_StopRecord(void);

Description

Stop record

Parameter

None

Return Value

Successful

Example

DrvAUR_StopRecord();

DrvAUR_SetDataOrder

Synopsis

VOID DrvAUR_SetDataOrder(E_AUR_ORDER eOrder)

Description

This function is used to set the PCM data order for each audio sample

Parameter

eOrder PCM data format. Please refer Table 3-7: Supportted PCM Data Format

Table 3-7: Supportted PCM Data Format

Field name	Value	Description
eAUR_ORDER_MONO_32BITS	0	Mono little endian 32 bits signed PCM
eAUR_ORDER_MONO_16BITS	1	Mono little endian 16 bits signed PCM
eAUR_ORDER_STEREO_16BITS	2	Stereo little endian 16 bits signed PCM

eAUR_ORDER_MONO_24BITS	3	(Non-standard 24 bits PCM)

Return Value

Successful

Example

```
DrvAUR_Open(eMicType, TRUE);

DrvAUR_SetDataOrder(eAUR_ORDER_MONO_16BITS);

if(eMicType == eAUR_MONO_MIC_IN){

        DrvAUR_AudioI2cWrite(0x22, 0x1E);    /* Adjust Pre-gain */

        DrvAUR_AudioI2cWrite(0x23, 0x0E);    /* Adjust Post-gain*/

        DrvAUR_DisableInt();

        DrvAUR_SetSampleRate(aArraySampleRate[i32Idx]);

        DrvAUR_AutoGainTiming(1,1,1);

        DrvAUR_AutoGainCtrl(TRUE, TRUE, eAUR_OTL_N12P6);

}else if((eMicType == eAUR_MONO_DIGITAL_MIC_IN) ||

        (eMicType == eAUR_STEREO_DIGITAL_MIC_IN)){

        DrvAUR_SetDigiMicGain(TRUE, eAUR_DIGI_MIC_GAIN_P19P2);

        DrvAUR_DisableInt();

        DrvAUR_SetSampleRate(eAUR_DIGI_MIC_GAIN_P19P2);

}
```

4. AVI Library Overview

4.1. Video render

FA9x/VA9x can support JPEG decoder to output decoded packet data in DIRECT_RGB555, DIRECT_RGB565, DIRECT_RGB888 or DIRECT_YUV422 format. User application must initialize VPOST as corresponding format specified in AVI function call aviPlayFile(…). AVI player library will configure JPEG output format as specified format and use DMA to copy the decoded data to VPOST frame buffer in Vsync period to avoid the tearing issue.
In this way, three frame buffers are required. One is allocated in VPOST initialized function and two buffers are allocated in AVI library.

4.2. How to use AVI player library

The AVI player library has managed the file access, JPEG decode and audio decode. User only gives the AVI file name and render method to play the movie. The AVI player required user to prepare the following things before playing an AVI movie:

- Initialize system with cache on
- Initialize file system and storage interface (ex. SD card)
- Initialize timer 0
- Initialize VPOST

The VPOST frame buffer format should be consistent with the AVI playback render mode:

- Direct RGB555 – VPOST should select ***DRVVPOST_FRAME_RGB555***
- Direct RGB565 – VPOST should select ***DRVVPOST_FRAME_RGB565***
- Direct RGB888 – VPOST should select ***DRVVPOST_FRAME_RGBx888 or DRVVPOST_FRAME_RGB888x***
- Direct YUV422 – VPOST should select ***DRVVPOST_FRAME_CBYCRY or DRVVPOST_FRAME_YCBYCR or DRVVPOST_FRAME_CRYCBY or DRVVPOST_FRAME_YCRYCB***

Currently, if the decoded Video size is less then the panel size, it will be located at the center of panel. Moreover, decoded image scales by 1/2 in horizontal and vertical direction if the decoded video width is larger than the panel width.
The AVI playback function does not support (x, y) coordinate that are the second and third argument of ***aviPlayFile()*** used to specify the render location on LCD now.

4.3. AVI player user callback

While playing an AVI move, user application may want to draw information on screen or manage user inputs. AVI library provides a callback function to allow user application to grab pieces of CPU time. The callback function pointer was passed to AVI player as the last argument of ***aviPlayFile()***.
Depends on the loading of playing an AVI movie, the user callback will be called several times in each one second. User application should finish the execution of callback function as soon as possible. Otherwise, the AVI playback can be broken because of not enough CPU time.

4.4. AVI playback information

While playing an AVI move, user application can get AVI file information and playback progress information from AVI player. The AVI information will be passed to user application as a parameter of callback function. All information is packed in the AVI_INFO_T structure.

4.5. API Enumeration

Name	Value	Description
JV_MODE_E		
DIRECT_RGB555	0x0	Direct RGB555 output format
DIRECT_RGB565	0x1	Direct RGB565 output format
DIRECT_RGB888	0x2	Direct RGB888 output format
DIRECT_YUV422	0x3	Direct YUV422 output format
AU_TYPE_E		
AU_CODEC_UNKNOWN	0x0	Unknown audio format
AU_CODEC_PCM	0x1	PCM audio format
AU_CODEC_IMA_ADPCM	0x2	ADPCM audio format
AU_CODEC_MP3	0x3	MP3 audio format

4.6. API Structure

Figure 4-1 AVI_INFO_T structure

Field	Type	Description
uMovieLength	UINT32	The total length of input AVI movie (in 0.01 second unit)
uPlayCurTimePos	UINT32	The current playback position. (in 0.01 second unit)
eAuCodec	AU_TYPE_E	Audio format type
nAuPlayChnNum	INT	Audio channel number. (1: mono, 2: stereo, 0: video-only)
nAuPlaySRate	INT	audio sampling rate
uVideoFrameRate	UINT32	Video frame rate.
usImageWidth	UINT16	Video image width
usImageHeight	UINT16	Video image height
uVidTotalFrames	UINT32	total number of video frames
uVidFramesPlayed	UINT32	Indicate how many video frames have been played
uVidFramesSkipped	UINT32	The number of frames was skipped. Video frames may be skipped due to A/V sync

4.7. Functions

aviStopPlayFile

Synopsis

```
int
aviStopPlayFile(void);
```

Description

Stop current AVI file playback.

Parameter

None

Return Value

Successful: Success

ERRCODE: Error

Example

None.

aviPlayFile

Synopsis

```
int
aviPlayFile(
char *suFileName,
int x,
int y,
JV_MODE_E mode,
AVI_CB *cb
) ;
```

Description

Play an AVI file.

Parameter

suFileName [in]

The full path file name of input AVI file.

x [in]

The left-up corner x-coordinate of AVI video render area. Not used now.

y [in]

The left-up corner y-coordinate of AVI video render area. Not used now.

mode [in]

Video render mode.

cb [in]

User application callback function.

Return Value

Successful: Success

ERRCODE: Error

Example

```
/*------------------------------------------------------------*/
/*  Direct RGB565 AVI playback !!           */
/*------------------------------------------------------------*/
lcdformatex.ucVASrcFormat = DRVVPOST_FRAME_RGB565;
vpostLCMInit(&lcdformatex, (UINT32 *)_VpostFrameBuffer);
fsAsciiToUnicode("c:\\Flip-20fps_640x480.avi", suFileName, TRUE);
aviPlayFile(suFileName, 0, 0, DIRECT_RGB565, avi_play_control);
```

aviGetFileInfo

Synopsis

int
aviGetFileInfo (
char *suFileName,
AVI_INFO_T *ptAviInfo
);

Description

Get the AVI file information.

Parameter

suFileName [in]

The full path file name of input AVI file.

ptAviInfo [in]

Return AVI parsing information.

Return Value

Successful: Success

ERRCODE: Error

Example

```
fsAsciiToUnicode("c:\\Flip-20fps.avi", suFileName, TRUE);
```

```
aviPlayFile(suFileName, &sAVIInfo);
```

aviSetPlayVolume

Synopsis

int

aviSetPlayVolume (

int vol

);

Description

Set the Left channel and Right channel playback audio volume.

Parameter

vol [in]

The audio volume

Return Value

Successful: Success

ERRCODE: Error

Example

```
aviSetPlayVolume(suFileName, 0x1F);
```

aviSetRightChannelVolume

Synopsis

int

aviSetRightChannelVolume (

int vol

);

Description

Set the Right channel audio playback volume only.

Parameter

vol [in]

The audio volume

Return Value

Successful: Success

ERRCODE: Error

Example

```
// Set Right Channel as Mute

aviSetPlayRightChannelVolume(suFileName, 0x0);
```

4.8. Error Code Table

Code Name	Value	Description
MFL_ERR_NO_MEMORY	0xFFFF8000	no memory
MFL_ERR_HARDWARE	0xFFFF8002	hardware general error
MFL_ERR_NO_CALLBACK	0xFFFF8004	must provide callback function
MFL_ERR_AU_UNSUPPORT	0xFFFF8006	not supported audio type
MFL_ERR_VID_UNSUPPORT	0xFFFF8008	not supported video type
MFL_ERR_OP_UNSUPPORT	0xFFFF800C	unsupported operation
MFL_ERR_PREV_UNSUPPORT	0xFFFF800E	preview of this media type was not supported or not enabled
MFL_ERR_FUN_USAGE	0xFFFF8010	incorrect function call parameter
MFL_ERR_RESOURCE_MEM	0xFFFF8012	memory is not enough to play/record a media file
MFL_ERR_FILE_OPEN	0xFFFF8020	cannot open file
MFL_ERR_FILE_TEMP	0xFFFF8022	temporary file access failure
MFL_ERR_STREAM_IO	0xFFFF8024	stream access error
MFL_ERR_STREAM_INIT	0xFFFF8026	stream was not opened
MFL_ERR_STREAM_EOF	0xFFFF8028	encounter EOF of file
MFL_ERR_STREAM_SEEK	0xFFFF802A	stream seek error
MFL_ERR_STREAM_TYPE	0xFFFF802C	incorrect stream type
MFL_ERR_STREAM_METHOD	0xFFFF8030	missing stream method
MFL_ERR_STREAM_MEMOUT	0xFFFF8032	recorded data has been over the application provided memory buffer
MFL_INVALID_BITSTREAM	0xFFFF8034	invalid audio/video bitstream forma
MFL_ERR_AVI_FILE	0xFFFF8080	Invalid AVI file format
MFL_ERR_AVI_VID_CODEC	0xFFFF8081	AVI unsupported video codec type
MFL_ERR_AVI_AU_CODEC	0xFFFF8082	AVI unsupported audio codec type

MFL_ERR_AVI_CANNOT_SEEK	0xFFFF8083	The AVI file is not fast-seekable
MFL_ERR_AVI_SIZE	0xFFFF8080	Exceed estimated size
MFL_ERR_MP3_FORMAT	0xFFFF80D0	incorrect MP3 frame format
MFL_ERR_MP3_DECODE	0xFFFF80D2	MP3 decode error
MFL_ERR_HW_NOT_READY	0xFFFF8100	the picture is the same as the last one
MFL_ERR_SHORT_BUFF	0xFFFF8104	buffer size is not enough
MFL_ERR_VID_DEC_ERR	0xFFFF8106	video decode error
MFL_ERR_VID_DEC_BUSY	0xFFFF8108	video decoder is busy
MFL_ERR_VID_ENC_ERR	0xFFFF810A	video encode error
MFL_ERR_UNKNOWN_MEDIA	0xFFFF81E2	unknow media type

4.9. MP3 Library Overview

Support MP3 sampling rate 8000 Hz, 11025 Hz, 16000 Hz, 22050 Hz, 32000 Hz, 44100 Hz and 48000 Hz.

How to use MP3 player library

Init cache.

Init UART.

Init timer.

Init filesystem.

Init storage device.

Init audio device.

Start play MP3 file.

MP3 player user callback

”ap_time”, the member of structure MV_CFG_T can excute user defined API. Any time information or control can be handled in it.

MP3 player information

Structure MV_INFO_T will give you the time information, inclde current time and total time.

4.10. API Enumeration

Name	Value	Description
MEDIA_TYPE_E		
MFL_MEDIA_MP3	0x5	MP3 audio format
STRM_TYPE_E		
MFL_STREAM_FILE	0x1	MP3 file
PLAY_CTRL_E		
PLAY_CTRL_STOP	0x5	Stop playback

4.11. Structure

Table 4-1 :MV_CFG_T structure

Field	Type	Description
eInMediaType	MEDIA_TYPE_E	PLAY - indicae the type of media to be played
eInStrmType	STRM_TYPE_E	PLAY - indicae the input stream method
szIMFAscii	CHAR *	PLAY - if in stream type is MFL_STREAM_FILE
suInMetaFile	CHAR *	PLAY - if in stream type is MFL_STREAM_FILE
szITFAscii	CHAR *	PLAY - if in stream type is MFL_STREAM_FILE
nAudioPlayVolume	INT	PLAY - volume of playback, 0~31, 31 is max.
uStartPlaytimePos	INT	PLAY - On MP3 playback start, just jump to a specific time offset then start playback. The time position unit is 1/100 seconds.
nAuABRScanFrameCnt	INT	PLAY - on playback, ask MFL scan how many leading frames to evaluate average bit rate. -1 means scan the whole file
ap_time	callback	callback
suInMediaFile	CHAR *	PLAY - if in stream type is MFL_STREAM_FILE

Table 4-2: MV_INFO_T structure

Field	Type	Description
uAuTotalFrames	UINT32	For playback, it's the total number of audio frames. For recording, it's the currently recorded frame number.
uPlayCurTimePos	UINT32	for playback, the play time position, in 1/100 seconds
uMovieLength	UINT32	in 1/100 seconds

4.12. Functions

mflMediaPlayer

Synopsis

INT mflMediaPlayer(MV_CFG_T *ptMvCfg)

Description

Start play MP3 file.

Parameter

ptMvCfg [in]

The MV_CFG_T structure

Return Value

Successful: Success

ERRCODE: Error

Example

mflMediaPlayer(&_tMvCfg)

mflGetMovieInfo

mflGetMovieInfo

Synopsis

INT mflGetMovieInfo(MV_CFG_T *ptMvCfg, MV_INFO_T **ptMvInfo)

Description

Get MP3 time information.

Parameter

ptMvCfg [in]

The MV_CFG_T structure

ptMvInfo [in/out]

The MV_INFO_T structure

Return Value

Successful: Success

ERRCODE: Error

Example

mflGetMovieInfo(ptMvCfg, &ptMvInfo)

mflPlayControl

mflPlayControl

Synopsis

INT mflPlayControl(MV_CFG_T *ptMvCfg, PLAY_CTRL_E ePlayCtrl, INT nParam)

Description

Control operation while playing MP3 file.

Parameter

ptMvCfg [in]

The MV_CFG_T strcture

ePlayCtrl [in]

The PLAY_CRTL_E enumeration

nParam [in]

Reserved

Return Value

Successful: Success

ERRCODE: Error

Example

mflPlayControl(&_tMvCfg, PLAY_CTRL_STOP, 0)

5. BLT Library Introduction

This document is written for user applications which want to make use of BLT through provided API.

5.1. Feature

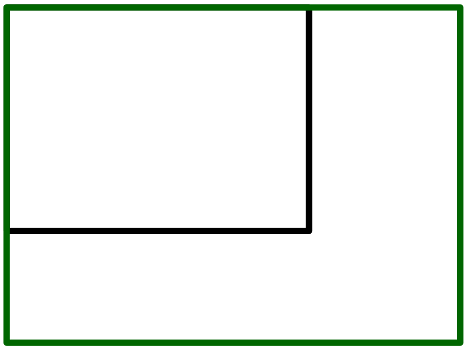
- Fill operation.
  - Fill color with alpha channel
- Blit operation
  - Transformation effects (Scaling, Rotation, Shearing, etc.) through 2x2 inverse transformation matrix.
  - Bitmap smoothing in bi-linear algorithm.
  - Tiling mode (for inversely mapped source pixels lying outside the boundaries of the source image)
    - No drawing
    - Clip to edge (closest edge pixel of the source image)
    - Repeat (source image repeated indefinitely in al directions)
  - Color transformation as defined in Adobe Flash
  - RGB565 color key
- Source format for Blit operation
  - ARGB8888
  - RGB565
  - Palette index with color ARGB8888
    - 1-bit, 2-bit, 4-bit, and 8-bit palette index
    - Endianness of palette index
- Destination format for Fill/Blit operation
  - ARGB8888
  - RGB555
  - RGB565

5.2. Transformation Matrix

In blit operation, transformation effects, such as scaling, rotation, translation, etc. can be achieved through a transformation matrix. These transformations can be combined into one and just one blit operation is needed to finish all the transformations. In the following, common transformations are listed, and user application can combine them to achieve wanted result.

Scaling

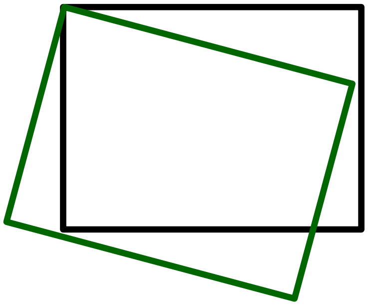
Resize the image by multiplying the location of each pixel by s_x on the x axis and s_y on the y axis.



$$\begin{pmatrix} x_d \\ y_d \\ 1 \end{pmatrix} = \begin{pmatrix} s_x & 0 & 0 \\ 0 & s_y & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x_s \\ y_s \\ 1 \end{pmatrix}$$

Rotation

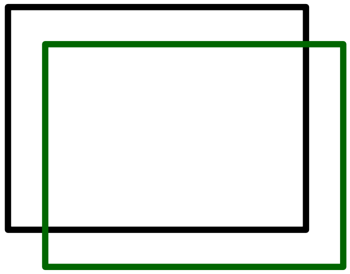
Rotate the image by an angle θ clockwise.



$$\begin{pmatrix} x_d \\ y_d \\ 1 \end{pmatrix} = \begin{pmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & con\theta & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x_s \\ y_s \\ 1 \end{pmatrix}$$

Translation

Translate the image by t_x along the x axis and t_y along the y axis.



$$\begin{pmatrix} x_d \\ y_d \\ 1 \end{pmatrix} = \begin{pmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x_s \\ y_s \\ 1 \end{pmatrix}$$

5.3. Amendment to User Transformation Matrix

On mapping back from destination CS[1] to source CS, a mapping point of destination pixel must be taken into consideration. Mapping point can be top-left (Top-left point as mapping point of destination pixel) or center (Center point as mapping point of destination pixel). In the blit implementation, top-left point is chosen and we may encounter an error due to the choice of mapping point. To help explain the issue, an example is given: blit with rotate 180º.

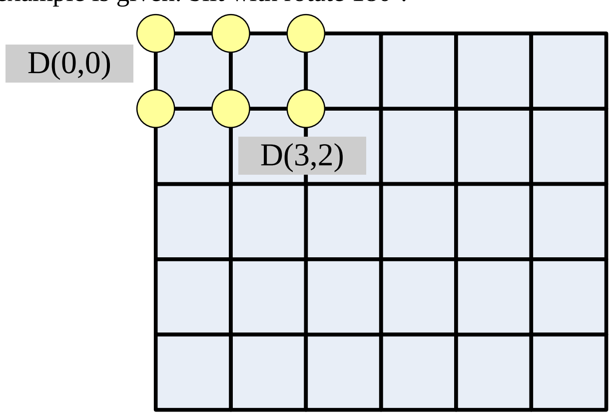


Figure 5-1: Top-left point as mapping point of destination pixel

[1] Coordinate system.

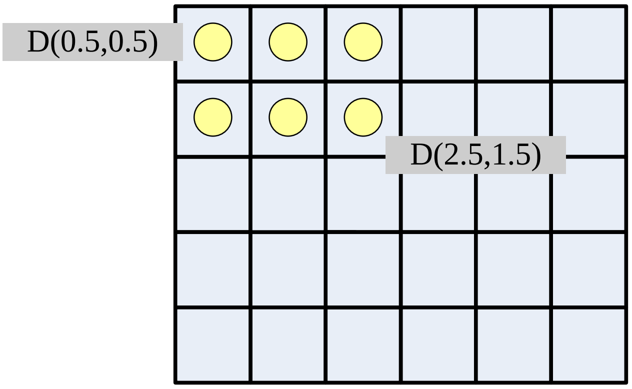


Figure 5-2: Center point as mapping point of destination pixel

1. We want to blit Source image and get Final result, This blit operation involves rotation and translation applied to the source image.

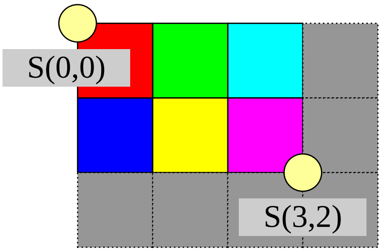


Figure 5-3: Source image

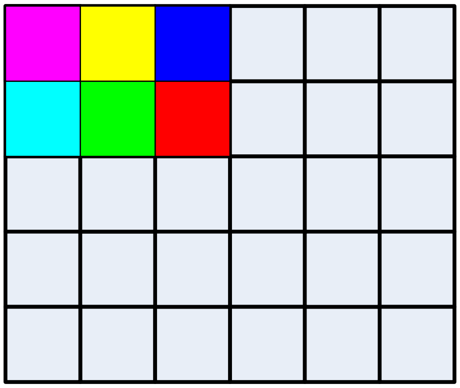


Figure 5-4: Final

2. First, just copy without any transformation effect and get No transform result.

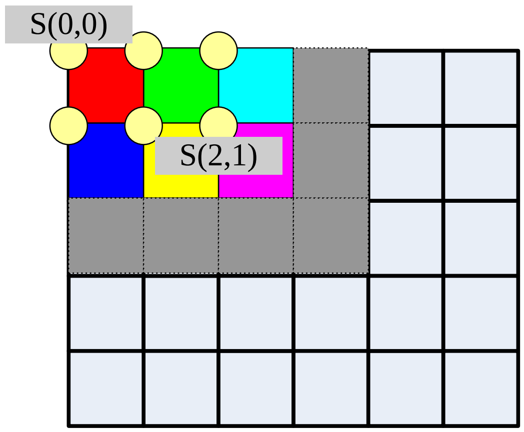


Figure 5-5: No transform

3. Rotate 180º clockwise and get Rotate 180o result.

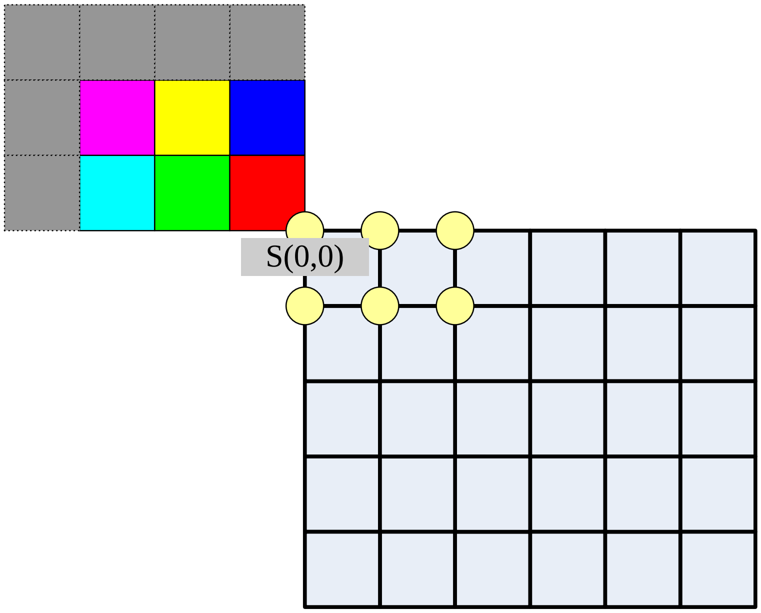


Figure 5-6: Rotate 180º

4. Translate 3 along x-axis and 2 along y-axis and get Rotate 180o + Translate (3, 2) result. But actually, we will get incorrect Rotate 180o + Translate (3, 2) (2) result. It is because in the hardware implementation, the top-left point of a destination pixel is picked as the mapping point. Take D(0, 0) as an example. It will map to S(3, 2) instead of S(2, 1) which is actually what we want.

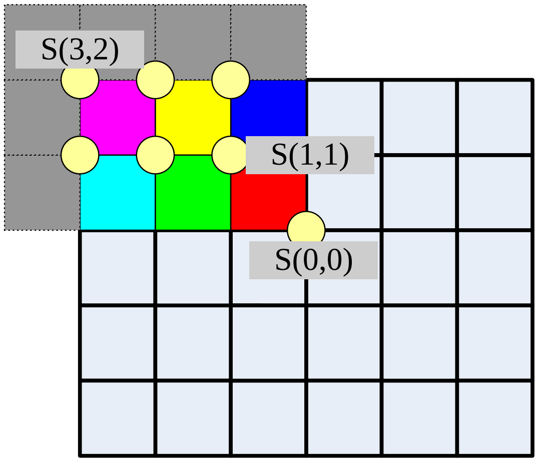


Figure 5-7: Rotate 180º + Translate (3, 2)

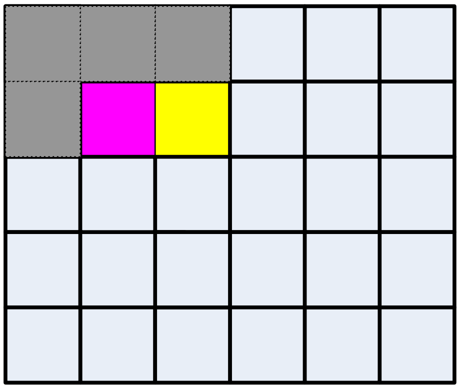


Figure 5-8: Rotate 180º + Translate (3, 2) (2)

5. To fix the issue, translate (-0.5, -0.5) to the end of all above transformations, and get Rotate 180o + Translate (3, 2) + Translate (-0.5, -0.5) result. And we finally get wanted Final result. In this case, D(0, 0) maps to S(2.5, 1.5), and so the source (2, 1) pixel (magenta) is blitted on the destination (0, 0) pixel.

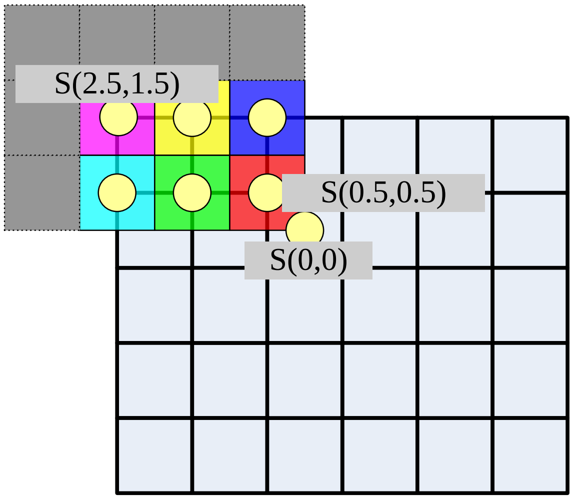


Figure 5-9: Rotate 180o + Translate (3, 2) + Translate (-0.5, -0.5)

5.4. Pixel Mapping

To use blit operation, think of pixel mapping in the inverse direction, that is, from destination CS to source CS. Fields associated with transformation matrix include:

- Elements a, b, c, and d in S_DRVBLT_MATRIX.
- i32XOffset and i32YOffset in S_DRVBLT_SRC_IMAGE.

Equations below give how these fields are associated with transformation matrix.

$$\begin{pmatrix} x_d \\ y_d \\ 1 \end{pmatrix} = \begin{pmatrix} s & t & t_x \\ u & v & t_y \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x_s \\ y_s \\ 1 \end{pmatrix}$$

$$\begin{pmatrix} s & t & t_x \\ u & v & t_y \\ 0 & 0 & 1 \end{pmatrix}^{-1} \begin{pmatrix} x_d \\ y_d \\ 1 \end{pmatrix} = \begin{pmatrix} x_s \\ y_s \\ 1 \end{pmatrix}$$

$$\begin{vmatrix} a & c & i32XOffset \\ b & d & i32YOffset \\ 0 & 0 & 1 \end{vmatrix} = \begin{vmatrix} s & t & t_x \\ u & v & t_y \\ 0 & 0 & 1 \end{vmatrix}^{-1}$$

When a point is mapped from destination CS to source CS, there are several cases to consider. Below gives an example to help explain:

$$\begin{pmatrix} x_d \\ y_d \\ 1 \end{pmatrix} = \begin{pmatrix} 1 & 0 & -1 \\ 0 & 1 & -1 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x_s \\ y_s \\ 1 \end{pmatrix}$$

1. In M0, D(0, 0) (origin pixel of destination CS) is inversely mapped to S(1, 1), which needn't be the origin pixel of the source image. D(0, 0) is filled with Red color.
2. In M1, D(1, 1) is inversely mapped to S(2, 2), which lies inside the source image. D(1, 1) is filled with Green color.
3. In M2, D(4, 2) is inversely mapped to S(5, 3), which lis outside the source image. Dependent on tiling mode specified in E_DRVBLT_FILL_STYLE, there are 3 different rendering results:
   甲、 No drawing: D(4, 2) is not drawn.
   乙、 Clip to edge: D(4, 2) is inversely mapped to S(3, 3). D(4, 2) is filled with Blue color.
   丙、 Repeat: Think of whole source CS as filled with source images and D(4, 2) is inversely mapped to S(5, 3), and then wraps to S(1, 3). D(4, 2) is filled with Yellow color.

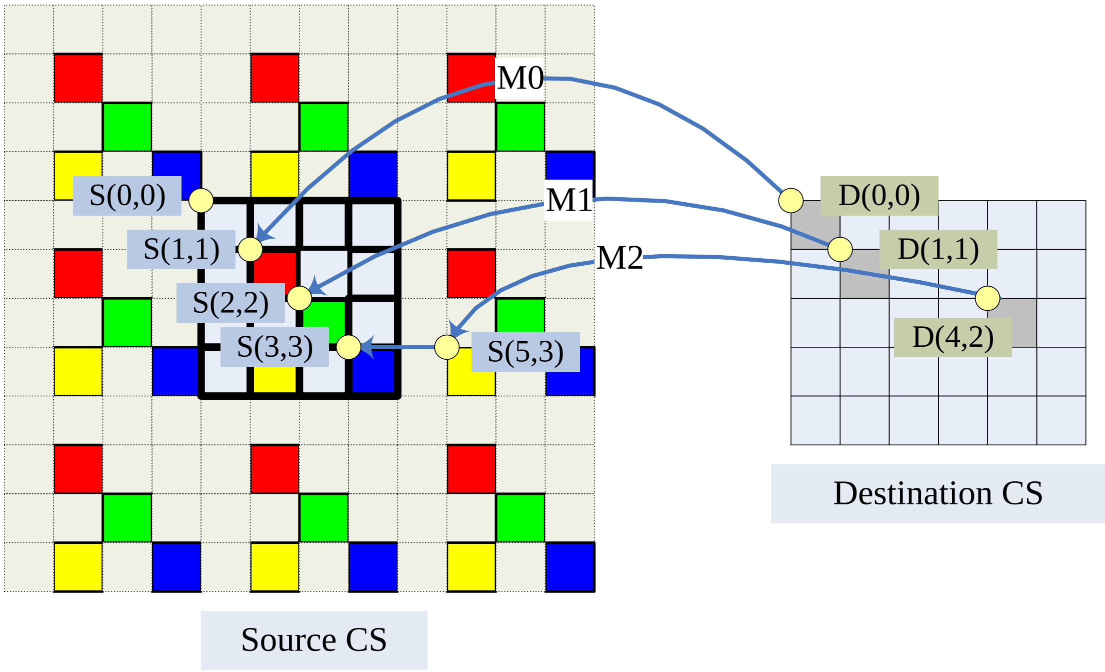


Figure 5-10: Mapping from destination CS to source CS

5.5. Color Transformation

In Blit operation, user application can decide to apply color transformation or not, which is defined by Adobe Flash and has the following formula. Besides, user application can further decide to apply the alpha channel only.

New alpha value = (old alpha value * alphaMultiplier) + alphaOffset
New red value = (old red value * redMultiplier) + redOffset
New green value = (old green value * greenMultiplier) + greenOffset
New blue value = (old blue value * blueMultiplier) + blueOffset

5.6. Palette

To use BLT palette, user must choose index size first. There are 4 index sizes (SFMT) supported:

- 1-bit index
- 2-bit index
- 4-bit index
- 8-bit index

After determination of index size, user then must set up two parts: palette entries and source image in palette index format, both of which will depend on index size.

Palette entries

Palette ranges from BLT_BA+0x400. Its format is ARGB8888, premultiplied-alpha by default and user can change it by setting up the field SET2DA.S_ALPHA.
For n-bit index size where n can only be 1, 2, 4, or 8, user must prepare 2 to the power of n (2, 4, 16, or 256 respectively) palette entries. Take n=2 for example, user must fill in 4 palette entries in the range, BLT_BA+0x400~BLT_BA+0x400+3 words.

Source image in palette index format

To specify source image in palette index format is the same as in other formats: pixel format (SFMT), start address (SADDR), width (SWIDTH), height (SEIGHT), stride (SSTRIDE). Note stride must be word-aligned. If palette index is not 8-bit, index order in one byte image data must be taken into consideration.
For example,
One byte in image data=b7b6b5b4b3b2b1b0
Index size=2-bit
Index order=big-endian (SET2DA.L_ENDIAN=0) ➔
b7b6=1st pixel, b5b4=2nd pixel, b3b2=3rd pixel, b1b0=4th pixel
Index order=little-endian (SET2DA.L_ENDIAN=1) ➔
b7b6=4th pixel, b5b4=3rd pixel, b3b2=2nd pixel, b1b0=1st pixel

5.7. API Data Structure

E_BLT_INT_TYPE

Interrupt type.

Name	Value	Description
BLT_INT_CMPLT	1	Fill/Blit operation completed

E_DRVBLT_FILLOP

Fill or Blit operation.

Name	Value	Description
eDRVBLT_DISABLE	0	Blit operation
eDRVBLT_ENABLE	1	Fill operation

E_DRVBLT_REVEAL_ALPHA

Premultiplied alpha or not for source format of ARGB8888

Name	Value	Description
eDRVBLT_EFFECTIVE	0	Premultiplied alpha
eDRVBLT_NO_EFFECTIVE	1	Non-premultiplied alpha

E_DRVBLT_TRANSFORM_FLAG

Transform flags for Blit operation.

Color transformation formula applied when eDRVBLT_HASCOLORTRANSFORM specified:
New alpha value = (old alpha value * alphaMultiplier) + alphaOffset
New red value = (old red value * redMultiplier) + redOffset
New green value = (old green value * greenMultiplier) + greenOffset
New blue value = (old blue value * blueMultiplier) + blueOffset

Alpha-only color transformation formula applied when both eDRVBLT_HASCOLORTRANSFORM and eDRVBLT_HASALPHAONLY specified:
New alpha value = (old alpha value * alphaMultiplier) + alphaOffset

Name	Value	Description
eDRVBLT_NONTRANSPARENCYE	0	No per-pixel transparency in the source.
eDRVBLT_HASTRANSPARENCY	1	Has per-pixel transparency in the source.
eDRVBLT_HASCOLORTRANSFORM	2	Apply color transformation formula.
eDRVBLT_HASALPHAONLY	4	If color transformation enabled, just apply the alpha-only formula.

E_DRVBLT_BMPIXEL_FORMAT

Source format for Blit operation.

If eDRVBLT_SRC_ARGB8888/palette index, source/palette color can be RGB888 or ARGB8888 dependent on E_DRVBLT_TRANSFORM_FLAG.

Name	Value	Description
eDRVBLT_SRC_ARGB8888	1	RGB888/ARGB8888
eDRVBLT_SRC_RGB565	2	RGB565
eDRVBLT_SRC_1BPP	4	1-bit palette index
eDRVBLT_SRC_2BPP	8	2-bit palette index
eDRVBLT_SRC_4BPP	16	4-bit palete index

eDRVBLT_SRC_8BPP	32	8-bit palette index

E_DRVBLT_DISPLAY_FORMAT

Destination format for Fill/Blit operation.

Name	Value	Description
eDRVBLT_DEST_ARGB8888	1	ARGB8888
eDRVBLT_DEST_RGB565	2	RGB565
eDRVBLT_DEST_RGB555	4	RGB555

E_DRVBLT_FILL_STYLE

Other flags for Blit operation.

eDRVBLT_CLIP_TO_EDGE/eDRVBLT_NONE_FIL specify how to behave when reverse mapping doesn't fall in the range of source bitmap.

Name	Value	Description
eDRVBLT_CLIP_TO_EDGE	1	The bitmap should be clipped to its edges, otherwise a repeating texture.
eDRVBLT_NOTSMOOTH	2	The bitmap should not be smoothed
eDRVBLT_NONE_FILL	4	Neither clip to edge nor repeating texture

E_DRVBLT_PALETTE_ORDER

Palette index in big-endian or little-endian.

Name	Value	Description
eDRVBLT_BIG_ENDIAN	0	Palette index in big endian
eDRVBLT_LITTLE_ENDIAN	1	Palette index in little endian

S_DRVBLT_MATRIX

Transformation matrix used in inverse mapping..

Name	Type	Description
a	INT32	
b	INT32	
c	INT32	

d	INT32	

S_DRVBLT_ARGB16

Multiplier/offset of A, R, G, and B channels used in color transformation.

Name	Type	Description
i16Blue	INT16	Color multiplier/offset of blue channel
i16Green	INT16	Color multiplier/offset of green channel
i16Red	INT16	Color multiplier/offset of red channel
i16Alpha	INT16	Color multiplier/offset of alpha channel

S_DRVBLT_ARGB8

ARGB8888 color

Name	Type	Description
u8Blue	UINT8	Value of blue channel
u8Green	UINT8	Value of green channel
u8Red	UINT8	Value of red channel
u8Alpha	UINT8	Value of alpha channel

S_DRVBLT_SRC_IMAGE

Source image.

Name	Type	Description
u32SrcImageAddr	UINT32	Source image start address
i32Stride	INT32	Source image’s stride in bytes
i32XOffset	INT32	X offset into the source to start rendering from
i32YOffset	INT32	Y offset into the source to start rendering from
i16Width	INT16	Source image’s width in pixels
i16Height	INT16	Source image’s height in pixels

S_DRVBLT_DEST_FB

Destination buffer.

Name	Type	Description
u32FrameBufAddr	UINT32	Destination buffer address to start rendering to
i32XOffset	INT32	No use
i32YOffset	INT32	No use
i32Stride	INT32	Destination buffer’s stride in bytes
i16Width	INT16	Destination buffer’s width in pixels
i16Height	INT16	Destination buffer’s height in pixels

5.8. API Function

bltOpen

Synopsis

ERRCODE bltOpen(void);

Description

Initialize BLT and install interrupt service routine.

Parameter

None

Return Value

E_SUCCESS Success

bltClose

Synopsis

void bltClose(void);

Description

Tear down BLT.

Parameter

None

Return Value

None

bltSetTransformMatrix

Synopsis

void bltSetTransformMatrix(S_DRVBLT_MATRIX sMatrix);

Description

Set up inverse transformation matrix.

Parameter

sMatrix Transformation matrix as defined in S_DRVBLT_MATRIX.

Return Value

None

bltGetTransformMatrix

Synopsis

void bltGetTransformMatrix(S_DRVBLT_MATRIX *psMatrix);

Description

Retrieve inverse transformation matrix which has set up.

Parameter

psMatrix User-prepared buffer to save read-back transformation matrix as defined in S_DRVBLT_MATRIX.

Return Value

None

bltSetSrcFormat

Synopsis

ERRCODE bltSetSrcFormat (E_DRVBLT_BMPIXEL_FORMAT eSrcFmt);

Description

Set up source format.

Parameter

eSrcFmt Source format as defined in E_DRVBLT_BMPIXEL_FORMAT.

Return Value

E_SUCCESS	Success
ERR_BLT_INVALID_SRCFMT	Invalid source format

bltGetSrcFormat

Synopsis

E_DRVBLT_BMPIXEL_FORMAT bltGetSrcFormat(void);

Description

Retrieve source format which has set up.

Parameter

None

Return Value

Source format as defined in E_DRVBLT_BMPIXEL_FORMAT.

bltSetDisplayFormat

Synopsis

ERRCODE bltSetDisplayFormat(E_DRVBLT_DISPLAY_FORMAT eDisplayFmt);

Description

Set up destination format.

Parameter

eDisplayFmt Destination format defined in E_DRVBLT_DISPLAY_FORMAT.

Return Value

E_SUCCESS	Success
ERR_BLT_INVALID_DSTFMT	Invalid destination format

bltGetDisplayFormat

Synopsis

E_DRVBLT_DISPLAY_FORMAT bltGetDisplayFormat(void);

Description

Retrieve destination format which has set up.

Parameter

None

Return Value

Destination format as defined in E_DRVBLT_DISPLAY_FORMAT.

bltEnableInt

Synopsis

void bltEnableInt(E_BLT_INT_TYPE eIntType);

Description

Enable specified interrupt type.

Parameter

eIntType	Interrupt type as defined in E_BLT_INT_TYPE.

Return Value

None

bltDisableInt

Synopsis

void bltDisableInt(E_BLT_INT_TYPE eIntType);

Description

Disable specified interrupt type.

Parameter

eIntType	Interrupt type as defined in E_BLT_INT_TYPE.

Return Value

None

bltIsIntEnabled

Synopsis

BOOL bltIsIntEnabled (E_BLT_INT_TYPE eIntType);

Description

Query if the specified interrupt type is enabled.

Parameter

eIntType	Interrupt type as defined in E_BLT_INT_TYPE.

Return Value

TRUE	Specified interrupt enabled
FALSE	Specified interrupt disabled

bltPollInt

Synopsis

BOOL bltPollInt(E_BLT_INT_TYPE eIntType);

Description

Query interrupt status of the specified interrupt type.

Parameter

eIntType	Interrupt type as defined in E_BLT_INT_TYPE.

Return Value

TRUE	Specified interrupt type active.
FALSE	Specified interrupt type inactive.

bltInstallCallback

Synopsis

void bltInstallCallback (E_BLT_INT_TYPE eIntType, PFN_BLT_CALLBACK pfnCallback, PFN_BLT_CALLBACK* pfnOldCallback);

Description

Install callback function invocated on interrupt generated.

Parameter

eIntType	Interrupt type as defined in E_BLT_INT_TYPE.
pfnCallback	New callback function to install. NULL to uninstall.
pfnOldCallback	User-prepared buffer to save previously installed callback function.

Return Value

None

bltSetColorMultiplier

Synopsis

void bltSetColorMultiplier(S_DRVBLT_ARGB16 sARGB16);

Description

Set up color multipliers of A, R, G, and B channels for color transformation.

Parameter

sARGB16 Color multipliers of A, R, G, and B channels as defined in S_DRVBLT_ARGB16.

Return Value

None

bltGetColorMultiplier

Synopsis

void bltGetColorMultiplier(S_DRVBLT_ARGB16* psARGB16);

Description

Retrieve color multipliers of A, R, G, and B channels which has set up.

Parameter

psARGB16 User-prepared buffer to save color multipliers of A, R, G, and B channels as defined in S_DRVBLT_ARGB16.

Return Value

None

bltSetColorOffset

Synopsis

void bltSetColorOffset(S_DRVBLT_ARGB16 sARGB16);

Description

Set up color offsets of A, R, G, and B channels for color transformation.

Parameter

sARGB16 Color offsets of A, R, G, and B channels as defined in S_DRVBLT_ARGB16.

Return Value

None

bltGetColorOffset

Synopsis

void bltGetColorOffset(S_DRVBLT_ARGB16* psARGB16);

Description

Retrieve color offsets of A, R, G, and B channels which has set up.

Parameter

psARGB16 User-prepared buffer to save color offsets of A, R, G, and B channels as defined in S_DRVBLT_ARGB16.

Return Value

None

bltSetSrcImage

Synopsis

void bltSetSrcImage(S_DRVBLT_SRC_IMAGE sSrcImage);

Description

Set up source image..

Parameter

sSrcImage Source image as defined in S_DRVBLT_SRC_IMAGE.

Return Value

None

bltSetDestFrameBuf

Synopsis

void bltSetDestFrameBuf(S_DRVBLT_DEST_FB sFrameBuf);

Description

Set up destination buffer..

Parameter

sFrameBuf Destination buffer as defined in S_DRVBLT_DEST_FB.

Return Value

None

bltSetARGBFillColor

Synopsis

void bltSetARGBFillColor(S_DRVBLT_ARGB8 sARGB8);

Description

Set up fill color for Fill operatioin, which can be ARGB8888 or RGB888 dependent on bltSetFillAlpha.

Parameter

sARGB8 Fill color as defined in S_DRVBLT_ARGB8.

Return Value

None

Note

If ARGB8888, it must be in non-premultiplied alpha format.

bltGetARGBFillColor

Synopsis

void bltGetARGBFillColor(S_DRVBLT_ARGB8* psARGB8);

Description

Retrieve ARGB8888 color for Fill operation which has set up.

Parameter

psARGB8 User-prepared buffer to save read-back ARGB8888 color for Fill operation.

Return Value

None

bltGetBusyStatus

Synopsis

BOOL bltGetBusyStatus(void);

Description

Query if Fill/Blit operation is busy.

Parameter

None

Return Value

TRUE	Busy
FALSE	Free

bltSetFillAlpha

Synopsis

void bltSetFillAlpha(BOOL bEnable);

Description

Set up whether or not fill color's alpha channel is in effect.

Parameter

bEnable

TRUE	Fill color is ARGB8888
FALSE	Fill color is RGB888

Return Value

None

bltGetFillAlpha

Synopsis

BOOL bltGetFillAlpha(void);

Description

Retrieve whether or not fill color's alpha channel is in effect which has set up.

Parameter

None

Return Value

TRUE	Fill color is ARGB8888.
FALSE	Fill color is RGB888

bltSetTransformFlag

Synopsis

void bltSetTransformFlag(UINT32 u32TransFlag);

Description

Set up transform flag.

Parameter

U32TransFlag Transform flag as defined in E_DRVBLT_TRANSFORM_FLAG.

Return Value

None

bltGetTransformFlag

Synopsis

UINT32 bltGetTransformFlag(void);

Description

Retrieve transform flag which has set up.

Parameter

None.

Return Value

Transform flag as defined in E_DRVBLT_TRANSFORM_FLAG.

bltSetPaletteEndian

Synopsis

void bltSetPaletteEndian(E_DRVBLT_PALETTE_ORDER eEndian);

Description

Set up endianness of palette index..

Parameter

eEndian	Endianness of palette index as defined in E_DRVBLT_PALETTE_ORDER.

Return Value

None

bltGetPaletteEndian

Synopsis

E_DRVBLT_PALETTE_ORDER bltGetPaletteEndian(void);

Description

Retrieve endianness of palette index which has set up.

Parameter

None

Return Value

Endianness of palette index as defined in E_DRVBLT_PALETTE_ORDER.

bltSetColorPalette

Synopsis

void bltSetColorPalette(UINT32 u32PaletteInx, UINT32 u32Num, S_DRVBLT_ARGB8 *psARGB);

Description

Set up palette's colors.

Parameter

u32PaletteInx	Index of palette to start to set up
u32Num	Number of colors to set up
psARGB	ARGB8888 colors

Return Value

None

bltSetFillOP

Synopsis

void bltSetFillOP(E_DRVBLT_FILLOP eOP);

Description

Set up operation to be Fill or Blit.

Parameter

eOP	Operation as defined in E_DRVBLT_FILLOP.

Return Value

None

bltGetFillOP

Synopsis

BOOL bltGetFillOP(void);

Description

Retrieve operation which has set up..

Parameter

None

Return Value

TRUE	Fill operation.
FALSE	Blit operation

bltSetFillStyle

Synopsis

void bltSetFillStyle(E_DRVBLT_FILL_STYLE eStyle);

Description

Set up other flags for Blit operation.

Parameter

eStyle	Other flags as defined in E_DRVBLT_FILL_STYLE.

Return Value

None

bltGetFillStyle

Synopsis

E_DRVBLT_FILL_STYLE bltGetFillStyle(void);

Description

Retrieve other flags for Blit operatioin which has set up.

Parameter

None

Return Value

Other flags as defined in E_DRVBLT_FILL_STYLE.

bltSetRevealAlpha

Synopsis

void bltSetRevealAlpha(E_DRVBLT_REVEAL_ALPHA eAlpha);

Description

Set up premultiplied alpha or not for source format of ARGB8888

Parameter

eAlpha	Premultiplied alpha or not as specified in E_DRVBLT_REVEAL_ALPHA

Return Value

None

bltGetRevealAlpha

Synopsis

BOOL bltGetRevealAlpha(void);

Description

Retrieve premultiplied alpha or not for source format of ARGB8888.

Parameter

None

Return Value

Premultiplied alpha or not as specified in E_DRVBLT_REVEAL_ALPHA

bltTrigger

Synopsis

void bltTrigger(void);

Description

Start Fill/Blit operation..

Parameter

None

Return Value

None

bltSetRGB565TransparentColor

Synopsis

void bltSetRGB565TransparentColor(UINT16 u16RGB565);

Description

Set up transparent color for source format of RGB565 for color key enabled

Parameter

u16RGB565	RGB565 to be transparent color

Return Value

None

bltGetRGB565TransparentColor

Synopsis

UINT16 bltGetRGB565TransparentColor(void);

Description

Retrieve transparent color which has set up..

Parameter

None

Return Value

RGB565 to be transparent color

bltSetRGB565TransparentCtl

Synopsis

void bltSetRGB565TransparentCtl(BOOL bEnable);

Description

Enable color key or not.

Parameter

bEnable

TRUE	Enable color key
FALSE	Disable color key

Return Value

None

bltGetRGB565TransparentCtl

Synopsis

BOOL bltGetRGB565TransparentCtl(void);

Description

Retrieve color key enabled or not.

Parameter

None

Return Value

TRUE	Color key enabled

FALSE	Color key disabled

bltFlush

Synopsis

void bltFlush(void);

Description

Wait for Fill/Blit operation to complete.

Parameter

None

Return Value

None

5.9. Error Code Table

Code Name	Value	Description
Successful	0	Success
ERR_BLT_INVALID_INT	BLT_ERR_ID | 0x01	Invalid interrupte type
ERR_BLT_INVALID_SRCFMT	BLT_ERR_ID | 0x02	Invalid source format
ERR_BLT_INVALID_DSTFMT	BLT_ERR_ID | 0x01	Invalid destination format

6. CRC Library Introduction

The cyclic redundancy check (CRC) generator can perform CRC calculation with programmable polynomial settings. It supports CPU PIO mode directly and can use the VDMA function to get the data.

6.1. Feature

- Supports four common polynomials CRC-CCITT, CRC-8, CRC-16, and CRC-32
  - CRC-CCITT: X16 + X12 + X5 + 1
  - CRC-8: X8 + X2 + X + 1
  - CRC-16: X16 + X15 + X2 + 1
  - CRC-32: X32 + X26 + X23 + X22 + X16 + X12 + X11 + X10 + X8 + X7 + X5 + X4 + X2 + X + 1
- Programmable seed value
- Supports programmable order reverse setting for input data and CRC checksum
- Supports programmable 1’s complement setting for input data and CRC checksum.
- Supports 8/16/32-bit of data width in CPU PIO mode
  - 8-bit write mode: 1-AHB clock cycle operation
  - 16-bit write mode: 2-AHB clock cycle operation
  - 32-bit write mode: 4-AHB clock cycle operation
- Two CRC channels

6.2. API Data Structure

E_CRC_CHANNEL_INDEX

CRC channel index.

Name	Value	Description
E_CHANNEL_0	0	CRC channel 0
E_CHANNEL_1	1	CRC channel 1

E_CRC_OPERATION

CRC channel operation.

Name	Value	Description
E_CH_DISABLE	0	CRC channel disable
E_CH_ENABLE	1	CRC channel enable

E_CRC_MODE

CRC polynomials.

Name	Value	Description
E_CRCCCITT	0	CRC-CCITT polynomial
E_CRC8	1	CRC-8 polynomial
E_CRC16	2	CRC-16 polynomial
E_CRC32	3	CRC-32 polynomial

E_WRITE_LENGTH

CRC data width in CPU PIO mode, VDMA mode only supports 32-bit write mode.

Name	Value	Description
E_LENGTH_BYTE	0	8-bit write mode
E_LENGTH_HALF_WORD	1	16-bit write mode
E_LENGTH_WORD	2	32-bit write mode

E_DATA_1sCOM

1’s complement setting for input data and CRC checksum.

Name	Value	Description
E_1sCOM_OFF	0	1’s complement disable
E_1sCOM_ON	1	1’s complement enable

E_DATA_REVERSE

Order reverse setting for input data and CRC checksum.

Name	Value	Description
E_REVERSE_OFF	0	Order reverse disable
E_REVERSE_ON	1	Order reverse enable

E_TRANSFER_MODE

CRC CPU PIO or VDMA mode.

Name	Value	Description
E_CRC_CPU_PIO	0	CRC CPU PIO mode
E_CRC_VDMA	1	CRC VDMA mode

S_CRC_CHANNEL_INFO

CRC channel information.

Name	Type	Description
bInRequest	BOOL	CRC channel is in request or not
bInUse	BOOL	CRC channel is in use or not

S_CRC_DESCRIPT_SETTING

CRC channel description of a calculation.

Name	Type	Description
ePolyMode	E_CRC_MODE	CRC polynomials
eWriteLength	E_WRITE_LENGTH	Data width of write modes
eChecksumCom	E_DATA_1sCOM	1's Complement setting for checksum
eWdataCom	E_DATA_1sCOM	1's Complement setting for input data
eChecksumRvs	E_DATA_REVERSE	order reverse setting for checksum
eWdataRvs	E_DATA_REVERSE	order reverse setting for input data
eTransferMode	E_TRANSFER_MODE	CRC run in CPU PIO or VDMA mode
uSeed	UINT32	CRC seed value

6.3. API Function

CRC_Init

Synopsis

INT32 CRC_Init(void);

Description

Initialize the software resource of CRC driver, call EDMA_Init to initialize VDMA and enable interrupt.

Parameter

None

Return Value

Successful	Always returns Successful

CRC_Exit

Synopsis

void CRC_Exit(void);

Description

Clear CRC initial flag.

Parameter

None

Return Value

None

CRC_Request

Synopsis

INT32 CRC_Request(INT32 channel);

Description

Specify a channel for request.

Parameter

channel	CRC channel number

Return Value

Successful	Specified channel is requested
CRC_ERR_INVAL	Specified channel number is invalid
CRC_ERR_BUSY	Specified channel is busy

CRC_Free

Synopsis

void CRC_Free(INT32 channel);

Description

Release a previously acquired channel.

Parameter

channel	CRC channel number

Return Value

None

CRC_FindandRequest

Synopsis

INT32 CRC_FindandRequest(void);

Description

Try to find a free channel and request it.

Parameter

None

Return Value

Successful	Allocated channel is returned
CRC_ERR_NODEV	No free channel is found

CRC_Run

Synopsis

UINT32 CRC_Run(INT32 channel, UINT8 *pDataBuf, UINT32 uDataLen, S_CRC_DESCRIPT_SETTING *psCRCDescript);

Description

Start to run a CRC calculation and wait for its finish.

Parameter

channel	CRC channel number
pDataBuf	Input buffer address
uDataLen	Length of input buffer in bytes
psCRCDescript	Pointer to the channel description of this CRC calculation

Return Value

Successful	CRC checksum is returned

CRC_ERR_STATUS	Channel is not in request
CRC_ERR_BUSY	Channel is in use and cannot run a calculation

6.4. Error Code Table

Code Name	Value	Description
Successful	0	Success
CRC_ERR_INVAL	CRC_ERR_ID | 0x01	Channel number is invalid
CRC_ERR_NODEV	CRC_ERR_ID | 0x02	No free channel is found
CRC_ERR_STATUS	CRC_ERR_ID | 0x03	Channel status is wrong
CRC_ERR_BUSY	CRC_ERR_ID | 0x04	Channel is busy

7. EDMA Library Overview

This library is designed to make user application to set N9H26 EDMA more easily.
The EDMA library has the following features:

- Support color space transforms (RGB565, RGB555, RGB888 and YUV422) for VDMA.
- Support transfers data to and from memory or transfer data to and from APB.
- Support hardware Scatter-Gather function.

7.1. Programming Guide

System Overview

The N9H26 contains an enhanced direct memory access (EDMA) controller that transfers data to and from memory or transfer data to and from APB. The EDMA controller has 11-channel DMA that include 3 channel VDMA (Video-DMA, Memory-to-Memory) and 8 channels PDMA (Peripheral-to-Memory or Memory-to-Peripheral). For channel 0/5/8 VDMA mode, it also support color format transform and stripe mode transfer. For PDMA channel (EDMA CH1~CH4, CH9~CH12), it can transfer data between the Peripherals APB IP (ex: UART, SPI, ADC….) and Memory. The N9H26 also support hardware scatter-gather function, software can set CSRx [SG_EN] to enable scatter-gather function.

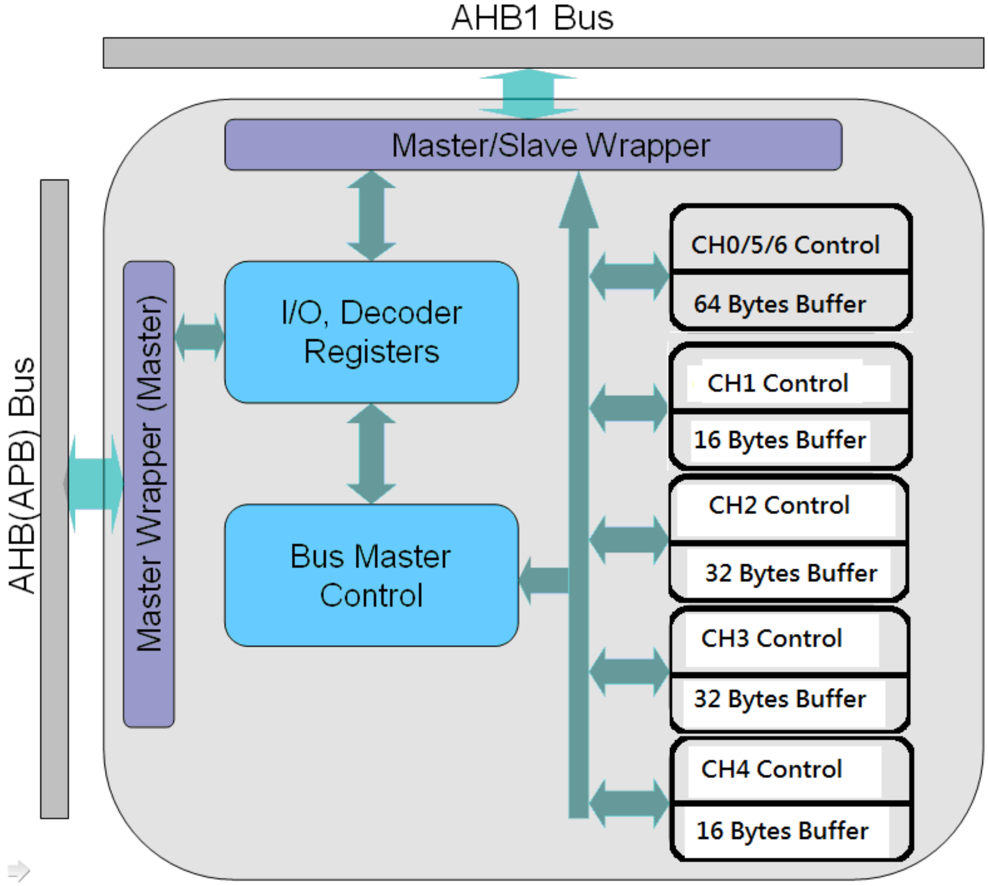
Software can stop the EDMA operation by disable DMA [DMACEN]. The CPU can recognize the completion of an EDMA operation by software polling or when it receives an internal EDMA interrupt. The N9H26 VDMA controller can increment source or destination address, decrement or fixed them as well, and the PDMA can increment source or destination, fixed or wrap around address.

EDMA Features

- AMBA AHB master/slave interface compatible, for data transfer and register read/write.
- Support packaging format color space transforms (RGB565, RGB555, RGB888 and YUV422) for VDMA.
- Support stride mode transfer mode for VDMA.
- VDMA support 32-bit source and destination addressing range, address increment, decrement and fixed.
- PDMA support 32-bit source and destination addressing range address increment, fixed and wrap around.
- Support hardware Scatter-Gather function.

Block Diagram

The following figure describes the architecture of EDMA.



EDMA Control

- **VDMA Transfer**

  The main purpose of VDMA channel is to perform a memory-to-memory transfer. Besides the pure memory copy, it also provides the color format transformation in packet during the transfer.

  Software must enable DMA channel DMA [DMACEN] and then write a valid source address to the DMA_SARx register, a destination address to the DMA_DSABx register, and a transfer count to the DMA_BCRx register. Next, trigger the DMA_CSRx [Trig_EN]. If the source address and destination are not in wrap around mode, the transfer will start transfer until DMA_CBCRx reaches zero (in wrap around mode, when DMA_CBCRx equal zero, the DMA will reload DMA_CBCRx and work around until software disable DMA_CSRx [DMACEN]). If an error occurs during the EDMA operation, the channel stops unless software clears the error condition, sets the DMA_CSRx [SW_RST] to reset the EDMA channel and set EDMA_CSRx [EDMACEN] and [Trig_EN] bits field to start again.

- **PDMA Transfer**

The PDMA is used to transfer data between SDRAM and APB device. Currently, the APB device only supports UART 0/1, SPIMS 0/1 and ADC audio recording. The data direction can be from APB device or to APB device dependent on the setting of PDMA_CSRx[MODE_SEL]. Hardware IP will do the necessary handshaking signal between PDMA and APB device.
In the PDMA transfer, the APB device data port should be set as the source or destination address dependent on the setting of PDMA_CSRx[MODE_SEL], and the address direction must be set as fixed for APB address. Besides this, the APB device has corresponding register setting to enable PDMA transfer.

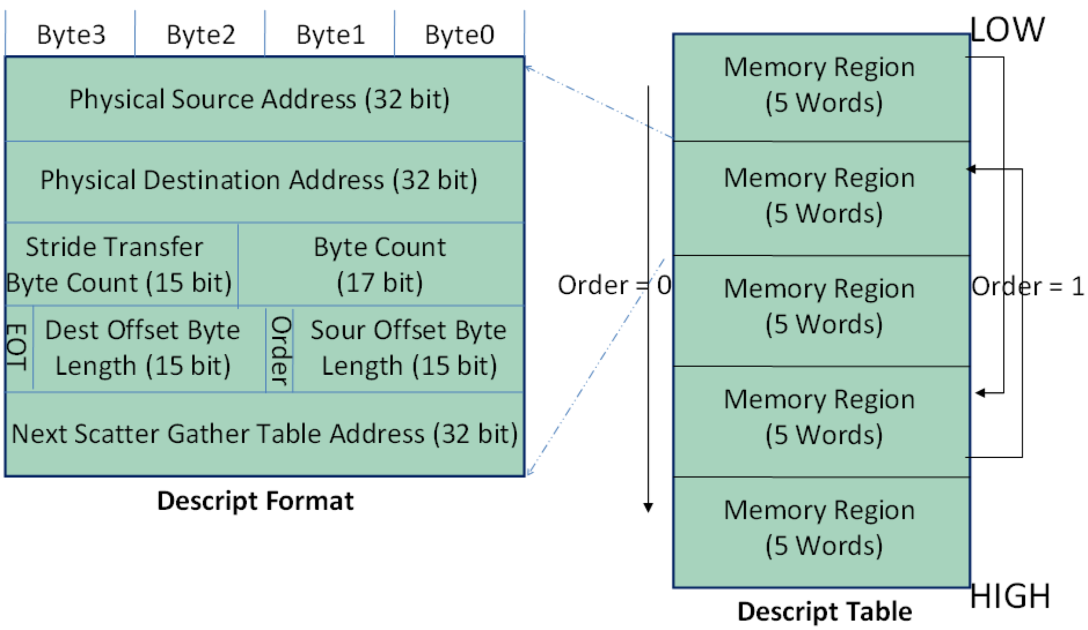
Below table lists the control register and control bit for it.

APB IP	Control Register	Control Bits
Uart 0/1	UA_IER (UA_BA0/1+0x04)	DMA_Tx_En and DMA_Rx_En
SPI0/1	SPI0/1_EDMA	EDMA_RW and EDMA_GO
ADC	AGCP1	EDMA_MODE

Moreover, the EDSSR register in global control is necessary to notice. The PDMA cannot use the same channel selection in it when PDMA is set.

- **Scatter Gather Transfer**

The N9H26 also support hardware scatter-gather function, software can set DMA_CSRx [SG_EN] to enable scatter-gather function. When in scatter-gather function mode, some register will automatically updated by descriptor table. The descriptor table format is show as following:



The field definition of scatter table is as below:

- Physical Source Address (32 bits)
- Physical Destination Address (32 bits)
- Byte Count : Transfer Byte Count (17 bits)
- Stride Transfer Byte Count (15 bits)
- EOT : End of Table (1 bit)
- Source Offset Byte Length (15 bits)

- Oder : Scatter Gather table in Link list mode or not (1 bit)
- Destination Offset Byte length (15 bits)
- Next Scatter Gather Table Address (32 bits)

Note : only when in stride transfer mode (CTCSR[Stride_EN]=1), Stride Transfer Byte count, Source Offset Byte length and Destination Offset Byte Length is meaningful

7.2. APIs Specification Functions

EDMA_Init

Synopsis

int EDMA_Init(void)

Description

This function initializes the software resource.

Parameter

None

Return Value

0 Always successes

Example

```
EDMA_Init ();
```

EDMA_Exit

Synopsis

void EDMA_Exit(void)

Description

Disable EDMA engine clock.

Parameter

None

Return Value

None

Example

```
EDMA_Exit ();
```

VDMA_FindandRequest

Synopsis

int VDMA_FindandRequest(void)

Description

This function tries to find a free channel in the specified priority group.

Parameter

None

Return Value

SUCCESS	Allocation channel is returned.
FAIL	EDMA_ERR_NODEV is returned.

Example

```
int g_VdmaCh;

g_VdmaCh = VDMA_FindandRequest ();
```

PDMA_FindandRequest

Synopsis

int PDMA_FindandRequest(void)

Description

This function tries to find a free channel in the specified priority group.

Parameter

None

Return Value

SUCCESS	Allocation channel is returned.
FAIL	EDMA_ERR_NODEV is returned.

Example

```
int g_PdmaCh;

g_PdmaCh = PDMA_FindandRequest ();
```

EDMA_SetupHandlers

Synopsis

int EDMA_SetupHandlers(int channel, int interrupt, PFN_DRVEDMA_CALLBACK irq_handler, void *data)

Description

This function is used to setup EDMA channel notification handlers.

Parameter

channel	EDMA channel number
interrupt	EDMA interrupt enable
irq_handler	The callback function pointer for specified EDMA channel .
data	User specified value to be passed to the handlers.

Return Value

SUCCESS	0 is returned.
FAIL	EDMA_ERR_NODEV is returned.

Example

```
/* Install Callback function */

EDMA_SetupHandlers(0, eDRVEDMA_BLKD_FLAG, EdmaIrqHandler, 0);
```

EDMA_SetupSingle

Synopsis

int EDMA_SetupSingle(int channel, unsigned int src_addr, unsigned int dest_addr, unsigned int dma_length)

Description

This function is used to setup EDMA channel for linear memory to/from device transfer.

Parameter

channel	EDMA channel number
src_addr	Source address
dest_addr	Destination address
dma_length	Length of the transfer request in bytes

Return Value

SUCCESS	0 is returned.
FAIL	< 0 is returned.
	EDMA_ERR_BUSY : specified channel is busy.
	EDMA_ERR_INVAL : null address or zero length.

Example

```
EDMA_SetupSingle (0, SRC_ADDR, DEST_ADDR, 0x10000);
```

EDMA_Free

Synopsis

void EDMA_Free(int channel)

Description

This function is used to release previously acquired channel.

Parameter

Channel	EDMA channel number

Return Value

None

Example

```
EDMA_Free (0);
```

EDMA_SetupSG

Synopsis

int EDMA_SetupSG(int channel, unsigned int src_addr, unsigned int dest_addr, unsigned int dma_length)

Description

This function is used to setup EDMA channel SG list.

Parameter

channel	EDMA channel number
src_addr	Source address
dest_addr	Destination address
length	Total length of the transfer request in bytes

Return Value

SUCCESS	0 is returned.
FAIL	< 0 is returned. EDMA_ERR_BUSY : specified channel is busy. EDMA_ERR_INVAL : zero length or address is not PAGE_SIZE alignment.

Example

```
EDMA_SetupSG (0, SRC_ADDR, DEST_ADDR, 0x10000);
```

EDMA_FreeSG

Synopsis

void EDMA_FreeSG(int channel)

Description

This function is used to release previously acquired channel SG list.

Parameter

Channel	EDMA channel number

Return Value

None

Example

```
EDMA_FreeSG (0);
```

EDMA_SetupCST

Synopsis

int EDMA_SetupCST(int channel, E_DRVEDMA_COLOR_FORMAT eSrcFormat, E_DRVEDMA_COLOR_FORMAT eDestFormat)

Description

This function is used to setup EDMA channel for color space transform.

Parameter

channel	EDMA channel number
eSrcFormat	The source color format
eDestFormat	The destination color format

Return Value

SUCCESS	0 is returned.
FAIL	EDMA_ERR_BUSY is returned.

Example

```
/* Setup color space transform RGB565 to YCbCr422 */

EDMA_SetupCST(g_VdmaCh, eDRVEDMA_RGB565, eDRVEDMA_YCbCr422);
```

EDMA_ClearCST

Synopsis

int EDMA_ClearCST(int channel)

Description

This function is used to disable EDMA channel color space transform.

Parameter

channel	EDMA channel number

Return Value

SUCCESS	0 is returned.
FAIL	EDMA_ERR_BUSY is returned.

Example

```
/* Disable EDMA color space transform */

EDMA_ClearCST (g_VdmaCh);
```

EDMA_Trigger

Synopsis

void EDMA_Trigger(int channel)

Description

This function is used to start EDMA channel transfer.

Parameter

channel	EDMA channel number

Return Value

None.

Example

```
/* Trigger EDMA channel transfer */

EDMA_Trigger (g_VdmaCh);
```

EDMA_IsBusy

Synopsis

int EDMA_IsBusy(int channel)

Description

This function is used to query EDMA channel is busy or not.

Parameter

channel	EDMA channel number

Return Value

TRUE	EDMA channel is busy.
FALSE	EDMA channel is ready.

Example

```
EDMA_IsBusy (g_VdmaCh);
```

EDMA_SetAPB

Synopsis

int EDMA_SetAPB(int channel, E_DRVEDMA_APB_DEVICE eDevice, E_DRVEDMA_APB_RW eRWAPB, E_DRVEDMA_TRANSFER_WIDTH eTransferWidth)

Description

This function is used to setup EDMA channel for APB device.

Parameter

channel	EDMA channel number
eDevice	Specify the APB device which will use the EDMA channel
eRWAPB	Indicate that read or write APB device
eTransferWidth	Set the transfer width for specified channel

Return Value

SUCCESS	0 is returned.
FAIL	EDMA_ERR_BUSY is returned.

Example

```
/* Setup ADC use EDMA channel*/

EDMA_SetAPB (g_PdmaCh, eDRVEDMA_ADC, eDRVEDMA_READ_APB, eDRVEDMA_WIDTH_32BITS);
```

EDMA_SetWrapINTType

Synopsis

int EDMA_SetWrapINTType(int channel, int type)

Description

Set the EDMA wrap around interrupt select for specified channel.

Parameter

channel	EDMA channel number
type	Set the wrap around mode for specified channel

Return Value

SUCCESS	0 is returned.
FAIL	EDMA_ERR_BUSY is returned.

Example

```
/* Set wrap around mode with half and empty */

EDMA_SetWrapINTType (g_PdmaCh, eDRVEDMA_WRAPAROUND_EMPTY |
eDRVEDMA_WRAPAROUND_HALF);
```

EDMA_SetDirection

Synopsis

int EDMA_SetDirection(int channel, int src_dir, int dest_dir)

Description

This function is used to set transfer direction for specified channel.

Parameter

channel	EDMA channel number
src_dir	The source transfer direction
dest_dir	The destination transfer direction

Return Value

SUCCESS	0 is returned.
FAIL	EDMA_ERR_BUSY is returned.

Example

```
/* Set source transfer direction fixed and destination wraparound*/

EDMA_SetDirection (g_PdmaCh , eDRVEDMA_DIRECTION_FIXED,
eDRVEDMA_DIRECTION_WRAPAROUND);
```

7.3. Error Code Table

Code Name	Value	Description
EDMA_ERR_NODEV	0xFFFF0401	No device error
EDMA_ERR_INVAL	0xFFFF0402	Invalid parameter error
EDMA_ERR_BUSY	0xFFFF0403	Channel busy error

8. EMAC Library Introduction

This document is written for user applications which want to make use of EMAC through provided API.

8.1. Feature

- Supports IEEE Std. 802.3 CSMA/CD protocol.
- Supports both half and full duplex for 10M/100M bps operation.
- Supports RMII interface.
- Supports MII Management function.
- Supports pause and remote pause function for flow control.
- Supports long frame (more than 1518 bytes) and short frame (less than 64 bytes) reception.
- Supports 16 entries CAM function for Ethernet MAC address recognition.
- Supports internal loop back mode for diagnostic.
- Supports 256 bytes embedded transmit and receive FIFO.
- Supports DMA function.

8.2. API Data Structure

S_FrameDescriptor

Tx/Rx buffer descriptor.

Name	Type	Description
Status1	UINT32	RX/TX ownership, RX status, TX controlbits
FrameDataPtr	UINT32	Frame data pointer
Status2	UINT32	TX status, RX NAT info
NextFrameDescriptor	UINT32	Next frame descriptor pointer

S_Etheader

Ethernet header

Name	Type	Description
DestinationAddr[6]	UINT8	Destination MAC address
SourceAddr[6]	UINT8	Source MAC address
LengthOrType[2]	UINT8	Frame size or type

S_MACFrame

MAC frame data structure.

Name	Type	Description
Header	S_Etheader	Ethernet header
LLCData[1522]	UNT8	Payload

S_MACTxStatus: reserve

S_MACRxStatus: reserve

NVT_EMAC_T

Major data structure for EMAC Init.

Name	Type	Description
srcMAcAddr[6]	UINT8	Source MAC address
speedMode	UINT32	100M or 10M bps, Half or Full duplex
recvPacketType	UINT32	Accept packet type, ex: unicast, broadcast.
rxFDBaseAddr	UINT32	RX fame descriptor base address
txFDBaseAddr	UINT32	TX frame descriptor base address
rxFBABaseAddr	UINT32	RX frame buffer address base
txFBABaseAddr	UINT32	TX frame buffer address base
portNo	UINT32	EMAC port0 or port1

8.3. API Function

EMAC_Init

Synopsis

BOOL EMAC_Init(NVT_EMAC_T *emac);

Description

Initialize EMAC and PHY.

Parameter

emac	Init setting structure as defined in NVT_EMAC_T.

Return Value

True	Sucess
False	Failed

EMAC_SetRxCallBack

Synopsis

BOOL EMAC_SetRxCallBack(PVOID pvFun);

Description

Set RX call back function

Parameter

pvFun	callback function pointer

Return Value

True	Sucess
False	Failed

EMAC_SendPacket

Synopsis

BOOL EMAC_SendPacket(UINT8 *data,int size);

Description

Send one packet.

Parameter

data	Paket data pointer
size	Packet size

Return Value

True	Sucess
False	Failed

EMAC_EnableWakeOnLan

Synopsis

void EMAC_EnableWakeOnLan();

Description

To enable EMAC support WOL and set as one wake up source

Parameter

None

Return Value

None

EMAC_Exit

Synopsis

void EMAC_Exit()

Description

Close EMAC and let it down

Parameter

None

Return Value

None

8.4. Error Code Table

Code Name	Value	Description
True	1	Success
False	0	Failure

9. Font Library Overview

The N9H26 Font library provides a set of APIs to write character or draw rectangle border to frame buffer. With these APIs, user can quickly to show some string on N9H26 demo board or evaluation board. The library is a software solution. After update the frame buffer, VPOST controller can show the content to panel or TV.

These libraries are created by using ARM Development Suite 1.2. Therefore, they only can be used in ADS environment.

9.1. Font Library API

InitFont

Synopsis

void InitFont(S_DEMO_FONT* ptFont, UINT32 u32FrameBufAddr);

Description

This function is used to init the font library. To get some information of font library.

Parameter

ptFont	Font library information pointer.
u32FrameBufAddr	Frame buffer base address.

Table 9-1:Font Information

Field name	Data Type	Description
u32FontRectWidth	UINT32	Font width. Now fixed in 16
u32FontRectHeight	UINT32	Font height. Now fixed in 22
u32FontOffset	UINT32	Font Offset. Now fixed in 11
u32FontStep	UINT32	Font Step. Now fixed in 10
u32FontOutputStride	UINT32	Output Stride. It should same as the panel width
u32FontInitDone	UINT32	1 = Font library initialized done. 0 = Font library not yet initialized done or

		deinitialized.
u32FontFileSize	UINT32	Useless.
pu32FontFileTmp	UINT32	Useless
pu32FontFile	UINT32	Pointer of font file
au16FontColor[3]	UINT16	RGB565 color au16FontColor[0]: Font background color au16FontColor[1]: Font color au16FontColor[2]: Border color

Return Value

None

Example

```
/* Initialize font library */

__align(32) static S_DEMO_FONT s_sDemo_Font;

__align(32) UINT16 u16FrameBuffer[_LCM_WIDTH_*_LCM_HEIGHT_];



InitFont(&s_sDemo_Font, u16FrameBufAddr);
```

DemoFont_PaintA

Synopsis

void DemoFont_PaintA(S_DEMO_FONT* ptFont, UINT32 u32x, UINT32 u32y, PCSTR pszString)

Description

This function writes a specified string to frame buffer.

Parameter

ptFont	Font library information pointer. Reference the Table 9-1:Font Information
u32x	start x position.
u32y	start y position.
pszString	The specified string for writing to frame buffer.

Return Value

None

Example

```
/* Draw a string to the position (0, 0) of frame buffer */
__align(32) static S_DEMO_FONT s_sDemo_Font
char szString[64];
sprintf(szString, "FA93 Font Code");
DemoFont_PaintA(&s_sDemo_Font, 0, 0, szString);
```

UnInitFont

Synopsis

void UnInitFont(S_DEMO_FONT* ptFont)

Description

De-Initialize the font library.

Parameter

ptFont Font library information pointer. Reference the Table 9-1:Font Information

Return Value

None

Example

```
/* De-Initialize the font library */
__align(32) static S_DEMO_FONT s_sDemo_Font
UninitFont(&s_sDemo_Font);
```

DemoFont_Rect

Synopsis

void DemoFont_Rect(SDEMO_FONT* ptFont, S_DEMO_RECT* ptRect)

Description

This function draws a solid rectangle to frame buffer.

Parameter

ptFont Font library information pointer. Reference the Table 9-1:Font Information

ptRect Solid retangle pointer

Table 9-2:Rectangle Information

Field name	Data Type	Description

u32StartX	UINT32	X position for the upper-left corner
u32StartY	UINT32	Y position for the upper-left corner
u32EndX	UINT32	X position for the lower-right corner
u32EndY	UINT32	Y position for the lower-right corner

Return Value

None

Example

```
/* Draw a solid rectangle with dimension 320x240*/

__align(32) static S_DEMO_FONT s_sDemo_Font;

static S_DEMO_RECT s_sDemo_Rect;

s_sDemo_Rect.u32StartX = 0;

s_sDemo_Rect.u32StartY = 0;

s_sDemo_Rect.u32EndX = 320-1;

s_sDemo_Rect.u32EndY =240-1;

DemoFont_Rect(&ptFont,

              &s_sDemo_Rect);
```

DemoFont_RectClear

Synopsis

void DemoFont_RectClear(SDEMO_FONT* ptFont, S_DEMO_RECT* ptRect)

Description

This function clears a solid rectangle to background color in frame buffer. The background color was fixed as 0. It means the color is black for RGB565 format.

Parameter

ptFont	Font library information pointer. Reference the Table 9-1:Font Information
ptRect	Solid retangle pointer. Reference the Table 9-2:Rectangle Information

Return Value

None

Example

```
/* Clear a solid rectangle from position (0, 0) to (319, 240) */

__align(32) static S_DEMO_FONT s_sDemo_Font;

static S_DEMO_RECT s_sDemo_Rect;

s_sDemo_Rect.u32StartX = 0;

s_sDemo_Rect.u32StartY = 0;

s_sDemo_Rect.u32EndX = 320-1;

s_sDemo_Rect.u32EndY =240-1;

DemoFont_RectClear(&ptFont,

              &s_sDemo_Rect);
```

Font_ClrFrameBuffer

Synopsis

void Font_ClrFrameBuffer(UINT32 u32FrameBufAddr)

Description

This function clears the specified frame buffer to fixed background color (black color). The dimension is specified in the header file- _LCM_WIDTH_ and _LCM_HEIGHT_ with 16-bit pixel format.

Parameter

u32FrameBufAddr	Frame buffer base address.

Return Value

None

Example

```
__align(32) UINT16 u16FrameBuffer[_LCM_WIDTH_*_LCM_HEIGHT_];



/* Clear frame buffer to background color-black*/

Font_ClrFrameBuffer(u16FrameBuffer);
```

DemoFont_Border

Synopsis

void DemoFont_Border(S_DEMO_FONT* ptFont, S_DEMO_RECT* ptRect, UINT32 u32Width);

Description

This function draw a hollow rectangle with the specified border width.

Parameter

ptFont	Font library information pointer. Reference the Table 9-1:Font Information
ptRect	Solid retangle pointer. Reference the Table 9-2:Rectangle Information.
u32Width	Border width.

Return Value

None

Example

```
__align(32) static S_DEMO_FONT s_sDemo_Font;



              S_DEMO_RECT s_sDemo_Rect;

__align(32) UINT16 u16FrameBuffer[_LCM_WIDTH_*_LCM_HEIGHT_];



InitFont(&s_sDemo_Font, u16FrameBuffer);

              s_sDemo_Rect.u32StartX =0;

s_sDemo_Rect.u32StartY = 0;

s_sDemo_Rect.u32EndX = _LCM_WIDTH_-1;

s_sDemo_Rect.u32EndY = _LCM_HEIGHT_-1;

/* Draw a hollow rectangle with dimension same as panel and border is 2 pixels width
*/

DemoFont_Border(&s_sDemoFont,

                     &s_sDemo_Rect,

                     2);
```

DemoFont_ChangeFontColor

Synopsis

void DemoFont_ChangeFontColor(S_DEMO_FONT* ptFont, UINT16 u16RGB565);

Description

This function sets the font color. The format is RGB565.

Parameter

ptFont	Font library information pointer. Reference the Table 9-1:Font Information
u16RGB565	RGB565n format

Return Value

None

Example

__align(32) static S_DEMO_FONT s_sDemo_Font;

/* Set the blue font color */

DemoFont_ChangeFontColor(&s_sDemo_Font, 0x001F);

DemoFont_GetFontColor

Synopsis

UINT16 DemoFont_GetFontColor(S_DEMO_FONT* ptFont);

Description

This function gets current font color. The return value format is RGB565.

Parameter

ptFont	Font library information pointer. Reference the Table 9-1:Font Information

Return Value

RGB565 format

Example

```
__align(32) static S_DEMO_FONT s_sDemo_Font;

UINT16 u16FontColor;

/* Get font color */

u16FontColor = DemoFont_GetFontColor(&s_sDemo_Font);
```

10. GNAND Libray Overview

N9H20/N9H26 Non-OS library consists of a sets of libraries. These libraries are built to access those on-chip functions such as VPOST, APU, SIC, USBH, USBD, GPIO, I2C, SPI and UART, as well as File System (NVTFAT), TCP/IP protocol (lwip), USB MassStorage devices (UMAS) and NAND Flash devices (GNAND). This document describes the provided APIs of GNAND library. With these APIs, user can quickly build a binary target for GNAND library on N9H26 micro processor.

These libraries are created by using ARM Development Suite 1.2. Therefore, they only can be used in ADS environment.

10.1. GNAND Library Introduction

In GNAND library, a NAND was though of as a disk. User can access NAND by logical block address and don’t worry about the bad block issue. It’s possible that a few leading physical blocks were reserved for boot code or information area. GNAND library will not access those reserved blocks.

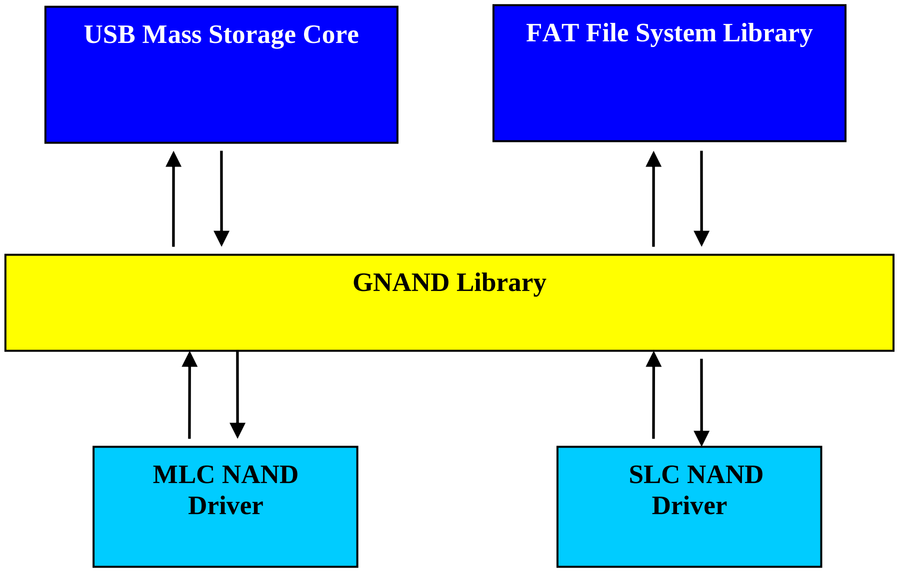
The Generic NAND (GNAND) library has the following features:

- Mapping between logical block and physical block to support bad block management
- Platform independent.
- Support both FAT file system and USB mass storage device
- Support both SLC and MLC NAND
- Able to recover from any power-off exceptions
- High performance, fast startup
- Support multiple NAND disk
- Support two disks in one NAND (reserved NAND partition)
- Dirty page management to support garbage collection feature
- Balanced usage on all physical blocks to support wear-leveling feature (will supported in the future)

10.2. Programming Guide

System Overview

GNAND library works as a hardware independent library. NAND disk access service was provided by NAND driver. File system access service was provided by upper layer FAT file system library or USB mass storage device driver. The relationship between these component libraries was shown in the following picture:



Initialize GNAND Library

To initialize GNAND library, just invoke **GNAND_InitNAND()**. Application must give corresponding NAND driver as input argument to **GNAND_InitNAND()**, then GNAND library can access NAND disk through NAND driver service.

GNAND library will validate the NAND disk is GNAND format or not. If it is not GNAND format, application can determine to program it as GNAND format or not. It depends on the third argument of **GNAND_InitNAND()**.

GNAND work with Nuvoton FAT Library

If **GNAND_InitNAND()** returns GNAND_OK, application can invoke **GNAND_MountNandDisk()** to mount NAND disk to NVTFAT file system.

NAND driver function set

To work as an underlying driver of GNAND, the NAND driver must provide the following function set and pass it to GNAND library with **GNAND_InitNAND()**.

```
#define NDRV_T struct ndrv_t

struct ndrv_t

{

       INT  (*init)(NDISK_T *NDInfo);

       INT  (*pread)(INT nPBlockAddr, INT nPageNo, UINT8 *buff);
```

```
        INT  (*pwrite)(INT nPBlockAddr, INT nPageNo, UINT8 *buff);

        INT  (*is_page_dirty)(INT nPBlockAddr, INT nPageNo);

        INT  (*is_valid_block)(INT nPBlockAddr);

        INT  (*ioctl)(INT param1, INT param2, INT param3, INT param4);

        INT  (*block_erase)(INT nPBlockAddr);

        INT  (*chip_erase)(VOID);

        VOID *next;

};
```

In **init(NDISK_T *info)** function, NAND driver should detect NAND disk and fill NAND disk information into <**NDISK_T *NDInfo**>, which was passed as an argument. If success, return 0.

NDISKT_T members

Member Name	Return by init()	Comments
vendor_ID	Optional	
device_ID	Optional	
NAND_type	Must	NAND_TYPE_SLC or NAND_TYPE_MLC
nZone	Must	Number of zones
nBlockPerZone	Must	Maximum number of physical blocks per zone
nPagePerBlock	Must	Number of pages per block
nLBPerZone	Must	Maximum number of allowed logical blocks per zone
nPageSize	Must	Page size in bytes
nStartBlock	Must	Reserved number of leading blocks
nBadBlockCount	Optional	Bad block count for all zones
driver	Must	NAND driver function set pointer
nNandNo	Optional	
pDisk	Optional	
reserved[60]	Ignore	
need2L2PN	Optional	Need second P2LN block or not
p2ln_block1	Optional	Physical block address for second P2LN block
p2lm	Ignore	GNAND internal used
l2pm	Ignore	GNAND internal used
dp_tbl	Ignore	GNAND internal used
db_idx[16]	Ignore	GNAND internal used
p2ln_block	Ignore	GNAND internal used

op_block	Ignore	GNAND internal used
op_offset	Ignore	GNAND internal used
last_op[32]	Ignore	GNAND internal used
err_sts	Ignore	GNAND internal used
next	Ignore	GNAND internal used

In **pread(INT nPBlockAddr, INT nPageNo, UINT8 *buff)** function, NAND driver execute a page read operation from physical block <**nPBlockAddr**> page <**nPageNo**>. And <**buff**> was guaranteed to be non-cacheable memory.

In **pwrite(INT nPBlockAddr, INT nPageNo, UINT8 *buff)** function, NAND driver execute a page programming operation to physical block <**nPBlockAddr**> page <**nPageNo**>. And <**buff**> was guaranteed to be non-cacheable memory.

In **is_page_dirty(INT nPBlockAddr, INT nPageNo)** function, NAND driver check the redundant area of physical block <**nPBlockAddr**> page <**nPageNo**>. If this page had ever been written, NAND driver should return 1, otherwise, return 0.

In **is_valid_block(INT nPBlockAddr)** function, NAND driver check if physical block <**nPBlockAddr**> is a valid block or not. If the block is a valid block, NAND driver should return 1, otherwise, return 0.

At current version, **ioctl()** was not used by GNAND library. NAND driver can give it a NULL value.

In **block_erase(INT nPBlockAddr)** function, NAND driver execute a block erase operation on physical block <**nPBlockAddr**>.

In **chip_erase()** function, NAND driver execute a chip erase operation on the NAND disk. Note that the whole GNAND information will lost after chip_erase(). You have to call GNAND_InitNAND() to rebuild GNAND format.

10.3. API Function

GNAND_InitNAND

Synopsis

INT GNAND_InitNAND (NDRV_T *ndriver, NDISK_T *ptNDisk, BOOL bEraseIfNotGnandFormat)

Description

Initialize a NAND disk.

Parameter

ndriver	NAND driver function set to hook NAND driver on GNAND library.
ptNDisk	NAND disk information that GNAND initiated. You need this pointer to call other GNAND APIs.
bEraseIfNotGnandFormat	
	If NAND disk was GNAND format, ignore this argument.
	If NAND disk was not GNAND format, format it if this argument is 1, otherwise, return an GNERR_GNAND_FORMAT error.

Return Value

0	– Success
Otherwise	– error code defined in Error Code Table

Example

```
NDRV_T _nandDiskDriver0 =

{

nandInit0,

nandpread0,

nandpwrite0,

nand_is_page_dirty0,

nand_is_valid_block0,

nand_ioctl,

nand_block_erase0,

nand_chip_erase0,
```

```
0
};
NDISK_T *ptNDisk;
int status;

fsInitFileSystem();

/* Initialize FMI */
sicIoctl(SIC_SET_CLOCK, 240000, 0, 0);
sicOpen();

ptNDisk = (NDISK_T *)malloc(sizeof(NDISK_T));
if (ptNDisk == NULL)
{
printf("malloc error!!\n");
return -1;
}

status = GNAND_InitNAND(&_nandDiskDriver0, ptNDisk, TRUE);
if (status < 0)
{
    printf("NAND disk init failed, status = %x\n", status);
    return status;
}

status = GNAND_MountNandDisk(ptNDisk);
if (status < 0)
{
```

```
    printf("Mount NAND disk failed, status = %x\n", status);

    return status;

}
```

GNAND_MountNandDisk

Synopsis

INT GNAND_MountNandDisk (NDISK_T *ptNDisk)

Description

Mount NAND disk to NVTFAT file system.

Parameter

ptNDisk	The pointer refer to the NAND disk information that initiated by GNAND_InitNAND().

Return Value

0	– Success
Otherwise	– error code defined in Error Code Table

Example

```
Refer to the example code of GNAND_InitNAND();
```

GNAND_read

Synopsis

INT GNAND_read (NDISK_T *ptNDisk, UINT32 nSectorNo, INT nSectorCnt, UINT8 *buff)

Description

Read logical sectors from NAND disk.

Parameter

ptNDisk	The pointer refer to the NAND disk information that initiated by GNAND_InitNAND().
nSectorNo	Read start sector number.
nSectorCnt	Number of sectors to be read.
buff	Memory buffer to receive data, which is 32 bytes aligned non-cacheable buffer.

Return Value

0	– Success

Otherwise – error code defined in Error Code Table

Example

```
INT io_read(PDISK_T *pDisk, UINT32 sector_no, INT number_of_sector, UINT8 *buff)

{

NDISK_T  *ptNDisk = (NDISK_T *)pDisk->pvPrivate;

return GNAND_read(ptNDisk, sector_no, number_of_sector, buff);

}
```

GNAND_write

Synopsis

INT GNAND_write (NDISK_T *ptNDisk, UINT32 nSectorNo, INT nSectorCnt, UINT8 *buff)

Description

Write logical sectors to NAND disk

Parameter

ptNDisk	The pointer refer to the NAND disk information that initiated by GNAND_InitNAND().
nSectorNo	Write start sector number.
nSectorCnt	Number of sectors to be written.
buff	Memory buffer to write data, which is 32 bytes aligned non-cacheable buffer

Return Value

0 – Success

Otherwise – error code defined in Error Code Table

Example

```
INT io_write(PDISK_T *pDisk, UINT32 sector_no, INT number_of_sector, UINT8 *buff)

{

NDISK_T  *ptNDisk = (NDISK_T *)pDisk->pvPrivate;

return GNAND_write(ptNDisk, sector_no, number_of_sector, buff);

}
```

GNAND_block_erase

Synopsis

INT GNAND_block_erase (NDISK_T *ptNDisk, INT pba)

Description

Erase a physical bock.

Parameter

ptNDisk	The pointer refer to the NAND disk information that initiated by GNAND_InitNAND().
pba	NAND physical block address.

Return Value

0	– Success
Otherwise	– error code defined in Error Code Table

Example

```
NDISK_T *ptNDisk;

int status;



/* erase physical block pba */

status = GNAND_block_erase(ptNDisk, pba);

if (status != 0)

{

/* handle error status */

}
```

GNAND_chip_erase

Synopsis

INT GNAND_chip_erase (NDISK_T *ptNDisk)

Description

This function erase all blocks in NAND chip. All data in chip will lost that include information for GNAND library.

Parameter

ptNDisk The pointer refer to the NAND disk information that initiated by GNAND_InitNAND().

Return Value

0 – Success

Otherwise – error code defined in Error Code Table

Example

```
NDISK_T *ptNDisk;

int status;

/* erase whole NAND chip */

status = GNAND_chip_erase(ptNDisk, pba);

if (status != 0)

{

/* handle error status */

}
```

GNAND_UnMountNandDisk

Synopsis

VOID GNAND_UnMountNandDisk (NDISK_T *ptNDisk)

Description

Unmount NAND disk from NVTFAT file system.

Parameter

ptNDisk The pointer refer to the NAND disk information that initiated by GNAND_InitNAND().

Return Value

0 – Success

Otherwise – error code defined in Error Code Table

Example

```
NDISK_T *ptNDisk;

int status;

status = GNAND_UnMountNandDisk(ptNDisk);
```

```
if (status != 0)

{

    /* handle error status */

}
```

10.4. Example code

The demo code test the GNAND library please refer to the SIC sample code of SDK Non-OS.

10.5. Error Code Table

CODE NAME	Value	Description
GNAND_OK	0	Success
GNERR_GENERAL	0xFFFFC001	General access error
GNERR_MEMORY_OUT	0xFFFFC005	No available memory
GNERR_GNAND_FORMAT	0xFFFFC010	NAND disk was not GNAND format
GNERR_FAT_FORMAT	0xFFFFC015	NAND disk was unformatted as FAT
GNERR_BLOCK_OUT	0xFFFFC020	There’s no available physical blocks
GNERR_P2LN_SYNC	0xFFFFC025	Internal error for P2LN table sync problem
GNERR_READONLY_NAND	0xFFFFC026	Cannot write data into readonly NAND disk
GNERR_IO_ERR	0xFFFFC030	NAND read/write/erase access failed
GNERR_NAND_NOT_FOUND	0xFFFFC040	NAND driver cannot find NAND disk.
GNERR_UNKNOW_ID	0xFFFFC042	Not supported NAND disk type

11. GPIO Library Overview

The GPIO library provides a set of APIs to control on-chip GPIO pins. This library depends on N9H26 System Library.

11.1. API Functions

gpio_open

Synopsis

int gpio_open (unsigned char port)

Description

It has replaced gpio_open (unsigned char port) with gpio_configure (unsigned char port, unsigned short num).

gpio_configure

Synopsis

int gpio_configure (unsigned char port, unsigned short num)

Description

This function configures the specified pin of a port as GPIO.

Parameter

port GPIO_PORTA, GPIO_PORTB, GPIO_PORTC, GPIO_PORTD, GPIO_PORTE, GPIO_PORTG, and GPIO_PORTH

num pin number

Return Value

Return 0 on success. -1 for unknown port number

Example

```
/* Configure the pin0 of portD as GPIO*/

gpio_configure (GPIO_PORTD, 0);
```

gpio_readport

Synopsis

int gpio_readport (unsigned char port, unsigned short *val)

Description

This function reads back all pin value of a GPIO port, ignore the direction of each pin.

Parameter

port GPIO_PORTA, GPIO_PORTB, GPIO_PORTC, GPIO_PORTD, GPIO_PORTE, GPIO_PORTG, and GPIO_PORTH

*val Return port value

Return Value

Return 0 one success, -1 for unknown port number

Example

```
/* Read PORTC value*/

unsigned short val;

gpio_readport(GPIO_PORTC, &val);
```

gpio_setportdir

Synopsis

int gpio_setportdir (unsigned char port, unsigned short mask, unsigned short dir)

Description

This function sets the pin direction of GPIO port. It could select the pin(s) to be configured with its second parameter.

Parameter

port GPIO_PORTA, GPIO_PORTB, GPIO_PORTC, GPIO_PORTD, GPIO_PORTE, GPIO_PORTG, and GPIO_PORTH

mask pin mask, each bit stands for one pin

dir Direction, each bit configures one pin, 0 means input, 1 means output

Return Value

Return 0 one success, -1 for unknown port number

Example

```
/* Set PORTC pin1 to output mode, and pin0 to input mode */
```

```
gpio_setportdir (GPIO_PORTC, 0x3, 0x2);
```

gpio_setportval

Synopsis

int gpio_setportval (unsigned char port, unsigned short mask, unsigned short val)

Description

This function sets the output value of GPIO port. It could select the pin(s) to be configured with its second parameter.

Parameter

port GPIO_PORTA, GPIO_PORTB, GPIO_PORTC, GPIO_PORTD, GPIO_PORTE, GPIO_PORTG, and GPIO_PORTH

mask pin mask, each bit stands for one pin

val Output value, each bit configures one pin, 0 means low, 1 means high

Return Value

Return 0 one success, -1 for unknown port number

Example

```
/* Set PORTC pin1 to output high, and pin0 to low */

gpio_setportval (GPIO_PORTC, 0x3, 0x2);
```

gpio_setportpull

Synopsis

int gpio_setportpull (unsigned char port, unsigned short mask, unsigned short pull)

Description

This function sets the pull up/down resistor of GPIO port. It could select the pin(s) to be configured with its second parameter.

Parameter

port GPIO_PORTA, GPIO_PORTB, GPIO_PORTC, GPIO_PORTD, GPIO_PORTE, GPIO_PORTG, and GPIO_PORTH

mask pin mask, each bit stands for one pin

pull Pull up/down resister state, each bit configures one pin, 0 means disable, 1 means enable

Return Value

Return 0 one success, -1 for unknown port number

Example

```
/* Enable PORTC pin1 pull up resistor, and disable pin0 pull up resistor */

gpio_setportpull (GPIO_PORTC, 0x3, 0x2);
```

gpio_setdebounce

Synopsis

int gpio_setdebounce (unsigned char clk, unsigned char src)

Description

This function is used to configure external interrupt de-bounce time.

Parameter

clk Debounce sampling clock, could be 1, 2, 4, 8, 16, 32, 64, 128, 256, 2*256, 4*256, 8*256, 16*256, 32*256, 64*256 and 128*256

src Debounce sampling interrupt source. Valid values are between 0~15. Each bit represents one interrupt source

Return Value

Return 0 on success, -1 on parameter error

Example

```
/* Set nIRQ0 debounce sampling clock to 128 clocks*/

gpio_setdebounce (128, 1);
```

gpio_getdebounce

Synopsis

void gpio_getdebounce (unsigned char *clk, unsigned char *src)

Description

This function gets current external interrupt de-bounce time setting.

Parameter

*clk Debounce sampling clock

*src Debounce sampling interrupt source

Return Value

None

Example

```
unsigned char clk;

unsigned char src;

gpio_getdebounce (&clk, &src);
```

gpio_setsrcgrp

Synopsis

int gpio_setsrcgrp (unsigned char port, unsigned short mask, unsigned char irq)

Description

This function is used to set external interrupt source group.

Parameter

port GPIO_PORTA, GPIO_PORTB, GPIO_PORTC, GPIO_PORTD, GPIO_PORTE, GPIO_PORTG, and GPIO_PORTH

mask pin mask, each bit stands for one pin

irq external irq number. Could be 0~3

Return Value

Return 0 on success, -1 on parameter error

Example

```
/* Set GPIO port C pin1 as source of nIRQ3 */

gpio_setsrcgrp (GPIO_PORTC, 1, 3);
```

gpio_getsrcgrp

Synopsis

int gpio_getsrcgrp (unsigned char port, unsigned int *val)

Description

This function is used to get current external interrupt source setting.

Parameter

port GPIO_PORTA, GPIO_PORTB, GPIO_PORTC, GPIO_PORTD, GPIO_PORTE, GPIO_PORTG, and GPIO_PORTH

*val Current source setting. Every two bits stands for the interrupt source each pin triggers

Return Value

Return 0 on success, and -1 for unknown port number

Example

```
/* Read GPIO port C interrupt group status */

unsigned int val;

gpio_setsrcgrp (GPIO_PORTC, &val);
```

gpio_setintmode

Synopsis

int gpio_setintmode (unsigned char port, unsigned short mask, unsigned short falling, unsigned short rising)

Description

This function sets the interrupt trigger mode of GPIO port. It could select the pin(s) to be configured with its second parameter.

Parameter

port GPIO_PORTA, GPIO_PORTB, GPIO_PORTC, GPIO_PORTD, GPIO_PORTE, GPIO_PORTG, and GPIO_PORTH

mask Pin mask, each bit stands for one pin

falling Triggers on falling edge, each bit stands for one pin

rising Triggers on rising edge, each bit stands for one pin

Return Value

Return 0 on success, -1 for parameter error

Example

```
/* Set PORT C pin 1 triggers on both falling and rising edge */

gpio_setintmode (GPIO_PORTC, 1, 1, 1);
```

gpio_getintmode

Synopsis

int gpio_getintmode (unsigned char port, unsigned short *falling, unsigned short *rising)

Description

This function is used to get interrupt trigger mode of GPIO port.

Parameter

port GPIO_PORTA, GPIO_PORTB, GPIO_PORTC, GPIO_PORTD, GPIO_PORTE, GPIO_PORTG, and GPIO_PORTH *falling Triggers on falling edge, each bit stands for one pin

*rising Triggers on rising edge, each bit stands for one pin

Return Value

Return 0 on success, -1 for parameter error

Example

```
/* Get PORT C trigger mode */

unsigned short falling;

unsigned short rising;

gpio_getintmode (GPIO_PORTC, &falling, &rising);
```

gpio_setlatchtrigger

Synopsis

int gpio_setlatchtrigger (unsigned char src)

Description

This function used to set latch trigger source.

Parameter

src Latch trigger source. Each bit stands for one external interrupt source. If the value is 1, GPIO port input value will be latched while interrupt triggers

Return Value

Return 0 on success, -1 for parameter error

Example

```
/* Enable latch for nIRQ0 and nIRQ3*/

gpio_setlatchtrigger (9);
```

gpio_getlatchtrigger

Synopsis

void gpio_getlatchtrigger (unsigned char *src)

Description

This function used to get latch trigger source.

Parameter

*src Latch trigger source

Return Value

None

Example

```
/* Get latch trigger source*/

unsigned char src;

gpio_getlatchtrigger (&src);
```

gpio_getlatchval

Synopsis

int gpio_getlatchval (unsigned char port, unsigned short *val)

Description

This function is used to get interrupt latch value.

Parameter

port GPIO_PORTA, GPIO_PORTB, GPIO_PORTC, GPIO_PORTD, GPIO_PORTE, GPIO_PORTG, and GPIO_PORTH

*val Variable to store latch value

Return Value

Return 0 on success, -1 for parameter error

Example

```
/* Get port C latch value */

unsigned short val;

gpio_getlatchval (GPIO_PORTC, &val);
```

gpio_gettriggersrc

Synopsis

int gpio_gettriggersrc (unsigned char port, unsigned short *src)

Description

This function is used to get interrupt trigger source.

Parameter

port GPIO_PORTA, GPIO_PORTB, GPIO_PORTC, GPIO_PORTD, GPIO_PORTE, GPIO_PORTG, and GPIO_PORTH

*src Variable to store trigger source

Return Value

Return 0 on success, -1 for parameter error

Example

```
/* Get port C interrupt trigger source */

unsigned short src;

gpio_gettriggersrc (GPIO_PORTC, &src);
```

gpio_cleartriggersrc

Synopsis

int gpio_cleartriggersrc(unsigned char port)

Description

This function is used to clear interrupt trigger source.

Parameter

port GPIO_PORTA, GPIO_PORTB, GPIO_PORTC, GPIO_PORTD, GPIO_PORTE, GPIO_PORTG, and GPIO_PORTH

Return Value

Return 0 on success, -1 for parameter error

Example

```
/* Clear port C interrupt trigger source */

gpio_cleartriggersrc (GPIO_PORTC);
```

12. H264 Codec Library Introduction

This document is written for user applications which want to use H264 Encoder or Decoder library API.

12.1. Feature

Encoder Features

- Follows MPEG-4 AVC/JVT/H.264 (ISO/IEC 14496-10) video coding standards
- Supports baseline profile to level 3.1
- Supports resolutions from 128x80 to 1280x720 in a step of 16 units
- Supports I and P frame encodings
- CBR and VBR rate controls by firmware
- Supports programmable in-loop filter parameters
- Supports programmable chroma QP index offset parameter

Decoder Features.

- Compliant with ITU-T Recommendation H.264|ISO/IEC 14496-10 Advanced Video Coding Standard (MPEG 4 Part 10)
- Supports baseline profile with a level from 1 to 3
- Supports resolutions of up to 720 x 480 at 60 fps
- Supports motion estimation with variable block sizes
- Supports quarter-pixel motion compensation
- Supports Context-based Adaptive Variable-Length Decoding (CAVLD)
- Supports I and P slices
- Supports in-loop de-blocking filter function (disable_deblocking_filter_idc! = 1) to execute filtering function, including slice boundary
- Not supports Arbitrary Slice Order (ASO) or Flexible Macroblock Ordering (FMO)

12.2. Rate Control for Encoder

The encoded bitstream rate control is implemented in application level. At the beginning, the application needs to call H264RateControlInit(…) function to initialize the variable in H264RateControl structure. After that, H264RateControlUpdate(…) function is used to calculate the next Quant value for next encode frame which is stored in the rtn_quant field of H264RateControl structure.
Speicify this rtn_quant in u32Quant filed of FAVC_ENC_PARAM structure for next encode frame. Then, the rate control will be completed in such kind of loop.

12.3. API Data Structure

IOCTL COMMAND

Ioctl command set for H264_ioctl function

Name	Value	Description
FAVC_IOCTL_DECODE_INIT	**0x4170**	Init H264 decoder
FAVC_IOCTL_DECODE_FRAME	**0x4172**	Decode one H264 frame
FAVC_IOCTL_ENCODE_INIT	**0x4173**	Init H264 Encode
FAVC_IOCTL_ENCODE_FRAME	**0x4175**	Encode one H264 frame
FAVC_IOCTL_GET_SPSPPS	**0x4179**	Get the encoded SPS PPS bitstream

FAVC_DEC_RESULT

H264 bitstream decoding result.

Name	Type	Description
bEndOfDec	UINT32	Used by library only
u32Width	UINT32	Decoded bitstream width
u32Height	UINT32	Decoded bitstream height
u32UsedBytes	UINT32	Reported used bitstream byte in buffer
u32FrameNum	UINT32	Decoded frame number
isDisplayOut	UINT32	0 -> Buffer in reorder buffer, 1 -> available buffer, -1 -> last flush frame
isISlice	UINT32	1-> I Slice, 0 -> P slice
Reserved0	UINT32	reserved

FAVC_DEC_PARAM

H264 bitstream decoding paramter.

Name	Type	Description
u32API_version	UINT32	API version
u32MaxWidth	UINT32	Not used now
u32MaxHeight	UINT32	Decoded bitstream height
u32FrameBufferWidth	UINT32	if (u32FrameBufferWidth != -1), decoded image width is cropped with u32FrameBufferWidth if (u32FrameBufferWidth == -1),

		decoded image width is continued on memory
u32FrameBufferHeight	UINT32	if (u32FrameBufferHeight != -1), decoded image height is cropped with u32FrameBufferHeight if (u32FrameBufferHeight == -1), decoded image height is continued on memory
u32Pkt_size	UINT32	Current decoding bitstream length (the exact bitstream length for one frame)
pu8Pkt_buf	UINT8*	Current decoding bitstream buffer address (application ready bitstream here)
pu8Display_addr[3]	UINT32	Buffer address for decoded data
got_picture	UINT32	0 -> Decoding has someting error. 1 -> decoding is OK in current bitstream
pu8BitStream_phy	UINT8*	physical address. buffer for bitstream (allocated and used by library only)
u32OutputFmt	UINT32	Decoded output format, 0-> Planar YUV420 format, 1-> Packet YUV422 foramt
crop_x	UINT32	pixel unit: crop x start point at decoded-frame (not supported now)
crop_y	UINT32	pixel unit: crop y start point at decoded-frame (not supported now)
tResult	FAVC_DEC_RESULT	Return decoding result by library

FAVC_ENC_PARAM

H264 encoding paramter.

Name	Type	Description
u32API_version	UINT32	API version
u32BitRate	UINT32	The encoded bitrate in bps.
u32FrameWidth	UINT32	The width of encoded frame in pels.
u32FrameHeight	UINT32	The height of encoded frame in pels
fFrameRate	UINT32	The base frame rate per second
u32IPInterval	UINT32	The frame interval between I-frames.
u32MaxQuant	UINT32	The maximum quantization value. (max = 51)
u32MinQuant	UINT32	The minimum quantization value. (min=0)

u32Quant	UINT32	The frame quantization value for initialization
ssp_output	INT32	This variable tells the H.264 must be encoded out sps + pps before slice data. - -> 1 : force the encoder to output sps+pps -> 0 : force the encoder to output sps+pps on any Slice I frame -> -1: (default) only output SPS+PPS on first IDR frame.
intra	INT32	This variable tells the H.264 must be encoded out an I-Slice type frame. -> 1 : forces the encoder to create a keyframe. -> 0 : forces the encoder not to create a keyframe. -> -1: (default) let the encoder decide (based on contents and u32IPInterval)
bROIEnable	INT32	To enable the function of encoding rectangular region of interest(ROI) within captured frame
u32ROIX	UINT32	The upper-left corner x coordinate of rectangular region of interest
u32ROIY	UINT32	The upper-left corner coordinate y of region of interest
u32ROIWidth	UINT32	The width of user-defined rectangular region of interest
u32ROIHeight	UINT32	The height of user-defined rectangular region of interest
pu8YFrameBaseAddr	UINT8*	The base address for input Y frame buffer
pu8UVFrameBaseAddr	UINT8*	The base address for input UV frame buffer in H.264 2D mode
pu8UFrameBaseAddr	UINT8*	The base address for input U frame buffer
pu8VFrameBaseAddr	UINT8*	The base address for input V frame buffer
bitstream	UINT8*	Bitstream Buffer address for driver to write bitstream
pu8BitstreamAddr	UINT8*	The bitstream buffer address while encoding one single frame allocated by librar
bitstream_size	UINT32	Bitstream length for current frame
keyframe	UINT32	This parameter is indicated the Slice type of frame
frame_cost	UINT32	frame_cout is updated by driver
no_frames	UINT32	The number of frames to be encoded
threshold_disable	UINT32	The transform coefficients threshold
chroma_threshold	UINT32	The chroma coefficients threshold (0 ~ 7)
luma_threshold	UINT32	The luma coefficients threshold (0 ~ 7)

beta_offset	UINT32	The beta offset for in-loop filter.
alpha_offset	UINT32	The alpha offset for in-loop filter.
chroma_qp_offset	UINT32	The chroma qp offset (-12 to 12 inclusively)
disable_ilf	UINT32	To disable in-loop filter or not
watermark_enable	UINT32	To enable watermark function or not (Don't enable it now)
watermark_interval	UINT32	To specify the watermark interval if watermark function is enabled
watermark_init_pattern	UINT32	To specify the initial watermark pattern if watermark function is enabled
pu8ReConstructFrame	UINT8*	The address of reconstruct frame buffer.
pu8ReferenceFrame	UINT8*	The address of reference frame buffer
pu8SysInfoBuffer	UINT8*	The address of system info buffer
pu8DMABuffer_virt	UINT8*	The physical address of DMA buffer
nvop_ioctl	INT32	This parameter is valid only on FAVC_IOCTL_ENCODE_NVOP
multi_slice	UINT32	Multi-slice mode
pic_height	UINT32	This parameter is used to keep the frame height for sps and pps on Multi Slice mode
pic_width	UINT32	This parameter is used to keep the frame width for sps and pps on Multi Slice mode
img_fmt	UINT32	0: 2D format, CbCr interleave, named H264_2D (VideoIn supported only)
control	UINT32	0 : Do NOT force one frame as one slice(default), 1 : Force one frame as one slice

12.4. API Function

H264Dec_Open

Synopsis

int H264Dec_open(void);

Description

Initialize H264 Decoder and install interrupt service routine.

Parameter

None

Return Value

1	Success
-1	Fail

H264Enc_Open

Synopsis

int H264Enc_Open(void);

Description

Initialize H264 Encoder and install interrupt service routine.

Parameter

None

Return Value

1	Success
-1	Fail

H264_ioctl

Synopsis

int H264_ioctl(int cmd, void* param);

Description

Perform the H264 encoder/decoder related operation

Parameter

cmd	Specify the operation for Encoder or Decoder which is defined in ioctl command set.
param	The pointer to FAVC_ENC_PARAM or FAVC_DEC_PARAM dependent on cmd

Return Value

0	Success
-1	Fail

H264Enc_Close

Synopsis

void H264Enc_Close(void);

Description

Close H264 Encoder and free related buffer allocation.

Parameter

None

Return Value

None

H264Dec_Close

Synopsis

void H264Dec_Close (void);

Description

Close H264 Decoder and free related buffer allocation.

Parameter

None

Return Value

None

nv_malloc

Synopsis

void* nv_malloc(int size, int alignment);

Description

Allocate memory in size which is algnment.

Parameter

size	specify the allocated memory size
alignment	specify the allocated memory alignment

Return Value

Pointer to allocated memory

nv_free

Synopsis

int nv_free(void* ptr);

Description

Free the memory specified by ptr.

Parameter

ptr pointer to memory which is to free.

Return Value

0 Success

12.5. Retun Code Table

AVC_RET

API return value for decoder

Name	Value	Description
RETCODE_OK	0	
RETCODE_ERR_MEMORY	1	
RETCODE_ERR_API	2	
RETCODE_ERR_HEADER	3	
RETCODE_ERR_FILL_BUFFER	4	
RETCODE_ERR_FILE_OPEN	5	
RETCODE_HEADER_READY	6	
RETCODE_BS_EMPTY	7	
RETCODE_WAITING	8	
RETCODE_DEC_OVERFLOW	9	
RETCODE_HEADER_FINISH	10	
RETCODE_DEC_TIMEOUT	11	
RETCODE_PARSING_TIMEOUT	12	
RETCODE_ERR_GENERAL	13	
RETCODE_NOT_SUPPORT	14	
RETCODE_FAILURE	15	
RETCODE_FRAME_NOT_COMPLETE	16	

13. I2C Library Overview

This library provides APIs for programmers to access I2C slaves connecting with N9H26 I2C interfaces. The default clock frequency is configured at 100 kHz after i2cOpen() is called, programmers could use i2cIoctl() function to change the frequency.

The maximum receive/transmit buffer length of this library is 450 bytes, which includes slave address and sub address. Data beyond this range will be ignored.

The I2C library will get the APB clock frequency from system library, application must set the CPU clock before using I2C library.

13.1. I2C Library APIs Specification

i2cInit

Synopsis

INT32 i2cInit(VOID)

Description

This function configures GPIO to I2C mode.

Parameter

None

Return Value

0 Always successes

Example

```
i2cInit();
```

i2cOpen

Synopsis

INT32 i2cOpen(VOID)

Description

This function initializes the software resource,enables I2C engine clock and sets the clock frequency to 100 kHz.

Parameter

None

Return Value

0	Successful
I2C_ERR_BUSY	Interface already opened

Example

```
INT32  status;

status = i2cOpen();
```

i2cClose

Synopsis

INT32 i2cClose(VOID)

Description

This function disables I2C engine clock.

Parameter

None

Return Value

0	Successful

Example

```
i2cClose();
```

i2cRead

Synopsis

INT32 i2cRead(PUINT8 buf, UINT32 len)

Description

This function reads data from I2C slave.

Parameter

buf	Receive buffer pointer
len	Receive buffer length

Return Value

> 0	Return read length on success
I2C_ERR_BUSY	Interface busy
I2C_ERR_IO	Interface not opened
I2C_ERR_NACK	Slave returns an erroneous ACK
I2C_ERR_LOSTARBITRATION	Arbitration lost during transmission

Example

```
UCHAR8 buf[8];

INT32 len = 0;

len = i2cRead(buf, 8); // Read 8 bytes from i2c slave
```

i2cRead_OV

Synopsis

INT32 i2cRead_OV(PUINT8 buf, UINT32 len)

Description

This function reads data from OmniVision sensor.

Parameter

buf	Receive buffer pointer
len	Receive buffer length

Return Value

> 0	Return read length on success
I2C_ERR_BUSY	Interface busy
I2C_ERR_IO	Interface not opened
I2C_ERR_NACK	Slave returns an erroneous ACK
I2C_ERR_LOSTARBITRATION	Arbitration lost during transmission

Example

```
UCHAR8 buf[1];

INT32 len = 0;

len = i2cRead_OV(buf, 1); // Read one bytes from OmniVision sensor
```

i2cWrite

Synopsis

INT32 i2cWrite(PUINT8 buf, UINT32 len)

Description

This function writes data to I2C slave.

Parameter

buf	Transmit buffer pointer
len	Transmit buffer length

Return Value

> 0	Return writes length on success
I2C_ERR_BUSY	Interface busy
I2C_ERR_IO	Interface not opened
I2C_ERR_NACK	Slave returns an erroneous ACK
I2C_ERR_LOSTARBITRATION	Arbitration lost during transmission

Example

```
UINT8 buf [5] = {0x00, 0x01, 0x02, 0x03, 0x04};

UINT32 len;

len = i2cWrite(buf, 5); // Write 5 bytes to I2C slave
```

i2cIoctl

Synopsis

INT32 i2cIoctl(UINT32 cmd, UINT32 arg0, UINT32 arg1)

Description

This function allows programmers configure I2C interface, the supported command and arguments listed in the table below.

Command	Argument 0	Argument 1	Description
I2C_IOC_SET_DEV_ADDRESS	Unsigned integer stores the slave address	Not used	This command sets the slave address
I2C_IOC_SET_SPEED	Unsigned integer stores the new frequency	Not used	Valid clock frequencies are 100 kHz and 400 kHz
I2C_IOC_SET_SUB_ADDRESS	Unsigned integer stores the sub address	Sub-address length	This command sets the sub-address and its length
I2C_IOC_SET_SINGLE_MASTER	Enable single master mode	Not used	This command enable/disable single master mode

Parameter

cmd	Command
arg0	First argument of the command
arg1	Second argument of the command

Return Value

0	On Success
I2C_ERR_IO	Interface not activated
I2C_ERR_NOTTY	Command not support, or parameter error

Example

```
/* Set clock frequency to 400 kHz */

i2cIoctl(I2C_IOC_SET_SPEED, 400, 0);
```

i2cExit

Synopsis

INT32 i2cExit(VOID)

Description

This function does nothing.

Parameter

None

Return Value

0	Always successful

Example

```
i2cExit();
```

13.2. Error Code Table

Code Name	Value	Description
I2C_ERR_LOSTARBITRATION	0xFFFF1101	Arbitration lost during transmission
I2C_ERR_NACK	0xFFFF1103	Slave returns an erroneous ACK
I2C_ERR_SLAVENACK	0xFFFF1104	slave not respond after address

I2C_ERR_NODEV	0xFFFF1105	Interface number out of range
I2C_ERR_BUSY	0xFFFF1106	Interface busy
I2C_ERR_IO	0xFFFF1107	Interface not activated
I2C_ERR_NOTTY	0xFFFF1108	Command not support, or parameter error

14. I2S Library Description

This library provides APIs for programmers to play/record PCM audio data from I2S engine.

14.1. API Functions

DrvI2S_Open

Synopsis

VOID DrvI2S_Open(VOID)

Description

This function will open I2S pins and engine clock.

Parameter

None

Return Value

None

Example

```
DrvI2S_Open();
```

DrvI2S_Close

Synopsis

VOID DrvI2S_Close(VOID)

Description

This function will close I2S pins and engine clock.

Parameter

None

Return Value

None

Example

```
DrvI2S_Close();

VOID DrvI2S_StartPlay (

      S_DRVI2S_PLAY* psPlayStruct

)
```

DrvI2S_StartPlay

Synopsis

VOID DrvI2S_StartPlay(S_DRVI2S_PLAY* psPlayStruct)

Description

After opening I2S pins and engine clock, this function will trigger I2S engine to start playing.

Parameter

psPlayStruct   Structure pointer for Play related parameters

Return Value

None

Example

```
DrvI2S_StartPlay((S_DRVI2S_PLAY*) &g_sPlay);
```

DrvI2S_StopPlay

Synopsis

VOID DrvI2S_StopPlay (VOID)

Description

Stop playing.

Parameter

None

Return Value

None

Example

```
DrvI2S_StopPlay();
```

DrvI2S_StartRecord

Synopsis

VOID DrvI2S_StartRecord(S_DRVI2S_RECORD* psRecordStruct)

Description

After opening I2S pins and engine clock, this function will trigger I2S engine to start recording.

Parameter

psRecordStruct Structure pointer for Record related parameters

Return Value

None

Example

```
DrvI2S_StartRecord((S_DRVI2S_RECORD*) &g_sRecord);
```

DrvI2S_StopRecord

Synopsis

VOID DrvI2S_StopRecord (VOID)

Description

Stop recording.

Parameter

None

Return Value

None

Example

```
DrvI2S_StopRecord();
```

DrvI2S_SetSampleRate

Synopsis

VOID DrvI2S_SetSampleRate(E_DRVI2S_SAMPLING eSamplaerate)

Description

Set Play/Record sampling rate.

Parameter

eSampleRate Given sampling rate.

Return Value

None

Example

```
DrvI2S_SetSampleRate((E_DRVI2S_SAMPLING) eDRVI2S_FREQ_44100);
```

15. JPEG Library Overview

N9H26 Non-OS library consists of a set of libraries. These libraries are built to access those on-chip functions such as VPOST, APU, SIC, USBH, USBD, GPIO, I2C, SPI and UART, as well as File System (NVTFAT), USB Mass Storage devices (UMAS) and NAND Flash devices (GNAND). This document describes the provided APIs of JPEG library. With these APIs, user can quickly build a binary target for JPEG library on N9H26 micro processor.

These libraries are created by using ARM Development Suite 1.2. Therefore, they only can be used in ADS environment.

15.1. JPEG Overview

This library is designed to make user application to use N9H26 JPEG more easily.
The JPEG library has the following features:

- JPEG Normal / Encode function
- JPEG Encode Upscale function
- JPEG Decode Downscale function
- JPEG Window Decode function
- JPEG Decode Input Wait function
- JPEG Decode Output Wait function

15.2. Programming Guide

System Overview

The JPEG Codec supports Baseline Sequential Mode JPEG still image compression and decompression that is fully compliant with ISO/IEC International Standard 10918-1 (T.81). The features and capability of the JPEG codec are listed below.

JPEG Features

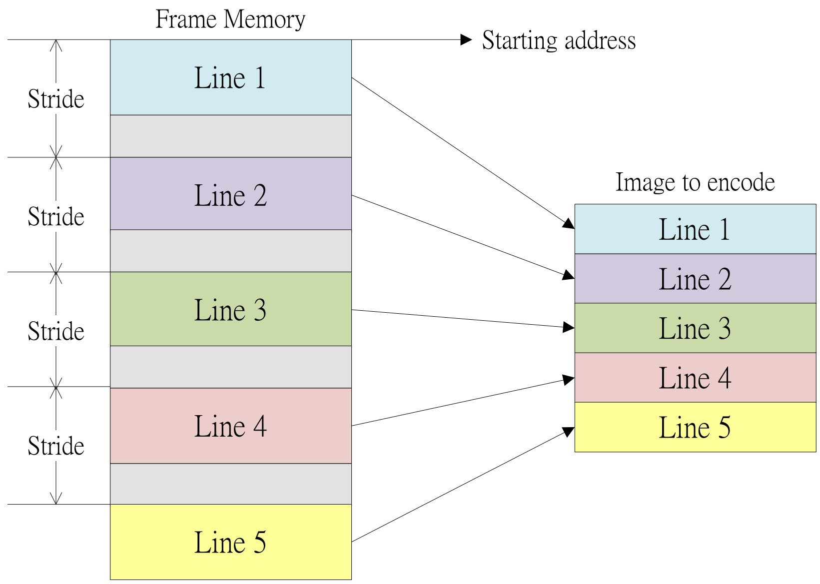
- Support to encode interleaved YCbCr 4:2:2/4:2:0 and gray-level (Y only) format image
- Support to decode interleaved YCbCr 4:4:4/4:2:2/4:2:0/4:1:1 and gray-level (Y only) format image
- Support to decode YCbCr 4:2:2 transpose format
- The encoded JPEG bit-stream format is fully compatible with JFIF and EXIF standards

- Support Capture and JPEG hardware on-the-fly access mode for encode
- Support JPEG and Playback hardware on-the-fly access mode for decode
- Support software input/output on-the-fly access mode for both encode and decode
- Support arbitrary width and height image encode and decode
- Support three programmable quantization-tables
- Support standard default Huffman-table and programmable Huffman-table for decode
- Support arbitrarily 1X~8X image up-scaling function for encode mode
- Support down-scaling function for encode and decode modes
- Support specified window decode mode
- Support quantization-table adjustment for bit-rate and quality control in encode mode
- Support rotate function in encode mode

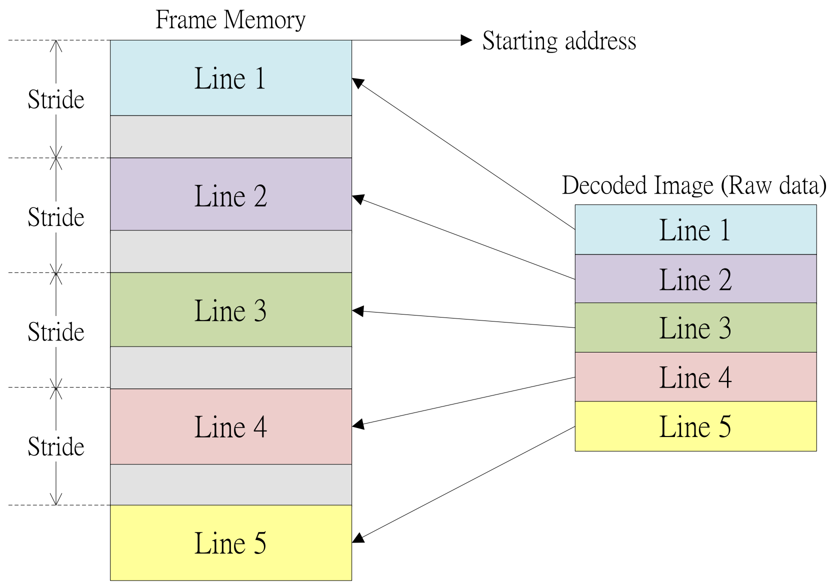
JPEG Operation Control

- **Memory access**

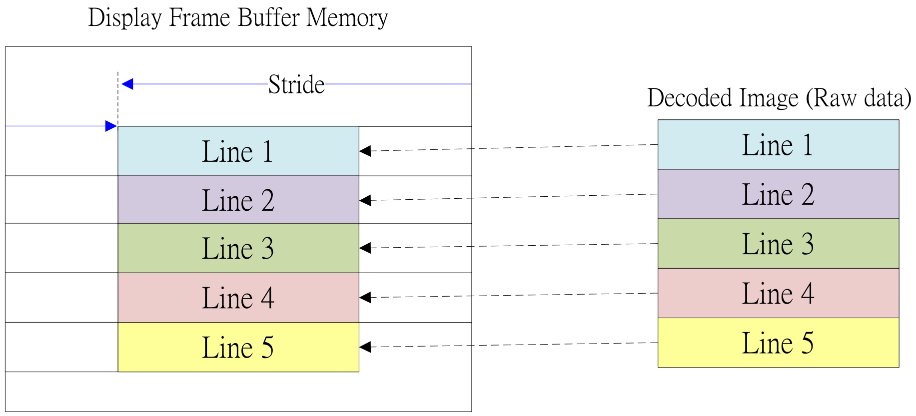
The following figure shows the encode mode to access the source data which are from sensor normally and stored on the SDRAM.



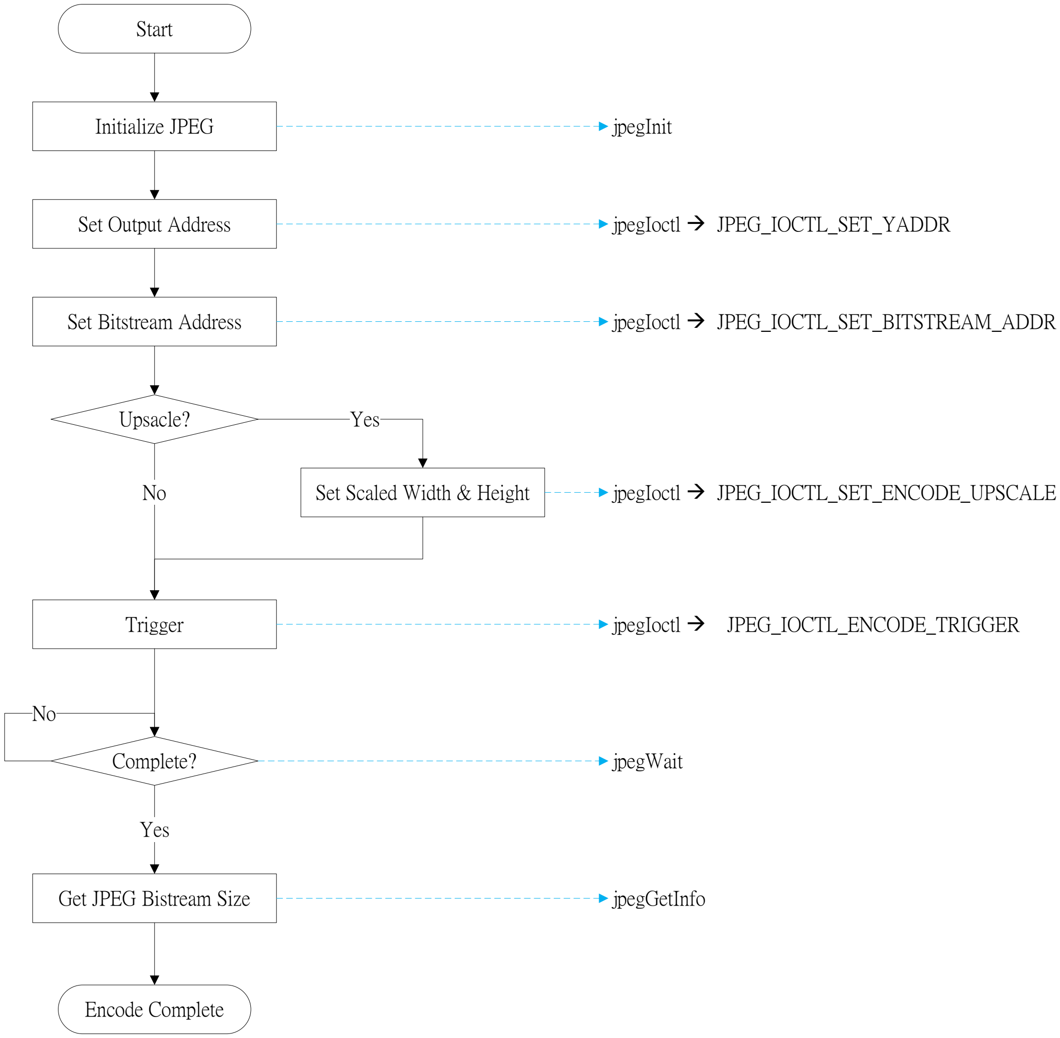
Following figure shows the decode mode to output the decoded raw data on the SDRAM.



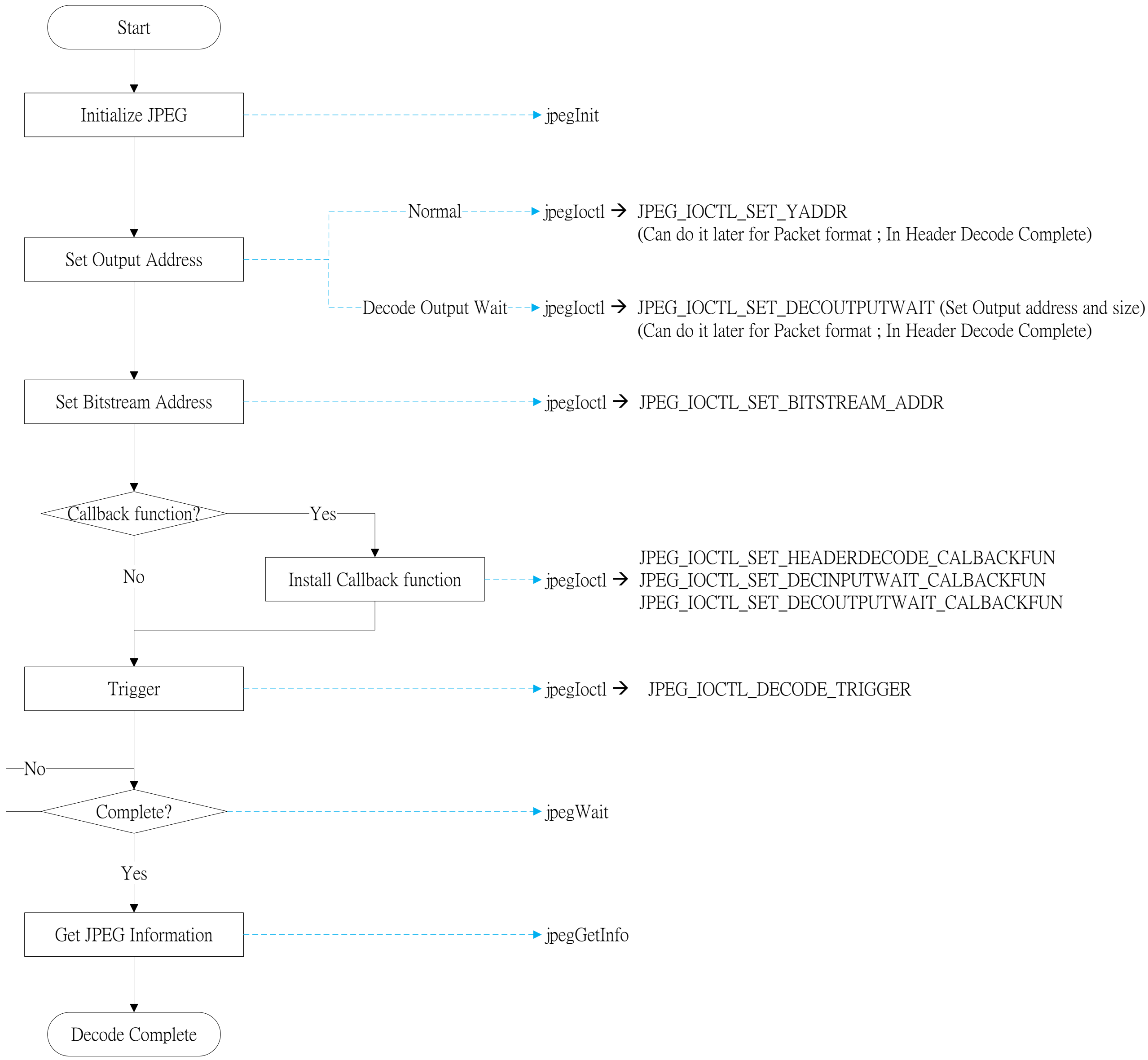
User can use stride function to output decoded image to any position on the Display Frame Buffer for Display. Following figure shows the decode mode with stride to output the decoded raw data on the Display Frame Buffer.



- **Encode operation flow**

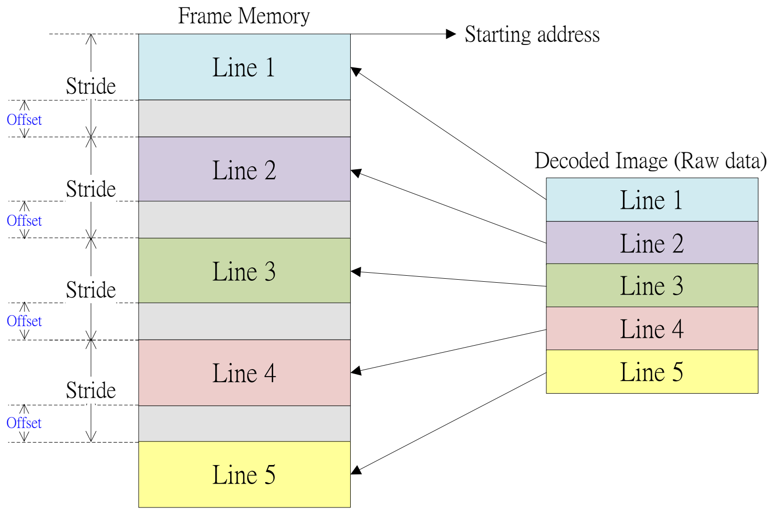

Start
Initialize JPEG
jpegInit
Set Output Address
jpegIoctl → JPEG_IOCTL_SET_YADDR
Set Bitstream Address
jpegIoctl → JPEG_IOCTL_SET_BITSTREAM_ADDR
Upsacle?
Yes
No
Set Scaled Width & Height
jpegIoctl → JPEG_IOCTL_SET_ENCODE_UPSCALE
Trigger
jpegIoctl → JPEG_IOCTL_ENCODE_TRIGGER
No
Complete?
jpegWait
Yes
Get JPEG Bistream Size
jpegGetInfo
Encode Complete

- **Decode operation flow**



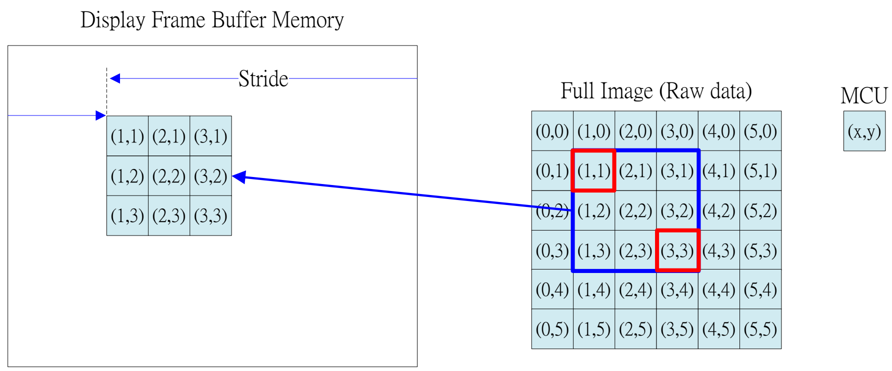
- **Decode stride**

Before clearing Header Decode End interrupt, the value of stride must be set to stride value instead of original width. Offset is the difference between Stride and Image width. If Offset is 0, the decoded Raw data is continuous.



- **Window Decode**

The JPEG decoder supports specified window decode mode. This function allows user to specify a sub-window region within the whole image to be decoded as shown in the following figure. Only the specified window region image will be decoded and stored to frame memory.

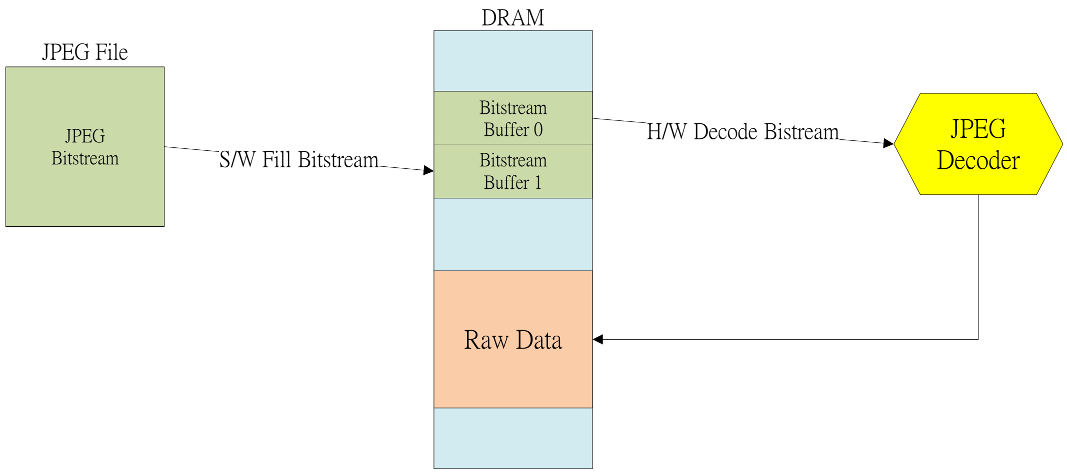


- **Decode Input Wait**

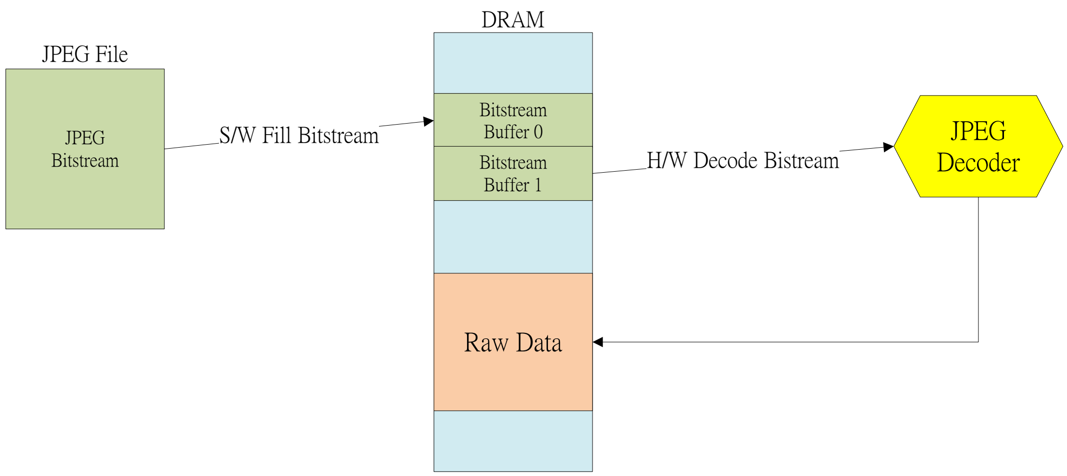
When the JPEG is in decoding mode, the input source is the JPEG bit-stream written by software. The bit-stream buffer size is in 2K unit dual-buffer manner. If the buffer-size is 2KB,user needs to fill 1KB bit-stream into one of the half buffer region before resuming JPEG operation when an input-wait interrupt is generated.

When JPEG engine decodes one of the half buffers, the Decode Input Wait call back function will be called. The Only thing user needs to do is to fill bit stream to the other buffer like the following Step 1 & Step 2 untill entired bistream is filled into the buffer.

[Step 1] JPEG engine decodes the data in Buffer 0 and S/W fills the data into Buffer 1



[Step 2] JPEG engine decodes the data in Buffer1 and S/W fills the data into Buffer 0

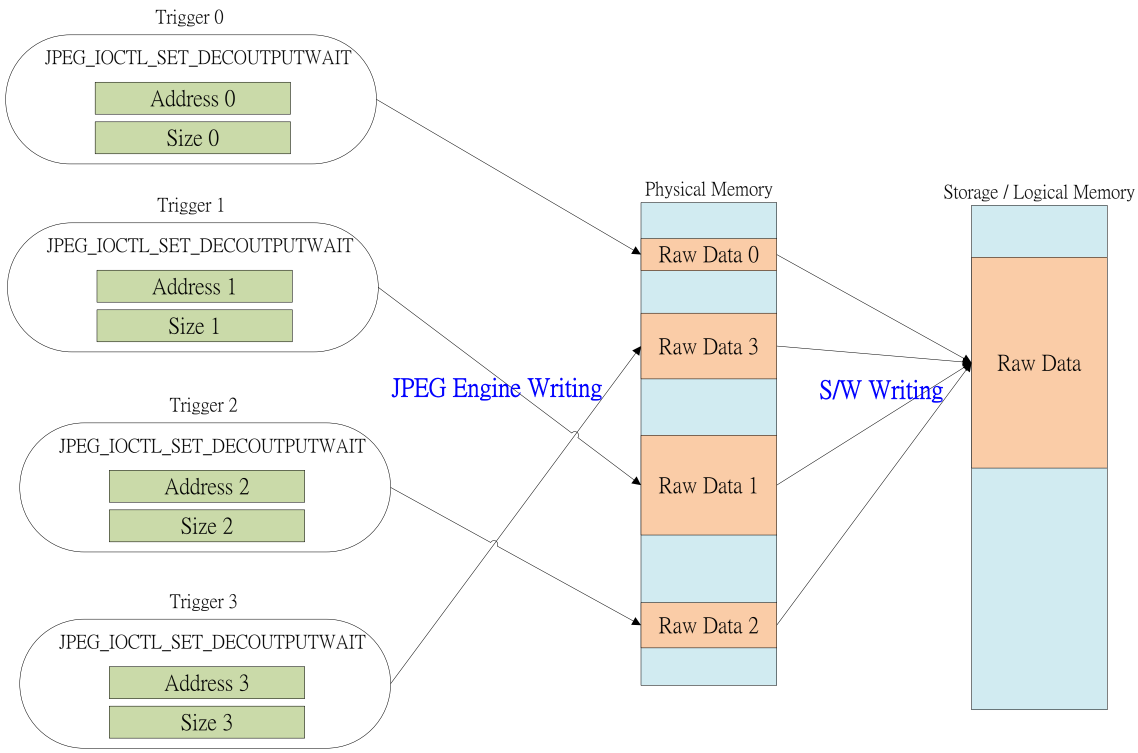


- **Decode Output Wait**

When there is not enough continuous space to store the decode output raw data, JPEG engine support a function to output data partially. User can get the whole data by assigning several output data address and size settings (JPEG_IOCTL_SET_DECOUTPUTWAIT). Using this function, user can get the JPEG decoded image that larger than the available continuous memory space.

The decode output wait call back function will be called when the Output Data size is equal to the Size assigned by IOCTL - JPEG_IOCTL_SET_DECOUTPUTWAIT. In the call back function, user should move the data to it's destination address and call the IOCTL again to set next address and data size.

[Note 1]. The data size of the final ICOTL must equal to the extract output size. Otherwise, user will get the Decode mplete interrupt instead of Decode output wait interrupt.



- **Header Decode Complete**

  In the callback function, user can get JPEG image width and height by calling jpegGetInfo(). After getting the information, user can use jpegIoctl to

  - Allocate and set output buffer → JPEG_IOCTL_SET_YADDR for Packet format Only
  - Change output buffer address → JPEG_IOCTL_SET_YADDR for Packet format Only
  - Set Downscale → JPEG_IOCTL_SET_DECODE_DOWNSCALE
  - Set Decode output Stride → JPEG_IOCTL_SET_DECODE_STRIDE
  - Set windows decode → JPEG_IOCTL_SET_WINDOW_DECODE

JPEG Library Constant Definition

- **Encode operation**

Name	Value	Description
Encode format		
JPEG_ENC_PRIMARY	0	Encode operation : Primary JPEG
JPEG_ENC_THUMBNAIL	1	Encode operation : Thumbnail JPEG
JPEG_ENC_SOURCE_PLANAR	0	Encode source : planar format
JPEG_ENC_SOURCE_PACKET	1	Primary Encode source : packet format

JPEG_ENC_PRIMARY_YUV420	0xA0	Primary Encode image format : YUV 4:2:0
JPEG_ENC_PRIMARY_YUV422	0xA8	Primary Encode image format : YUV 4:2:2
JPEG_ENC_PRIMARY_GRAY	0xA1	Primary Encode image format : GRAY
JPEG_ENC_THUMBNAIL_YUV420	0x90	Thumbnail Encode image format : YUV 4:2:0
JPEG_ENC_THUMBNAIL_YUV422	0x98	Thumbnail Encode image format : YUV 4:2:2
JPEG_ENC_THUMBNAIL_GRAY	0x91	Thumbnail Encode image format : GRAY
Encode Header control		
JPEG_ENC_PRIMARY_DRI	0x10	Restart Interval in Primary JPEG Header
JPEG_ENC_PRIMARY_QTAB	0x20	Quantization-Table in Primary JPEG Header
JPEG_ENC_PRIMARY_HTAB	0x40	Huffman-Table in Primary JPEG Header
JPEG_ENC_PRIMARY_JFIF	0x80	JFIF Header in Primary JPEG Header
JPEG_ENC_THUMBNAIL_DRI	0x1	Restart Interval in Thumbnail JPEG Header
JPEG_ENC_THUMBNAIL_QTAB	0x2	Quantization-Table in Thumbnail JPEG Header
JPEG_ENC_THUMBNAIL_HTAB	0x4	Huffman-Table in Thumbnail JPEG Header
JPEG_ENC_THUMBNAIL_JFIF	0x8	JFIF Header in Thumbnail JPEG Header

- **Decode operation**

Name	Value	Description
Decode output format		
JPEG_DEC_PRIMARY_PLANAR_YUV	0x8021	Primary Decode output format : planar format
JPEG_DEC_PRIMARY_PACKET_YUV422	0x0021	Primary Decode output format : planar YUV422
JPEG_DEC_PRIMARY_PACKET_RGB555	0x004021	Primary Decode output format : packet RGB555
JPEG_DEC_PRIMARY_PACKET_RGB555R1	0x404021	Primary Decode output format : packet RGB555R1
JPEG_DEC_PRIMARY_PACKET_RGB555R2	0x804021	Primary Decode output format : packet RGB555R2
JPEG_DEC_PRIMARY_PACKET_RGB565	0x006021	Primary Decode output format : packet RGB565
JPEG_DEC_PRIMARY_PACKET_RGB565R1	0x406021	Primary Decode output

		format : packet RGB565R1
JPEG_DEC_PRIMARY_PACKET_RGB565R2	0x806021	Primary Decode output format : packet RGB565R2
JPEG_DEC_PRIMARY_PACKET_RGB888	0x14021	Primary Decode output format : packet RGB888
JPEG_DEC_THUMBNAIL_PLANAR_YUV	0x8031	Thumbnail Decode output format : planar YUV
JPEG_DEC_THUMBNAIL_PACKET_YUV422	0x0031	Thumbnail Decode output format : packet RGB555
JPEG_DEC_THUMBNAIL_PACKET_RGB555	0x4031	Thumbnail Decode output format : packet RGB565
JPEG format		
JPEG_DEC_YUV420	0x000	JPEG format is YUV420
JPEG_DEC_YUV422	0x100	JPEG format is YUV422
JPEG_DEC_YUV444	0x200	JPEG format is YUV444
JPEG_DEC_YUV411	0x300	JPEG format is YUV411
JPEG_DEC_GRAY	0x400	JPEG format is Gray
JPEG_DEC_YUV422T	0x500	JPEG format is YUV422 Transport

JPEG Library Property Definition

The JPEG library provide property structure to set JPEG property.

JPEG_INFO_T;

Name	Value	Description
yuvformat	JPEG_DEC_YUV420 JPEG_DEC_YUV422 JPEG_DEC_YUV444 JPEG_DEC_YUV411 JPEG_DEC_GRAY JPEG_DEC_YUV422T	JPEG format (Decode only)
width	< 8192	Decode Output width (Decode only)
height	< 8192	Decode Output height (Decode only)
jpeg_width	< 65535	JPEG width (Decode only)
jpeg_height	< 65535	JPEG height (Decode only)
stride	< 8192	Decode output Stride (Decode only)

bufferend	Reserved	Reserved
image_size[2]	< 2^{24} -1	Encode Bitstream Size (Encode Only)

The JPEG library provide window decode function, user can partially decode the JPEG image by MCU unit (16 pixels *16 pixels).

JPEG_WINDOW_DECODE_T

Name	Value	Description
u16StartMCUX	0~511	Decode MCU Horizontal Start index
u16StartMCUY	0~511	Decode MCU Vertical Start index
u16EndMCUX	0~511	Decode MCU Horizontal End index
u16EndMCUY	0~511	Decode MCU Vertical End index
u32Stride	< 8192	Decode output Stride

15.3. JPEG API

jpegOpen

Synopsis

INT jpegOpen(VOID)

Description

This function initializes the software resource, sets the engine clock and enables its interrupt

Parameter

None

Return Value

E_SUCCESS - Always successes

Example

```
jpegOpen();
```

jpegClose

Synopsis

VOID jpegClose(VOID)

Description

Disable clock of JPEG engine and disable its interrupt

Parameter

None

Return Value

None

Example

```
jpegClose();
```

jpegInit

Synopsis

VOID jpegInit(VOID)

Description

Reset JPEG engine and set default value to its registers

Parameter

None

Return Value

None

Example

```
jpegInit();
```

jpegGetInfo

Synopsis

VOID jpegGetInfo(JPEG_INFO_T *info)

Description

This function can get JPEG width and height after header decode complete and get JPEG bit stream size after encode complete.

Parameter

info	JPEG Data type pointer stores the returned JPEG header information

Return Value

None

Example

```
JPEG_INFO_T jpegInfo;

/* Get JPEG Header information */

jpegGetInfo(&jpegInfo);
```

jpegWait

Synopsis

INT jpegWait(VOID)

Description

After triggers JPEG engine, application need to wait the completion flag while JPEG engine completes it job.

Parameter

None

Return Value

E_FAIL	Error happen
E_SUCCESS	Action is done

Example

```
jpegWait();
```

jpegIsReady

Synopsis

BOOL jpegIsReady(VOID)

Description

The function can get the JPEG engine status.

Parameter

None

Return Value

TRUE	Engine is ready
FALSE	Engine is busy

Example

```
jpegIsReady ();
```

jpegSetQTAB

Synopsis

INT jpegSetQTAB(

PUINT8	puQTable0,
PUINT8	puQTable1,
PUINT8	puQTable2,
UINT8	u8num

);

Description

The function can specify the Quantization table

Parameter

puQTable0	Specify the address of Quantization table 0
puQTable1	Specify the address of Quantization table 1
puQTable2	Specify the address of Quantization table 2
u8num	Specify the number of Quantization table

Return Value

E_SUCCESS : Success

E_JPEG_TIMEOUT : Set Quantization table timeout

Example

```
jpegSetQTAB(g_au8QTable0,g_au8QTable1, 0, 2);
```

jpegIoctl

Synopsis

VOID jpegIoctl(UINT32 cmd, UINT32 arg0, UINT32 arg1)

Description

This function allows programmers configure JPEG engine, the supported command and arguments listed in the table below.

Command	Argument 0	Argument 1	comment
JPEG_IOCTL_SET_YADDR	JPEG Y component frame buffer address		Specify the JPEG Y component

			frame buffer address.
JPEG_IOCTL_SET_YSTRIDE	JPEG Y component frame buffer stride		Specify the JPEG Y component frame buffer stride
JPEG_IOCTL_SET_USTRIDE	JPEG U component frame buffer stride		Specify the JPEG U component frame buffer stride
JPEG_IOCTL_SET_VSTRIDE	JPEG V component frame buffer stride		Specify the JPEG V component frame buffer stride
JPEG_IOCTL_SET_BITSTREAM_ADDR	JPEG bit stream buffer starting address		Specify the bit stream frame buffer starting address
JPEG_IOCTL_SET_SOURCE_IMAGE_HEIGHT	The encode source image height in pixel		Specify the encode source image height in pixel
JPEG_IOCTL_ENC_SET_HEADER_CONTROL	JPEG_ENC_PRIMARY_DRI JPEG_ENC_PRIMARY_QTAB JPEG_ENC_PRIMARY_HTAB JPEG_ENC_PRIMARY_JFIF		Specify the header information includes in the encoding bit stream
JPEG_IOCTL_SET_DEFAULT_QTAB			Specify the Quantization table
JPEG_IOCTL_SET_DECODE_MODE	JPEG_DEC_PRIMARY_PLANAR_YUV JPEG_DEC_PRIMARY_PACKET_YUV422 JPEG_DEC_PRIMARY_PACKET_RGB555 JPEG_DEC_PRIMARY_PACKET_RGB555R1 JPEG_DEC_PRIMARY_PACKET_RGB555R2 JPEG_DEC_PRIMARY_PACKET_RGB565 JPEG_DEC_PRIMARY_PACKET_RGB565R1 JPEG_DEC_PRIMARY_PACKET_RGB565R2 JPEG_DEC_PRIMARY_PACKET_RGB888		Specify the decoded image output format
JPEG_IOCTL_SET_ENCODE_MODE	JPEG_ENC_SOURCE_PLANAR JPEG_ENC_SOURCE_PACKET	JPEG_ENC_PRIMARY_YUV420 JPEG_ENC_PRIMARY_YUV422	Specify the encode source format and encoding image format
JPEG_IOCTL_SET_DIMENSION	Image height	Image width	Set the encode image dimension or decode output image dimension
JPEG_IOCTL_ENCODE_TRIGGER			Trigger the JPEG operation for encoding
JPEG_IOCTL_DECODE_TRIGGER			Trigger the JPEG operation for decoding
JPEG_IOCTL_WINDOW_DECODE	JPEG_WINDOW_DECODE_T		Enable window decode mode and set the decode window region
JPEG_IOCTL_SET_DECODE_STRIDE	Decode Output Stride (in pixel)		Specify the decode output stride
JPEG_IOCTL_SET_DECODE_DOWNSCALE	Scaled Height	Scaled Width	Set Decode downscale function
JPEG_IOCTL_SET_ENCODE_UPSCALE	Scaled Height	Scaled Width	Set Encode Upscale function
JPEG_IOCTL_SET_HEADERDECODE_CALBACKFUN	Header Decode Complete Call Back function pointer		Set Header Decode Complete Call Back function pointer
JPEG_IOCTL_SET_DECINPUTWAIT_CALBACKFUN	Decode Input Wait Call Back function pointer		Set Decode Input Wait Call Back function pointer

JPEG_IOCTL_ADJUST_QTAB	JPEG_ENC_PRIMARY JPEG_ENC_THUMBNAIL	Quantization-Table Adjustment and control values[0]	Set Quantization-Table Adjustment and control
JPEG_IOCTL_ENC_RESERVED_FOR_SOFTWARE	Reserved size		Reserve memory space for user application
JPEG_IOCTL_SET_UADDR	Address for U Component		Set address for U Component
JPEG_IOCTL_SET_VADDR	Address for V Component		Set address for V Component
JPEG_IOCTL_SET_ENCODE_PRIMARY_RESTART_INTERVAL	Primary Restart interval		Set Primary Restart interval size
JPEG_IOCTL_SET_ENCODE_THUMBNAIL_RESTART_INTERVAL	Thumbnail Restart interval		Set Thumbnail Restart interval size
JPEG_IOCTL_GET_ENCODE_PRIMARY_RESTART_INTERVAL	The pointer to store Primary Restart interval size		Get Primary Restart interval size
JPEG_IOCTL_GET_ENCODE_THUMBNAIL_RESTART_INTERVAL	The pointer to store Thumbnail Restart interval size		Get Thumbnail Restart interval size
JPEG_IOCTL_SET_THUMBNAIL_DIMENSION	Thumbnail Heightt	Thumbnail Width	Set Thumbnail Dimension
JPEG_IOCTL_SET_ENCODE_SW_OFFSET	Offset		Set Software Encode Offset
JPEG_IOCTL_GET_THUMBNAIL_DIMENSION	The pointer to store Thumbnail Heightt	The pointer to store Thumbnail Width	Get Thumbnail Dimension
JPEG_IOCTL_GET_ENCODE_SW_OFFSET	The pointer to store Encode Offset		Get Software Encode Offset
JPEG_IOCTL_SET_ENCODE_PRIMARY_DOWNSCALE	Primary Downscaled Heightt	Primary Downscaled Width	Set Primary Encode downscale Size (Planar format only)
JPEG_IOCTL_SET_ENCODE_THUMBNAIL_DOWNSCALE	Thumbnail Downscaled Heightt	Thumbnail Downscaled Width	Set Thumbnail Encode downscale Size (Planar format only)
JPEG_IOCTL_SET_ENCODE_PRIMARY_ROTATE_RIGHT			Encode rotate right (Planar format only)
JPEG_IOCTL_SET_ENCODE_PRIMARY_ROTATE_LEFT			Encode rotate left (Planar format only)
JPEG_IOCTL_SET_ENCODE_PRIMARY_ROTATE_NORMAL			Encode no rotate (Planar format only)
JPEG_IOCTL_SET_DECOUTPUTWAIT_CALBACKFUN	Decode Output Wait call back function pointer		Set Decode Output Wait call back function (Packetformat Only)
JPEG_IOCTL_SET_DECOUTPUTWAIT	Data Output Address	Data Output Size	Set Decode Output Wait address and size
JPEG_IOCTL_GET_DECOUTPUTWAIT_ADDR	The pointer to store Decode Output Wait Address		Get Decode Output Wait Address
JPEG_IOCTL_GET_DECOUTPUTWAIT_SIZE	The pointer to store Decode Output Wait Size		Get Decode Output Wait Size

Parameter

cmd Command

arg0 First argument of the command

arg1 Second argument of the command

Return Value

None

Example

```
/* Set Downscale to QVGA */

jpegIoctl(JPEG_IOCTL_SET_DECODE_DOWNSCALE, 240, 320);


/* Set Decode Stride to Panel width (480 pixel)*/

jpegIoctl(JPEG_IOCTL_SET_DECODE_STRIDE, 480, 0);


/* Set Decoded Image Address */

jpegIoctl(JPEG_IOCTL_SET_YADDR, u32FrameBuffer, 0);


/* Set Bit stream Address */

 jpegIoctl(JPEG_IOCTL_SET_BITSTREAM_ADDR, u32BitStream, 0);


/* Set Decode Input Wait mode (Input wait buffer is 8192) */

jpegIoctl(JPEG_IOCTL_SET_DECINPUTWAIT_CALBACKFUN, (UINT32) JpegDecInputWait, 8192);


 /* Decode mode */

jpegIoctl(JPEG_IOCTL_SET_DECODE_MODE, JPEG_DEC_PRIMARY_PACKET_YUV422, 0);


/* Set JPEG Header Decode End Call Back Function */

jpegIoctl(JPEG_IOCTL_SET_HEADERDECODE_CALBACKFUN, (UINT32) JpegDecHeaderComplete,
0);


/* Trigger JPEG decoder */

jpegIoctl(JPEG_IOCTL_DECODE_TRIGGER, 0, 0);
```

```
/* Set Source Y/U/V Stride */

jpegIoctl(JPEG_IOCTL_SET_YSTRIDE, u16Width, 0);

jpegIoctl(JPEG_IOCTL_SET_USTRIDE, u16Width/2, 0);

jpegIoctl(JPEG_IOCTL_SET_VSTRIDE, u16Width/2, 0);



/* Primary Encode Image Width / Height */

jpegIoctl(JPEG_IOCTL_SET_DIMENSION, u16Height, u16Width);



/* Encode upscale 2x */

jpegIoctl(JPEG_IOCTL_SET_ENCODE_UPSCALE, u16Height * 2, u16Width * 2);



/* Set Encode Source Image Height */

jpegIoctl(JPEG_IOCTL_SET_SOURCE_IMAGE_HEIGHT, u16Height, 0);



/* Include Quantization-Table and Huffman-Table */

jpegIoctl(JPEG_IOCTL_ENC_SET_HEADER_CONTROL, JPEG_ENC_PRIMARY_QTAB |
JPEG_ENC_PRIMARY_HTAB, 0);



/* Use the default Quantization-table 0, Quantization-table 1 */

jpegIoctl(JPEG_IOCTL_SET_DEFAULT_QTAB, 0, 0);
```

Note [0]

8 bits Quantization-Table Adjustment and control value.

7	6	5	4	3	2	1	0
P_QADJUST				**P_QVS**			

Bits	**Descriptions**

[7:4]	**P_QADJUST**	**Primary Quantization-Table Adjustment** If the sum of the position (x, y) of quantization-table is greater than **P_QADJUST**, the quantization value will be set to 127. Otherwise the value will keep as the original. 8x8 DCT block: x = 0~7, y = 0~7 if ((x+y) > P_QADJUST) => Q' = 127 else => Q' = Q
[3:0]	**P_QVS**	**Primary Quantization-Table Scaling Control** Q' = (P_QVS[3]*2*Q)+(P_QVS[2]*Q)+(P_QVS[1]*Q/2)+(P_QVS[0]*Q/4)

15.4. Example code

This demo code has sample code for "Normal Encode", "Encode Upscale", "Normal Decode", "Decode Downscale & Stride", "Decode Input Wait", and "Decode Output Wait" (write/read from SD Card). Please refer to the JPEG sample code of SDK Non-OS.

16. PWM Library Overview

This library is designed to make user application to set N9H26 PWM more easily.
The PWM library has the following features:

- PWM signal frequency and duty setting
- PWM Capture function

16.1. Programming Guide

System Overview

The N9H26 have 4 channels pwm-timers. The 4 channels pwm-timers has 2 prescaler, 2 clock divider, 4 clock selectors, 4 16-bit counters, 4 16-bit comparators, 2 Dead-Zone generator. They are all driven by system clock. Each channel can be used as a timer and issue interrupt independently.
Each two channels pwm-timers share the same prescaler(channel0-1 share prescalar0 and channel2-3 share prescalar1). Clock divider provides each channel with 5 clock sources (1, 1/2, 1/4, 1/8, 1/16). Each channel receives its own clock signal from clock divider which receives clock from 8-bit prescaler. The 16-bit counter in each channel receive clock signal from clock selector and can be used to handle one pwm period. The 16-bit comparator compares number in counter with threshold number in register loaded previously to generate pwm duty cycle.

The N9H26 have 4 channels pwm-timers and each pwm-timer includes a capture channel. The Capture 0 and PWM 0 share a timer that included in PWM 0; and the Capture 1 and PWM 1 share another timer, and etc. Therefore user must setup the PWM-timer before turn on Capture feature. After enabling capture feature, the capture always latched PWM-counter to CRLR when input channel has a rising transition and latched PWM-counter to CFLR when input channel has a falling transition. Capture channel 0 interrupt is programmable by setting CCR0[1] (Rising latch Interrupt enable) and CCR0[2] (Falling latch Interrupt enable) to decide the condition of interrupt occur. Capture channel 1 has the same feature by setting CCR0[17] and CCR0[18]. And capture channel 2 & 3 has the same feature by setting CCR1[1],CCR1[2] and CCR1[17], CCR1[18] respectively. Whenever Capture issues Interrupt 0/1/2/3, the PWM counter 0/1/2/3 will be reload at this moment.

There are only four interrupts from PWM to advanced interrupt controller (AIC). PWM 0 and Capture 0 share the same interrupt channel, PWM1 and Capture 1 share the same interrupt and so on. Therefore, PWM function and Capture function in the same channel cannot be used at the same time.

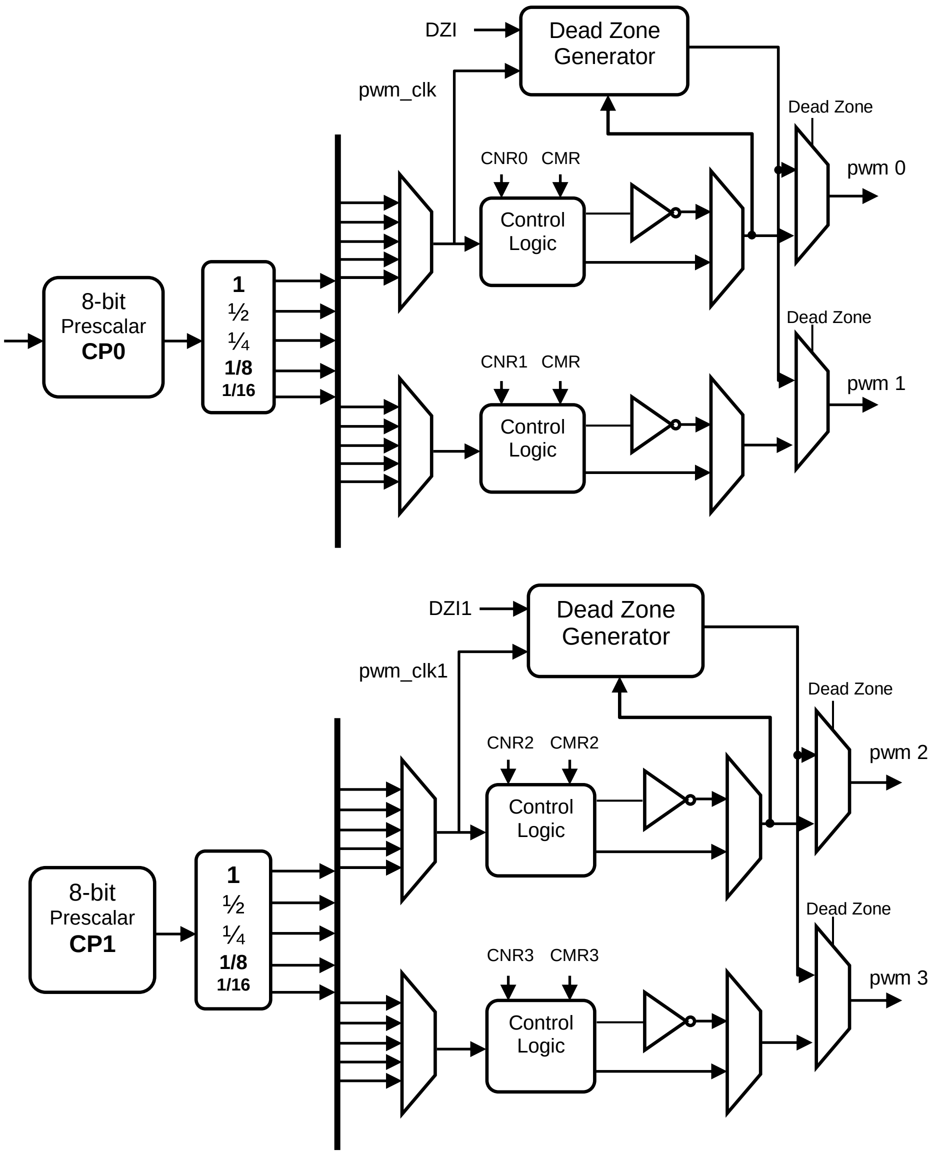
PWM Features

- Two 8-bit prescalers and Two clock dividers
- Four clock selectors

- Four 16-bit counters and four 16-bit comparators
- Two Dead-Zone generator
- Capture function

Block Diagram

The following figure describes the architecture of pwm in one group. (channel0&1 are in one group and channel2&3 are in another group)



PWM Timer Control

- **Prescaler and clock selector**

The PWM has two groups (two channels in each group) of timers. The clock input of the group is according to the PWM Prescaler Register (**PPR**) value. The PWM prescaler divided the clock input by PPR+1 before it is fed to the counter. Please notice that when the PPR value equals zero, the prescaler output clock will stop. Furthermore, according to the PWM Clock Select Register (**CSR**) value, the clock input of PWM timer channel can be divided by 1,2,4,8 and 16.

Consider following examples, which explain the PWM timer period (Duty).

$$\text{period} = \frac{1}{(SourceClock) \div (PPR+1) \div CSR}$$

[Note 1]. PWM source clock can be APLL/UPLL/XIN.

When the PWM engine clock = 60 MHz, the maximum and minimum PWM timer counting period is described as follows.
Maximum period: PPR = 255 (since the length of PPR is 8bit) and CSR = 16

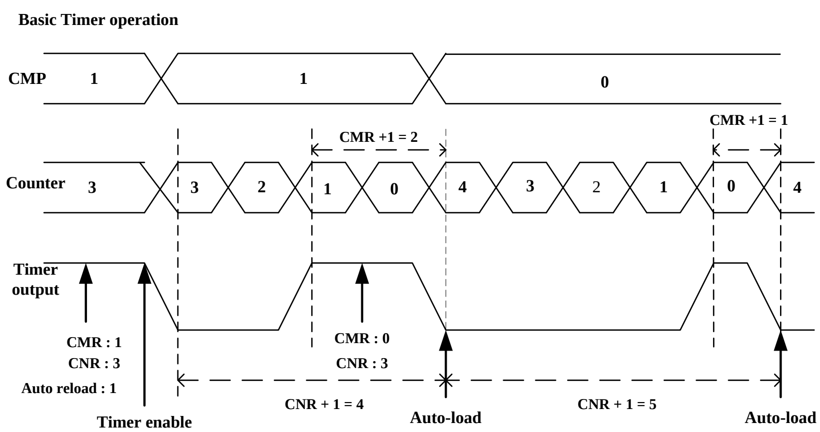
$$\text{period}_{\max} = \frac{1}{(60Mhz) \div (255+1) \div 16} = 68.266us$$

Minimum period: PCLK = 60 MHz, PPR=1 and CSR=1

$$\text{period}_{\min} = \frac{1}{(60Mhz) \div (1+1) \div 1} = 0.0333us$$

The maximum and minimum intervals between two interrupts depend on the $period_{max}$, $period_{min}$ and PWM Counter Register(**CNRx**) length. The maximum interval between two interrupts is (65535)*(51.2us) since the length of CNR is 16bit. Please notice that the above calculation is based on the PCLK = 60MHz. Therefore, all of the values need to be recalculated when the PCLK is not equal to 60Mhz.

- **Basic Timer Operation**



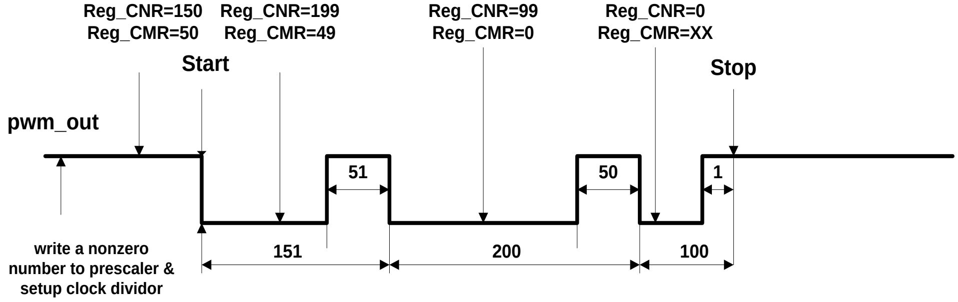
- **PWM Double Buffering and Automatic Reload**

N9H26 PWM Timers have a double buffering function, enabling the reload value changed for next timer operation without stopping current timer operation. Although new timer value is set, current timer operation still operate successfully.

The counter value can be written into CNR0~3 and current counter value can be read from PDR0~3.

The auto-reload operation copies from CNR0~3 to down-counter when down-counter reaches zero. If CNR0~3 are set as zero, counter will be halt when counter count to zero. If auto-reload bit is set as zero, counter will be stopped immediately

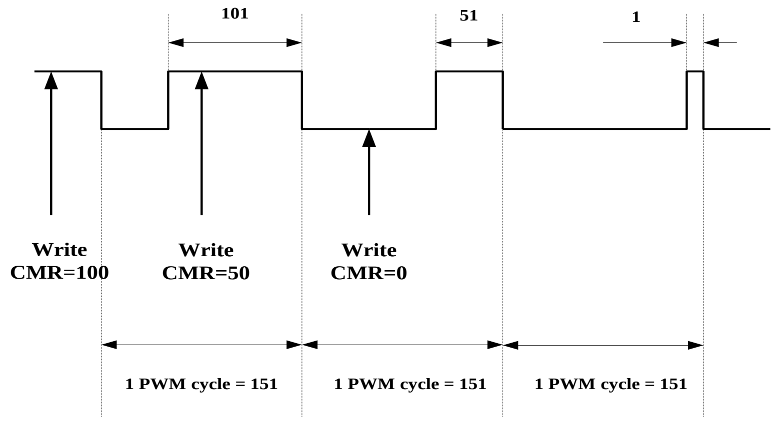
PWM double buffering



- **PWM Double Buffering and Automatic Reload**

  The double buffering function allows CMR written at any point in current cycle. The loaded value will take effect from next cycle.

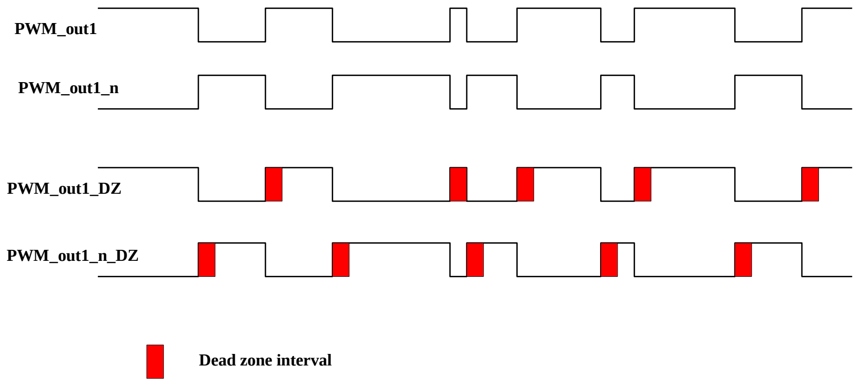
Modulate PWM controller ouput duty ratio(CNR = 150)



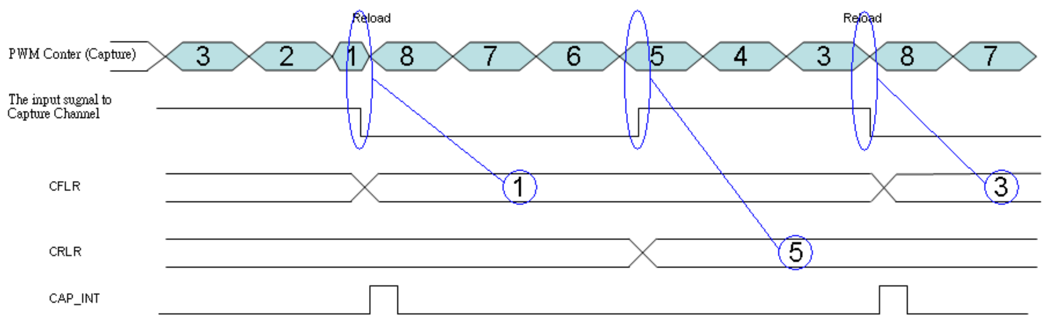
- **PWM Double Buffering and Automatic Reload**

  N9H26 PWM is implemented with Dead Zone generator. They are built for power device protection. This function enables generation of a programmable time gap at the rising of PWM output waveform. User can program PPR [31:24] and PPR [23:16] to determine the two Dead Zone interval respectively.

Dead zone generator operation



- **Capture Basic Timer Operation**



At this case, the CNR is 8:

1. When set falling interrupt enable, the pwm counter will be reload at time of interrupt occur.
2. The channel low pulse width is (CNR – CRLR).
3. The channel high pulse width is (CRLR - CFLR).
4. The channel cycle time is (CNR – CFLR).

PWM Library Constant Definition

Name	Value	Description
PWM_TIMER0	0x0	PWM Timer 0
PWM_TIMER1	0x1	PWM Timer 1
PWM_TIMER2	0x2	PWM Timer 2
PWM_TIMER3	0x3	PWM Timer 3
PWM_CAP0	0x0	PWM Capture 0
PWM_CAP1	0x1	PWM Capture 1
PWM_CAP2	0x2	PWM Capture 2
PWM_CAP3	0x3	PWM Capture 3

PWM_CAP_NO_INT	0	No PWM Capture Interrupt
PWM_CAP_RISING_INT	1	PWM Capture Rising Interrupt
PWM_CAP_FALLING_INT	2	PWM Capture Falling Interrupt
PWM_CAP_RISING_FLAG	6	Capture rising interrupt flag
PWM_CAP_FALLING_FLAG	7	Capture falling interrupt flag
PWM_CLOCK_DIV_1	4	Input clock divided by 1
PWM_CLOCK_DIV_2	0	Input clock divided by 2
PWM_CLOCK_DIV_4	1	Input clock divided by 4
PWM_CLOCK_DIV_8	2	Input clock divided by 8
PWM_CLOCK_DIV_16	3	Input clock divided by 16
PWM_TOGGLE_MODE	TRUE	PWM Timer Toggle mode
PWM_ONE_SHOT_MODE	FALSE	PWM Timer One-shot mode

PWM Library Property Definition

The PWM library provides property structure to set PWM timer property.

Name	Value	Description
u8Frequency	>= 0	The timer/capture frequency[0]
u8HighPulseRatio	1~100	High pulse ratio
u8Mode	PWM_ONE_SHOT_MODE / PWM_TOGGLE_MODE	PWM Timer Trigger mode
bInverter	TRUE / FALSE	Inverter Enable / Inverter Disable
u8ClockSelector	PWM_CLOCK_DIV_1/ PWM_CLOCK_DIV_2/ PWM_CLOCK_DIV_4/ PWM_CLOCK_DIV_8/ PWM_CLOCK_DIV_16	Clock Selector [1]
u16PreScale	2 ~ 256	Clock Prescale [1]
u32Duty	0~65535	Pulse duty [2]

[0] PWM provides two timer setting mode: Frequency-setting and Property-setting modes.

- Frequency-setting mode (***u8Frequency*** > 0)

  User doesn't need to set ***u8ClockSelector*** / ***u16PreScale*** / ***u32Duty*** fields. PWM library will set the proper values according to current APB clock automatically.

- Property-setting mode (***u8Frequency*** = 0)
- User must set ***u8ClockSelector* / *u16PreScale* / *u32Duty*** fields by himself. Please refer to the previous section “Prescaler and clock selector.

[1] The value take effect only when Property-setting mode.

[2] The value takes effect when Property-setting mode or the Capture functions. It is the capture monitor period.

16.2. PWM API

PWM_Open

Synopsis

VOID PWM_Open (VOID)

Description

Enable PWM engine clock and reset PWM

Parameter

None

Return Value

None

Example

```
/* Enable PWM clock */
PWM_Open();
```

PWM_Close

Synopsis

VOID PWM_Close (VOID)

Description

Disable PWM engine clock and the I/O enable

Parameter

None

Return Value

None

Example

/* Disable PWM clock */

PWM_Close();

PWM_SetClockSetting

Synopsis

BOOL PWM_SetClockSetting(E_SYS_SRC_CLK eSrcClk, UINT32 u32PllDiver, UINT32 u32EngineDiver)

Description

This function is used to set PWM engine clock source and divie

Parameter

eSrcClk	PWM clock source.
	It could be eSYS_EXT=0, eSYS_APLL= 2 and eSYS_UPLL = 3.
u32PllDiver	PWM PLL Divider Selection (1~8)
	()
u32EngineDiver	Engine Clock divider (1~256)

Return Value

TRUE	- Success.
FALSE	- Setting Fail..

Note

1. Parameter “u32PllDiver” is only be valid when eSrcClk is eSYS_APLL or eSYS_UPLL

Example

/* PWM Egine clock is UPLL / 4, and Engine Clock divider is 2 */

PWM_SetClockSetting(eSYS_UPLL, 4, 2);

PWM_GetEngineClock

Synopsis

UINT32 PWM_GetEngineClock(E_SYS_SRC_CLK* peSrcClk)

Description

This function is used to get Current PWM engine clock

Parameter

peSrcClk Sytem clock source.

It could be eSYS_EXT=0, eSYS_APLL= 2 and eSYS_UPLL = 3.

Return Value

PWM Engine Clock (Hz)

Example

```
u32PWMClock = PWM_GetEngineClock(&eSrcClk) ;
sysprintf("PWM    Clock Source is ");
switch(eSrcClk)
{
        case eSYS_EXT:
        sysprintf("External Crystal\n");
                break;
        case eSYS_APLL:
                sysprintf("APLL\n");
                break;
        case eSYS_UPLL:
                sysprintf("UPLL\n");
                break;
}
sysprintf("PWM Clock is %dHz\n",u32PWMClock);
```

PWM_SetTimerClk

Synopsis

FLOAT PWM_SetTimerClk (UINT8 u8Timer, PWM_TIME_DATA_T *sPt)

Description

This function is used to configure the frequency/pulse/mode/inverter function

Parameter

u8Timer	The function to be set PWM_TIMER0 ~ PWM_TIMER3: PWM timer 0 ~ 3 PWM_CAP0 ~ PWM_CAP3: PWM capture 0 ~ 3
sPt	PWM property information

Return Value

= 0	- Setting Fail.
> 0	- Success. The actual frequency by PWM timer.

Note

2. The function will set the frequency property automatically (It will change the parameters to the values that it sets to hardware) when user set a nonzero frequency value
3. The function can set the proper frequency property (Clock selector/Prescale) for capture function and user needs to set the proper pulse duty by himself.

Example

```
//* Set PWM Timer 0 Configuration */
PWM_SetTimerClk(PWM_TIMER0,&sPt);
```

PWM_SetTimerIO

Synopsis

VOID PWM_SetTimerIO (UINT8 u8Timer, BOOL bEnable)

Description

This function is used to enable/disable PWM timer/capture I/O function

Parameter

u8Timer	The function to be set PWM_TIMER0 ~ PWM_TIMER3: PWM timer 0 ~ 3 PWM_CAP0 ~ PWM_CAP3: PWM capture 0 ~ 3
bEnable	Enable (TRUE) / Disable (FALSE)

Return Value

None

Example

```
/* Enable Output for PWM Timer 0 */
PWM_SetTimerIO(PWM_TIMER0,TRUE);
```

PWM_Enable

Synopsis

VOID PWM_Enable (UINT8 u8Timer, BOOL bEnable)

Description

This function is used to enable PWM timer / capture function

Parameter

u8Timer	The function to be set PWM_TIMER0 ~ PWM_TIMER3: PWM timer 0 ~ 3

PWM_CAP0 ~ PWM_CAP3: PWM capture 0 ~ 3

bEnable	Enable (TRUE) / Disable (FALSE)

Return Value

None

Example

```
/* Enable the PWM Timer0 */
PWM_Enable(PWM_TIMER0,TRUE);
```

PWM_IsTimerEnabled

Synopsis

BOOL PWM_IsTimerEnabled (UINT8 u8Timer)

Description

This function is used to get PWM specified timer enable/disable state

Parameter

u8Timer	The function to be set PWM_TIMER0 ~ PWM_TIMER3: PWM timer 0 ~ 3

Return Value

TURE	- The specified timer is enabled.
FALSE	- The specified timer is disabled.

Example

```
/*    Check PWM Timer0 is enabled or not */
If (PWM_IsTimerEnabled(PWM_TIMER0))
        sysprintf("PWM Timer 0 is enabled\n");
else
        sysprintf("PWM Timer 0 isn't enabled\n");
```

PWM_SetTimerCounter

Synopsis

VOID PWM_SetTimerCounter (UINT8 u8Timer, UINT16 u16Counter)

Description

This function is used to set the PWM specified timer counter

Parameter

u8Timer The function to be set

PWM_TIMER0 ~ PWM_TIMER3: PWM timer 0 ~ 3

u16Counter The timer value. (0~65535)

Return Value

None

Note

If the counter is set to 0, the timer will stop.

Example

/* Set PWM Timer 0 counter as 0 */

PWM_SetTimerCounter(PWM_TIMER0,0);

PWM_GetTimerCounter

Synopsis

UINT32 PWM_GetTimerCounter (UINT8 u8Timer)

Description

This function is used to get the PWM specified timer counter value

Parameter

u8Timer The function to be set

PWM_TIMER0 ~ PWM_TIMER3: PWM timer 0 ~ 3

u16Counter The timer value. (0~65535)

Return Value

The specified timer-counter value

Example

```
/* Loop when Counter of PWM Timer0 isn’t 0 */

while(PWM_GetTimerCounter(PWM_TIMER0));
```

PWM_EnableDeadZone

Synopsis

VOID PWM_EnableDeadZone (UINT8 u8Timer, UINT8 u8Length, BOOL bEnableDeadZone)

Description

This function is used to set the dead zone length and enable/disable Dead Zone function

Parameter

u8Timer	The function to be set PWM_TIMER0 ~ PWM_TIMER3: PWM timer 0 ~ 3
u8Length	Dead Zone Length : 0~255
bEnableDeadZone	Enable DeadZone (TRUE) / Disable DeadZone (FALSE)

Return Value

None

Note

1. If Deadzone for PWM_TIMER0 or PWM_TIMER1 is enabled, the output of PWM_TIMER1 is inverse waveform of PWM_TIMER0.
2. If Deadzone for PWM_TIMER2 or PWM_TIMER3 is enabled, the output of PWM_TIMER3 is inverse waveform of PWM_TIMER2.

Example

```
/* Enable Deadzone of PWM Timer 0 and set it to 100 units*/

PWM_EnableDeadZone(PWM_TIMER0, 100, TRUE)
```

PWM_EnableInt

Synopsis

VOID PWM_EnableInt (UINT8 u8Timer, UINT8 u8Int)

Description

This function is used to enable the PWM timer/capture interrupt

Parameter

u8Timer	The function to be set PWM_TIMER0 ~ PWM_TIMER3: PWM timer 0 ~ 3 PWM_CAP0 ~ PWM_CAP3: PWM capture 0 ~ 3
u8Int	Capture interrupt type (The parameter is valid only when capture function) PWM_CAP_RISING_INT: The capture rising interrupt. PWM_CAP_FALLING_INT: The capture falling interrupt. PWM_CAP_ALL_INT: All capture interrupt.

Return Value

None

Example

```
/* Enable Interrupt Sources of PWM Timer 0 */

PWM_EnableInt(PWM_TIMER0,0);

/* Enable Interrupt Sources of PWM Capture3 */

PWM_EnableInt(PWM_CAP3, PWM_CAP_FALLING_INT);
```

PWM_DisableInt

Synopsis

VOID PWM_DisableInt (UINT8 u8Timer, UINT8 u8Int)

Description

This function is used to disable the PWM timer/capture interrupt

Parameter

u8Timer	The function to be set
	PWM_TIMER0 ~ PWM_TIMER3: PWM timer 0 ~ 3
	PWM_CAP0 ~ PWM_CAP3: PWM capture 0 ~ 3
u8Int	Capture interrupt type (The parameter is valid only when capture function)
	PWM_CAP_RISING_INT: The capture rising interrupt.
	PWM_CAP_FALLING_INT: The capture falling interrupt.
	PWM_CAP_ALL_INT: All capture interrupt.

Return Value

None

Example

```
/* Disable Capture Interrupt */

PWM_DisableInt(PWM_CAP3,PWM_CAP_ALL_INT);
```

PWM_InstallCallBack

Synopsis

VOID PWM_InstallCallBack (UINT8 u8Timer, PFN_PWM_CALLBACK pfncallback, PFN_PWM_CALLBACK *pfnOldcallback)

Description

This function is used to install the specified PWM timer/capture interrupt call back function

Parameter

u8Timer	The function to be set	
		PWM_TIMER0 ~ PWM_TIMER3: PWM timer 0 ~ 3
		PWM_CAP0 ~ PWM_CAP3: PWM capture 0 ~ 3
pfncallback		The callback function pointer for specified timer / capture.
pfnOldcallback		The previous callback function pointer for specified timer / capture.

Return Value

None

Example

```
/* Install Callback function */

PWM_InstallCallBack(PWM_TIMER0, PWM_PwmIRQHandler, &pfnOldcallback);
```

PWM_ClearInt

Synopsis

VOID PWM_ClearInt (UINT8 u8Timer)

Description

This function is used to clear the PWM timer/capture interrupt.

Parameter

u8Timer	The function to be set	
		PWM_TIMER0 ~ PWM_TIMER3: PWM timer 0 ~ 3
		PWM_CAP0 ~ PWM_CAP3: PWM capture 0 ~ 3

Return Value

None

Example

```
/* Clear the PWM Capture 3 Interrupt */

PWM_ClearInt(PWM_CAP3);
```

PWM_GetIntFlag

Synopsis

BOOL PWM_GetIntFlag (UINT8 u8Timer)

Description

This function is used to get the PWM timer/capture interrupt flag

Parameter

u8Timer The function to be set

PWM_TIMER0 ~ PWM_TIMER3: PWM timer 0 ~ 3

PWM_CAP0 ~ PWM_CAP3: PWM capture 0 ~ 3

Return Value

TRUE - The specified interrupt occurs.

FLASE - The specified interrupt doesn't occur.

Example

```
/* Get PWM Timer 0 Interrupt flag*/

PWM_GetIntFlag(PWM_TIMER0);
```

PWM_GetCaptureIntStatus

Synopsis

VOID PWM_GetCaptureIntStatus (UINT8 u8Capture, UINT8 u8IntType)

Description

Check if there's a rising / falling transition

Parameter

u8Timer The function to be set

PWM_CAP0 ~ PWM_CAP3: PWM capture 0 ~ 3

u8Int Capture interrupt type (The parameter is valid only when capture function)

PWM_CAP_RISING_INT: The capture rising interrupt.

PWM_CAP_FALLING_INT: The capture falling interrupt.

Return Value

TRUE - The specified interrupt occurs.

FLASE - The specified interrupt doesn't occur.

Example

```
/* Wait for Interrupt Flag (Falling) */
```

```
while(PWM_GetCaptureIntStatus(PWM_CAP0, PWM_CAP_FALLING_FLAG)!=TRUE);
```

PWM_ClearCaptureIntStatus

Synopsis

VOID PWM_ClearCaptureIntStatus (UINT8 u8Capture, UINT8 u8IntType)

Description

Clear the rising / falling transition interrupt flag

Parameter

u8Timer The function to be set

PWM_CAP0 ~ PWM_CAP3: PWM capture 0 ~ 3

u8Int Capture interrupt type (The parameter is valid only when capture function)

PWM_CAP_RISING_INT: The capture rising interrupt.

PWM_CAP_FALLING_INT: The capture falling interrupt.

Return Value

None

Example

```
/* Clear the Capture Interrupt Flag */

PWM_ClearCaptureIntStatus(PWM_CAP0, PWM_CAP_FALLING_FLAG);
```

PWM_GetRisingCounter

Synopsis

UINT16 PWM_GetRisingCounter (UINT8 u8Capture)

Description

The value which latches the counter when there’s a rising transition

Parameter

u8Timer The function to be set

PWM_CAP0 ~ PWM_CAP3: PWM capture 0 ~ 3

Return Value

This function is used to get value which latches the counter when there’s a rising transition

Example

```
/* Get the Rising Counter Data */
```

```
u32Count[u32i++] = PWM_GetRisingCounter(PWM_CAP0);
```

PWM_GetFallingCounter

Synopsis

UINT16 PWM_GetFallingCounter (UINT8 u8Capture)

Description

The value which latches the counter when there's a falling transition

Parameter

u8Timer	The function to be set
	PWM_CAP0 ~ PWM_CAP3: PWM capture 0 ~ 3

Return Value

This function is used to get value which latches the counter when there's a falling transition

Example

```
/* Get the Falling Counter Data */

u32Count[u32i++] = PWM_GetFallingCounter(PWM_CAP0);
```

17. RFC Library Introduction

The RF-CODEC includes the Convolution encode, Viterbi decode, Inner Interleave, and Inner De- Interleave. These are a forward error correction code (FEC) for wireless transceiver. The convolution encode includes a puncture function to change the coding rate from 1/2 to 2/3, 3/4, 5/6, or 7/8. If selecting 7/8 coding rate, the transfer data rate is maximum; otherwise, if selecting 1/2 coding rate, it gains the maximum BER performance. The Viterbi Decode is hard decision and the trace-back length is 32. The interleave function is used to disperse the transfer data. Because the performance of the Viterbi decode will be worst by burst error. The RF-CODEC block diagram is in Figure1. One thing is important that the RF-CODEC only supports PDMA function to handle the data from or to memory.

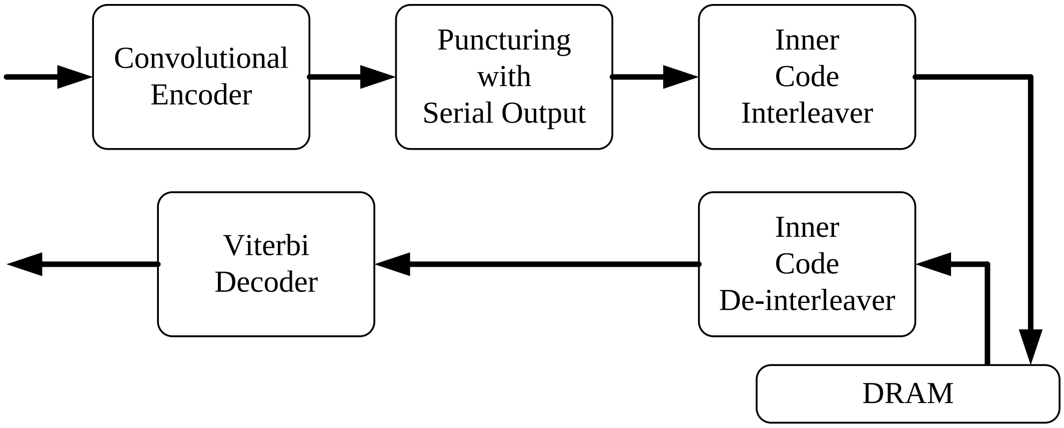


Figure1. RF-CODEC Block Diagram

17.1. Feature

- Supports Convolution encode and Viterbi decode
    - Coding rate supports 1/2, 2/3, 3/4, 5/6 and 7/8
- Supports Inner Interleave and Inner De-Interleave
- Supports PDMA function to handle the data from or to memory

17.2. API Data Structure

E_RF_PNCTR_MODE

The coding rate setting in the puncture function.

Name	Value	Description
E_PNCTR_1_2	0	Coding rate is 1/2
E_PNCTR_2_3	1	Coding rate is 2/3
E_PNCTR_3_4	2	Coding rate is 3/4
E_PNCTR_5_6	3	Coding rate is 5/6
E_PNCTR_7_8	4	Coding rate is 7/8

17.3. API Function

RF_Open

Synopsis

INT32 RF_Open(void);

Description

Initialize RFC engine, install interrupt service routine, and call EDMA_Init to initialize PDMA engine.

Parameter

None

Return Value

Successful	Always returns Successful

RF_Close

Synopsis

void RF_Close(void);

Description

Tear down RFC engine.

Parameter

None

Return Value

None

RF_Enable_Int

Synopsis

void RF_Enable_Int(void);

Description

Enable RFC interrupt souce.

Parameter

None

Return Value

None

RF_Disable_Int

Synopsis

void RF_Disable_Int(void);

Description

Disable RFC interrupt souce.

Parameter

None

Return Value

None

RF_Set_Puncture

Synopsis

INT32 RF_Set_Puncture(E_RF_PNCTR_MODE ePnctrMod);

Description

Set the coding rate of the puncture function.

Parameter

ePnctrMod	The coding rate of the puncture function

Return Value

Successful	Set puncture is successful
RFC_ERR_PNCTR_MODE	Invalid puncture coding rate

RF_Get_Puncture

Synopsis

E_RF_PNCTR_MODE RF_Get_Puncture(void);

Description

Get the coding rate of the puncture function.

Parameter

None

Return Value

Successful	The puncture coding rate is returned

RF_Encrypt

Synopsis

INT32 RF_Encrypt(UINT8* plainBuf, UINT8* cipherBuf, INT32 plainDataLen);

Description

Start to run a RFC encryption calculation and wait for its finish.

Parameter

plainBuf	Pointer to input plain text buffer
cipherBuf	Pointer to output cipher text buffer
plainDataLen	Length of plain buffer in bytes

Return Value

(Value > 0)	Length of output buffer in bytes
RFC_ERR_DATA_BUF	RFC input buffer address is wrong

RF_Decrypt

Synopsis

INT32 RF_Decrypt(UINT8* cipherBuf, UINT8* plainBuf, UINT32 plainDataLen);

Description

Start to run a RFC decryption calculation and wait for its finish.

Parameter

cipherBuf	Pointer to input cipher text buffer
plainBuf	Pointer to output plain text buffer

plainDataLen	Length of plain buffer in bytes

Return Value

(Value > 0)	Length of output buffer in bytes
RFC_ERR_DATA_BUF	RFC input buffer address is wrong

17.4. Error Code Table

Code Name	Value	Description
Successful	0	Success
RFC_ERR_FAIL	RFC_ERR_ID | 0x01	Internal error
RFC_ERR_PNCTR_MODE	RFC_ERR_ID | 0x02	Invalid puncture coding rate
RFC_ERR_DATA_BUF	RFC_ERR_ID | 0x03	NULL buffer address

18. Rotation Library Overview

The N9H26 Rotation library provides a set of APIs to rotate image in SDRAM. It use SRAM as temporatory buffer. With these APIs, user can rotate image quickly.

The Rotation engine supports rotation left 90 degree and right 90 degree. It doesn't support downscale and format conversion. It only suppors to rotate packet RGB565, packet XRGB888 and packet YUV422. It support souce line offset and destination line offset.

These libraries are created by using ARM Development Suite 1.2. Therefore, they only can be used in ADS environment.

18.1. Rotation Library APIs Specification

rotOpen

Synopsis

VOID rotOpen(VOID)

Description

This function is used to open the rotatin library.

Parameter

None

Return Value

None

Example

```
/* Open Rotation engine clock */

rotOpen();
```

rotClose

Synopsis

VOID rotClose(VOID)

Description

Close the rot library.

Parameter

None

Return Value

Noe

Example

```
/* Close Rotation library*/

rotClose();
```

rotInstallISR

Synopsis

void rotInstallCallback (UINT32 u32IntNum,

PVOID pvIsr);

Description

This function is used to install callback function that is used to notice the upper layer for specified rotation image is done, buffer overrun or memory abort.

Parameter

u32IntNum Rotation interrupt type. Please refer *Table 18-1:Interrupt Type*

pvIsr Callback function

Table 18-1:Interrupt Type

Field name	Value	Description
E_ROT_COMP_INT	0	Rotation done interrupt
E_ROT_ABORT_INT	1	Memory abort interrupt
E_ROT_OVERFLOW_INT	2	Buffer overrun interrupt

Return Value

None.

Example

```
    rotOpen();
```

```
rotInstallISR(E_ROT_COMP_INT, (PVOID)rotDoneHandler); /* Rotation done */

rotInstallISR(E_ROT_ABORT_INT, (PVOID)rotAbortHandler); /* Memory Abort */
```

rotImageConfig

Synopsis

INT32 rotImageConfig(T_ROT_CONF* ptRotConf)

Description

This function is used to config Rotation engine.

Parameter

ptRotConf The structure to config Rotation engine.

Please refer Table 18-2: The definition of configuration structure

Table 18-2: The definition of configuration structure

Field name	Value	Description
eRotFormat	E_ROT_PACKET_RGB565 = 0 E_ROT_PACKET_RGB888 = 1 E_ROT_PACKET_YUV422 = 2	Pixel Format
eBufSize	E_LBUF_4 = 0 E_LBUF_8 = 2 E_LBUF_16 = 16	Use SRAM line.
eRotDir	E_ROT_ROT_R90 = 0 E_ROT_ROT_L90 = 1	Right or left rotation
u32RotDimHW	[31:16] : Rotate image height [15:0] : Rotate image width	Rotate image dimension
u32SrcLineOffset		Source line offset
u32DstLineOffset		Source line offset
u32SrcAddr		Source Buffer Address
u32DstAddr		Destination Buffer Address

Return Value

Successful

Example

```
    T_ROT_CONF tRotConf;

    rotOpen();

rotInstallISR(E_ROT_COMP_INT, (PVOID)rotDoneHandler); /* Rotation done */

rotInstallISR(E_ROT_ABORT_INT, (PVOID)rotAbortHandler); /* Memory Abort */

    tRotConf.eBufSize = E_LBUF_4;

    tRotConf.eRotDir = E_ROT_ROT_L90;

    tRotConf.eRotFormat = E_ROT_PACKET_RGB565;

    tRotConf.u32RotDimHW = 0x01E00280;

    tRotConf.u32SrcLineOffset = 0;

    tRotConf.u32DstLineOffset= 0;

    tRotConf.u32SrcAddr = ADDR_ROT_SRC_ADDR;

    tRotConf.u32DstAddr = ADDR_ROT_DST_ADDR
```

rotGetPacketPixelWidth

Synopsis

INT32 rotGetPacketPixelWidth(E_ROTENG_FMT ePacFormat)

Description

The function is used to get data width for the specified format.

Parameter

ePacFormat   Rotation format. Please refer Table 18-3:Rotation Format

Table 18-3:Rotation Format

Field name	Value	Description
E_ROT_PACKET_RGB565	0	Packet RGB565. The data width is 2
E_ROT_PACKET_RGB888	1	Packet RGB888. The data width is 4
E_ROT_PACKET_RGB888	2	Packet YUV422. The data width is 2

Return Value

The data width of rotation image. Byte unit.

Example

```
    UINT8 u8PixelWidth;
```

```
    u8PixelWidth=rotGetPacketPixelWidth(ptRotConf->eRotFormat);
```

rotTrigger

Synopsis

INT32 rotTrigger (void)

Description

The function is used to get data width for the specified format

Parameter

None

Return Value

1: Meaning Rotation engine busy

0: Successful.

Example

```
    UINT8 u8PixelWidth;

    u8PixelWidth=rotGetPacketPixelWidth(ptRotConf->eRotFormat);
```

18.2. Error Code Table

Code Name	Value	Description
Successful	0	Successful
ERR_ROT_BUSY	0xFFFF2001	Rotation engine is busy

19. RSC Library Introduction

The RS_CODEC controller performs two main functions - Reed-Solomon Encoder / Decoder and Convolutional Interleaver / Deinterleaver. When in encode mode, data from system bus can be encoded by Reed-Solomon Encoder and interleaved by convolutional interleaver. When in decode mode, data from system bus can be de-interleaved and decoded by Reed-Solomon Decoder.

19.1. Feature

- Supports Reed-Solomon Encoder / Decoder
  - (N=204, K=188, t=8) with the Field Generator Polynomial: $p(x)=x^8+x^4+x^3+x^2+1$
  - Can correct 8 bytes error in 188 bytes block transmission
- Supports Convolutional Interleaver / Deinterleaver
  - Convolutional byte-wise interleaving with depth I=12 and 17 bytes FIFO
- Support PDMA to access RSC read / write buffers

19.2. Function

RS_Open

Synopsis

INT32 RS_Open(void);

Description

Initialize RSC engine, install interrupt service routine, and call EDMA_Init to initialize PDMA engine.

Parameter

None

Return Value

Successful	Always returns Successful

RS_Close

Synopsis

void RS_Close(void);

Description

Tear down RSC engine.

Parameter

None

Return Value

None

RS_Enable_Int

Synopsis

void RS_Enable_Int(void);

Description

Enable RSC interrupt souce.

Parameter

None

Return Value

None

RS_Disable_Int

Synopsis

void RS_Disable_Int(void);

Description

Disable RSC interrupt souce.

Parameter

None

Return Value

None

RS_Encrypt

Synopsis

INT32 RS_Encrypt(UINT8* plainBuf, UINT8* cipherBuf, INT32 dataLen, UINT8 isInterleave);

Description

Start to run a RSC encryption calculation and wait for its finish.

Parameter

plainBuf	Pointer to input plain text buffer
cipherBuf	Pointer to output cipher text buffer
dataLen	Length of input buffer in bytes
isInterleave	RSC runs in interleave or deinterleave mode

Return Value

(Value > 0)	Length of output buffer in bytes
RSC_ERR_DATA_LEN	RSC input data length is wrong
RSC_ERR_DATA_BUF	RSC input buffer address is wrong

RS_Decrypt

Synopsis

INT32 RS_Decrypt(UINT8* cipherBuf, UINT8* plainBuf, UINT32 dataLen, UINT8 isInterleave);

Description

Start to run a RSC decryption calculation and wait for its finish.

Parameter

cipherBuf	Pointer to input cipher text buffer
plainBuf	Pointer to output plain text buffer
dataLen	Length of input buffer in bytes
isInterleave	RSC runs in interleave or deinterleave mode

Return Value

(Value > 0)	Length of output buffer in bytes
RSC_ERR_DATA_LEN	RSC input data length is wrong
RSC_ERR_DATA_BUF	RSC input buffer address is wrong
RSC_ERR_DEC_ERROR	RSC decode error and cannot fix

19.3. Error Code Table

Code Name	Value	Description
Successful	0	Success
RSC_ERR_FAIL	RSC_ERR_ID | 0x01	Internal error
RSC_ERR_DATA_LEN	RSC_ERR_ID | 0x02	Data length is not block alignment
RSC_ERR_DATA_BUF	RSC_ERR_ID | 0x03	NULL buffer address
RSC_ERR_DEC_ERROR	RSC_ERR_ID | 0x04	RSC decode error

20. RTC Library Overview

This library is designed to make user application access N9H26 RTC more easily.
The RTC library has the following features:

- Support RTC Current/Alarm time access.
- Support System Power Off Control

20.1. Programming Guide

System Overview

Real Time Clock (RTC) block can be operated by independent power supply while the system power is off. The RTC uses a 32.768 KHz external crystal. It can transmit data to CPU with BCD values. The data includes the time by (second, minute and hour), the day by (day, month and year). In addition, to achieve better frequency accuracy, the RTC counter can be adjusted by software.
The built in RTC is designed to generate the alarm interrupt and periodic interrupt signals. The period interrupt can be 1/128, 1/64, 1/32, 1/16, 1/8, 1/4, 1/2 and 1 second. The alarm interrupt indicates that time counter and calendar counter have counted to a specified time recorded in TAR and CAR.
The wakeup signal is used to wake the system up from sleep mode.

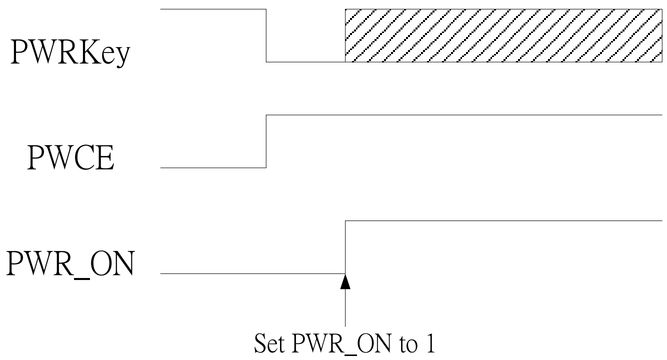
RTC Features

- There is a time counter (second, minute, hour) and calendar counter (day, month, year) for user to check the time.
- Absolute Alarm register (second, minute, hour, day, month, year).
- Relative Alarm
- Alarm Mask for Minutely / Hourly / Daily / Weeky / Monthly/Yearly Alarm
- 12-hour or 24-hour mode is selectable.
- Recognize leap year automatically.
- The day of week counter.
- Frequency compensate register (FCR).
- Beside FCR, all clock and alarm data expressed in BCD code.
- Support time tick interrupt.
- Support wake up function.
- System Power off Control function

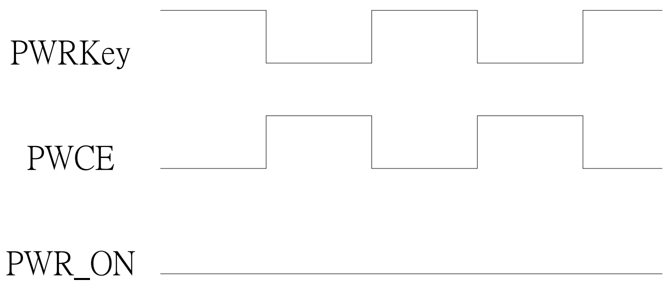
System Power Control Flow

- **Power On from Key**

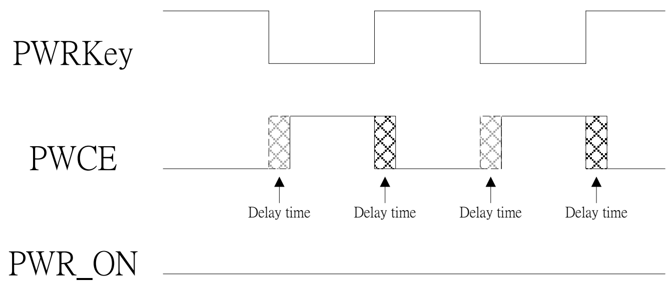
User presses the Power Key to make the Power Control Signal, PWCE to high. If PWR_ON bit is set, the Power Key can be released and the PWCE will be keep on. When system is power on, IBR will set PWR_ON first.



If PWR_ON doesn't be set to 1, the PWCE will back to low when the Power Key is released.



And RTC supports a function (POWER_KEY_DURATION_LENGTH) to postpone the time to set PWCE to high when pressing Power Key or to postpone the time to set PWCE to low when releasing Power Key. The delay time is from 62ms to 868ms. The function is default disabled. User can enable it after first power on and the setting can be kept when RTC is powered even whole system is power-off.



[Note] The function (POWER_KEY_DURATION_LENGTH) only works only when Power Key is pressed or released.

- **Power Key Duration (POWER_KEY_DURATION)**

The delay time between Power Key pressed and PWCE high (or Power Key released and PWCE low). Minimum duration that power key must be pressed to turn on core power.

- Minimum power key duration = 0.25*(POWER_KEY_DURATION+1) sec.

- **Normal system Power Control Flow**

The control steps are as follows

1. User press the power key, RPWR, to makes the power control signal, PWCE pin, to high. If the PWR_ON bit, PWRON[0], be set, the power key can be released and the PWCE will keep on. If the PWR_ON bit, PWRON [0], doesn't be set as 1, the PWCE will back to low when the power key is released.
2. If there is another pulse on power key when the PWR_ON bit is set, the system will get an interrupt signal (PSWI). User can decide to clear the PWR_ON or not. If this bit is clear, the PWCE will go to low to turn off the core power. If the PWRON bit is also kept high, the PWCE pin will keep in high level. If there is not any pulse on the power key and the PWR_ON bit is clear by user, the PWCE pin is also set to low at this time.

The follow table is the system power control flow true table.

Input		Output	Note
PWRKey	PWR_ON	PWCE	
X1	X2	Y	
1	0	0	RTC powered only (Default state)
0	0	1	Press key, Power On
0	1	1	keep key & S/W Set X2, Power On
1	1	1	Left key, Power keep On
0	1	1	Press key, get INT, intend to power Off
1	0	0	Left key & S/W clean X2, power Off Or S/W clean X2 , don't need press key, power off
X	1	1	RST_ active, still keep power whenX2=1
PWCE is open drain output **X1, internal pull-up** **X2, it is R/W able** **There is Interrupt from key be pressed**			

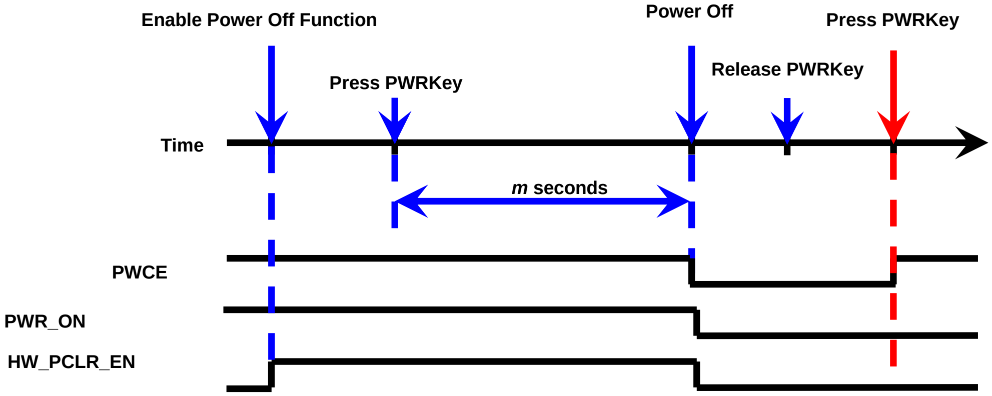
- **Force system Power Off Control Flow**

The RTC supports a hardware automatic power off function and a software power off function like Notebook. For hardware power off function, it can be enable and disable in HW_PCLR_EN bit and the user presses the power button for a few seconds to power off system. The time to press power the button to power off is configured in PCLR_TIME.

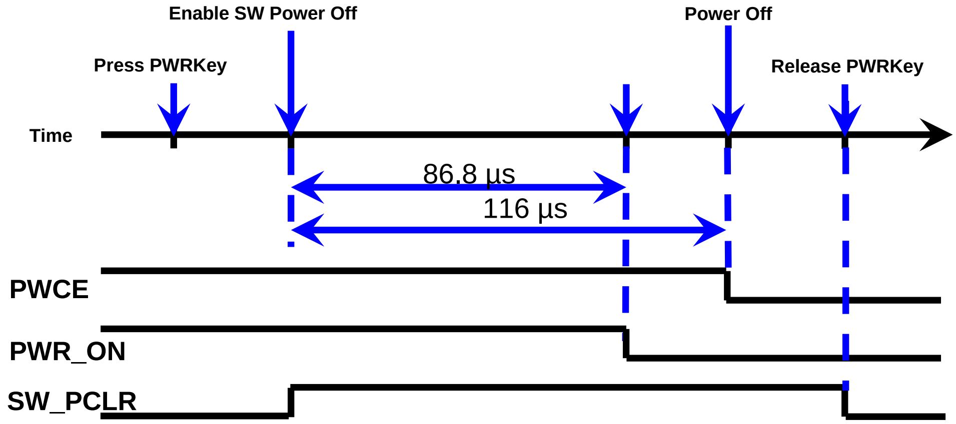
PCLR_TIME Setting	Pressed time to power off	PCLR_TIME Setting	Pressed time to power off
0	2~3 second	8	10~11 seconds
1	3~4 second	9	11~12 seconds
2	4~5 seconds	10	12~13 seconds
3	5~6 seconds	11	13~14 seconds
4	6~7 seconds	12	14~15 seconds
5	7~8 seconds	13	15~16 seconds
6	8~9 seconds	14	16~17 seconds
7	9~10 seconds	15	17~18 seconds

The RTC supports a hardware power off function to provide the power off flow like Notebook. The user presses the power button for a few seconds to power off the system. The time to press power key to power off is counted by hardware. After the time, hardware will set the PWCE to low and clear the PWR_ON and HW_PCLR_EN. After power off, user can decide to set the PWR_ON bit to power on system or not when the PWRKey is pressed.

The timing of the hardware power off function is following



The RTC also supports a software power off function. The user presses the power button for a few seconds to power off the system. The time to press power key to power off is counted by user. When the PWR_ON bit is cleared by user, the PWCE outputs low after 116us and the SW_PCLR bit is cleared when the power key is released. See the timing Figure as following.



RTC Library Constant Definition

Name	Value	Description
RTC_CLOCK_12	0	12-Hour mode
RTC_CLOCK_24	1	24-Hour mode
RTC_AM	1	a.m.
RTC_PM	2	p.m.
RTC_LEAP_YEAR	1	Leap year
RTC_TICK_1_SEC	0	1 tick per second
RTC_TICK_1_2_SEC	1	2 tick per second
RTC_TICK_1_4_SEC	2	4 tick per second
RTC_TICK_1_8_SEC	3	8 tick per second
RTC_TICK_1_16_SEC	4	16 tick per second
RTC_TICK_1_32_SEC	5	32 tick per second
RTC_TICK_1_64_SEC	6	64 tick per second
RTC_TICK_1_128_SEC	7	128 tick per second
RTC_SUNDAY	0	Day of Week: Sunday
RTC_MONDAY	1	Day of Week: Monday
RTC_TUESDAY	2	Day of Week: Tuesday
RTC_WEDNESDAY	3	Day of Week: Wednesday
RTC_THURSDAY	4	Day of Week: Thursday
RTC_FRIDAY	5	Day of Week: Friday
RTC_SATURDAY	6	Day of Week: Saturday
RTC_ALARM_INT	0x01	Aboslute Alarm Interrupt
RTC_TICK_INT	0x02	Tick Interrupt
RTC_PSWI_INT	0x04	Power Switch Interrupt

RTC_RELATIVE_ALARM_INT	0x08	Relative Alarm Interrupt
RTC_ALL_INT	0x0F	All Interrupt
RTC_IOC_IDENTIFY_LEAP_YEAR	0	Identify the leap year command
RTC_IOC_SET_TICK_MODE	1	Set tick mode command
RTC_IOC_GET_TICK	2	Get tick command
RTC_IOC_RESTORE_TICK	3	Restore tick command
RTC_IOC_ENABLE_INT	4	Enable interrupt command
RTC_IOC_DISABLE_INT	5	Disable interrupt command
RTC_IOC_SET_CURRENT_TIME	6	Set Current time command
RTC_IOC_SET_ALAMRM_TIME	7	Set Alarm time command
RTC_IOC_SET_FREQUENCY	8	Set Frequency command
RTC_IOC_SET_POWER_ON	9	Set Power On (Set PWR_ON to 1)
RTC_IOC_SET_POWER_OFF	10	Set Power Off (Set PWR_ON to 0)
RTC_IOC_SET_POWER_OFF_PERIOD	11	Set Power Off Period (PCLR_TIME)
RTC_IOC_ENABLE_HW_POWEROFF	12	Enable H/W Power Off
RTC_IOC_DISABLE_HW_POWEROFF	13	Disable H/W Power Off
RTC_IOC_GET_POWERKEY_STATUS	14	Get Power Key Status
RTC_IOC_SET_PSWI_CALLBACK	15	Set Power Switch Interrupt Callback function
RTC_IOC_GET_SW_STATUS	16	Get SW Status data (8 bits)
RTC_IOC_SET_SW_STATUS	17	Set SW Status data (8 bits)
RTC_IOC_SET_RELEATIVE_ALARM	18	Set relative alarm and install call backfunvtion
RTC_IOC_SET_POWER_KEY_DURATION	19	Set Power Control Signal Delay
RTC_IOC_SET_POWER_KEY_LEVEL_TRIG	20	Set Power Key Trigger Mode – Level Trigger
RTC_IOC_SET_POWER_KEY_EDGE_TRIG	21	Set Power Key Trigger Mode – Edge Trigger
RTC_IOC_GET_SW_REGISTER0	22	Get SW Status Register 0 data (32 bits)
RTC_IOC_SET_SW_REGISTER0	23	Set SW Status Register 0 data (32 bits)
RTC_IOC_GET_SW_REGISTER1	24	Get SW Status Register 1 data (32 bits)
RTC_IOC_SET_SW_REGISTER1	25	Set SW Status Register 1 data (32 bits)
RTC_CURRENT_TIME	0	Current time
RTC_ALARM_TIME	1	Alarm time
RTC_WAIT_COUNT	10000	RTC Initial Time out Value
RTC_YEAR2000	2000	RTC Year Reference Value

RTC Library Time and Date Definition

The RTC library provides time structure to access RTC time property.

Name	Value	Description
u8cClockDisplay	RTC_CLOCK_12 / RTC_CLOCK_24	12 Hour Clock / 24 Hour Clock
u8cAmPm	RTC_AM / RTC_PM	the AM hours / the PM hours
u32cSecond	0~59	Second value
u32cMinute	0~59	Minute value
u32cHour	1~11 / 0~23	Hour value
u32cDayOfWeek	RTC_SUNDAY~ RTC_SATURDAY	Day of week
u32cDay	1~31	Day value
u32cMonth	1~12	Month value
u32Year	0~99	Year value
u32AlarmMaskDayOfWeek	0/1 (Disable/Enable)	Dya of Week Alarm Mask Enable
u32AlarmMaskSecond	0/1 (Disable/Enable)	Second Alarm Mask Enable
u32AlarmMaskMinute	0/1 (Disable/Enable)	Minute Alarm Mask Enable
u32AlarmMaskHour	0/1 (Disable/Enable)	Hour Alarm Mask Enable
u32AlarmMaskDay	0/1 (Disable/Enable)	Day Alarm Mask Enable
u32AlarmMaskMonth	0/1 (Disable/Enable)	Month Alarm Mask Enable
u32AlarmMaskYear	0/1 (Disable/Enable)	Year Alarm Mask Enable

20.2. RTC API

RTC_Init

Synopsis

UINT32 RTC_Init (VOID)

Description

This function is to initialize RTC and install Interrupt service routine

Parameter

None

Return Value

E_SUCCESS	- Success
E_RTC_ERR_EIO	- Access RTC Failed.

Example

/* RTC Initialize */

RTC_Init();

RTC_Open

Synopsis

UINT32 RTC_Open (RTC_TIME_DATA_T *sPt)

Description

This function configures RTC current time.

Parameter

sPt	RTC time property and current time information

Return Value

E_SUCCESS	- Success
E_RTC_ERR_EIO	- Access RTC Failed.
E_RTC_ERR_CALENDAR_VALUE	- Wrong Calendar Value
E_RTC_ERR_TIMESACLE_VALUE	- Wrong Time Scale Value
E_RTC_ERR_TIME_VALUE	- Wrong Time Value
E_RTC_ERR_DWR_VALUE	- Wrong Day Value
E_RTC_ERR_FCR_VALUE	- Wrong Compensation value

Example

```
/* Initialization the RTC timer */

if(RTC_Open(&sInitTime) !=E_RTC_SUCCESS)

       sysprintf("Open Fail!!\n");
```

RTC_Close

Synopsis

UINT32 RTC_Close (VOID)

Description

Disable AIC channel of RTC and both tick and alarm interrupt

Parameter

None

Return Value

E_SUCCESS	- Success

Example

```
/* Disable RTC */

RTC_Close();
```

RTC_Read

Synopsis

UINT32 RTC_Read (E_RTC_TIME_SELECT eTime, RTC_TIME_DATA_T *sPt)

Description

Read current date/time or alarm date/time from RTC

Parameter

eTime	The current/alarm time to be read	
	RTC_CURRENT_TIME	- Current time
	RTC_ALARM_TIME	- Alarm time
sPt	RTC time property and current time information	

Return Value

E_SUCCESS	- Success
E_RTC_ERR_EIO	- Access RTC Failed.
E_RTC_ERR_ENOTTY	- Command not support, or incorrect parameters.

Example

```
/* Get the current time */

RTC_Read(RTC_CURRENT_TIME, &sCurTime);
```

RTC_WriteEnable

Synopsis

UITN32 RTC_WriteEnable (BOOL bEnable)

Description

Enable /Disable RTC register access

Parameter

bEnable	TRUE/FALSE

Return Value

E_SUCCESS	- Success
E_RTC_ERR_EIO	- Access RTC Failed.

Example

```
/* Enable RTC Access */

RTC_WriteEnable(TRUE);

/* Disable RTC Access */

RTC_WriteEnable(FALSE);
```

RTC_DoFrequencyCompensation

Synopsis

BOOL RTC_DoFrequencyCompensation(VOID)

Description

Set Frequency Compensation Data if RTC crystal frequency isn't accurate.

Parameter

None

Return Value

E_SUCCESS	- Success
E_RTC_ERR_FCR_VALUE	- Can't do compensation.

Example

```
RTC_DoFrequencyCompensation ()
```

RTC_Ioctl

Synopsis

UINT32 RTC_Ioctl (INT32 i32Num, E_RTC_CMD eCmd,, UINT32 u32Arg0, UINT32 u32Arg1)

Description

This function allows user to set some commands for application, the support commands and arguments listed in the table below (Argument 1 is reserved for feature use).

Command	Argument 0	Argument 1	Comment
RTC_IOC_IDENTIFY_LEAP_YEAR	Unsigned integer pointer to store the return leap year value	None	Get the leap year
RTC_IOC_SET_TICK_MODE	Unsigned integer stores the tick mode data	None	Set Tick mode
RTC_IOC_GET_TICK	Unsigned integer pointer to store the return tick number	None	Get the tick counter
RTC_IOC_RESTORE_TICK	None	None	Restore the tick counter
RTC_IOC_ENABLE_INT	interrupt type	None	Enable interrupt
RTC_IOC_DISABLE_INT	interrupt type	None	Disable interrupt
RTC_IOC_SET_CURRENT_TIME	None	None	Set current time
RTC_IOC_SET_ALAMRM_TIME	None	None	Set alarm time
RTC_IOC_SET_FREQUENCY	Unsigned integer stores the Frequency Compensation value	None	Set Frequency Compensation Data
RTC_IOC_SET_PWRON	None	None	Set Power on
RTC_IOC_SET_PWROFF	None	None	Set Power off
RTC_IOC_SET_POWER_OFF_PERIOD	Unsigned integer stores the power off period value : 0~15	None	Set Power Off Period
RTC_IOC_ENABLE_HW_POWEROFF	None	None	Enable H/W Power Off
RTC_IOC_DISABLE_HW_POWEROF	None	None	Disable H/W Power Off
RTC_IOC_GET_POWERKEY_STATUS	Unsigned integer pointer to store the return Power Key status	None	Get Power Key Status
RTC_IOC_SET_PSWI_CALLBACK	The call back function pointer for Power Switch Interrupts	None	Set Power Switch Interrupt Callback function
RTC_IOC_GET_SW_STATUS	Unsigned integer pointer to store the return SW Status (8 Bits)	None	Get SW Status data (8 bits)
RTC_IOC_SET_SW_STATUS	Unsigned integer stores the SW Status data (8 Bits)	None	Set SW Status data (8 bits)

RTC_IOC_SET_RELEATIVE_ALARM	The call back function pointer for Relative Alarm Interrupts	Alarm time (0~4095)	Set relative alarm and install call backfunvtion
RTC_IOC_SET_POWER_KEY_DURATION	power key duration	None	Set Power Control Signal Delay
RTC_IOC_SET_POWER_KEY_LEVEL_TRIG	None	None	Set Power Key Trigger Mode – Level Trigger
RTC_IOC_SET_POWER_KEY_EDGE_TRIG	None	None	Set Power Key Trigger Mode – Edge Trigger
RTC_IOC_GET_SW_REGISTER0	Unsigned integer pointer to store the return SW Status Register 0 (32 Bits)	None	Get SW Status Register 0 data (32 bits)
RTC_IOC_SET_SW_REGISTER0	Unsigned integer stores the SW Status Register 0 (32 Bits)	None	Set SW Status Register 0 data (32 bits)
RTC_IOC_GET_SW_REGISTER1	Unsigned integer pointer to store the return SW Status Register 1 (32 Bits)	None	Get SW Status Register 1 data (32 bits)
RTC_IOC_SET_SW_REGISTER1	Unsigned integer stores the SW Status Register 1 (32 Bits)	None	Set SW Status Register 1 data (32 bits)

Parameter

sicFeature	SIC_SET_CLOCK, SIC_SET_CALLBACK
u32Arg0	Depend on feature setting
u32Arg1	Depend on feature setting

Return Value

None

Example

```
/* Set Tick setting */

RTC_Ioctl(0,RTC_IOC_SET_TICK_MODE, (UINT32)&sTick,0);



* Enable RTC Tick Interrupt and install tick call back function */

RTC_Ioctl(0,RTC_IOC_ENABLE_INT, (UINT32)RTC_TICK_INT,0);



/* Press Power Key during 6 sec to Power off */

RTC_Ioctl(0, RTC_IOC_SET_POWER_OFF_PERIOD, 6, 0);
```

```
/* Install the callback function for Power Key Press */
RTC_Ioctl(0, RTC_IOC_SET_PSWI_CALLBACK, (UINT32)PowerKeyPress, 0);


/* Enable Hardware Power off */
RTC_Ioctl(0, RTC_IOC_ENABLE_HW_POWEROFF, 0, 0);


/* Query Power Key Status */
RTC_Ioctl(0, RTC_IOC_GET_POWERKEY_STATUS, (UINT32)&u32PowerKeyStatus, 0);


/* Power Off - S/W can call the API to power off any time he wants */
RTC_Ioctl(0, RTC_IOC_SET_POWER_OFF, 0, 0);


/* Enable RTC Relative alarm Interrupt and install call back function */
RTC_Ioctl(0,RTC_IOC_SET_RELEATIVE_ALARM, 10, (UINT32)RTC_Releative_AlarmISR);


/* Set Power Control Signal Delay */
              RTC_Ioctl(0,RTC_IOC_SET_POWER_KEY_DELAY,  1, 0);
 Delay time Formula
Minimum Power key duration = 0.25*(POWER_KEY_DURATION+1) sec
```

20.3. Example code

The demo code test “Time display”, “Absolute Alarm, “ Relative Alarm” , “Power down Wakeup”, “Software Power Off (Normal Case) Control Flow”, “Hardware Power Off (System Crash) Control Flow”, “Software Force to Power Off”, and “Alarm Mask”. Please refer to the RTC sample code of SDK Non-OS.

20.4. Error Code Table

Code Name	Value	Description
E_RTC_SUCCESS	0	Operation success
E_RTC_ERR_CALENDAR_VALUE	1	Wrong Calendar Value
E_RTC_ERR_TIMESACLE_VALUE	2	Wrong Time Scale Value
E_RTC_ERR_TIME_VALUE	3	Wrong Time Value
E_RTC_ERR_DWR_VALUE	4	Wrong Day Value
E_RTC_ERR_FCR_VALUE	5	Wrong Compensation value
E_RTC_ERR_EIO	6	Access RTC Failed.
E_RTC_ERR_ENOTTY	7	Command not support, or parameter incorrect.
E_RTC_ERR_ENODEV	8	Interface number incorrect.

21. RTC Power Control Library Overview

N9H26 RTC provides a power control function for system power control. The application note describes the function in detail.

21.1. Power Control Function Overview

RTC Power Control supports power on and power off functions:

Power On

N9H26 can be power on by Power Key or RTC alarm.

Power Off

RTC provides three modes to Power off.

- Hardware Force Power Off
  Hardware Force Power Off function is to power off system by holding the power key about the specified period even when software crash.
- Software Force Power Off
  When Power Key is pressed, system can be power off by software.
- Software Power off
  When Power Key is released, system can be power off by software.

21.2. Preliminary Definition

Power Key (PWRKEY)

PWRKEY is the power key for user to power On/Off system power except RTC power.

Power Control Signal (PWCE)

PWCE is the power control signal to control the power control unit.

Power Key Status (PWR_KEY)

Power Key Status
- 1: Indicated the power key status is high
- 0: Indicated the power key is pressed to low.

Software Status (SW_STATUS)

RTC provides 8 bits to store software information.

Hardware Force Power Off Enable (HW_PCLR_EN)

RTC provides a Hardware Force Power Off function to power off system by holding the power key about the specified period even when software crash. The bit is to enable the Hardware Force Power Off function.

Hardware Force Power Off Period (PCLR_TIME)

If user holds the power key about the specified period, the system will be power off. The following table is the period setting.

Setting	Hold Time to power off	Setting	Hold Time to power off
0	2~3 second	**8**	10~11 seconds
1	3~4 second	**9**	11~12 seconds
2	4~5 seconds	**10**	12~13 seconds
3	5~6 seconds	**11**	13~14 seconds
4	6~7 seconds	**12**	14~15 seconds
5	7~8 seconds	**13**	15~16 seconds
6	8~9 seconds	**14**	16~17 seconds
7	9~10 seconds	**15**	17~18 seconds

Power on (PWR_ON)

The bit is used to control PWCE to control system power.
- PWCE will change to high state when this bit changes from 0 to 1 and the Power Key is pressed.
- PWCE will change to low state when this bit changes from 1 to 0 and the Power Key is released.

Power-down Mode

Whole system is power-off except RTC.

Power key duration (POWER_KEY_DURATION_LENGTH)

The delay time between Power Key pressed and PWCE high (or Power Key released and PWCE low)
- Minimum power key duration = 0.25*(POWER_KEY_DURATION+1) sec.

Interrupt Enable & Status

RTC provides three interrupts (They can't keep when Power-down Mode)

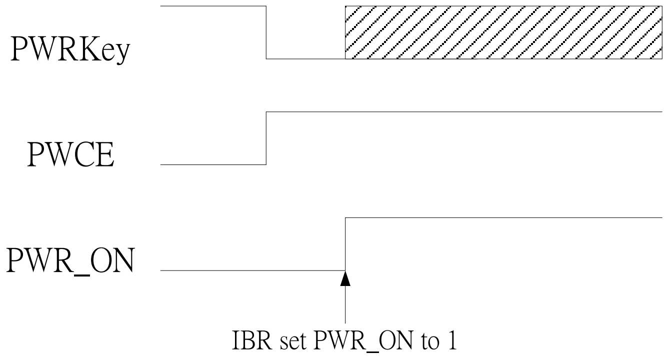
- Alarm Interrupt (AIER & AI)
- Time Tick Interrupt (TIER & TI)
- Power Switch Interrupt (PSWIER & PSWI)
  It indicates that the Power Key has been pressed.

21.2.1. System Power On Control Flow

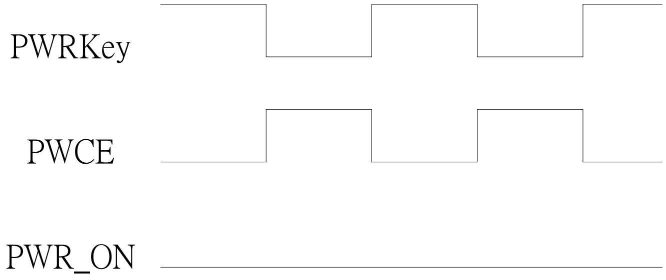
Two ways to power on system:

Power On from Power Key

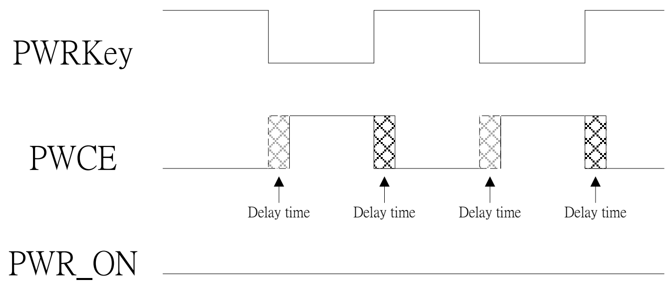
User presses the Power Key to make the Power Control Signal, PWCE to high. If PWR_ON bit is set, the Power Key can be released and the PWCE will be keep on. When system is power on, IBR will set PWR_ON first.



If PWR_ON doesn't be set to 1, the PWCE will back to low when the Power Key is released.



And RTC supports a function (**POWER_KEY_DURATION_LENGTH)**) to postpone the time to set PWCE to high when pressing Power Key or to postpone the time to set PWCE to low when releasing Power Key. The delay time is from 62ms to 868ms. The function is default disabled. User can enable it after first power on and the setting can be kept when RTC is powered even whole system is power-off.



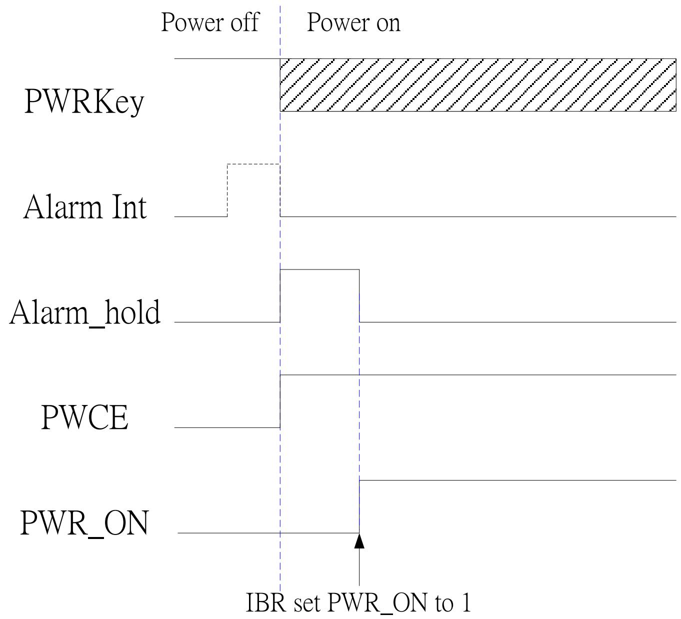
[Note 1]. **The function (POWER_KEY_DURATION_LENGTH)) only works only when Power Key is pressed or released.**

[Note 2]. **POWER KEY TRIGGER MODE**

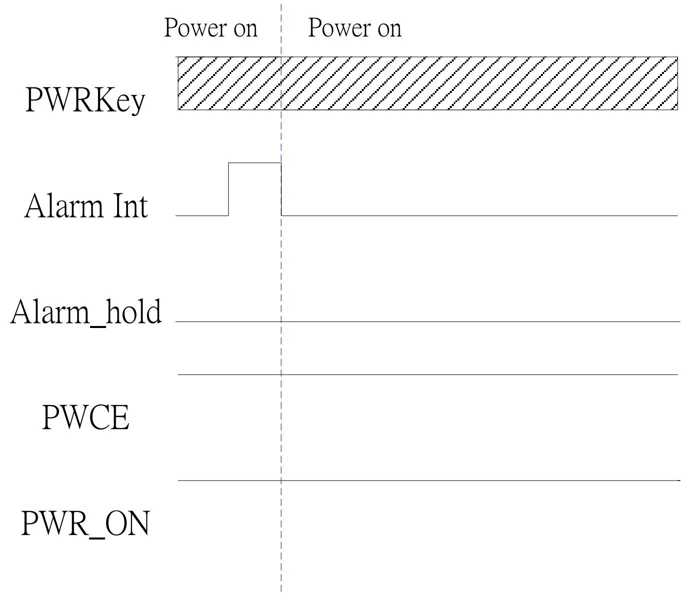
- **1: EDGE TRIGE**
  - **RTC is powered on while power key is pressed longer than programmed duration and then released**
- **0: LEVEL TRIGGER**
  - **RTC is powered on while power key is pressed longer programmed duration**

Power On from RTC Alarm

In Power-down mode, if RTC alarm occurs, RTC keeps an internal Alarm_hold signal to force the PWCE to high. After PWR_ON is set, the Alarm_hold signal is clear and PWCE is released, then PWCE keeps on by PWR_ON. When system is power on, IBR will set PWR_ON first.

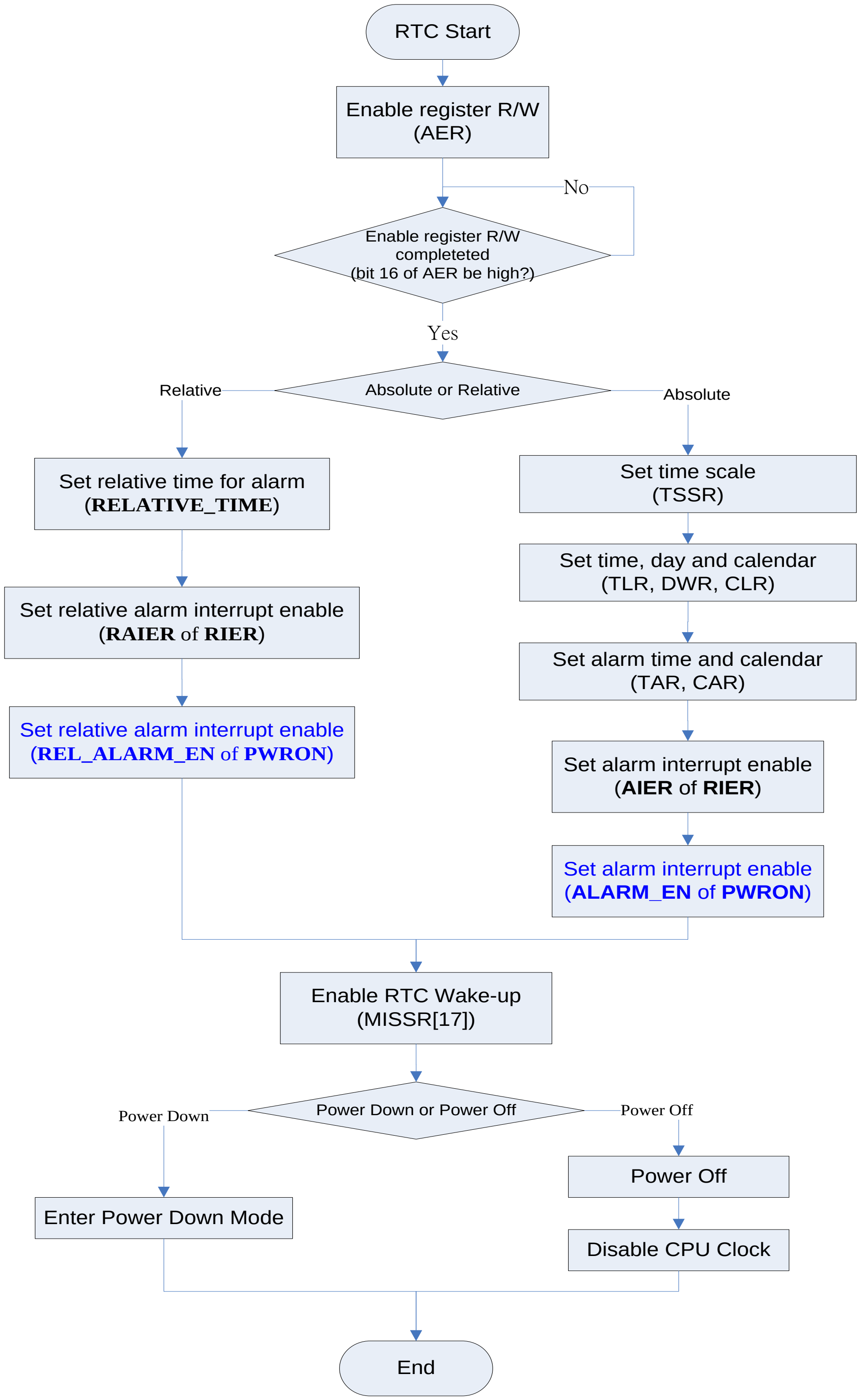


In normal mode, if RTC alarm occurs, the Alarm_hold signal isn't set. Therefore, PWCE doesn't force to high by Alarm_hold.



[Note1] Alarm_hold is set only when PWR_ON is low.
[Note2] If user doesn't want to power on by RTC Alarm, user must let the alarm condition can't be reached to avoid false wakeup. Ex, Clear the alarm time.

The Power down Wakeup from RTC alarm programming flow is as follows.



[Note1] If user won't enable wakeup function, please don't enable the alarm enable bit of **PWRON (REL_ALARM_EN or ALARM_EN)**

Power On Source Judgment

Because the interrupt status flag can't keep in Power-down Mode, user can't use interrupt flag to determine which Power on Source is. The way to confirm it is to check the RTC Alarm time and Current time right after IBR. If they aren't the same (or close), system is power-on from Power Key. The following table is all the cases of Power on Source.

Power Key Status	Time Match	Power on Source
Pressed	No	Power Key
Pressed	Yes	Power Key and RTC Alarm
Released	No	Reset Key/WDT Reset/Power on Exception
Released	Yes	RTC Alarm

Power On Exception

When user removes N9H26's battery and put it back later, N9H26 will be power on automatically without Power Key pressed or RTC Alarm (like user presses the reset button). Using the above-mentioned condition, we can let N9H26 power off in the situation. And the way to differentiate between Reset and Power Exception (ex. Removing N9H26's battery) is to write a specific key word in DRAM or SRAM when N9H26 is power on and clear it when N9H26 is power off normally.(Data in SRAM or DRAM will be lost when N9H26's power is off)

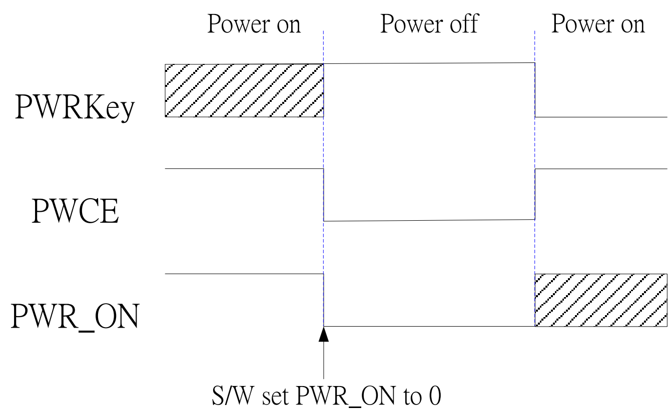
	Specific Key word	Power on source	Software action
Hardware or Software Power Off	Unknown value	Power Key or RTC Alarm	Keep Power On
Reset/WDT	Not Changed	N/A	Keep Power On
Power on Exception	**Unknown value**	**N/A**	**Power off**

21.2.2. System Power Off Control Flow

There are two modes to power off system.

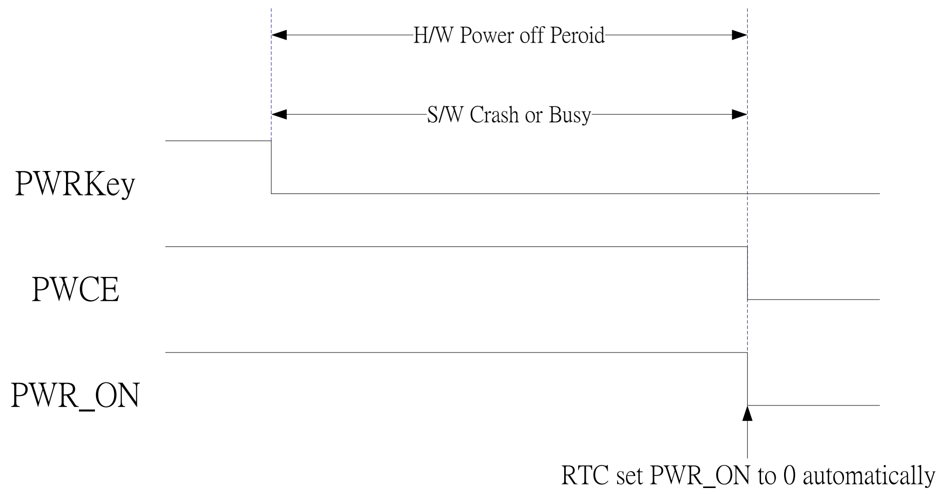
Software Power Off

If user wants to power off system, ex. Specified time to power off or user press power key to power off system, user must set PWR_ON to 0 to power off system any time he wants.



Hardware Force Power Off

RTC provides a Hardware Force Power Off function to power off system even when software crash. After enabling the function (HW_PCLR_EN), if user holds the power key about the specified period, the system will be power off.



21.3. Power Control Flow Truth Table

Here is the Power Control Flow Truth Table except the force mode.

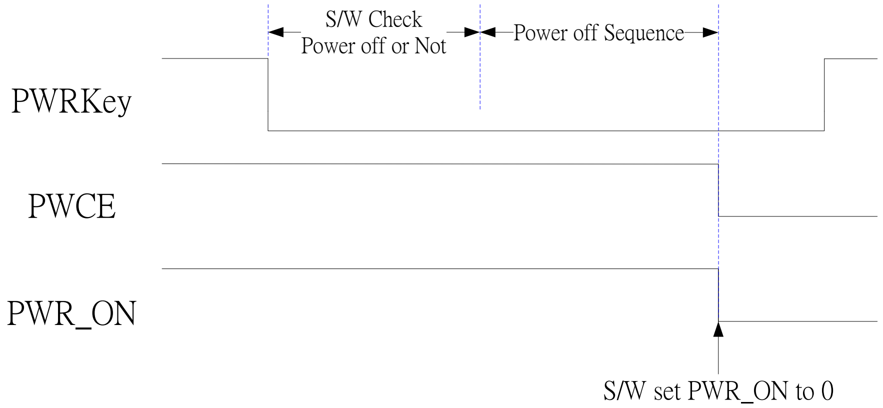
Step	Input				Output	Note
	X1	X2	X3	X4	Y	
	PWRKey	PWR_ON	RST_	Alarm-hold	PWCE	

Power key control flow						
0	**1**	**0**	**0**	**0**	**0**	**RTC powered only (Default state)**
1	**0**	**0**	**X**	**0**	**1**	**Press key, Power On**
2	**0**	**1**	**1**	**0**	**1**	**keep key pressed & S/W Set X2, Power On**
3	**1**	**1**	**1**	**0**	**1**	**Release key, Power keep On**
4	**0**	**1**	**1**	**0**	**1**	**Press key, get INT, intend to power Off**
5	**1**	**0**	**1**	**0**	**0**	**Release key & S/W clean X2, power Off** **Or S/W clean X2 , don't need press key, power off**
Reset						
0	**X**	**1**	**0**	**0**	**1**	**RST_ active, still keep power when X2=1**
Alarm flow						
0	**1**	**0**	**0**	**0**	**0**	**RTC powered only (Default state)**
1	**1**	**0**	**X**	**1**	**1**	**Alarm**
2	**1**	**1**	**1**	**0**	**1**	**IBR set X2**
PWCE (open drain output) = /PWRKEY + Alarm-hold + /PWR_ON when HW_PCLR_EN=0 **X1, internal pull-up** **X2, it is R/W able** **X4, internal signal. Will be 1 after alarm if X2=0, and be cleared after X2 set.** **There is Interrupt from key be pressed**						

21.4. Power off Flow Example

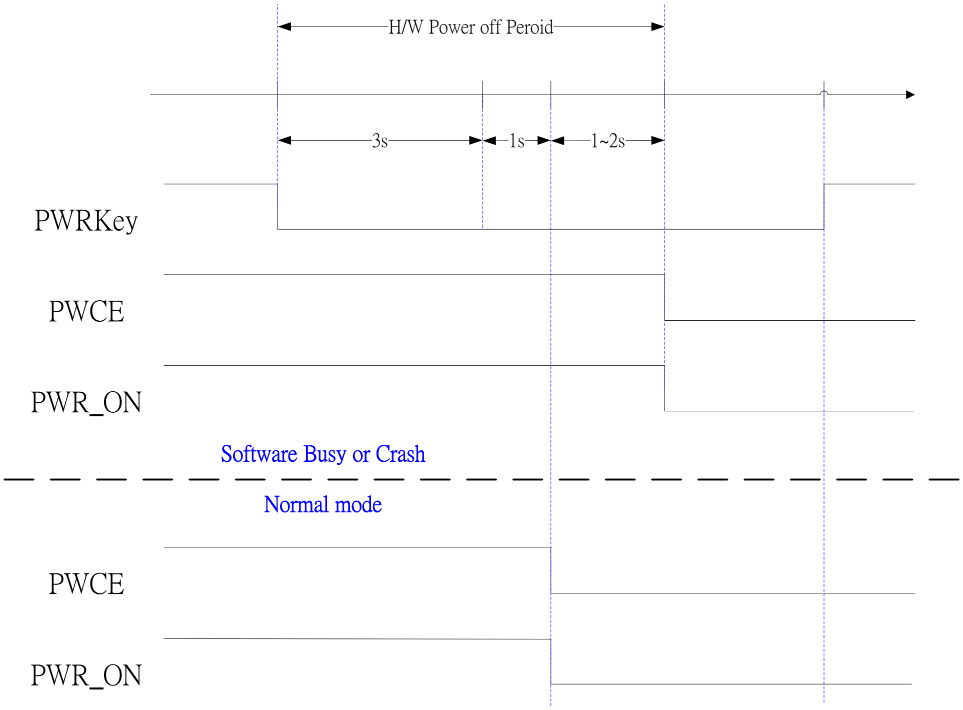
Normal Power Off Flow

When user gets the Power Switch Interrupt, user can decide to do the power off sequence or not to do it. If the Power off sequence is done, user can set PWR_ON to 0 to power off system right away.



Software Busy/Crash Power Off Flow

- The example sets the Hardware Power off period as 6 seconds.
- It takes 3 seconds to decide to do the power off sequence or not to do it.
- It takes 1 second to do power off sequence.



22. SDIO Library Overview

N9H26 Non-OS library consists of a sets of libraries. These libraries are built to access those on-chip functions such as VPOST, APU, SIC, USBH, USBD, GPIO, I2C, SPI and UART, as well as File System (NVTFAT), TCP/IP protocol (lwip), USB MassStorage devices (UMAS) and NAND Flash devices (GNAND). This document describes the provided APIs of SDIO library. With these APIs, user can quickly build a binary target for SDIO library on N9H26 micro processor.

These libraries are created by using ARM Development Suite 1.2. Therefore, they only can be used in ADS environment.

22.1. SDIO Library

This library is designed to make user application access N9H26 SDIO (Secure-Digital Input / Output) controller more easily. This interface can directly connect to SD card.

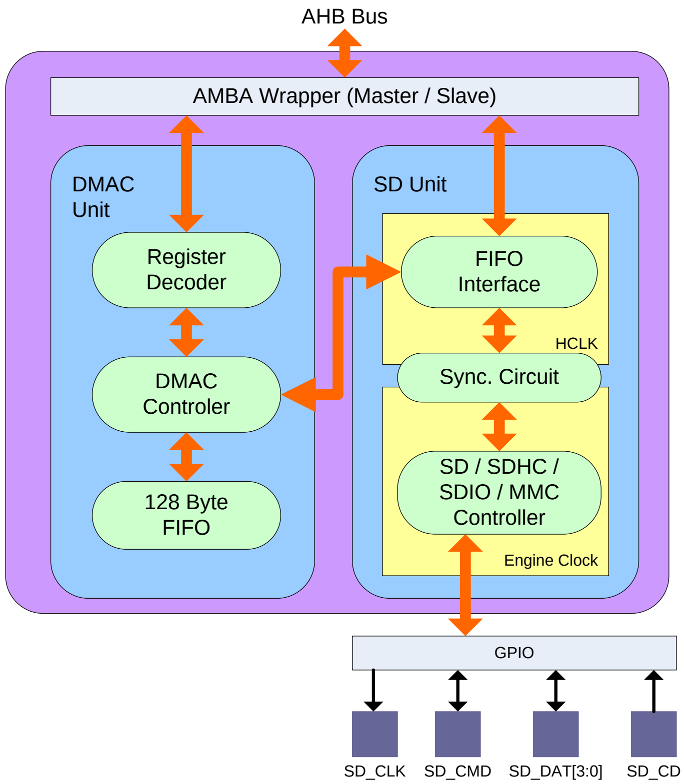
The SDIO library has the following features:

- Support single DMA channel and address in non-word boundary.
- Support SD/SDHC/SDIO/MMC card.

22.2. Programming Guide

System Overview

The SDIO controller of N9H26 chip has DMAC unit and SD unit. The DMAC unit provides a DMA (Direct Memory Access) function for SD unit to exchange data between system memory (ex. SDRAM) and shared buffer (128 bytes), and the SD unit control the interface of SD/SDHC/SDIO/MMC. The SDIO controller can support SD/SDHC/SDIO/MMC card and the SD unit is cooperated with DMAC unit to provide a fast data transfer between system memory and cards. The block diagram of SDIO controller is shown as following:



22.3. SDIO API

sdioOpen

Synopsis

void sdioOpen (VOID)

Description

sdioOpen() will initialize the SDIO and DMAC interface hardware. It configures GPIO to SDIO mode, and installs ISR. This function is board dependent. It probably needs some modifications before it can work properly on your target board.

Parameter

None

Return Value

None

Example

```
/* initialize SDIO mode */

sdioIoctl(SDIO_SET_CLOCK, 192000, 0, 0);  /* clock from PLL */

sdioOpen();
```

sdioClose

Synopsis

void sdioClose (VOID)

Description

sdioClose() will Close the SDIO and DMAC interface hardware. It configures GPIO to close DMAC and disable ISR for SDIO.

Parameter

None

Return Value

None

Example

```
sdioClose();
```

sdioIoctl

Synopsis

VOID sdioIoctl (INT32 sdioFeature, INT32 sdioArg0, INT32 sdioArg1, INT32 sdioArg2)

Description

sdioIoctl() allows user set engine clock and callback functions, the support features and arguments listed in the table below.

Feature	Argument 0	Argument 1	Argument 2
SDIO_SET_CLOCK	AHB clock by KHz	None	None
SDIO_SET_CALLBACK	Card type (FMI_SDIO_CARD / FMI_SDIO1_CARD)	SD Card Remove callback function	SD Card Insert callback function
SDIO_GET_CARD_STATUS	Pointer to return value of SD card status	None	None

Parameter

sdioFeature	SDIO_SET_CLOCK, SDIO_SET_CALLBACK, SDIO_GET_CARD_STATUS
sdioArg0	Depend on feature setting
sdioArg1	Depend on feature setting
sdioArg2	Depend on feature setting

Return Value

For SDIO_GET_CARD_STATUS, the card status assign to sdioArg0. The value TRUE means SD card inserted, FALSE means SD card removed.

Example

```
Refer to the example code of sdioOpen().
```

22.4. SDIO API

sdioSdOpen

Synopsis

INT sdioSdOpen (void)	open SD card 0
INT sdioSdOpen0 (void)	open SD card 0
INT sdioSdOpen1 (void)	open SD card 1

Description

This function initialize the SDIO host interface and program the SD card from identify mode to stand-by mode.

Parameter

None

Return Value

>0	– Total sector number of SD card
Otherwise	– Refer error code defined in Error Code Table

Example

```
if (sdioSdOpen0() <= 0)      // Open SDIO port 0

{

printf("Error in initializing SD card !! \n");
```

```
/* handle error status */

}
```

sdioSdClose

Synopsis

void sdioSdClose (void) close SD card 0

void sdioSdClose0 (void) close SD card 0

void sdioSdClose1 (void) close SD card 1

Description

This function close the SDIO host interface.

Parameter

None

Return Value

None

Example

```
sdioSdClose();                // Close SDIO port 0
```

sdioSdRead

Synopsis

INT sdioSdRead (INT32 sdSectorNo, INT32 sdSectorCount, INT32 sdTargetAddr)
for SD card 0

INT sdioSdRead0 (INT32 sdSectorNo, INT32 sdSectorCount, INT32 sdTargetAddr)
for SD card 0

INT sdioSdRead1 (INT32 sdSectorNo, INT32 sdSectorCount, INT32 sdTargetAddr)
for SD card 1

Description

This function will read the data from SD card.

Parameter

sdSectorNo	Sector No. to get the data from
sdSectorCount	Sector count of this access
sdTargetAddr	The address which data upload to SDRAM

Return Value

0	- On success
FMISDIO_TIMEOUT	- Access timeout
FMISDIO_NO_SD_CARD	- Card removed
FMISDIO_SD_CRC7_ERROR	- Command/Response error
FMISDIO_SD_CRC16_ERROR	- Data transfer error

Example

```
#define FMI_TEST_SIZE  (512*128)

__align(4096) UINT8 fmiReadBackBuffer[FMI_TEST_SIZE];

// read 128 sectors data from SD card sector address 300.

status = sdioSdRead(300, FMI_TEST_SIZE/512, (unsigned int)fmiReadBackBuffer);
```

sdioSdWrite

Synopsis

INT sdioSdWrite (INT32 sdSectorNo, INT32 sdSectorCount, INT32 sdSourceAddr)
for SD card 0

INT sdioSdWrite0 (INT32 sdSectorNo, INT32 sdSectorCount, INT32 sdSourceAddr)
for SD card 0

INT sdioSdWrite1 (INT32 sdSectorNo, INT32 sdSectorCount, INT32 sdSourceAddr)
for SD card 1

Description

This function write the data into SD card.

Parameter

sdSectorNo	Sector No. to get the data from
sdSectorCount	Sector count of this access
sdSourcetAddr	The address which download data from SDRAM

Return Value

0	- On success
FMISDIO_TIMEOUT	- Access timeout
FMISDIO_NO_SD_CARD	- Card removed
FMISDIO_SD_CRC7_ERROR	- Command/Response error
FMISDIO_SD_CRC_ERROR	- Data transfer error

Example

```
#define FMI_TEST_SIZE  (512*128)
```

```
__align(4096) UINT8 fmiFlash_Buf[FMI_TEST_SIZE];

// write 128 sectors data to SD card sector address 3000.

status = sdioSdWrite(3000, FMI_TEST_SIZE/512, (unsigned int)fmiFlash_Buf);
```

22.5. Example code

The demo code test the SD card by read / write / compare please refer to the SDIO sample code of SDK Non-OS.

22.6. Error Code Table

Code Name	Value	Description
FMISDIO_TIMEOUT	0xFFFF0101	Access timeout
FMISDIO_NO_MEMORY	0xFFFF0102	No available memory
Error Code for SD Card		
FMISDIO_NO_SD_CARD	0xFFFF0110	No SD card insert
FMISDIO_ERR_DEVICE	0xFFFF0111	Unknown device type
FMISDIO_SD_SELECT_ERROR	0xFFFF0113	Select card from identify mode to stand-by mode error
FMISDIO_SD_INIT_ERROR	0xFFFF0115	SD Card initial and identify error
FMISDIO_SD_CRC7_ERROR	0xFFFF0116	Command/Response error
FMISDIO_SD_CRC16_ERROR	0xFFFF0117	Data reading error
FMISDIO_SD_CRC_ERROR	0xFFFF0118	Data writing error
FMISDIO_SD_CMD8_ERROR	0xFFFF0119	SD command 8 error

23. SIC Library Overview

N9H26 Non-OS library consists of a sets of libraries. These libraries are built to access those on-chip functions such as VPOST, APU, SIC, USBH, USBD, GPIO, I2C, SPI and UART, as well as File System (NVTFAT), TCP/IP protocol (lwip), USB MassStorage devices (UMAS) and NAND Flash devices (GNAND). This document describes the provided APIs of SIC library. With these APIs, user can quickly build a binary target for SIC library on N9H26 micro processor.

These libraries are created by using ARM Development Suite 1.2. Therefore, they only can be used in ADS environment.

23.1. Storage Interface Controller Library

This library is designed to make user application access N9H26 Storage Interface Controller (SIC) more easily. This interface can directly connect to SD and NAND Flash.

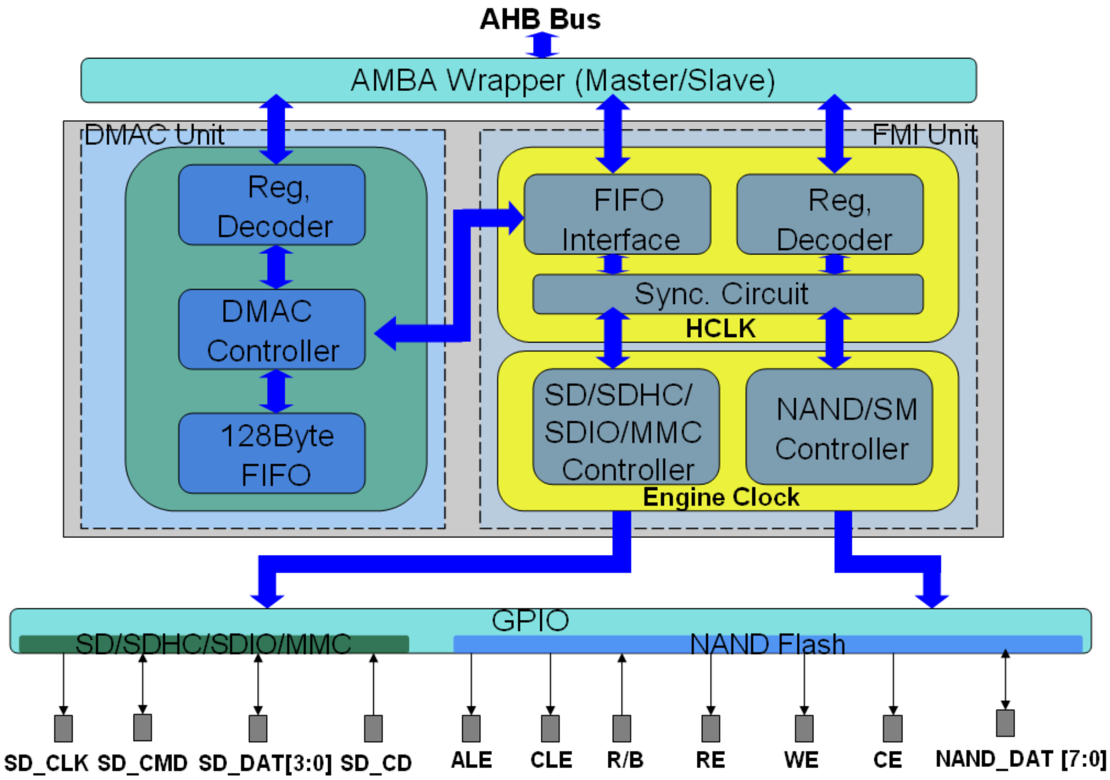
The SIC library has the following features:

- Support single DMA channel and address in non-word boundary.
- Support SD/SDHC/SDIO/MMC card.
- Supports SLC and MLC NAND type Flash.
- Adjustable NAND page sizes. (512 / 2048 / 4096 / 8192 bytes + spare area)
- Support up to 4bit / 8bit / 12bit / 15bit / 24bit hardware ECC calculation circuit to protect data communication.
- Programmable NAND/SM timing cycle.

23.2. Programming Guide

System Overview

The Storage Interface Controller (SIC) of N9H26 chip has SIC_DMAC unit and SIC_FMI unit. The SIC_DMAC unit provides a DMA (Direct Memory Access) function for FMI to exchange data between system memory (ex. SDRAM) and shared buffer (128 bytes), and the SIC_FMI unit control the interface of SD/SDHC/SDIO/MMC or NAND/SM. The storage interface controller can support SD/SDHC/SDIO/MMC card and NAND-type flash and the FMI is cooperated with DMAC to provide a fast data transfer between system memory and cards. The block diagram of SIC controller is shown as following:



NAND Driver and GNAND Library

The SIC library provide NAND driver API to access NAND chip directly. However, the NAND driver don't support management features for NAND chip that don't guarantee all blocks are valid. The management features include bad block management, garbage collection, and wear-leveling. We provide GNAND library to support these management features and suggest to use GNAND library before using SIC NAND driver. Please refer to document "N9H26 Non-OS GNAND Library Reference Guide" for GNAND library detail information.

23.3. SIC API

sicOpen

Synopsis

void sicOpen (VOID)

Description

sicOpen() will initialize the SIC and DMAC interface hardware. It configures GPIO to FMI mode, and installs ISR. This function is board dependent. It probably needs some modifications before it can work properly on your target board.

Parameter

None

Return Value

None

Example

```
/* initialize SIC to FMI (Flash Memory Interface controller) mode */

sicIoctl(SIC_SET_CLOCK, 192000, 0, 0);  /* clock from PLL */

sicOpen();
```

sicClose

Synopsis

void sicClose (VOID)

Description

sicClose() will Close the SIC and DMAC interface hardware. It configures GPIO to close DMAC and disable ISR for SIC.

Parameter

None

Return Value

None

Example

```
sicClose();
```

sicIoctl

Synopsis

VOID sicIoctl (INT32 sicFeature, INT32 sicArg0, INT32 sicArg1, INT32 sicArg2)

Description

sicIoctl() allows user set engine clock and callback functions, the support features and arguments listed in the table below.

Feature	Argument 0	Argument 1	Argument 2
SIC_SET_CLOCK	AHB clock by KHz	None	None
SIC_SET_CALLBACK	Card type (FMI_SD_CARD)	SD Card Remove callback function	SD Card Insert callback function
SIC_GET_CARD_STATUS	Pointer to return value of SD card status	None	None

Parameter

sicFeature SIC_SET_CLOCK, SIC_SET_CALLBACK, SIC_GET_CARD_STATUS

sicArg0 Depend on feature setting

sicArg1 Depend on feature setting

sicArg2 Depend on feature setting

Return Value

For SIC_GET_CARD_STATUS, the card status assign to sicArg0. The value TRUE means SD card inserted, FALSE means SD card removed.

Example

```
Refer to the example code of sicOpen().
```

23.4. SIC / SD API

sicSdOpen

Synopsis

INT sicSdOpen (void) open SD card 0

INT sicSdOpen0 (void) open SD card 0

INT sicSdOpen1 (void) open SD card 1

INT sicSdOpen2 (void) open SD card 2

Description

This function initialize the SD host interface and program the SD card from identify mode to stand-by mode.

Parameter

None

Return Value

>0 – Total sector number of SD card

Otherwise – Refer error code defined in Error Code Table

Example

```
if (sicSdOpen0() <= 0)       // Open SD port 0

{

printf("Error in initializing SD card !! \n");

/* handle error status */

}
```

sicSdClose

Synopsis

void sicSdClose (void) close SD card 0

void sicSdClose0 (void) close SD card 0

void sicSdClose1 (void) close SD card 1

void sicSdClose2 (void) close SD card 2

Description

This function close the SD host interface.

Parameter

None

Return Value

None

Example

```
sicSdClose();        // Close SD port 0
```

sicSdRead

Synopsis

INT sicSdRead (INT32 sdSectorNo, INT32 sdSectorCount, INT32 sdTargetAddr)
for SD card 0

INT sicSdRead0 (INT32 sdSectorNo, INT32 sdSectorCount, INT32 sdTargetAddr)
for SD card 0

INT sicSdRead1 (INT32 sdSectorNo, INT32 sdSectorCount, INT32 sdTargetAddr)
for SD card 1

INT sicSdRead2 (INT32 sdSectorNo, INT32 sdSectorCount, INT32 sdTargetAddr)
for SD card 2

Description

This function will read the data from SD card.

Parameter

sdSectorNo	Sector No. to get the data from
sdSectorCount	Sector count of this access
sdTargetAddr	The address which data upload to SDRAM

Return Value

0	- On success
FMI_TIMEOUT	- Access timeout
FMI_NO_SD_CARD	- Card removed
FMI_SD_CRC7_ERROR	- Command/Response error
FMI_SD_CRC16_ERROR	- Data transfer error

Example

```
#define FMI_TEST_SIZE  (512*128)

__align(4096) UINT8 fmiReadBackBuffer[FMI_TEST_SIZE];

// read 128 sectors data from SD card sector address 3000.

status = sicSdRead(3000, FMI_TEST_SIZE/512, (unsigned int)fmiReadBackBuffer);
```

sicSdWrite

Synopsis

INT sicSdWrite (INT32 sdSectorNo, INT32 sdSectorCount, INT32 sdSourceAddr)
for SD card 0

INT sicSdWrite0 (INT32 sdSectorNo, INT32 sdSectorCount, INT32 sdSourceAddr)
for SD card 0

INT sicSdWrite1 (INT32 sdSectorNo, INT32 sdSectorCount, INT32 sdSourceAddr)
for SD card 1

INT sicSdWrite2 (INT32 sdSectorNo, INT32 sdSectorCount, INT32 sdSourceAddr)
for SD card 2

Description

This function write the data into SD card.

Parameter

sdSectorNo	Sector No. to get the data from
sdSectorCount	Sector count of this access
sdSourcetAddr	The address which download data from SDRAM

Return Value

0	- On success
FMI_TIMEOUT	- Access timeout
FMI_NO_SD_CARD	- Card removed
FMI_SD_CRC7_ERROR	- Command/Response error
FMI_SD_CRC_ERROR	- Data transfer error

Example

```
#define FMI_TEST_SIZE  (512*128)

__align(4096) UINT8 fmiFlash_Buf[FMI_TEST_SIZE];

// write 128 sectors data to SD card sector address 3000.

status = sicSdWrite(3000, FMI_TEST_SIZE/512, (unsigned int)fmiFlash_Buf);
```

23.5. SIC / NAND API

nandInit0

Synopsis

INT nandInit0 (NDISK_T *NDISK_info)	for NAND chip 0
INT nandInit1 (NDISK_T *NDISK_info)	for NAND chip 1

Description

This function configures SIC register to initial DMAC and FMI to NAND mode. It also initial the internal data structure for future use. Since different NAND chip need different parameters, nandInit0() also read the product ID from NAND chip to try to configure correct parameters for it. This function is NAND chip dependent. It probably needs some modifications before it can work properly on your target NAND chip.

Parameter

NDISK_info	The internal data for NAND disk information. nandInit0() will initial it and reture to caller.

Return Value

0	- Success

Otherwise - Refer error code defined in Error Code Table

Example

```
NDISK_T *ptMassNDisk;

NDISK_T MassNDisk;

ptMassNDisk = (NDISK_T *)&MassNDisk;

if (nandInit0(ptMassNDisk) < 0)

{

    printf("NAND initial fail !!\n");

    /* handle error status */

}
```

nand_ioctl

Synopsis

INT nand_ioctl (INT param1, INT param2, INT param3, INT param4)

Description

nand_ioctl() is reserved for I/O control utility for NAND. It is empty now and could support new functions in the future.

Parameter

param1	Depend on feature setting
param2	Depend on feature setting
param3	Depend on feature setting
param4	Depend on feature setting

Return Value

0	- Success
Otherwise	- Refer error code defined in Error Code Table

Example

```
None
```

nandpread0

Synopsis

INT nandpread0 (INT PBA, INT page, UINT8 *buff) for NAND chip 0

INT nandpread1 (INT PBA, INT page, UINT8 *buff) for NAND chip 1

Description

This function read a page of data from NAND.

Parameter

PBA	physical block address of NAND that read data from.
page	page number in PBA block that read data from.
buff	the RAM address to store the reading data.

Return Value

0	- Success
Otherwise	- Refer error code defined in Error Code Table

Example

```
__align(32) UINT8 fmiFlash_Buf[PAGE_SIZE];

// read a page of data from NAND block 5 page 10 and store at fmiFlash_Buf

status = nandpread0(5, 10, fmiFlash_Buf);

if (status < 0)

{

/* handle error status */

}
```

nandpwrite0

Synopsis

INT nandpwrite0 (INT PBA, INT page, UINT8 *buff) for NAND chip 0

INT nandpwrite1 (INT PBA, INT page, UINT8 *buff) for NAND chip 1

Description

This function write a page of data to NAND.

Parameter

PBA	physical block address of NAND to write data.
page	page number in PBA block to write data.
buff	the RAM address to get the writing data.

Return Value

0	- Success
Otherwise	- Refer error code defined in Error Code Table

Example

```
__align(32) UINT8 fmiFlash_Buf[PAGE_SIZE];

// write a page of data from fmiFlash_Buf to NAND block 5 page 10

status = nandpwrite0(5, 10, fmiFlash_Buf);

if (status < 0)

{

/* handle error status */

}
```

nand_is_page_dirty0

Synopsis

INT nand_is_page_dirty0 (INT PBA, INT page)	for NAND chip 0
INT nand_is_page_dirty1 (INT PBA, INT page)	for NAND chip 1

Description

This function check the redundancy area of the NAND page and return the dirty status to indicate whether a page is dirty or not. Dirty page means you cannot write data to it directly. You have to erase this block first to clean it.

Parameter

PBA	physical block address of NAND to check the dirty status.
page	page number in PBA block to check the dirty status.

Return Value

0	- Clean page that can write data directly
1	- Dirty page that cannot write data directly

Example

```
/* check dirty status for NAND block 5 page 10 */

status = nand_is_page_dirty0(5, 10);

if (status == 0)

{
```

```
printf("This page is clean !! You can write data to it directly.\n");
}
else
{
    printf("This page is dirty !! You cannot write data to it directly.\n");
}
```

nand_is_valid_block0

Synopsis

INT nand_is_valid_block0 (INT PBA)	for NAND chip 0
INT nand_is_valid_block1 (INT PBA)	for NAND chip 1

Description

This function check the redundancy area of the NAND block and return the valid status to indicate whether a block is valid or not. Valid block page means you can write data to it directly or indirectly (maybe need to erase block first). You cannot write data into a invalid block always since it could be a bad block.

Parameter

PBA	physical block address of NAND to check the valid status.

Return Value

0	- Valid block that can write data into it directly or indirectly
1	- Invalid block that cannot write data into it always

Example

```
/* check valid status for NAND block 5 */
status = nand_is_valid_block0(5);
if (status == 0)
{
printf("This block is valid !! You can write data to it directly or indirectly.\n");
}
else
{
```

```
    printf("This block is invalid !! You cannot write data to it always.\n");

}
```

nand_block_erase0

Synopsis

INT nand_block_erase0 (INT PBA) for NAND chip 0

INT nand_block_erase1 (INT PBA) for NAND chip 1

Description

This function erase a block. You should call this API first if you want to write data into a dirty page.

Parameter

PBA	physical block address of NAND to erase.

Return Value

0	- Erase block successfully
Otherwise	- Refer error code defined in Error Code Table

Example

```
/* erase NAND block 5 */

status = nand_block_erase0(5);

if (status == 0)

{

printf("This block is erased !!\n");

}

else

{

    printf("This block erase fail !!\n");

}
```

nand_chip_erase0

Synopsis

INT nand_chip_erase0 (VOID) for NAND chip 0

INT nand_chip_erase1 (VOID)   for NAND chip 1

Description

This function erase all blocks in NAND chip. All data in chip will lost that include information for GNAND library.

Parameter

None

Return Value

0	- Erase chip successfully
Otherwise	- Refer error code defined in Error Code Table

Example

```
/* erase whole NAND chip */

status = nand_chip_erase0();

if (status == 0)

{

printf("This chip is erased !!\n");

}

else

{

    printf("This chip erase fail !!\n");

}
```

23.6. Example code

The demo code test the flash card by read / write / compare please refer to the SIC sample code of SDK Non-OS.

23.7. Error Code Table

Code Name	Value	Description
FMI_TIMEOUT	0xFFFF0101	Access timeout

FMI_NO_MEMORY	0xFFFF0102	No available memory
Error Code for SD Card		
FMI_NO_SD_CARD	0xFFFF0110	No SD card insert
FMI_ERR_DEVICE	0xFFFF0111	Unknown device type
FMI_SD_SELECT_ERROR	0xFFFF0113	Select card from identify mode to stand-by mode error
FMI_SD_INIT_ERROR	0xFFFF0115	SD Card initial and identify error
FMI_SD_CRC7_ERROR	0xFFFF0116	Command/Response error
FMI_SD_CRC16_ERROR	0xFFFF0117	Data reading error
FMI_SD_CRC_ERROR	0xFFFF0118	Data writing error
FMI_SD_CMD8_ERROR	0xFFFF0119	SD command 8 error
Error Code for NAND		
FMI_SM_INIT_ERROR	0xFFFF0120	NAND/SM card initial error
FMI_SM_RB_ERR	0xFFFF0121	NAND don't become ready from busy status
FMI_SM_STATE_ERROR	0xFFFF0122	NAND return fail for write command
FMI_SM_ECC_ERROR	0xFFFF0123	Read data error and uncorrectable by ECC
FMI_SM_STATUS_ERR	0xFFFF0124	NAND return fail for erase command
FMI_SM_ID_ERR	0xFFFF0125	NAND chip ID don't supported
FMI_SM_INVALID_BLOCK	0xFFFF0126	NAND block is invalid to erase or write
FMI_SM_MARK_BAD_BLOCK_ERR	0xFFFF0127	Fail to mark a block to bad
FMI_SM_REGION_PROTECT_ERR	0xFFFF0128	NAND return fail for write command because of region protect

24. SPI Library Description

This library provides APIs for programmers to access SPI device connecting with N9H26 SPI interfaces. The SPI library will get the APB clock frequency from system library, application must set the CPU clock before using SPI library.

24.1. API Functions

spiOpen

Synopsis

INT32 spiOpen(SPI_INFO_T *pInfo)

Description

This function initialize the SPI interface.

Parameter

```
typedef struct _spi_info_t
{
        INT32   nPort;              /* select SPI0 (0) or SPI1 (1) */
        BOOL    bIsSlaveMode;       /* set the interface mode - master mode or slave mode */
        BOOL    bIsClockIdleHigh;   /* set the clock idle state – high or low */
        BOOL    bIsLSBFirst;        /* set LSB transfer first or MSB first */
        BOOL    bIsAutoSelect;      /* set automatically active / inactive CS pin */
        BOOL    bIsActiveLow;       /* define the active level of device select signal */
        BOOL    bIsTxNegative;      /* set the Tx signal changed on rising edge or falling edge */
        BOOL    bIsLevelTrigger;    /* set the input slave select signal is edge-trigger or level-trigger */
} SPI_INFO_T;
```

Return Value

= 0 Success

< 0 Fail

Example

```
spiOpen();
```

spiClose

Synopsis

INT32 spiClose(UINT8 u8Port)

Description

This function disable SPI engine clock.

Parameter

u8Port	Select SPI0 (0) or SPI1 (1)

Return Value

= 0	Success
< 0	Fail

Example

```
spiClose (0);
```

spiIoctl

Synopsis

VOID spiIoctl(INT32 spiPort, INT32 spiFeature, INT32 spiArg0, INT32 spiArg1)

Description

This function allows programmers configure SPI interface.

Parameter

spiPort	Select SPI0 (0) or SPI1 (1)
spiFeature	SPI_SET_CLOCK
spiArg0	APB clock by MHz
spiArg1	Device output clock by kHz

Return Value

0	success

Example

```
/* apb clock is 48MHz, output clock is 10MHz */
```

```
spiIoctl(0, SPI_SET_CLOCK, 48, 10000);
```

spiEnable

Synopsis

INT spiEnable(INT32 spiPort)

Description

This function will active the SPI interface to access device (active CS#).

Parameter

spiPort	Select SPI0 (0) or SPI1 (1)

Return Value

0	success

Example

spiEnable(0);

spiDisable

Synopsis

INT spiDisable(INT32 spiPort)

Description

This function will inactive the SPI interface (inactive CS#).

Parameter

spiPort	Select SPI0 (0) or SPI1 (1)

Return Value

0	success

Example

```
spiDisable(0);
```

spiRead

Synopsis

INT spiRead(INT port, INT RxBitLen, INT len, CHAR *pDst)

Description

This function is used to read the data back from the SPI interface.

Parameter

port select SPI0 (0) or SPI1 (1)

RxBitLen set the receive bit length. *SPI_8BIT*, *SPI_16BIT*, *SPI_32BIT*

len data count. SPI_8BIT is byte count; SPI_16BIT is half-word count; SPI_32BIT is word count.

pDst Read back destination

Return Value

0 Success

Example

```
/* read 1 byte data from SPI device */

spiRead(0, SPI_8BIT, 1, (CHAR *)&rdata);
```

spiWrite

Synopsis

INT spiWrite(INT port, INT TxBitLen, INT len, CHAR *pSrc)

Description

This function is used to write the data to the SPI interface.

Parameter

port select SPI0 (0) or SPI1 (1)

TxBitLen set the transmit bit length. *SPI_8BIT*, *SPI_16BIT*, *SPI_32BIT*

len data count. SPI_8BIT is byte count; SPI_16BIT is half-word count; SPI_32BIT is word count

pSrc data source address

Return Value

0 Success

Example

```
/* write 1 half-word to SPI device */

wdata = 0x80ff;

spiWrite(0, SPI_16BIT, 1, (CHAR *)&wdata);
```

spiEnableInt

Synopsis

VOID spiEnableInt(UINT8 u8Port)

Description

This function is used to enable the SPI interrupt.

Parameter

u8Port Select SPI0 (0) or SPI1 (1)

Return Value

None

Example

spiEnableInt(0);

spiDisableInt

Synopsis

VOID spiDisableInt(UINT8 u8Port)

Description

This function is used to disable the SPI interrupt.

Parameter

u8Port Select SPI0 (0) or SPI1 (1)

Return Value

None

Example

```
spiDisableInt(0);
```

spiInstallCallBack

Synopsis

ERRCODE spiInstallCallBack(UINT8 u8Port, PFN_DRVSPI_CALLBACK pfncallback, PFN_DRVSPI_CALLBACK *pfnOldcallback)

Description

This function is used to install the specified SPI interrupt call back function.

Parameter

u8Port Select SPI0 (0) or SPI1 (1)

pfncallback The callback function pointer for specified SPI port.

pfnOldcallback The previous callback function pointer for specified SPI port.

Return Value

0 Success

Example

```
spiInstallCallBack (0, SPIIRQHandler, &pfnOldcallback);
```

spiSetGo

Synopsis

VOID spiSetGo(UINT8 u8Port)

Description

This function is used to set GO_BUSY bit to trigger the SPI port.

Parameter

u8Port Select SPI0 (0) or SPI1 (1)

Return Value

None

Example

```
spiSetGo(0);
```

spiSetByteEndin

Synopsis

VOID spiSetByteEndin(UINT8 u8Port, E_DRVSPI_OPERATION eOP)

Description

This function is used to enable or disable the byte endin.

Parameter

u8Port Select SPI0 (0) or SPI1 (1)

eOP Select enable or disable the byte endin

Return Value

None

Example

```
spiSetByteEndin(0, eDRVSPI_DISABLE);;
```

25. SPU Library Description

This library provides APIs for programmers play PCM audio data from SPU engine. Except playing audio this library also provides 10-band equalizer APIs. SPU engine only plays audio, no record function is included.

25.1. API Functions

spuOpen

Synopsis

VOID spuOpen(UINT32 u32SampleRate)

Description

This function will set the audio clock, play buffer address and install its interrupt.

Parameter

u32SampleRate   Specific sampling rate

Return Value

None

Example

```
spuOpen();
```

spuStartPlay

Synopsis

VOID spuStartPlay(PFN_DRVSPU_CB_FUNC *fnCallBack, UINT8 *data)

Description

After setting IO control to engine, this function will trigger SPU engine to start playing.

Parameter

fnCallBack   Play call back function pointer data Source PCM audio data pointer

Return Value

None

Example

```
int playCallBack(UINT8 * pu8Buffer)

{

…

}

spuStartPlay((PFN_DRVSPU_CB_FUNC *) playCallBack, (UINT8 *)SPU_SOURCE);
```

spuStopPlay

Synopsis

VOID spuStopPlay (VOID)

Description

Stop play.

Parameter

None

Return Value

None

Example

spuStopPlay ();

spuClose

Synopsis

VOID spuClose(VOID)

Description

This function disables SPU engine.

Parameter

None

Return Value

None

Example

spuClose ();

spuIoctl

Synopsis

VOID spuIoctl(UINT32 cmd, UINT32 arg0, UINT32 arg1)

Description

This function allows programmers configure SPU engine, the supported command and arguments listed in the table below.

Command	Argument 0	Argument 1	Description
SPU_IOCTL_SET_VOLUME	Specifies left channel volume ranging from 0 (min.) to 0x3F (max.)	Specifies right channel volume ranging from 0 (min.) to 0x3F (max.)	Set SPU volume
SPU_IOCTL_SET_MONO	Not used	Not used	Set SPU to the mono mode
SPU_IOCTL_SET_STEREO	Not used	Not used	Set SPU to the stereo mode
SPU_IOCTL_GET_FRAG_SIZE	Fragment size	Not used	Get the fragment size from library

Parameter

Cmd Command

arg0 First argument of the command

arg1 Second argument of the command

Return Value

None

Example

spuIoctl(SPU_IOCTL_SET_VOLUME, 0x3f, 0x3f);

spuDacOn

Synopsis

VOID spuDacOn(UINT8 level)

Description

This function is used to enable DAC interface and must used before calling spuStartPlay().

Parameter

level   delay time for de-pop noise

Return Value

None

Example

```
spuDacOn (1);
```

spuDacOff

Synopsis

VOID spuDacOff(VOID)

Description

This function is used to disable DAC interface and must used after calling spuStopPlay().

Parameter

None

Return Value

None

Example

```
spuDacOff ();
```

spuEqOpen

Synopsis

VOID spuEqOpen (E_DRVSPU_EQ_BAND eEqBand, E_DRVSPU_EQ_GAIN eEqGain)

Description

Open 10-band equalizer.

Parameter

eEqBand	Equalizer band setting
eEqGain	Equalizer gain setting for each band

Return Value

None

Example

```
spuEqOpen(eDRVSPU_EQBAND_2, eDRVSPU_EQGAIN_P7DB);
```

spuEqClose

Synopsis

VOID spuEqClose (VOID)

Description

Close Equalizer function.

Parameter

None

Return Value

None

Example

```
spuEqClose ();
```

25.2. System Library Overview

The System library provides a set of APIs to control on-chip functions such as Timers, UARTs, AIC, Cache and power management. With these APIs, user can quickly create a test program to run on demo board or evaluation board.

This library is created by using ARM Development Suite 1.2. Therefore, it only can be used in ADS environment.

25.3. Timer API Functions

Table 25-1 : Timer Channel

Channel name	Value	Description
TIMER0	0	Timer 0
TIMER1	1	Timer 1
TIMER2	2	Timer 2
TIMER3	3	Timer 3
WDTIMER	4	Watch Dog Timer

Table 25-2:Timer Mode

Timer Mode	Value	Description
ONE_SHOT_MODE	0	One shot mode.
PERIODIC_MODE	1	Periodic mode.
TOGGLE_MODE	2	Toggle mode.
UNINTERRUPT_MODE	3	Uninterrrupt mode.

Table 25-3:Watch-Dog Interval Select

Interval Select	Value	Description
WDT_14BITS	0	Timer 0
WDT_16BITS	1	Timer 1
WDT_18BITS	2	Timer 2
WDT_20BITS	3	Timer 3

sysSetTimerEvent

Synopsis

INT32 sysSetTimerEvent(UINT32 nTimeNo, UINT32 nTimeTick, PVOID pvFun);

Description

This function is used to set the event of selected timer. *nTimeNo* is used to select timer 0 to timer 3. The event function which pointed by *pvFun* shall be executed after *nTimeTick* system timer tick. The function is useless for WDTIMER.

Parameter

nTimeNo	Timer 0 ~ timer 3. Please refer Table 25-1 : Timer Channel.
nTimeTick	Tick count before event executed
pvFun	Event function pointer

Return Value

Event number. Please remember the event number if you want to uninstall the timer event.

Example

```
/* Set event function "hello" after 100 tick */

INT nEventNo;

VOID hello(VOID)

{
```

```
        sysPrintf("Hello World!\n");

}

nEventNo = sysSetTimerEvent (TIMER0, 100, (PVOID)hello);

…..

sysClearTimerEvent (TIMER0, nEventNo);
```

sysClearTimerEvent

Synopsis

VOID sysClearTimerEvent(UINT32 nTimeNo, UINT32 uTimeEventNo);

Description

This function is used to clear the event of selected timer. *nTimeNo* is used to select timer 0 ~ timer 3. The event function which indicated by *uTimeEventNo* shall be cleared. The function is useless for WDTIMER.

Parameter

nTimeNo	TIMER0, TIMER1
uTimeEventNo	Event number which want to clear. The event number is the return value of function-sysSetTimerEvent().

Return value

None

Example

```
/* clear event NO 5*/

sysClearTimerEvent (TIMER0, 5);
```

sysClearWatchDogTimerCount

Synopsis

VOID sysClearWatchDogTimerCount(VOID);

Description

This function is used to clear watch dog timer reset counter. When interrupt occurred, the system will be reset after 1024 clock cycles. Clear the timer reset counter, the system will not be reset.

Parameter

None

Return value

None

Example

```
sysClearWatchDogTimerCount();
```

sysClearWatchDogTimerInterruptStatus

Synopsis

VOID sysClearWatchDogTimerInterruptStatus(VOID);

Description

This function is used to clear watch dog timer interrupt status. When interrupt occurred, the watch dog timer interrupt flag will be set. Clear this flag, the interrupt will occur again.

Parameter

None

Return value

None

Example

```
sysClearWatchDogTimerInterruptStatus();
```

sysDelay

Synopsis

VOID sysDelay(UINT32 uTicks);

Description

This function is used to delay a specific period. *uTicks* is the length of delay time which unit is ten milliseconds. Please notice that the delay period has an extent of error which is less than ten milliseconds.

Parameter

uTicks   delay period which unit is ten milliseconds

Return value

None

Example

```
/* delay 1s*/
```

```
sysDelay(100);
```

sysDisableWatchDogTimer

Synopsis

VOID sysDisableWatchDogTimer(VOID);

Description

This function is used to disable watch dog timer.

Parameter

None

Return value

None

Example

```
sysDisableWatchDogTimer();
```

sysDisableWatchDogTimerReset

Synopsis

VOID sysDisableWatchDogTimerReset(VOID);

Description

This function is used to disable watch dog timer reset function.

Parameter

None

Return value

None

Example

```
sysDisableWatchDogTimerReset();
```

sysEnableWatchDogTimer

Synopsis

VOID sysEnableWatchDogTimer(VOID);

Description

This function is used to enable watch dog timer.

Parameter

None

Return value

None

Example

```
sysEnableWatchDogTimer();
```

sysEnableWatchDogTimerReset

Synopsis

VOID sysEnableWatchDogTimerReset(VOID);

Description

This function is used to enable watch dog timer reset function. The system will be reset when this function is enabled.

Parameter

None

Return value

None

Example

```
sysEnableWatchDogTimerReset();
```

sysGetCurrentTime

Synopsis

VOID sysGetCurrentTime(DateTime_T *curTime);

Description

This function is used to get local time. *curTime* is a structure pointer which contains year, month, day, hour, minute, and second information.

Parameter

*curTime structure pointer which contains the following information

typedef struct datetime_t

{

UINT32 year;

UINT32 mon;

UINT32 day;

UINT32 hour;

UINT32 min;

UINT32 sec;

} DateTime_T;

Return value

None

Example

```
/* set local time*/

DateTime_T    TimeInfo;

sysGetCurrentTime(TimeInfo);
```

sysGetTicks

Synopsis

UINT32 sysGetTicks(INT32 nTimeNo);

Description

This function gets the Timer 0 or Timer 1's current tick count.

Parameter

nTimeNo   TIMER0, TIMER1

Return value

The current selected timer tick count.

Example

```
/* Get current timer 0 tick count */

UINT32 btime;

btime = sysGetTicks(TIMER0);
```

sysInstallWatchDogTimerISR

Synopsis

PVOID sysInstallWatchDogTimerISR(INT32 nIntTypeLevel, PVOID pvNewISR);

Description

This function is used to set up own watch dog timer interrupt service routine. *nIntTypeLevel* is select interrupt to be FIQ or IRQ, and level group 0 ~ 7. *pvNewISR* is the own interrupt service routine's pointer.

Parameter

nIntTypeLevel	FIQ_LEVEL_0, IRQ_LEVEL_1 ~ IRQ_LEVEL_7
pvNewISR	the pointer of watch dog timer interrupt service routine

Return value

a pointer which point to old ISR

Example

```
/* Set watch dog timer interrupt to be IRQ and group level 1 */

PVOID oldVect;

oldVect = sysInstallWatchDogTimerISR(IRQ_LEVEL_1, myWatchDogISR);
```

sysResetTicks

Synopsis

INT32 sysResetTicks(INT32 nTimeNo);

Description

This function used to reset Timer 0 or Timer 1's global tick counter. The function is useless for WDTIMER.

Parameter

nTimeNo	TIMER0, TIMER1

Return value

Successful

Example

```
/* Reset timer 0 tick count */

INT32 status;

status = sysResetTicks(TIMER0);
```

sysSetLocalTime

Synopsis

VOID sysSetLocalTime(DateTime_T ltime);

Description

This function is used to set local time. *ltime* is a structure which contains year, month, day, hour, minute, and second information.

Parameter

ltime structure which contains the following information

```
typedef struct datetime_t
{
        UINT32 year;
        UINT32 mon;
        UINT32 day;
        UINT32 hour;
        UINT32 min;
        UINT32 sec;
} DateTime_T;
```

Return value

None

Example

```
/* set local time*/

DateTime_T    TimeInfo;

TimeInfo.year = 2006;

TimeInfo.mon = 6;

TimeInfo.day = 12

TimeInfo.hour = 9;

TimeInfo.min = 0;

TimeInfo.sec = 30;

sysSetLocalTime(TimeInfo);
```

sysSetTimerReferenceClock

Synopsis

INT32 sysSetTimerReferenceClock(UINT32 nTimeNo, UINT32 uClockRate);

Description

This function used to set the timer's reference clock. The default reference clock is system clock (15MHz). The function is useless for WDTIMER.

Parameter

nTimeNo TIMER0, TIMER1

uClockRate reference clock

Return Value

Successful

Example

```
/* Set 20MHz to be timer 0's reference clock */

INT32 status;

status = sysSetTimerReferenceClock(TIMER0, 20000000);
```

sysSetWatchDogTimerInterval

Synopsis

INT32 sysSetWatchDogTimerInterval(INT32 nWdtInterval);

Description

This function is used to set the watch dog timer interval. The default is 0.5 minutes. You can select interval to be 0.5, 1, 2, and 4 minutes.

Parameter

nWdtInterval WDT_INTERVAL_0, WDT_INTERVAL_1, WDT_INTERVAL_2, WDT_INTERVAL_3.

The watch dog timer interval is shown as follows bases on 12MHz.

nWdtInterval	Interrupt Timeout	Reset Timeout	Real Time Interval
WDT_INTERVAL_0	2^{14} clocks	2^{14} + 1024 clocks	0.371 sec.
WDT_INTERVAL_1	2^{16} clocks	2^{16} + 1024 clocks	1.419 sec.
WDT_INTERVAL_2	2^{18} clocks	2^{18} + 1024 clocks	5.614 sec.
WDT_INTERVAL_3	2^{20} clocks	2^{20} + 1024 clocks	22.391 sec.

Return value

Successful

Example

```
/* Set watch dog timer interval to WDT_INTERVAL_0 */

INT32 status;
```

```
status = sysSetWatchDogTimerInterval(WDT_INTERVAL_0);
```

sysStartTimer

Synopsis

INT32 sysStartTimer(INT32 nTimeNo, UINT32 uTicksPerSecond, INT32 nOpMode);

Description

nTimeNo is used to select Timer 0, Timer 1, Timer 2, Timer3 or What-dog Timer. Because of the chip's timer has four operation modes, the *nOpMode* is used to set the operation mode. *uTicksPerSecond* indicates that how many ticks per second.

Parameter

nTimeNo	TIMER0, TIMER1, TIMER2, TIMER3 or WDTIMER.
nTickPerSecond	Tick number per second.
	It is useless if WDTIMER
nOpMode	Working mode. Please refer the Table 25-2:Timer Mode
	It is useless for WDTIMER

Return Value

Successful

Example

```
/* Start the timer 1, and set it to periodic mode and 100 ticks per second */

INT32 status;

status = sysStartTimer(TIMER1, 100, PERIODIC_MODE);
```

sysStopTimer

Synopsis

INT32 sysStopTimer(INT32 nTimeNo);

Description

sysStopTimer will stop the specified timer channel. *nTimeNo* is used to select timer 0 ~ timer 3 or Watch Dog Timer. After disabling timer, this function will restore the interrupt service routine.

Parameter

nTimeNo	TIMER0, TIMER1, TIMER2, TIMER3 or WDTIMER.

Return Value

Successful

Example

/* Stop the timer 1 */

INT32 status;

status = sysStopTimer(TIMER1);

sysUpdateTickCount

Synopsis

INT32 sysUpdateTickCount(INT32 nTimeNo, UINT32 uCount);

Description

This function used to update Timer 0 or Timer 1's global tick counter.

Parameter

nTimeNo TIMER0, TIMER1

uCount tick counter value

Return Value

Successful

Example

/* update timer 0's tick counter as 3000 */

sysUpdateTickCount (TIMER0, 3000);

25.4. UART Function

Table 25-4: UART Port

Port Name	Value	Description
WB_UART_0	0	UART 0 – High Speed UART
WB_UART_1	1	UART 1 – Normal Speed UART

Table 25-5: UART Data Bits

Data Bits	Value	Description
WB_DATA_BITS_5	0	5 Data Bits
WB_DATA_BITS_6	1	6 Data Bits

WB_DATA_BITS_7	2	7 Data Bits
WB_DATA_BITS_8	3	8 Data Bits

Table 25-6: UART Stop Bits

Stop Bits	Value	Description
WB_STOP_BITS_1	0x0	1 Stop Bit
WB_STOP_BITS_2	0x4	2 Stop Bits

Table 25-7: UART Parity Bits

Parity Buts	Value	Description
WB_PARITY_NONE	0x0	Non Parity Bit
WB_PARITY_ODD	0x8	Odd Parity Bit
WB_PARITY_EVEN	0x18	Even Parity Bit

Table 25-8: UART FIFO Threshold

FIFO	Value	Description
LEVEL_1_BYTE	0x0	1 Byte FIFO
LEVEL_4_BYTES	0x1	4 Bytes FIFO
LEVEL_8_BYTES	0x2	8 Bytes FIFO
LEVEL_14_BYTES	0x3	14 Bytes FIFO
LEVEL_30_BYTE	0x4	30 Bytes FIFO (High Speed UART Only)
LEVEL_46_BYTES	0x5	46 Bytes FIFO (High Speed UART Only)
LEVEL_62_BYTES	0x6	62 Bytes FIFO (High Speed UART Only)

Table 25-9: UART Interrupt type

FIFO	Value	Description
UART_INT_RDA	0x0	UART Data Ready
UART_INT_RDTO	0x1	UART Time out
UART_INT_NONE	0xFF	Not to enable UART

sysGetChar

Synopsis

CHAR sysGetChar(VOID);

Description

This function is user to obtain the next available character from the UART. Nothing is echoed. When no available characters are found, the function waits until a character from UART is found.

Parameter

None

Return Value

A character from UART

Example

```
/* get user's input*/
CHAR cUserInput;
cUserInput = sysGetChar();
```

sysInitializeUART

Synopsis

INT32 sysInitializeUART(WB_UART *uart);

Description

WB_UART is the device initialization structure. The definition is as following:

```
typedef struct UART_INIT_STRUCT
{
        UINT32 uart_no;
        UINT32 freq;
        UINT32 baud_rate;
        UINT32 data_bits;
        UINT32 stop_bits;
        UINT32 parity;
        UINT32 rx_trigger_level;
} WB_UART;
```

uart->uart_no is UART port to be initialized.

uart->freq is UART reference clock. Default is 15MHz. If user have different reference clock, used this parameter to change it.

uart->baud_rate is used to set the COM port baud rate. The range is from 9600 to 230400.

The UART data bit can be 5, 6, 7, or 8. Use *uart->data_bits* to set the suitable data bits.

The UART stop bit can be 1, or 2. Use *uart->stop_bits* to set the suitable stop bits.

uart->parity is used to set the suitable parity check.

uart->rx_trigger_level is used to set the suitable trigger level.

Parameter

uart->uart_no	WB_UART_0: High speed UART port. WB_UART_1: Normal speed UART port.
uart->data_bits	WB_DATA_BITS_5 ~ WB_DATA_BITS_8
uart->stop_bits	WB_STOP_BITS_1, WB_STOP_BITS_2
uart->parity	WB_PARITY_NONE, WB_PARITY_ODD, WB_PARITY_EVEN

uart->rx_trigger_level LEVEL_1_BYTE, LEVEL_4_BYTES, LEVEL_8_BYTES, LEVEL_14_BYTES are for normal/high speed UART. And LEVEL_30_BYTES, LEVEL_46_BYTES and LEVEL_62_BYTES are only for high speed UART. Normal speed UART means the baud rate less or equal to 115200 bps. And high speed UART means the baud rate up to 921600 bps.

Return Value

Successful/ WB_INVALID_PARITY/ WB_INVALID_DATA_BITS/ WB_INVALID_STOP_BITS/ WB_INVALID_BAUD

Example

```
WB_UART_T uart;

uart.uart_no = WB_UART_1 ;

uart.uiFreq = APB_SYSTEM_CLOCK;

uart.uiBaudrate = 115200;

uart.uiDataBits = WB_DATA_BITS_8;

uart.uiStopBits = WB_STOP_BITS_1;

uart.uiParity = WB_PARITY_NONE;

uart.uiRxTriggerLevel = LEVEL_1_BYTE;

sysInitializeUART(&uart);    WB_UART_T uart;
```

sysPrintf

Synopsis

VOID sysPrintf(PCHAR pcStr, …);

Description

The function sends the specified *str* to the terminal through the RS-232 interface by interrupt mode.

Parameter

pcStr pointer of string which want to display

Return Value

None

Example

```
sysPrintf("Hello World!\n");
```

sysprintf

Synopsis

VOID sysPrintf(PCHAR pcStr, …);

Description

The function sends the specified *str* to the terminal through the RS-232 interface by polling mode.

Parameter

pcStr pointer of string which want to display

Return Value

None

Example

```
sysprintf("Hello World!\n");
```

sysPutChar

Name

sysPutChar – put a character out to UART

Synopsis

VOID sysPutChar(UCHAR ch);

Description

The function sends the specified *ch* to the UART.

Parameter

ch character which want to display

Return Value

None

Example

```
sysPutChar("A");
```

sysUartInstallcallback

Name

sysUartInstallcallback – install callback function for high speed UART data ready event or data time out event processing.

Synopsis

void sysUartInstallcallback(UINT32 u32IntType,
PFN_SYS_UART_CALLBACK pfnCallback);

Description

The function is used to install the call back function for received data ready or received data time out. The call back function need following structure.

typedef void (*PFN_SYS_UART_CALLBACK)(
UINT8* u8Buf,
UINT32 u32Len);

u8Buf	Received data buffer pointer.
u32Len	Received data length.

Parameter

u32IntType interrupt type. Please refer Table 25-9: UART Interrupt type

pfnCallback a function pointer to process the received data ready and received data time out event.

Return Value

None

Example

```
sysUartInstallcallback(UART_INT_RDA, UartDataValid_Handler);

sysUartInstallcallback(UART_INT_RDTO, UartDataTimeOut_Handler);
```

sysUartEnableInt

Name

sysUartEnableInt– enable UART interrupt type.

Synopsis

VOID sysUartEnableInt(INT32 eIntType);

Description

The function is used to enable UART interrupt.

Parameter

eIntType	UART interrupt type. Please refer Table 25-9: UART Interrupt type

Return Value

None

Example

```
sysUartEnableInt(UART_INT_RDA);
sysUartEnableInt(UART_INT_RDTO);
…..
sysUartEnableInt(UART_INT_NONE);
```

sysUartTransfer

Name

sysUartTransfer– Start up the UART transfer.

Synopsis

VOID sysUartTransfer(char* pu8buf, UINT32 u32Len);

Description

The function is used to transfer data.

Parameter

pu8buf	Transfer data buffer pointer.
u32Len	Transfer data length.

Return Value

None

Example

```
sysUartTransfer(pi8UartBuf,    u32Count);
```

25.5. AIC Functions

Table 25-10: Interrupt No.

AIC Interrupt No	Value	Description
IRQ_WDT	1	Watch Dog Timer Interrupt
IRQ_EXTINT0	2	GPIO Group 0 interrupt
IRQ_EXTINT1	3	GPIO Group 1 interrupt
IRQ_EXTINT2	4	GPIO Group 2 interrupt
IRQ_EXTINT3	5	GPIO Group 3 interrupt
IRQ_IPSEC	6	AES Interrupt
IRQ_SPU	7	SPU Interrupt
IRQ_I2S	8	I2S Interrupt
IRQ_VPOST	9	VPOST Interrupt
IRQ_VIN	10	Video In 0 Interrupt
IRQ_MDCT	11	MDCT Interrupt
IRQ_BLT	12	BLT Interrupt
IRQ_VPE	13	VPE Interrupt
IRQ_HUART	14	High Speed UART Interrupt
IRQ_TMR0	15	Timer 0 Interrupt
IRQ_TMR1	16	Timer 1 Interrupt
IRQ_UDC	17	USB Device Controller Interrupt
IRQ_SIC	18	Storage Interrupt Controller Interrupt
IRQ_SDIO	19	Secure Digital Input / Output Control Interrupt
IRQ_UHC	20	USB Host Controller Interrupt
IRQ_EHCI	21	Enhanced Host Controller Interface Interrupt
IRQ_OHCI	22	Host Controller Interface Interrupt
IRQ_EDMA0	23	Enhanced DMA 0 Interrupt
IRQ_EDMA1	24	Enhanced DMA 1 Interrupt
IRQ_SPIMS0	25	SPI Master / Slave 0 Interrupt
IRQ_SPIMS1	26	SPI Master / Slave 1 Interrupt

IRQ_AUDIO	27	Audio Record Interrupt
IRQ_TOUCH	28	Touch Controller Interrupt
IRQ_RTC	29	RTC Interrupt
IRQ_UART	30	UART Interrupt
IRQ_PWM	31	PWM Interrupt
IRQ_JPG	32	JPEG Codec Interrupt
IRQ_VDE	33	H264 Decode Interrupt
IRQ_VEN	34	H264 Encode Interrupt
IRQ_SDIC	35	SDIC Interrupt
IRQ_EMCTX	36	EMC TX Interrupt
IRQ_ EMCRX	37	EMC RX Interrupt
IRQ_I2C	38	I2C Interrupt
IRQ_KPI	39	Keypad Interrupt
IRQ_RSC	40	RS Codec Interrupt
IRQ_VTB	41	Convolution / Viterbi Codec Interrupt
IRQ_ROT	42	Convolution / Viterbi Codec Interrupt
IRQ_PWR	43	System Wake-Up Interrupt
IRQ_LVD	44	Low Voltage Detector Interrupt
IRQ_VIN1	45	Video In 1 Interrupt
IRQ_TMR2	46	Timer 2 Interrupt
IRQ_TMR3	47	Timer 3 Interrupt

Table 25-11 : Interrupt Exception Type

Exception Type	Value	Description
WB_SWI	0	Software Interrupt
WB_D_ABORT	1	Data Abort Interrupt
WB_I_ABORT	2	Instruction Abort Interrupt
WB_UNDEFINE	3	Undefined Interrupt

Table 25-12: Interrupt Priority

Interrupt Priority	Value	Description
FIQ_LEVEL_0	0	Highest Priority
IRQ_LEVEL_1	1	Level 1 Priority

IRQ_LEVEL_2	2	Level 2 Priority
IRQ_LEVEL_3	3	Level 3 Priority
IRQ_LEVEL_4	4	Level 4 Priority
IRQ_LEVEL_5	5	Level 5 Priority
IRQ_LEVEL_6	6	Level 6 Priority
IRQ_LEVEL_7	7	Lowest Priotity

Table 25-13: Local Interrupt Type

Local Interrupt Type	Value	Description
ENABLE_IRQ	0x7F	Enable ARM Core's IRQ bit
ENABLE_FIQ	0xBF	Enable ARM Core's FIQ bit
ENABLE_FIQ_IRQ	0x3F	Enable ARM core's FIQ and IRQ bit
DISABLE_IRQ	0x80	Disable ARM Core's IRQ bit
DISABLE_FIQ	0x40	Disable ARM Core's FIQ bit
DISABLE_FIQ_IRQ	0xC0	Disable ARM core's FIQ and IRQ bit

Table 25-14: Interrupt Trigger Type

Interrupt Trigger Type	Value	Description
LOW_LEVEL_SENSITIVE	0x00	Low Level Trigger Type
HIGH_LEVEL_SENSITIVE	0x01	High Level Trigger Type
NEGATIVE_EDGE_TRIGGER	0x02	Falling Edge Trigger Type
POSITIVE_EDGE_TRIGGER	0x03	Rising Edge Trigger Type

sysDisableInterrupt

Name

sysDisableInterrupt – disable interrupt source

Synopsis

INT32 sysDisableInterrupt(UINT32 intNo);

Description

This function is used to disable interrupt source.

Parameter

intNo interrupt source number. Please refer the Table 25-10: Interrupt No.

Return Value

Successful or Fail.

Example

```
/* Disable timer 0 interrupt (source number is 7) */

INT32 status;

status = sysDisableInterrupt(7);
```

sysEnableInterrupt

Synopsis

INT32 sysEnableInterrupt(UINT32 intNo);

Description

This function is used to enable interrupt source. Please refer the Table 25-10: Interrupt No.

Parameter

intNo interrupt source number

Return Value

Successful or Fail.

Example

```
/* Enable timer 0 interrupt (source number is 7) */

INT32 status;

status = sysEnableInterrupt(7);
```

sysGetIBitState

Synopsis

BOOL sysGetIBitState (VOID);

Description

This function is used to get the status of interrupt disable bit, I-bit, of CPSR register.

Parameter

None

Return Value

TRUE – I-bit is clear, FALSE – I-bit is set.

Example

```
BOOL int_status;

Int_status = sysGetIBitState();
```

sysGetInterruptEnableStatus

Synopsis

UINT32 sysGetInterruptEnableStatus(VOID);

Description

This function is used to get the enable/disable status of low channel interrupts which save in AIC_IMR register.

Parameter

None

Return Value

value of AIC_IMR register

Example

```
/* Set AIC as software mode */

UINT32 uIMRValue;

uIMRValue = sysGetInterruptEnableStatus();
```

sysGetInterruptHighEnableStatus

Synopsis

UINT32 sysGetInterruptHighEnableStatus(VOID);

Description

This function is used to get the enable/disable status of high channel interrupts which save in AIC_IMRH register.

Parameter

None

Return Value

value of AIC_IMRH register

Example

```
/* Set AIC as software mode */

UINT32 uIMRValue;

uIMRValue = sysGetInterruptHighEnableStatus();
```

sysInstallExceptionHandler

Synopsis

PVOID sysInstallExceptionHandler(INT32 exceptType, PVOID pNewHandler);

Description

This function is used to install *pNewHandler* into *exceptType* exception.

Parameter

exceptType	WB_SWI, WB_D_ABORT, WB_I_ABORT, WB_UNDEFINE Please refer the Table 25-11 : Interrupt Exception Type
pNewHandler	pointer of the new handler

Return Value

a pointer which point to old handler

Example

/* Setup own software interrupt handler */

PVOID oldVect;

oldVect = sysInstallExceptionHandler(WB_SWI, pNewSWIHandler);

sysInstallFiqHandler

Synopsis

PVOID sysInstallFiqHandler(PVOID pNewISR);

Description

Use this function to install FIQ handler into interrupt vector table.

Parameter

pNewISR	pointer of the new ISR handler

Return Value

a pointer which point to old ISR

Example

```
/* Setup own FIQ handler */

PVOID oldVect;

oldVect = sysInstallFiqHandler(pNewFiqISR);
```

sysInstallIrqHandler

Synopsis

PVOID sysInstallIrqHandler(PVOID pNewISR);

Description

Use this function to install FIQ handler into interrupt vector table.

Parameter

pNewISR	pointer of the new ISR handler

Return Value

A pointer which point to old ISR

Example

```
/* Setup own IRQ handler */

PVOID oldVect;

oldVect = sysInstallIrqHandler(pNewIrqISR);
```

sysInstallISR

Synopsis

PVOID sysInstallISR(INT32 intTypeLevel, INT_SOURCE_E intNo, PVOID pNewISR);

Description

Interrupt priority level is 0 ~ 7. Level 0 is FIQ, and level 1 ~ 7 are IRQ. The highest priority is 0, and the lowest priority is 7. Use this function to set up interrupt source (*intNo*) *pNewISR* handler to AIC interrupt vector table.

Parameter

intTypeLevel	FIQ_LEVEL_0, IRQ_LEVEL_1 ~ IRQ_LEVEL_7
	Please refer the Table 25-12: Interrupt Priority
intNo	interrupt source number
	Please refer the Table 25-10: Interrupt No.
pNewISR	Function pointer of new ISR.

Return Value

A function pointer which points to old ISR

Example

```
/* Setup timer 0 handler */

PVOID oldVect;

oldVect = sysInstallISR(IRQ_LEVEL_1, IRQ_TMR0, pTimerISR);
```

sysSetAIC2SWMode

Synopsis

INT32   sysSetAIC2SWMode(VOID);

Description

This function is used to set AIC as software mode. When the system AIC in software mode, the priority of each interrupt source shall be handled by software.

Parameter

intState ENABLE_IRQ, ENABLE_FIQ, ENABLE_FIQ_IRQ, DISABLE_IRQ, DISABLE_FIQ, DISABLE_FIQ_IRQ

Return Value

Successful

Example

```
/* Set AIC as software mode */

sysSetAIC2SWMode();
```

sysSetGlobalInterrupt

Synopsis

INT32 sysSetGlobalInterrupt(INT32 intState);

Description

The function is used to enable or disable all interrupt sources.

Parameter

intState ENABLE_ALL_INTERRUPTS or

DISABLE_ALL_INTERRUPTS

Return Value

Successful

Example

```
/* Disable all interrupt */

INT32 status;

status = sysSetGlobalInterrupt(DISABLE_ALL_INTERRUPTS);
```

sysSetInterruptPriorityLevel

Synopsis

INT32 sysSetInterruptPriorityLevel(INT_SOURCE_E intNo, UINT32 intLevel);

Description

The interrupt has 8 group levels. The highest priority is 0, and the lowest priority is 7. Use this function can change the priority level after install ISR.

Parameter

intNo	interrupt source number Please refer the Table 25-10: Interrupt No.
intLevel	Interrupt priority. Please refer Table 25-12: Interrupt Priority.

Return Value

Successful or Fail.

Example

```
/* Change timer 0 priority to level 4 */

INT32 status;

status = sysSetInterruptPriorityLevel(7, 4);
```

sysSetInterruptType

Synopsis

INT32 sysSetInterruptType(INT_SOURCE_E intNo, UINT32 intSourceType);

Description

The interrupt has four kinds of interrupt source types. They are low level sensitive, high level sensitive, negative edge trigger, and positive edge trigger. The default is high level sensitive. This function is used to change the interrupt source type.

Parameter

intNo	interrupt source number Please refer the Table 25-10: Interrupt No.
intSourceType	Interrupt trigger type. Please refer the Table 25-14: Interrupt Trigger Type

Return Value

Successful or Fail.

Example

```
/* Change timer 0 source type to be positive edge trigger */

INT32 status;

status = sysSetInterruptType(IRQ_TMR0, POSITIVE_EDGE_TRIGGER);
```

sysSetLocalInterrupt

Synopsis

INT32 sysSetLocalInterrupt(INT32 intState);

Description

The CPSR I bit and F bit need to be enabled or disabled, when using interrupt. This function is used to enable / disable I bit and F bit.

Parameter

intState	Enable or disable ARM core's F and I bit. Please refer Table 25-13: Local Interrupt Type

Return Value

Successful

Example

```
/* Enable I bit of CPSR */

INT32 state;

state = sysSetLocalInterrupt(ENABLE_IRQ);
```

25.6. Cache Function

sysDisableCache

Synopsis

VOID sysDisableCache(VOID);

Description

This function is used to disable cache.

Parameter

None

Return Value

None

Example

```
/* disabled cache */

sysDisableCache();
```

sysEnableCache

Synopsis

VOID sysEnableCache(UINT32 uCacheOpMode);

Description

This function is used to enable cache.

Parameter

uCacheOpMode CACHE_WRITE_BACK, CACHE_WRITE_THROUGH

Return Value

None

Example

```
/* enable cache */

sysEnableCache();
```

sysFlushCache

Synopsis

VOID sysFlushCache(INT32 cacheType);

Description

This function is used to flush system cache. The parameter, cacheType is used to select cache which needs to be flushed.

Parameter

cacheType	I_CACHE, D_CACHE, I_D_CACHE

Return Value

None

Example

```
/* flush cache */

sysFlushCache(I_D_CACHE);
```

sysGetCacheState

Synopsis

VOID sysGetCacheState (VOID);

Description

This function is used to get the enable/disable status of cache.

Parameter

None

Return Value

None

Example

```
/* Read cache status */

BOOL status;

status = sysGetCacheState();
```

sysGetSdramSizebyMB

Synopsis

INT32 sysGetSdramSizebyMB(VOID);

Description

This function returns the size (in Mbytes) of total memory.

Parameter

None

Return Value

Memory size or Fail

Example

```
/* Get the memory size */

INT32 memsize;

memsize = sysGetSdramSizebyMB();

sysprintf("The total memory size is %dMbytes\n", memsize);
```

sysInvalidCache

Synopsis

VOID sysInvalidCache (VOID);

Description

This function is used to invalid both Instruction and Data cache contents.

Parameter

None

Return Value

None

Example

```
/* Invalid cache */

sysInvalidCache();
```

sysSetCachePages

Synopsis

INT32 sysSetCachePages(UINT32 addr, INT32 size, INT32 cache_mode);

Description

This function is used to change the cache mode of a memory area. Note that the starting address and the size must be 4Kbytes boundary.

Parameter

addr The memory starting address.

size The memory size.

cache_mode CACHE_WRITE_BACK / CACHE_WRITE_THROUGH / CACHE_DISABLE.

Return Value

Successful or Fail

Example

```
/* enable cache to write-back mode */

sysEnableCache(CACHE_WRITE_BACK);

…

sysFlushCache();

/* Change the memory region 0x1000000 ~ 0x1001000 to be non-cachebale */

sysSetCachePages(0x1000000, 4096, CACHE_DISABLE);
```

25.7. Clock Control function

sysGetExternalClock

Synopsis

UINT32 sysGetExternalClock(void);

Description

This function is used to get external clock setting. IBR only support 2 kinds of external clock frequency. 12MHz or 27MHz. So external clock will be 12MHz or 27MHz. The power on setting must meet the external clock.

Parameter

None

Return Value

External clock. Unit : Hz

Example

```
/* Read system clock setting */

UINT32 u32ExtFreq;

u32ExtFreq = sysGetExternalClock();
```

sysSetSystemClock

Synopsis

UINT32 sysSetSystemClock(E_SYS_SRC_CLK eSrcClk,
UINT32 u32PllHz,
UINT32 u32SysHz);

Description

This function is used to write system clock setting includes PLL output frequency, System clock. The function gets the external clock automatically by power on setting.

Parameter

eSrcClk : Sytem clock source.

It could be eSYS_EXT, eSYS_APLL and eSYS_UPLL. They mean the system clock source come from external clock, APLL and UPLL respectively.

u32PllHz : Set the APLL or UPLL output frequency.

Unit : Hz.

u32SysHz : Set the system clock output frequency.

Unit : Hz.The system clock source can be external, APLL or UPLL.

There are some limitations in the clock function due to hardware's limitation.

1. These frqequency exist multiplication factor It means PLL >= n*SYS, And HCLK clock is always equal to SYS clock/2.

   Where n is integer. And HCLK clock is SDR/DDR/DDR2 clock.
2. PLL clock must under or equal to 432MHz.
3. System clock must under or equal to the source clock.
4. HCLK clock depens on the layout and core power. Generally, it can up to 150MHz in core power 1.2V.

Return Value

Successful or Error code

Example

```
/* Write system clock setting */
```

```
sysSetSystemClock(eSYS_UPLL,        // system clock come from UPLL
                     288000000,     // UPLL = 288MHz
                     288000000)     // SYS = 288MHz
```

sysSetDramClock

Synopsis

UINT32 sysSetDramClock(E_SYS_SRC_CLK eSrcClk,
UINT32 u32PllHz,
UINT32 u32DdrHz);

Description

This function is used to write memory clock setting includes PLL output frequency, memory clock. The function gets the external clock automatically by power on setting.

Parameter

eSrcClk :	Sytem clock source.
	It will be limited to eSYS_MPLL.
u32PllHz	MPLL output frequency.
	Unit : Hz.
u32DdrHz :	Set the memory clock output frequency.
	Unit : Hz.The system clock source can only be MPLL.

There are some limitations in the clock function due to hardware's limitation.

1. MCLK clock is equal to half of u32DdrHz. .
2. MCLK need great than HCLK1, HCLK2 and HCLK3.
3. Max MPLL output clock will be 360MHz.

Return Value

Successful or Error code

Example

```
/* Write memory clock setting */
sysSetDramClock(eSYS_MPLL,          // system clock come from MPLL
                     360000000,     // MPLL = 360MHz
                     360000000)     // DDR = 360MHz
sysSetSystemClock(eSYS_UPLL,        // system clock come from UPLL
```

```
                288000000,      // UPLL = 288MHz

                288000000)      // SYS = 288MHz
```

sysSetCPUClock

Synopsis

UINT32 sysSetCPUClock(UINT32 u32CPUClock);

Description

This function is used to set CPU clock.

Parameter

u32CPUClock: CPU clock.

There are some limitations in the clock function due to hardware's limitation.

1. The CPU clock comes from SYS clock. It must less or equal to SYS clock.
2. The CPU divider only support even divider. It means CPU = SYS, SYS/2, SYS/4,... or SYS/16.
3. HCLK1 clock depends on CPU clock.
   - If CPU divider =1, HCLK1 = CPU/2.
   - If CPU divider !=1, HCLK1 = CPU.

Return Value

Successful or Error code

Example

```
/* Write system clock setting */

sysSetSystemClock(eSYS_UPLL,        //E_SYS_SRC_CLK eSrcClk,

                     192000000,           //UINT32 u32PllKHz,

                     192000000);          //UINT32 u32SysKHz,

              sysSetCPUClock(192000000);
```

sysSetAPBClock

Synopsis

UINT32 sysSetAPBClock(UINT32 u32APBClock);

Description

This function is used to set APB clock.

Parameter

u32APBClock: APB clock.

There are some limitations in the clock function due to hardware's limitation.

1. The APB clock comes from HCLK1 clock. It must less or equal to HCLK1 clock.
2. Max APB divider is 8.

Return Value

Successful or Error code

Example

```
/* Write system clock setting */
sysSetSystemClock(eSYS_UPLL,                //E_SYS_SRC_CLK eSrcClk,
                     288000000,             //UINT32 u32PllKHz,
                     288000000);            //UINT32 u32SysKHz,
              sysSetCPUClock(288000000);                 //HCLK1 = 144MHz.
              sysSetAPBClock(72000000);                  //APB = 72MHz
```

sysGetPLLOutputHz

Synopsis

UINT32 sysGetPLLOutputHz (E_SYS_SRC_CLK eSysPll,
UINT32 u32FinHz);

Description

This function is used to read PLL output frequency.

Parameter

peSrcClk	Specified PLL wants to know. It could be eSYS_APLL= 2 and eSYS_UPLL = 3.
u32FinHz:	External clock. Unit : Hz.

Return Value

Specified PLL output clock. Unit : Hz.

Example

```
u32ExtFreq = sysGetExternalClock();
```

```
u32PllOutHz = sysGetPLLOutputHz(eSYS_UPLL, u32ExtFreq);
```

sysGetSystemClock

Synopsis

UINT32 sysGetSystemClock(void);

Description

This function is used to get system clock.

Parameter

None

Return Value

System clock. Unit: Hz.

Example

```
/* Read system clock setting */

UINT32 u32SysFreq;

u32SysFreq = sysGetSystemClock();
```

sysGetDramClock

Synopsis

UINT32 sysGetDramClock(void);

Description

This function is used to get DRAM clock.

Parameter

None

Return Value

DRAM clock. Unit: Hz.

Example

```
/* Read DRAM clock setting */

UINT32 u32DramFreq;

u32DramFreq = sysGetDramClock();
```

sysGetCPUClock

Synopsis

UINT32 sysGetCPUClock(void);

Description

This function is used to get CPU clock.

Parameter

None

Return Value

CPU clock. Unit: Hz.

Example

```
/* Read CPU clock setting */

UINT32 u32CPUFreq;

u32CPUFreq = sysGetCPUClock();
```

sysGetHCLK1Clock

Synopsis

UINT32 sysGetHCLK1Clock(void);

Description

This function is used to get HCLK1 clock.

Parameter

None

Return Value

HCLK1 clock. Unit: Hz.

Example

```
/* Read HCLK1 clock setting */

UINT32 u32HCLK1Freq;

u32HCLK1Freq = sysGetHCLK1Clock();
```

sysGetAPBClock

Synopsis

UINT32 sysGetAPBClock(void);

Description

This function is used to get APB clock.

Parameter

None

Return Value

APB clock. Unit: Hz.

Example

```
/* Read HCLK1 clock setting */

UINT32 u32APBFreq;

u32APBFreq = sysGetAPBClock();
```

sysSetPllClock

Synopsis

UINT32 sysSetPllClock(E_SYS_SRC_CLK eSrcClk,
UINT32 u32TargetHz) ;

Description

There are two PLL in the chip. User can assign one PLL as system clock source. The other one PLL can be assigned the output frequency through the function.

Parameter

eSrcClk:	eSYS_APLL = 2 or eSYS_UPLL = 3.
u32TargetHz:	Target PLL output frequency. Unit : Hz.

Return Value

Specified PLL output frequency. Unit : Hz. The return value may not same as the specified value due to hardware's limitation. If not meet the hardware SPEC, library will auto to search the nearly frqequency.

Example

```
/* Write system clock setting */

sysSetSystemClock(eSYS_UPLL,        // system clock come from UPLL
```

```
                      300000000,     // UPLL = 300MHz
                      300000000);    // SYS = 300MHz
/*Specified APLL clock */
sysSetPllClock(eSYS_APLL,
              432000000);           // SYS = 432MHz
```

sysCheckPllConstraint

Synopsis

UINT32 sysCheckPllConstraint (BOOL bIsCheck);

Description

This function is used to enable or disable constraint checking for setting PLL clock.

Parameter

None

Return Value

None

Example

```
/* Set PLL clock without constraint check */
sysCheckPllConstraint(FALSE);       //Disable constraint checking
sysSetSystemClock(eSYS_UPLL,        // system clock come from UPLL
                      318000000,     // UPLL = 318MHz
                      318000000);    // SYS = 318MHz
sysCheckPllConstraint(FALSE);       //Enable constraint checking for next time.
```

sysSetSystemDivider

Synopsis

UINT32 sysSetSystemDivider (UINT32 u32Hclk,
                                                            UINT32 u32SysDiv);

Description

This function is used to set system clock divider. It speeds up to slower down all of clocks after system clock for power consumption consider.

Parameter

u32Hclk: HCLK clock. The clock is the system clock divide by 2.

u32SysDiv: The system clock divider. The value should be from 0 ~ 7.

Return Value

Successful or Error code.

Example

```
sysSetSystemClock(eSYS_UPLL,        // system clock come from UPLL

                     288000000,     // UPLL = 288MHz

                     288000000);    // SYS = 288MHz

sysSetCPUClock(144000000)           // CPU = 144MHz. HCLK1 = 144MHz

sysSetAPBClock(72000000)            // APB = 72MHz


sysSetSystemDivider (288000000/4/2, 3);    // System clock divider = (3+1) = 4.

                                    // HCLK = UPLL/8 = 36MHz.

                                    // CPU = 18MHz, APB = 9MHz
```

25.8. Power management Function

System can enter standby mode with DDR memory enter self refresh mode. The program code was kept in DDR memory and PLLs, CPU, system clock, AHB and APB were turned off. There are 10 wake-up channels to wake-up system if system in standby mode.

Table 25-15: Wakeup Channels.

Wake up channel	Value	Description
WE_EMAC	0x1	Wake up by magic packet
WE_UHC20	0x2	Wake up by device attaced/deattached
WE_GPIO	0x100	Wake up by GPIO level change
WE_RTC	0x200	Wake up by RTC
WE_UART	0x800	Wake up by UART (RTS pin)
WE_UDC	0x1000	Wake up by attached/detached from USB host

WE_UHC	0x2000	Wake up by device attached/detached
WE_ADC	0x4000	Wake up by touch panel touch
WE_KPI	0x8000	Wake up by KPI pressing

sysPowerDown

Synopsis

INT sysPowerDown(UINT u32WakeUpSrc);

Description

This function was used to enter standby mode. The function also specified the wake-up channel to wake up system. Programmer need to disable the analog IPs such as TV DAC, ADC and LVD and so on before entry standby mode.

Parameter

u32WakeUpSrc Wakeup channels. Please reference Table 25-15: Wakeup Channels.

Return Value

Successful

Example

```
sysPowerDown(WE_GPIO);
```

25.9. Error Code Table

Code Name	Value	Description
Successful	0	Successful
Fail	-1	Fail
WB_INVALID_PARITY	-1	Invalid parity
WB_INVALID_DATA_BITS	-2	Invalid data bits
WB_INVALID_STOP_BITS	-3	Invalid stop bits
WB_INVALID_BAUD	-4	Invalid baud rate
WB_PM_PD_IRQ_Fail	-1	Invalid power down IRQ
WB_PM_Type_Fail	-2	Invalid power manager type
WB_PM_INVALID_IRQ_NUM	-3	Invalid IRQ number
E_ERR_CLK	0xB0000001	Wrong clock setting

26. Touch ADC Library Overview

The N9H26 Touch ADC library provides a set of APIs to report the X and Y-axis coordinate, battery voltage and analog keypad. With these APIs, user can read the position that was touched in touch panel, get the current battery voltage and get the keypad scancode.

These libraries are created by using ARM Development Suite 1.2. Therefore, they only can be used in ADS environment.

26.1. Touch ADC Library APIs Specification

DrvADC_Open

Synopsis

INT32 DrvADC_Open (void);

Description

This function is used to open the Touch ADC library.

Parameter

None

Return Value

Successful

Example

```
/* Initialize Touch ADC library and enable IP clock*/

DrvADC_Open();
```

DrvADC_Close

Synopsis

INT32 DrvADC_Close(void)

Description

Close the ADC library.

Parameter

None

Return Value

Successful

Example

```
/* Close Touch ADC library*/

DrvADC_Close();
```

DrvADC_InstallCallback

Synopsis

INT32 DrvADC_InstallCallback(E_ADC_INT_TYPE eIntType,

PFN_ADC_CALLBACK pfnCallback,

PFN_ADC_CALLBACK* pfnOldCallback);

Description

This function was used to install callback function that is used to notice the upper layer for event complete.

Parameter

eIntType	Interrupt event type.
pfnCallback	The callback function want to register
pfnOldCallback	old callback function

Table 26-1: ADC read mode

Field name	Value	Description
eADC_KEY	0	(Unused in the driver)
eADC_TOUCH	1	(Unused in the driver)
eADC_AIN	2	Normal ADC conversion event done type.
eADC_POSITION	3	Converse position event done type
eADC_PRESSURE	4	Conversion pressure event done type

Return Value

-1 or Successful.

Example

```
/* Read the x and y-axis coordinate */
static void Pressure_callback(UINT32 u32code)
{/* The u32code[14:0] is parameterZ2. u32code[15] is Valid(1) or Invalid(0).
The u32code[30:16] is Z1 position. u32code[31] is Valid(1) or Invalid(0) */
       …
}
static void Position_callback(UINT32 u32code)
{/* The u32code[14:0] is Y position. u32code[15] is Valid(1) or Invalid(0).
The u32code[30:16] is X position. u32code[31] is Valid(1) or Invalid(0).*/
       …
}
DrvADC_Open();
DrvADC_InstallCallback(eADC_POSITION,
                      Position_callback,
                      &pfnOldCallback);
DrvADC_InstallCallback(eADC_PRESSURE,
                      Pressure_callback,
                      &pfnOldCallback);
```

DrvADC_PenDetection

Synopsis

INT32 DrvADC_PenDetection(BOOL bIs5Wire)

Description

This function was used to read the touching position and presssure

Parameter

bIs5Wire	5 wires or 4 wires touch panel.
	1: 5 wires touch panel
	0: 4 wires touch panel

Return Value

Error code

Name	Value	Description
E_ADC_BUSY	0xB800F001	Touch ADC is busy
E_TOUCH_UP	1	Pen state is up. (No touching event)
Successful	0	Pen state is down. Touch ADC is triggering.

Example

```
DrvADC_Open();

DrvADC_InstallCallback(eADC_POSITION,

                     Position_callback,

                     &pfnOldCallback);

DrvADC_InstallCallback(eADC_PRESSURE,

                     Pressure_callback,

                     &pfnOldCallback);


btime = sysGetTicks(TIMER0);

etime = btime;

while ((etime - btime) <= 300)

{

       while(TouchPanel_time==TRUE){

              TouchPanel_time = FALSE;

              do{

                     ret = DrvADC_PenDetection(bIs5Wire);

              }while(ret != Successful);

       }

       etime = sysGetTicks(TIMER0);

}
```

```
sysClearTimerEvent(TIMER0, tmp);
```

DrvADC_KeyDetection

Synopsis

INT32 DrvADC_KeyDetection(UINT32 u32Channel, UINT32* pu32KeyCode)

Description

This function was used to read the scancode of keypad.

Parameter

u32Channel	Channel number. The value from 1 to 3.
pu32KeyCode	Scancode.

Return Value

Error code

Name	Value	Description
E_ADC_BUSY	0xB800F001	Touch ADC is busy
E_KEYPAD_UP	1	keypad state is up. (No keypad event)
Successful	0	keypad state is down.

Example

```
DrvADC_Open();

btime = sysGetTicks(TIMER0);

etime = btime;

while ((etime - btime) <= 300){

       if(DrvADC_KeyDetection(u32Channel, &u32KeyCode)==Successful){     // ready

               if(u32KeyCode!=0)

                       sysprintf("Key Scan code = 0x%x\n", u32KeyCode);

       }else

               if(u32KeyCode!=0)

                       sysprintf("Key Scan code = 0x%x\n", u32KeyCode);


       etime = sysGetTicks(TIMER0);

}
```

```
sysClearTimerEvent(TIMER0, tmp);
```

DrvADC_VoltageDetection

Synopsis

INT32 DrvADC_VoltageDetection (UINT32 u32Channel)

Description

This function was used to read the conversion value.

Parameter

u32Channel Channel number. The value from 1 to 3.

Return Value

Error code

Name	Value	Description
E_ADC_BUSY	0xB800F001	Touch ADC is busy
Successful	0	Touch ADC is triggering.

Example

```
static void VoltageDetect_callback(UINT32 u32code)

{/* u32code is the ADC value */

        bIsValidVoltageDet = TRUE;

        u32VoltageValue = u32code;

        u32Count = u32Count+1;

        if(u32code==0){

                sysprintf("Voltage Detect Value %d = %d\n", u32Count, u32code);

        }

        sysprintf("Voltage Detect Value %d = %d\n", u32Count, u32code);

}

DrvADC_Open();

DrvADC_InstallCallback(eADC_AIN,

                        VoltageDetect_callback,

                        &pfnOldCallback);
```

```
                btime = sysGetTicks(TIMER0);

                etime = btime;

while ((etime - btime) <= 1000)

{

        while(VoltageDetect_time==TRUE){

                VoltageDetect_time = FALSE;

                if(DrvADC_VoltageDetection(u32Channel)==Successful){//ready

                        if(bIsValidVoltageDet==TRUE){ //Key code has been updated

                                bIsValidVoltageDet = FALSE;

                        }

                }

        }

        etime = sysGetTicks(TIMER0);

}

sysClearTimerEvent(TIMER0, tmp);
```

26.2. Error Code Table

Code Name	Value	Description
E_ADC_BUSY	0xB800F000	Touch ADC is busy
E_TOUCH_UP	1	Pen state is up
E_KEYPAD_UP	1	Keypad state is up
Successful	0	No error

27. UDC Library

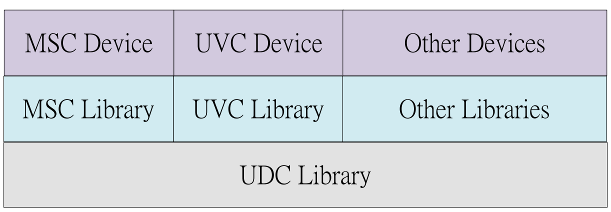
This library is designed to make user application to use N9H26 UDC more easily.
The UDC library has the following features:

- Support all Basic USB operations.
- Pass USB-IF Chapter 9.

SDK Non-OS provide two usb class libraries for the USB class reference sample. User can refer to the libraries to develop him own class libraries. Mass Storage Class device: mscd library.

  - Pass the USB-IF Mass Storage Class Test
  - Provide flash options to build MSC device as a Composite device with RAM disk, NAND Disk, and SD Card Reader.
- USB Video Class device : uvcd library.
  - Pass the USB-IF Video Class Test
  - Provide a video cam sample to send two test patterns to PC.

User can use UDC library to implement all USB basic operations (Send descriptors, Reset command and etc.), and a USB class library (like MSCD) to provide USB class functions.



27.1. Programming Guide

System Overview

The USB device controller interfaces the AHB bus and the UTMI bus. The USB controller contains both the AHB master interface and AHB slave interface. CPU programs the USB controller registers through the AHB slave interface. For IN or OUT transfer, the USB device controller needs to write data to memory or read data from memory through the AHB master interface. The USB device controller is complaint with USB 2.0 specification and it contains four configurable endpoints in addition to control endpoint. These endpoints could be configured to BULK, INTERRUPT or ISO. The USB device controller has a built-in DMA to relieve the load of CPU.

Features

- USB Specification version 2.0 compliant.
- Interfaces between USB 2.0 bus and the AHB bus.
- Supports 16-bit UTMI Interface to USB2.0 Transceiver.
- Support direct register addressing for all registers from the AHB bus.
- Software control for device remote-wakeup.
- AHB bus facilitates connection to common micro controllers and DMA controllers.
- Supports 4 configurable endpoints in addition to Control Endpoint
- Each of these endpoints can be Isochronous, Bulk or Interrupt and they can be either of IN or OUT direction.
- Three different modes of operation of an in-endpoint (Auto validation mode, manual validation mode, Fly mode.)
- DP RAM is used as end point buffer.
- DMA operation is carried out by AHB master
- Supports Endpoint Maximum Packet Size up to 1024 bytes.

UDC Library Property Definition

The UDC library provides property structure to set UDC property more easily.

USBD_INFO_T (The fields for internal used are not in the table)

Name	Description
Descriptor pointer	
pu32DevDescriptor	Device Descriptor pointer
pu32QulDescriptor	Device Qualifier Descriptor pointer
pu32HSConfDescriptor	Standard Configuration Descriptor pointer for High speed
pu32FSConfDescriptor	Standard Configuration Descriptor pointer for Full speed
pu32HOSConfDescriptor	Other Speed Configuration Descriptor pointer for High speed
pu32FOSConfDescriptor	Other Speed Configuration Descriptor pointer for Full speed
pu32StringDescriptor[5]	String Descriptor pointer
Descriptor length	
u32DevDescriptorLen	Device Descriptor Length
u32QulDescriptorLen	Device Qualifier Descriptor pointer Length
u32HSConfDescriptorLen	Standard Configuration Descriptor Length for High speed
u32FSConfDescriptorLen	Standard Configuration Descriptor Length for Full speed
u32HOSConfDescriptorLen	Other Speed Configuration Descriptor Length for High speed
u32FOSConfDescriptorLen	Other Speed Configuration Descriptor Length for Full speed
u32StringDescriptorLen[5]	String Descriptor Length
USBD Init	

pfnHighSpeedInit	High speed USB Device Initialization function
pfnFullSpeedInit	Full speed USB Device Initialization function
Endpoint Number	
i32EPA_Num	Endpoint Number for EPA (-1 : Not used)
i32EPB_Num	Endpoint Number for EPB (-1 : Not used)
i32EPC_Num	Endpoint Number for EPC (-1 : Not used)
i32EPD_Num	Endpoint Number for EPD (-1 : Not used)
Endpoint Call Back	
pfnEPACallBack	Callback function pointer for Endpoint A Interrupt
pfnEPBCallBack	Callback function pointer for Endpoint B Interrupt
pfnEPCCallBack	Callback function pointer for Endpoint C Interrupt
pfnEPDCallBack	Callback function pointer for Endpoint D Interrupt
Class Call Back	
pfnClassDataINCallBack	Callback function pointer for Class Data IN
pfnClassDataOUTCallBack	Callback function pointer for Class Data OUT
pfnDMACompletion	Callback function pointer for DMA Complete
pfnReset	Callback function pointer for USB Reset Interrupt
pfnSOF	Callback function pointer for USB SOF Interrupt
pfnPlug	Callback function pointer for USB Plug Interrupt
pfnUnplug	Callback function pointer for USB Un-Plug Interrupt
VBus status	
u32VbusStatus	VBus Status

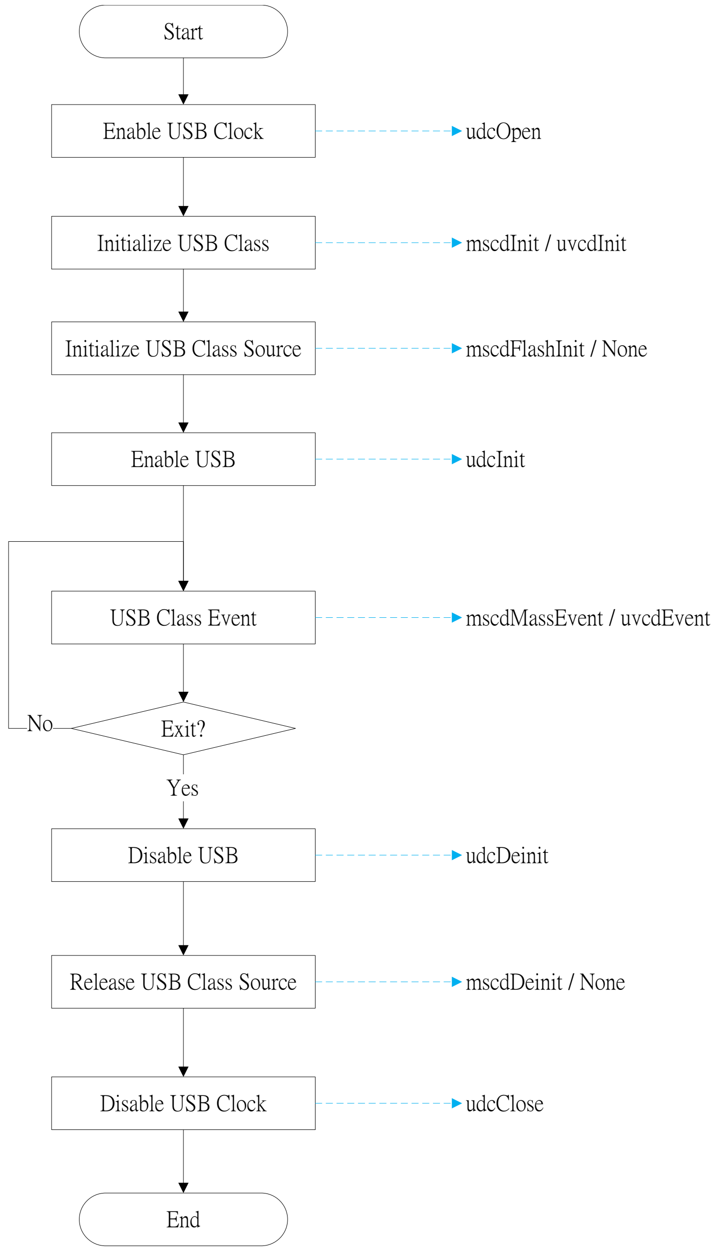
The USB Device initial function initializes the basic setting of USB device controller including endpoints buffer allocate, endpoint number, endpoint type, speed mode, and interrupt, etc. User can modify the function to change USB speed and endpoint properties.

- *pfnHighSpeedInit*
  - mscdHighSpeedInit
  - uvcdHighSpeedInit
- *pfnFullSpeedInit*
  - mscdFullSpeedInit
  - uvcdFullSpeedInit

PC classifies USB device according to the descriptors. With Non-OS SDK structure, the descriptors are initialized in the class Init functions. The functions set proper descriptors and the callback functions.

- *mscdInit*
- *uvcdInit*

Programming Flow



27.2. USB Device (UDC) API

udcOpen

Synopsis

VOID udcOpen(VOID)

Description

This function enables the engine clock.

Parameter

None

Return Value

None

Example

```
udcOpen ();
```

udcClose

Synopsis

VOID udcClose (VOID)

Description

This function disables the engine clock.

Parameter

None

Return Value

None

Example

```
udcClose ();
```

udcInit

Synopsis

VOID udcInit(VOID)

Description

This function initializes the software resource, enables its interrupt, and set VBus detect function.

Parameter

None

Return Value

None

Example

udcInit ();

udcDeinit

Synopsis

VOID udcDeinit (VOID)

Description

Disable VBus detect function

Parameter

None

Return Value

None

Example

```
udcDeinit ();
```

udcIsAttached

Synopsis

BOOL udcIsAttached(VOID)

Description

This function can get USB attach status.

Parameter

None

Return Value

TRUE - USB is attached.

FALSE - USB isn’t attached.

Example

```
/* Check USB attach status */

if(udcIsAttached ())

       sysprintf(“USB is attached\n”);

else

       sysprintf(“USB isn’t attached\n”);
```

udcIsAttachedToHost

Synopsis

BOOL udcIsAttachedToHost (VOID)

Description

This function can get USB current attach device status.

Parameter

None

Return Value

TRUE - USB is attached to Host now.

FALSE - USB doesn’t get any command from Host now.

Example

```
/* Check USB HOST attach status */

if(udcIsAttachedToHost ())

       sysprintf(“USB is attached to Host now\n”);

else

       sysprintf(“USB doesn’t get any command from Host \n”);
```

Note

It takes time for Host to sent command to device. So usr may set a timeout tme to check the status, i.e., user needs to polling the status during the timeout time.

27.3. Mass Storage Class (MSCD) API

mscdInit

Synopsis

VOID mscdInit(VOID)

Description

This function initializes software source (descriptors, callback functions, buffer configuration)

Parameter

None

Return Value

None

Example

```
mscdInit ();
```

mscdDeinit

Synopsis

VOID mscdDeinit (VOID)

Description

This function release software source (allocated by mscdInit)

Parameter

None

Return Value

None

Example

```
mscdDeinit ();
```

mscdFlashInit

Synopsis

UINT8 mscdFlashInit (NDISK_T *pDisk, INT SDsector);

Description

Initial the Flash capacity for usb device controller use.(One chip selector NAND flash and one port SD)

Parameter

pDisk	The internal data for NAND disk information.
SDsector	Total sector for SD disk.

Return Value

0	- Fail
1	- Success

Example

```
NDISK_T MassNDisk;

INT SDsector;

SDsector = sicSdOpen0();

mscdFlashInit(&MassNDisk, SDsector);
```

Note

1. User can assign the export NAND flash (CS0/CS1/CS2) by mscdNandEnable.(Default is CS0 if user doesn't use mscdNandEnable)
2. User can assign the export SD card (Port0/Port1/Port2) by **mscdSdEnable**. (Default is Port0 if user doesn't use mscdSdEnable)
3. The API can only single port SD and single CS NAND by mscdSdEnable or mscdNandEnable.
4. If user wants to export only SD, please link N9H26_MSC_ SD.a
5. If user wants to export only NAND, please link N9H26_MSC_ NAND.a
6. If user wants to export both SD and NAND, please link N9H26_MSC_NAND_SD.a

mscdFlashInitNAND

Synopsis

UINT8

mscdFlashInitNAND (

NDISK_T *pDisk,

NDISK_T *pDisk1,

NDISK_T *pDisk2,

INT SDsector

);

Description

Initial the Flash capacity for usb device controller use (thress chip selector NAND flash and one port SD) .

Parameter

pDisk	The internal data for NAND disk information for CS0.
pDisk1	The internal data for NAND disk information for CS1.
pDisk2	The internal data for NAND disk information for CS2.
SDsector	Total sector for SD disk.

Return Value

0	- Fail
1	- Success

Example

```
NDISK_T MassNDisk, MassNDisk1, MassNDisk2;

INT SDsector;

SDsector = sicSdOpen0();

mscdFlashInitNAND (&MassNDisk, &MassNDisk1, &MassNDisk2, SDsector);
```

Note

1. User can assign the export NAND flash (CS0/CS1/CS2) by mscdNandEnable.(Default is CS0 if user doesn’t use mscdNandEnable)
2. User can assign the export SD card (Port0/Port1/Port2) by mscdSdEnable. (Default is Port0 if user doesn’t use mscdSdEnable)
3. The API can only single port SD by mscdSdEnable.
4. If user wants to export only SD, please link N9H26_MSC_ SD.a
5. If user wants to export only NAND, please link N9H26_MSC_ NAND.a
6. If user wants to export both SD and NAND, please link N9H26_MSC_NAND_SD.a

mscdFlashInitExtend

Synopsis

UINT8

mscdFlashInitExtend (

NDISK_T *pDisk,

NDISK_T *pDisk1,

NDISK_T *pDisk2,

INT SDsector0,

INT SDsector1,

INT SDsector2,

INT RamSize

);

Description

Initial the Flash capacity for usb device controller use (thress chip selector NAND flash and three ports SD).

Parameter

pDisk	The internal data for NAND disk information for CS0.
pDisk1	The internal data for NAND disk information for CS1.
pDisk2	The internal data for NAND disk information for CS2.
SDsector0	Total sector for SD0 disk.
SDsector1	Total sector for SD1 disk.
SDsector2	Total sector for SD2 disk.
RamSize	MSC_RAMDISK_1M~ MSC_RAMDISK_64M

Return Value

0	- Fail
1	- Success

Example

```
NDISK_T MassNDisk, MassNDisk1, MassNDisk2;

INT SDsector;

SDsector = sicSdOpen0();

mscdFlashInitNAND (&MassNDisk, &MassNDisk1, &MassNDisk2, SDsector);
```

Note

1. User can assign the export NAND flash (CS0/CS1/CS2) by mscdNandEnable.(Default is CS0 if user doesn’t use mscdNandEnable)
2. User can assign the export SD card (Port0/Port1/Port2) by mscdSdEnable. (Default is Port0 if user doesn’t use mscdSdEnable)
3. If user wants to export only SD, please link N9H26_MSC_ SD.a
4. If user wants to export only NAND, please link N9H26_MSC_ NAND.a
5. If user wants to export both SD and NAND, please link N9H26_MSC_NAND_SD.a

6. If user wants to export only all flash, please link N9H26_MSC_All.a

mscdSdEnable

Synopsis

VOID mscdSdEnable (UINT32 u32Enable)

Description

This function enables the SD port for MSC.

Parameter

u32Enable	MSC_SD_MP_PORT0~ MSC_SD_MP_PORT2
	MSC_SD_PORT0~ MSC_SD_PORT2

Return Value

None

Example

```
       /* Export two SD ports (Multiple partition) */

mscdSdEnable (MSC_SD_MP_PORT0| MSC_SD_MP_PORT1);

       /* Export one SD port (Single partition) */

mscdSdEnable (MSC_SD_ PORT0);
```

mscdNandEnable

Synopsis

VOID mscdNandEnable (UINT32 u32Enable)

Description

This function enables the NAND CS for MSC.

Parameter

u32Enable	MSC_NAND_CS0~ MSC_ NAND _CS2

Return Value

None

Example

```
       /* Export two NAND CS */

mscdSdEnable (MSC_NAND_CS0| MSC_NAND_CS2);
```

```
        /* Export one NAND CS */
mscdSdEnable (MSC_NAND_CS0);
```

mscdSdUserWriteProtectPin

Synopsis

VOID mscdSdUserWriteProtectPin (

UINT32	u32SdPort,
BOOL	bEnable,
UINT32	u32GpioPort,
UINT32	u32GpioPin

)

Description

This function enables/disables the SD write protect function and SD write protect pin for MSC.

Parameter

u32SdPort	MSC_SD_PORT0~ MSC_SD_PORT2
bEnable	Enable or Disable Write Protection function (TRUE/FALSE)
u32GpioPort	MSC_SD_GPIO_PORTA~ MSC_SD_GPIO_PORTE, MSC_SD_GPIO_PORTG, MSC_SD_GPIO_PORTH
u32GpioPin	GPIO pin number : 0~15

Return Value

None

Example

```
        /* Set GPIOA Pin 2 for SD port0 Write Protect Pin */
mscdSdUserWriteProtectPin (MSC_SD_PORT0, TRUE, MSC_SD_GPIO_PORTA, 2);
        /* Disable SD Port 0 Write Protect Pin function*/
mscdSdUserWriteProtectPin (MSC_SD_PORT0, FALSE, 0, 0);
```

Note

Only SD Port0 has default Write Protection pin and Write Protection function is default enable and use the default pin (GPA0).

mscdSdUserCardDetectPin

Synopsis

VOID mscdSdUserCardDetectPin (

UINT32	u32SdPort,
BOOL	bEnable,
UINT32	u32GpioPort,
UINT32	u32GpioPin

)

Description

This function enables/disables the SD card detection funvyion for MSC.

Parameter

u32SdPort	MSC_SD_PORT0~ MSC_SD_PORT2
bEnable	Enable or Disable card detection (TRUE/FALSE)
u32GpioPort	MSC_SD_GPIO_PORTA~ MSC_SD_GPIO_PORTE, MSC_SD_GPIO_PORTG, MSC_SD_GPIO_PORTH
u32GpioPin	GPIO pin number : 0~15

Return Value

None

Example

```
       /* Set GPIOA Pin 2 for SD port0 Card detect Pin */

mscdSdUserCardDetectPin (MSC_SD_PORT0, TRUE, MSC_SD_GPIO_PORTA, 2);

       /* Disable SD Port 0 Card detect function*/

mscdSdUserCardDetectPin (MSC_SD_PORT0, FALSE, 0, 0);
```

Note

1. Only SD Port0/2 has default Card detect pin and Card detect function is default enable and use the default pin (GPA1 for Port 0 and GPE11for Port2).
2. If user disable the Card detect function, MSC will consider that the SD card is always exist.

mscdMassEvent

Synopsis

VOID mscdMassEvent (PFN_USBD_EXIT_CALLBACK* callback_fun)

Description

This function processes all the mass storage class commands such as read, write, inquiry, etc. The function has loop in it and it exits the loop according to the return value of the callback function.

Parameter

callback_fun The callback function for the Mass Event Exit condition. If it returns FALSE, the mass event service is disabled.

Return Value

None

Example

```
mscdMassEvent(udcIsAttached);
```

Note

The API must be called when all APIs about MSC is completed.

27.4. USB Video Class (UVCD) API

uvcdInit

Synopsis

VOID uvcdInit(PFN_UVCD_PUCONTROL_CALLBACK* callback_func)

Description

This function initializes software source and install the Process Unit Callback function.

Parameter

callback_func Process Uint Call back function pointer

Return Value

None

Example

```
/* Initial UVC and install Process Uint Call back function */

uvcdInit(ProcessUnitControl);

/* Process Uint Call back function */
```

```
UINT32 ProcessUnitControl(UINT32 u32ItemSelect,UINT32 u32Value)

{

       switch(u32ItemSelect)

       {

               case PU_BACKLIGHT_COMPENSATION_CONTROL:

                       sysprintf("Set Backlight -> %d\n",u32Value);

                       break;

               case PU_BRIGHTNESS_CONTROL:

                       sysprintf("Set Brightness -> %d\n",u32Value);

                       break;

               case PU_CONTRAST_CONTROL:

                       sysprintf("Set Contrast -> %d\n",u32Value);

                        break;

               case PU_HUE_CONTROL:

                       sysprintf("Set Hue -> %d\n",u32Value);

                        break;

               case PU_SATURATION_CONTROL:

                       sysprintf("Set Saturation -> %d\n",u32Value);

                        break;

               case PU_SHARPNESS_CONTROL:

                       sysprintf("Set Sharpness -> %d\n",u32Value);

                        break;

               case PU_GAMMA_CONTROL:

                       sysprintf("Set Gamma -> %d\n",u32Value);

                        break;

               case PU_POWER_LINE_FREQUENCY_CONTROL:

                       sysprintf("Set Power Line Frequency -> %d\n",u32Value);
                       break;
```

```
        }

        return 0;
}
```

uvcdSendImage

Synopsis

BOOL uvcdSendImage(UINT32 u32Addr, UINT32 u32transferSize, BOOL bStillImage)

Description

This function is to send preview or snapshot image to USB Host.

Parameter

u32Addr	Image data address
u32transferSize	Image data size
bStillImage	TRUE (Snapshot) / FALSE (Preview)

Return Value

None

Example

```
/* Send Image */

uvcdSendImage(u32Addr, u32transferSize, uvcStatus.StillImage);
```

uvcdIsReady

Synopsis

BOOL uvcdIsReady(VOID)

Description

This function is to check UVC is ready to send image or not.

Parameter

None

Return Value

TRUE	Ready
FALSE	Busy

Example

```
/* Wait for Complete */

while(!uvcdIsReady());
```

27.5. Example code

This demo code has sample code for MSC (Mass Storage Class) and UVC (USB Video Class)
Please refer to the mass_storage & video_class sample codes of SDK Non-OS.

28. USB Core Library Overview

28.1. USB Core Library Overview

The USB Core library is composed of four major parts, which are OHCI driver, EHCI driver, USB driver, and USB hub device driver. Each of these four drivers also represents one of the three-layered USB driver layers. Figure 1-1 presents the driver layers of the USB library.

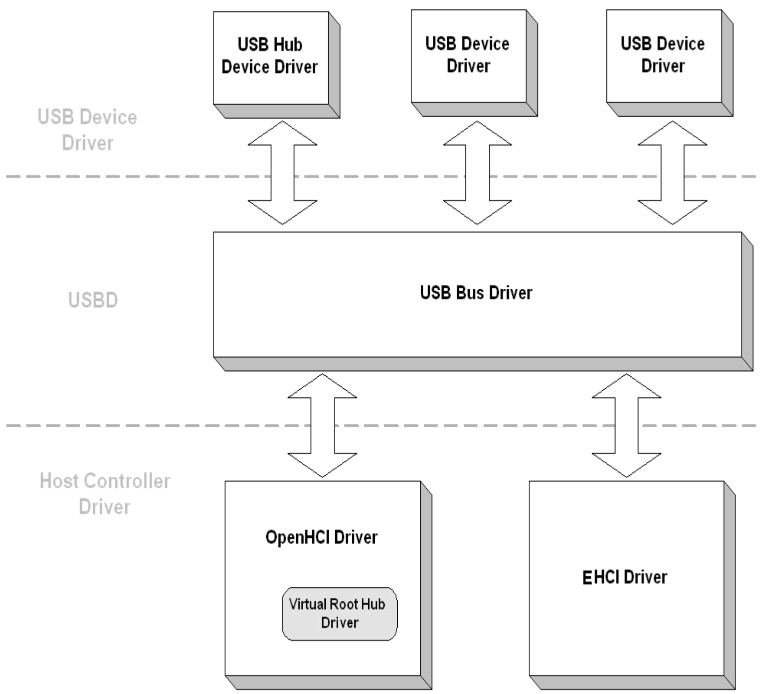


Figure 28-1 USB driver layer of USB library

28.2. Data Structures

The USB Core library has included many complicated data structures to describe a USB bus, a device, a driver, various descriptors, and so on. To realize these data structures may be necessary for a USB device driver designer. In the following sections, we will introduce all data structures you may need. These data structures are all defined in header file <usb.h>.

USB_DEV_T

USB_DEV_T is the data structure used to represent a device instance. Once the host finds that a device presented on a USB bus, the USB system software is notified. The USB system software resets and enables the hub port to reset the device. It then creates a ***USB_DEV_T*** for the newly detected device. For each USB device presented on the bus, even the same device type, USB system software will create a ***USB_DEV_T*** to represent it as an instance.

The contents of all members of ***USB_DEV_T*** are automatically assigned by USB system software. The USB system software will assign a unique device number, read device descriptor and configuration descriptors, and create parent/child relationships. The definition of USB_DEV_T is listed below, and the detailed descriptions can be found in *Table 28-1: Members of USB_DEV_T*

```
typedef struct usb_device

{

    INT     devnum;

    INT     slow;

    enum

    {

            USB_SPEED_UNKNOWN = ,

            USB_SPEED_LOW,

            USB_SPEED_FULL,

            USB_SPEED_HIGH

    }       speed;

    struct usb_tt  *tt;

    INT     ttport;

    INT     refcnt;

    UINT32  toggle[2];
```

```
    UINT32  halted[2];
    INT     epmaxpacketin[16];
    INT     epmaxpacketout[16];
    struct usb_device  *parent;
    INT     hub_port;
    USB_BUS_T *bus;
    USB_DEV_DESC_T  descriptor;
    USB_CONFIG_DESC_T *config;
    USB_CONFIG_DESC_T *actconfig;
    CHAR    **rawdescriptors;
    INT     have_langid;
    INT     string_langid;
    VOID    *hcpriv;
    INT     maxchild;
    struct usb_device  *children[USB_MAXCHILDREN];
} USB_DEV_T;
```

Table 28-1: Members of USB_DEV_T

Member	Description
devnum	Device number on USB bus; each device instance has a unique device number
slow	Is low speed device speed ? (1: yes; 0: no)
speed	Device speed
refcnt	Reference count (to count the number of users using the device)
toggle[2]	Data toggle; one bit for each endpoint ([0] = IN, [1] = OUT)
halted[2]	Endpoint halts; one bit for each endpoint ([0] = IN, [1] = OUT)
epmaxpacketin[16]	IN endpoints specific maximum packet size (each entry represents for an IN endpoint of this device)
epmaxpacketout[16]	OUT endpoints specific maximum packet size (each entry represents for

	an OUT endpoint of this device)
parent	Parent device in the bus topology (generally, it should be a hub)
bus	The bus on which this device was presented
descriptor	Device descriptor
config	All of the configuration descriptors
actconfig	The descriptor of the active configuration
rawdescriptors	Raw descriptors for each configuration descriptor (driver can find class specific or vendor specific descriptors from the *rawdescriptors*)
have_langid	Whether string_langid is valid yet
string_langid	Language ID for strings
hcpriv	Host controller private data
maxchild	Number of ports if this is a hub device
children[ ]	Link to the downstream port device if this is a hub device

28.3. Descriptor Structures

In the USB_DEV_T structure, device descriptor, configuration descriptors, and raw descriptor are included. The USB Driver will acquire these descriptors from device automatically while the device is probed. The USB Driver issues GET_DESCRIPTOR standard device request to acquire the configuration descriptors. It also parses the returned descriptors to create configuration-interface-endpoint descriptor links. Client software can obtain any configuration, interface, or endpoint descriptors by tracing the descriptor link started from USB_DEV_T. As USB Driver cannot understand class-specific and vendor-specific descriptors, it does not create link for these descriptors. If the client software wants to obtain any class-specific or vendor-specific descriptors, it can parse the descriptors stored in raw descriptor, which is the original descriptors list returned from the device. Table2-2, Table 2-3, Table 2-4, and Table 2-5 describe the structures defined for device descriptors, configuration descriptors, interface descriptors, and endpoint descriptors, respectively.

Figure 2-1 presents an overview on the relationship of these data structures. From USB_DEV_T (device instance structure), USB_DEV_DEC_T (device descriptor structure) and USB_CONFIG_DEC_T (configuration descriptor structure), USB_IF_DESC_T (interface descriptor structure), to USB_EP_DESC_T (endpoint descriptor structure), all structure entries are linked in top-down order.

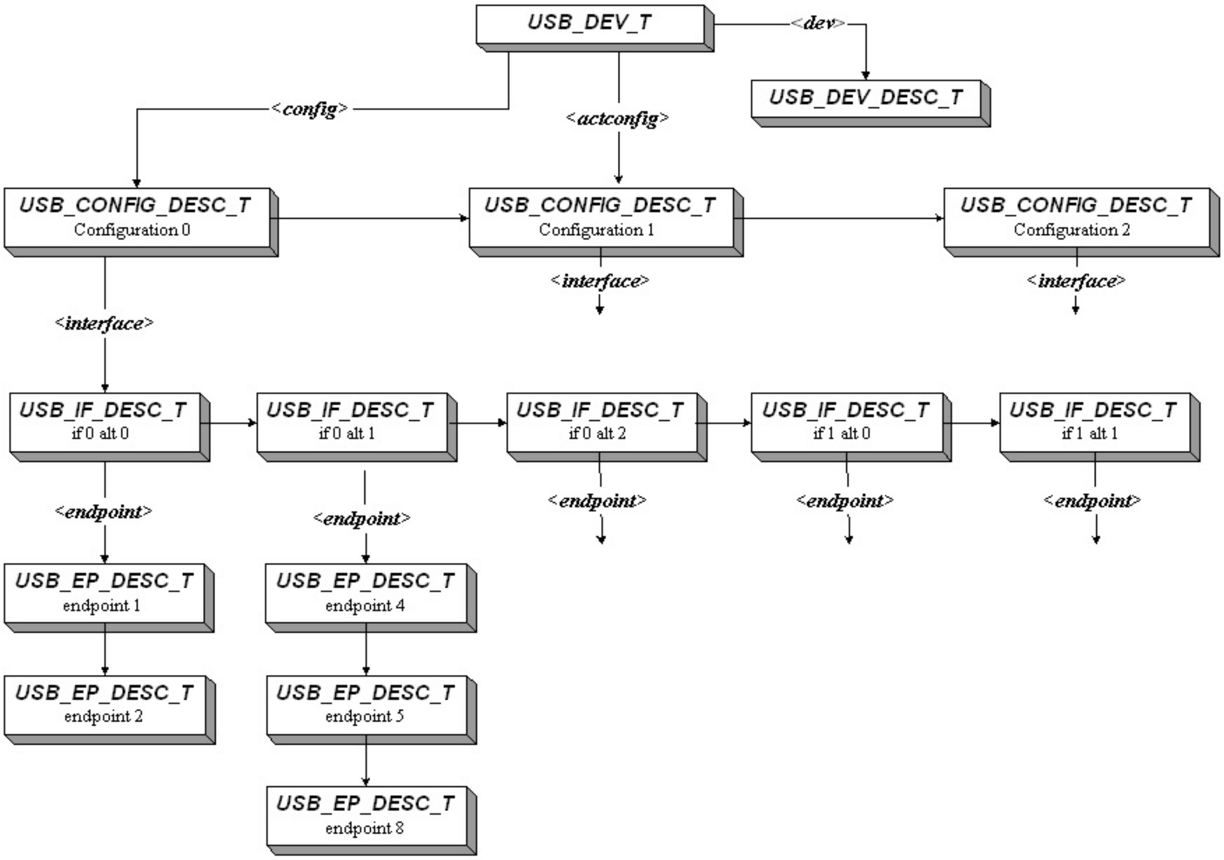


Figure 28-2:Descriptors relationship

```
/* Device descriptor */

typedef struct usb_device_descriptor

{

    __packed UINT8  bLength;

    __packed UINT8  bDescriptorType;

    __packed UINT16 bcdUSB;

    __packed UINT8  bDeviceClass;

    __packed UINT8  bDeviceSubClass;

    __packed UINT8  bDeviceProtocol;

    __packed UINT8  bMaxPacketSize0;

    __packed UINT16 idVendor;

    __packed UINT16 idProduct;
```

```
    __packed UINT16 bcdDevice;
    __packed UINT8  iManufacturer;
    __packed UINT8  iProduct;
    __packed UINT8  iSerialNumber;
    __packed UINT8  bNumConfigurations;
} USB_DEV_DESC_T;
```

Table 28-2: Members of USB_DEV_DESC_T

Member	Description
bLength	Size of the descriptor in bytes
bDescriptorType	DEVICE descriptor type (0x01)
bcdUSB	USB specification release number in BCD format
bDeviceClass	Device class code
bDeviceSubclass	Device subclass code
bDeviceProtocol	Protocol code
bMaxPacketSize0	Maximum packet size for endpoint zero
idVendor	Vendor ID
idProduct	Product ID
iManufacturer	Device release number in BCD format
iProduct	Index of string descriptor describing product
iSerialNumber	Index of string descriptor describing the serial number
bNumConfigurations	Number of possible configurations

You may have found that the definition of ***USB_DEV_DESC_T*** is fully compliant to the definition of device descriptor defined in USB 1.1 specification. In fact, the USB Driver acquires the device descriptor and fills it into this structure without making any modifications.

```
/* Configuration descriptor information.. */
typedef struct usb_config_descriptor
{
    __packed UINT8   bLength;
```

```
    __packed UINT8   bDescriptorType;

    __packed UINT16  wTotalLength;

    __packed UINT8   bNumInterfaces;

    __packed UINT8   bConfigurationValue;

    __packed UINT8   iConfiguration;

    __packed UINT8   bmAttributes;

    __packed UINT8   MaxPower;

    USB_IF_T  *interface;

    UINT8   *extra;

    INT     extralen;

} USB_CONFIG_DESC_T;
```

Table 28-3: Members of USB_CONFIG_DESC_T

Member	Description
bLength	Size of the descriptor in bytes
bDescriptorType	CONFIGURATION descriptor type (0x02)
wTotalLength	The total length of data returned for this descriptor
bNumInterfaces	Number of interface supported by this configuration
bConfigurationValue	Value to use as an argument to the SetConfiguration() request to select the active configuration
iConfiguration	Index of string descriptor describing this configuration
bmAttributes	Bitmap describing the configuration characteristics
MaxPower	Maximum power consumption of the USB device from the bus in this specific configuration when the device is fully operational (in mA)
interface	Refer to the interface descriptor list (recorded in USB_IF_DESC_T structure format) returned by this configuration
extra	Refer to the memory buffer preserve the raw data of this configuration descriptor itself
extralen	The length of the <*extra*> memory buffer

The ***dev->config*** refers to a list of configurations supported by this device. Client software can access any configuration by indexing the configuration, for example, dev->config[0] is referred to the first configuration of this device. While <***config***> of ***USB_DEV_T*** refers to the configuration list, <***actconfig***> refers to the currently activated configuration. There can be only one configuration activated at the same time.

The structure members from <***bLength***> to <***MaxPower***> are fully compliant to that defined in USB 1.1 specification. The <***interface***> refers to a list of interfaces supported by this configuration. In addition, USB Driver keeps the interface descriptor itself in a dynamically allocated memory buffer, which is referred to by <***extra***>, and the length of this memory buffer is <***extralen***>.

An interface may contain several alternate settings. Each alternate setting has its own set of endpoints. USB Driver creates a single ***USB_IF_DESC_T*** structure for each alternate interface setting and links them in the order that they presented in the returned data of a configuration descriptor.

```
/* Interface descriptor */

typedef struct usb_interface_descriptor

{

    __packed UINT8  bLength;

    __packed UINT8  bDescriptorType;

    __packed UINT8  bInterfaceNumber;

    __packed UINT8  bAlternateSetting;

    __packed UINT8  bNumEndpoints;

    __packed UINT8  bInterfaceClass;

    __packed UINT8  bInterfaceSubClass;

    __packed UINT8  bInterfaceProtocol;

    __packed UINT8  iInterface;

    USB_EP_DESC_T *endpoint;

    UINT8  *extra;

    INT    extralen;

} USB_IF_DESC_T;
```

Table 28-4: Members of USB_IF_DESC_T

Member	Description
bLength	Size of the descriptor in bytes
bDescriptorType	INTERFACE descriptor type (0x04)
bInterfaceNumber	Number of interface. Zero-based value identifying the index in the array of concurrent interfaces supported by this configuration.
bAlternateSetting	Value used to select alternate setting for this interface
bNumEndpoints	Number of endpoints used by this interface (excluding endpoint zero)
bInterfaceClass	Class code
bInterfaceSubClass	Subclass code
bInterfaceProtocol	Protocol code
iInterface	Index of string descriptor describing this interface
endpoint	Refer to the endpoint descriptor list (recorded in USB_EP_DESC_T structure format) of this interface returned by this configuration
extra	Refer to the memory buffer preserve the raw data of this interface descriptor itself
extralen	The length of the <*extra*> memory buffer

The ***dev->config[n]->interface*** refers to a list of interfaces supported by configuration n. The structure members from <***bLength***> to <***iInterface***> are fully compliant to that defined in USB 1.1 specification. The <***endpoint***> refers to a list of endpoints supported by this interface. In addition, USB Driver keeps the interface descriptor itself in a dynamically allocated memory buffer, which is referred to by <***extra***>, and the length of this memory buffer is <***extralen***>.

```
/* Endpoint descriptor */

typedef struct usb_endpoint_descriptor

{

    __packed UINT8  bLength;

    __packed UINT8  bDescriptorType;

    __packed UINT8  bEndpointAddress;

    __packed UINT8  bmAttributes;

    __packed UINT16 wMaxPacketSize;

    __packed UINT8  bInterval;
```

```
    __packed UINT8  bRefresh;

    __packed UINT8  bSynchAddress;

    UINT8   *extra;

    INT     extralen;

} USB_EP_DESC_T;
```

Table 28-5: Members of USB_EP_DESC_T

Member	Description
bLength	Size of the descriptor in bytes
bDescriptorType	ENDPOINT descriptor type (0x05)
bEndpointAddress	The address of this endpoint
bmAttributes	Transfer type of this endpoint
wMaxPacketSize	The maximum packet size this endpoint is capable of sending or receiving
bInterval	Interval for polling endpoint for data transfers (in milliseconds)
bRefresh	Audio extensions to the endpoint descriptor
bSynchAddress	Audio extensions to the endpoint descriptor
extra	Refer to the memory buffer preserve the raw data of this endpoint descriptor itself
extralen	The length of the <*extra*> memory buffer

DEV_REQ_T

DEV_REQ_T is used to represent the eight bytes device request in a control transfer. All device requests, including standard device requests, class-specific device requests, and vendor-specific device requests, are written in the ***DEV_REQ_T*** structure, which is also a member of a URB, and transferred to device through the control pipe.

```
typedef struct

{

__packed UINT8  requesttype;

__packed UINT8  request;

__packed UINT16 value;

__packed UINT16 index;
```

```
__packed UINT16 length;

} DEV_REQ_T;
```

Table 28-6: Members of DEV_REQ_T

Member	Description
requesttype	Characteristics of request
request	Specific request
value	Word-sized field that varies according to request
index	Word-sized field that varies according to request
length	Number of bytes to transfer if there is a DATA stage

USB_DEV_ID_T

When the USB System Software detects a device being attached, it must find out the corresponding device driver for each of its interface from the registered driver list. It can try to invoke the ***probe()*** routine of each registered device driver for each device interface, but this is not efficient and time-consuming. If the USB System Software can make some simple judgment before trying invoking a device driver, it will be better. This is the purpose of ***USB_DEV_ID_T***. The USB Library employ device ID to identify the appropriate device drivers.

When a device driver is registered to USB Driver, it may provide a device ID table, which is structured in ***USB_DEV_ID_T*** format. In the device ID table, driver can specify the characteristics of the USB device interface that the driver would serve. If a driver does not provide a device ID table, then the USB Driver will always try to invoke it when a new device is detected.

The device driver can use device ID table to specify several checks of characteristics, including vendor ID, device ID, release number, device class, device subclass, device protocol, interface class, interface subclass, and interface protocol. The device driver can specify one or more checks. The more checks are specified, the more specific device interface can be identified. Table 2-7 lists the entries of device ID table.

```
typedef struct usb_device_id

{

    UINT16  match_flags;

    UINT16  idVendor;

    UINT16  idProduct;

    UINT16  bcdDevice_lo;

    UINT16  bcdDevice_hi;

    UINT8   bDeviceClass;
```

```
    UINT8   bDeviceSubClass;
    UINT8   bDeviceProtocol;
    UINT8   bInterfaceClass;
    UINT8   bInterfaceSubClass;
    UINT8   bInterfaceProtocol;
    UINT32  driver_info;
} USB_DEV_ID_T;
```

Table 28-7: Members of DEV_REQ_T

Member	Description
matchflag	A bitmask of flags, used to determine which of the following items are to be used for matching
idVendor	Used to compare the vendor ID recorded in device descriptor
idProduct	Used to compare the product ID recorded in device descriptor
bcdDevice_lo	Specify the low limit of device release number
bcdDevice_hi	Specify the high limit of device release number
bDeviceClass	Used to compare the class code in device descriptor
bDeviceSubClass	Used to compare the subclass code in device descriptor
bDeviceProtocol	Used to compare the protocol code in device descriptor
bInterfaceClass	Used to compare the class code in interface descriptor
bInterfaceSubClass	Used to compare the subclass code in interface descriptor
bInterfaceProtocol	Used to compare the protocol code in interface descriptor

There are 10 check items can be used to identify a specific type of device. To select which of these check items should be used to identify a device type is controlled by the <***matchflag***> member, which is a 16bits bit-mask flag. Each bit of < ***matchflag*** > is corresponding to one of these check items. The bit-map definition of < ***matchflag*** > is defined as the followings:

```
#define USB_DEVICE_ID_MATCH_VENDOR          0x0001
#define USB_DEVICE_ID_MATCH_PRODUCT         0x0002
#define USB_DEVICE_ID_MATCH_DEV_LO          0x0004
#define USB_DEVICE_ID_MATCH_DEV_HI          0x0008
```

```
#define USB_DEVICE_ID_MATCH_DEV_CLASS       0x0010

#define USB_DEVICE_ID_MATCH_DEV_SUBCLASS    0x0020

#define USB_DEVICE_ID_MATCH_DEV_PROTOCOL    0x0040

#define USB_DEVICE_ID_MATCH_INT_CLASS       0x0080

#define USB_DEVICE_ID_MATCH_INT_SUBCLASS    0x0100

#define USB_DEVICE_ID_MATCH_INT_PROTOCOL    0x0200
```

For convenience of driver implementation, the USB library also provides some useful macros that facilitate the development of device driver. These macros are all listed in the followings, you can also define your own macros:

```
/* Some useful macros */

#define USB_DEVICE(vend,prod) \

        { USB_DEVICE_ID_MATCH_DEVICE, vend, prod, 0, 0,

          0, 0, 0, 0, 0, 0, 0 }



#define USB_DEVICE_VER(vend,prod,lo,hi) \

        { USB_DEVICE_ID_MATCH_DEVICE_AND_VERSION, vend,

          prod, lo, hi, 0, 0, 0, 0, 0, 0, 0 }



#define USB_DEVICE_INFO(cl,sc,pr) \

        { USB_DEVICE_ID_MATCH_DEV_INFO, 0, 0, 0, 0, cl,

          sc, pr, 0, 0, 0, 0 }



#define USB_INTERFACE_INFO(cl,sc,pr) \

        { USB_DEVICE_ID_MATCH_INT_INFO, 0, 0, 0, 0, 0,

          0, 0, cl, sc, pr, 0 }
```

USB_DRIVER_T

The USB library has defined a generalized structure for all USB device drivers. To implement a USB device driver based on this library, you must create such a structure and register it to the USB Driver. Once you have registered your device driver, the USB Driver can determine whether to launch your driver when a new device is attached.

As we will give detail introduction to the implementation of USB device driver, we only briefly describe the members of ***USB_DRIVER_T*** as following:

```
typedef struct usb_device_id

{

    UINT16  match_flags;

    UINT16  idVendor;

    UINT16  idProduct;

    UINT16  bcdDevice_lo;

    UINT16  bcdDevice_hi;

    UINT8   bDeviceClass;

    UINT8   bDeviceSubClass;

    UINT8   bDeviceProtocol;

    UINT8   bInterfaceClass;

    UINT8   bInterfaceSubClass;

    UINT8   bInterfaceProtocol;

    UINT32  driver_info;

} USB_DEV_ID_T;
```

Table 28-8: Members of DEV_REQ_T

Member	Description
matchflag	A bitmask of flags, used to determine which of the following items are to be used for matching
idVendor	Used to compare the vendor ID recorded in device descriptor
idProduct	Used to compare the product ID recorded in device descriptor
bcdDevice_lo	Specify the low limit of device release number
bcdDevice_hi	Specify the high limit of device release number
bDeviceClass	Used to compare the class code in device descriptor

bDeviceSubClass	Used to compare the subclass code in device descriptor
bDeviceProtocol	Used to compare the protocol code in device descriptor
bInterfaceClass	Used to compare the class code in interface descriptor
bInterfaceSubClass	Used to compare the subclass code in interface descriptor
bInterfaceProtocol	Used to compare the protocol code in interface descriptor

URB_T

USB specification has defined four transfer type: control, bulk, interrupt, and isochronous. In the USB library, all these four transfer types are accomplished by URB (USB Request Block). Please refer to Chapter 3 for details about the implementation of each transfer type by using URB.

.

28.4. Data Transfer

USB specification defines four transfer types, control, bulk, interrupt, and isochronous. The USB device driver performs data transfers by preparing an URB and transfer it to the underlying USB system software. The URBs are designed to be accommodated with all four transfer types. By configuring the URB, USB device driver can specify the destination device interface and endpoint, the data buffer and data length to be transferred, the callback routine on completion, and other detail information. USB device driver passed the URB to the underlying USB system software, which will interpret the URB and accomplish the data transfers by initiating USB transactions between W90X900 Host Controller and the target device endpoint.

URB has been designed to be accommodated with all four USB data transfer types. Due to the characteristics of different transfer types, various requirements must be satisfied to fulfill the transfer. For example, URB contains <***setup_packet***> for control transfer, <***interval***> for interval transfer, <***start_frame***> and <***number_of_packets***> for isochronous transfer, and <***transfer_buffer***> for all transfers. To implement a USB device driver, the programmers use URBs to accomplish all data transfers to all of the various endpoints.

For a specific endpoint, after delivering a URB to the underlying USB system software, the USB device driver must not deliver another URB to the same endpoint until the current transfer was done by the USB system software. That is, the driver must be blocked in waiting completion of the URB. URB includes a <***complete***> function pointer to solve the block waiting issue. The USB device driver provided a callback function and have <complete> pointer being referred to the callback function. On completion of this URB, the USB system software will invoke the callback function. Thus, the USB device driver was notified with the completion event, and can stop waiting. Note that the callback functions are invoked from an HISR, the execution time must be as short as possible.

28.5. Pipe Control

Before delivering an URB, the USB device driver must determine which device and which endpoint the URB will operate on. This destination device and endpoint is determined by <***pipe***> of URB. <***pipe***> is actually a 32-bits unsigned integer. The USB library defined pipe structure with a 32-bits unsigned integer. The USB library has defined several useful macros for pipe control. The pipe is defined as the followings:

<table>
<tr><th>31</th><th>30</th><th>29</th><th>28</th><th>27</th><th>26</th><th>25</th><th>24</th></tr>
<tr><td colspan="2">Pipe Type</td><td colspan="3">Reserved</td><td>Speed</td><td colspan="2">Reserved</td></tr>
<tr><th>23</th><th>22</th><th>21</th><th>20</th><th>19</th><th>18</th><th>17</th><th>16</th></tr>
<tr><td colspan="4">Reserved</td><td>Data0/1</td><td colspan="3">Endpoint</td></tr>
<tr><th>15</th><th>14</th><th>13</th><th>12</th><th>11</th><th>10</th><th>9</th><th>8</th></tr>
<tr><td></td><td colspan="7">Device</td></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>Direction</td><td colspan="5">Reserved</td><td colspan="2">Max Size</td></tr>
</table>

Table 28-9: Members of Pipe Control

Member	Description
Max Size [1 .. 0]	The maximum packet size. This field has been obsoleted. Now the maximum packet size is recorded in <*epmaxpacketin*> and <*epmaxpacketout*> fields of *USB_DEV_T*.
Direction[7]	Direction of data transfer. 0 = Host-to-Device [out]; 1 = Device-to-Host [in]
Device[8 .. 14]	Device number. This is the unique device address, which is assigned by Host Controller driver by ***SET_ADDRESS*** standard request. With this unique device number, the USB device driver can correctly locate the target device.
Endpoint[15 .. 18]	Endpoint number. This is the endpoint number on the target device, that the pipe is created with. By definition, a pipe corresponds to a unique endpoint on a unique device. By determining the device number and endpoint number, USB device driver can uniquely identify a specific endpoint of a specific device.

Data0/1[19]	Data toggle Data0/Data1. This bit is used to record the current data toggle condition.
Speed[26]	Endpoint transfer speed. 1 = Low speed; 0 = Full speed.
Pipe Type[30 .. 31]	Transfer type. 00 = isochronous; 01 = interrupt; 10 = control; 11 = bulk.

The USB library has provided a lot of macros facilities for USB device driver designer. The device driver can use the facilities to rescuer the trouble of managing bit fields. These macros are listed in the followings:

Transfer Type

```
#define PIPE_ISOCHRONOUS               0

#define PIPE_INTERRUPT                 1

#define PIPE_CONTROL                   2

#define PIPE_BULK                      3


#define usb_pipetype(pipe)    (((pipe) >> 30) & 3)

#define usb_pipecontrol(pipe) (usb_pipetype((pipe)) == PIPE_CONTROL)

#define usb_pipebulk(pipe)    (usb_pipetype((pipe)) == PIPE_BULK)

#define usb_pipeint(pipe)     (usb_pipetype((pipe)) == PIPE_INTERRUPT)\

#define usb_pipeisoc(pipe)    (usb_pipetype((pipe)) == PIPE_ISOCHRONOUS
```

Maximun Packet Size

```
#define usb_maxpacket(dev, pipe, out)   (out              \

        ? (dev)->epmaxpacketout[usb_pipeendpoint(pipe)]   \

: (dev)->epmaxpacketin [usb_pipeendpoint(pipe)] )
```

Direction

```
#define usb_packetid(pipe) (((pipe) & USB_DIR_IN) ?        \

                           USB_PID_IN : USB_PID_OUT)

#define usb_pipeout(pipe)  ((((pipe) >> 7) & 1) ^ 1)

#define usb_pipein(pipe)   (((pipe) >> 7) & 1)
```

Device Number

```
#define usb_pipedevice(pipe)    (((pipe) >> 8) & 0x7f)

#define usb_pipe_endpdev(pipe)  (((pipe) >> 8) & 0x7ff)
```

Endpoint Number

```
#define usb_pipe_endpdev(pipe)  (((pipe) >> 8) & 0x7ff)

#define usb_pipeendpoint(pipe)  (((pipe) >> 15) & 0xf)
```

Data Toggle

```
#define usb_pipedata(pipe)      (((pipe) >> 19) & 1)

#define usb_gettoggle(dev, ep, out)                   \

                  (((dev)->toggle[out] >> ep) & 1)

#define usb_dotoggle(dev, ep, out)                    \

                  ((dev)->toggle[out] ^= (1 << ep))

#define usb_settoggle(dev, ep, out, bit)              \

                 ((dev)->toggle[out] =               \

                 ((dev)->toggle[out] & ~(1 << ep)) | \

                 ((bit) << ep))
```

Speed

```
#define usb_pipeslow(pipe)      (((pipe) >> 26) & 1)
```

Pipe Creation

```
static __inline UINT32 __create_pipe(USB_DEV_T *dev, UINT32 endpoint)

{

    return (dev->devnum << 8) | (endpoint << 15) | (dev->slow << 26);

}



static __inline UINT32 __default_pipe(USB_DEV_T *dev)
```

```
{
        return (dev->slow << 26);
}


/* Create various pipes... */
#define usb_sndctrlpipe(dev,endpoint)         \
          (0x80000000 | __create_pipe(dev,endpoint))
#define usb_rcvctrlpipe(dev,endpoint)         \
          (0x80000000 | __create_pipe(dev,endpoint) | USB_DIR_IN)
#define usb_sndisocpipe(dev,endpoint)         \
          (0x00000000 | __create_pipe(dev,endpoint))
#define usb_rcvisocpipe(dev,endpoint)         \
          (0x00000000 | __create_pipe(dev,endpoint) | USB_DIR_IN)
#define usb_sndbulkpipe(dev,endpoint)         \
          (0xC0000000 | __create_pipe(dev,endpoint))
#define usb_rcvbulkpipe(dev,endpoint)         \
          (0xC0000000 | __create_pipe(dev,endpoint) | USB_DIR_IN)
#define usb_sndintpipe(dev,endpoint)          \
          (0x40000000 | __create_pipe(dev,endpoint))
#define usb_rcvintpipe(dev,endpoint)          \
          (0x40000000 | __create_pipe(dev,endpoint) | USB_DIR_IN)
#define usb_snddefctrl(dev)                  \
          (0x80000000 | __default_pipe(dev))
#define usb_rcvdefctrl(dev)                  \
          (0x80000000 | __default_pipe(dev) | USB_DIR_IN)
```

28.6. Control Transfer

IN this section, we will introduce how to make control transfers by URBs. A control transfer is accomplished by sending a device request to the control endpoint of the target device. Depend on the request sent to device, there may be data stage or not.

The URB provided a <***setup_packet***> field to accommodate the device request command. The USB device driver must have the <***setup_packet***> of its URB being referred to an <unsigned char> array, which contained the device request command to be transferred. Note that <***setup_packet***> is designed to be used with control transfer.

If a device request included data stage, the data to be transferred must be referred to by the <***transfer_buffer***> pointer of URB. If the device request required data to be sent from Host to Device, the USB device driver must prepare a DMA buffer (non-cacheable) and fill the data to be transferred into this buffer. Then, the USB device driver have <***transfer_buffer***> pointer refer to this buffer, and specify the length of the buffer with <***transfer_buffer_length***> of the URB. If the device request requires data to be sent from Device to Host, the USB device driver must prepare a DMA buffer to receive the data from Device. Again, the USB device driver used <***transfer_buffer***> and <***Transfer_buffer_length***> to describe its DMA buffer. The <actual_length> is written by USB system software to tell the device driver how many bytes are actually transferred.

The USB device driver also has to prepare a callback function to be invoked by the USB system software. The callback function will be invoked on the completion of URB, in spite of success or fail. Generally, the callback function is responsible for waking up the task that delivered the URB. The callback function may also check the status of the URB to determine the transfer is successful or not. The following is an example of control transfer.

```
static VOID  ctrl_callback(URB_T *urb)
{
    PEGASUS_T   *pegasus = urb->context;

    switch ( urb->status )
    {
        case USB_ST_NOERROR:
            if (pegasus->flags & ETH_REGS_CHANGE)
            {
                pegasus->flags &= ~ETH_REGS_CHANGE;
                pegasus->flags |= ETH_REGS_CHANGED;
                update_eth_regs_async(pegasus);
```

```
                return;
            }
            break;
        case USB_ST_URB_PENDING:
            return;
        case USB_ST_URB_KILLED:
            break;
        default:
            printf("Warning - status %d\n", urb->status);
    }
    pegasus->flags &= ~ETH_REGS_CHANGED;
    if (pegasus->flags & CTRL_URB_SLEEP)
    {
       pegasus->flags &= ~CTRL_URB_SLEEP;
       NU_Set_Events(&pegasus->events, 1, NU_OR);  /* set event */
    }
}

static INT  get_registers(PEGASUS_T *pegasus, UINT16 indx, UINT16 size, VOID *data)
{
    INT    ret;
    UINT8  *dma_data;

    while (pegasus->flags & ETH_REGS_CHANGED)
    {
        pegasus->flags |= CTRL_URB_SLEEP;
        USB_printf("ETH_REGS_CHANGED waiting...\n");
        NU_Retrieve_Events(&pegasus->events, 1, NU_AND,
```

```
                         (unsigned long *)&ret, NU_SUSPEND);
    }

    dma_data = (UINT8 *)USB_malloc(size, BOUNDARY_WORD);
    if (!dma_data)
        return -ENOMEM;

    pegasus->dr->requesttype = PEGASUS_REQT_READ;
    pegasus->dr->request = PEGASUS_REQ_GET_REGS;
#ifdef LITTLE_ENDIAN
    pegasus->dr->value = 0;
    pegasus->dr->index = indx;
    pegasus->dr->length = size;
#else
    pegasus->dr->value = USB_SWAP16(0);
    pegasus->dr->index = USB_SWAP16(indx);
    pegasus->dr->length = USB_SWAP16(size);
#endif
    pegasus->ctrl_urb.transfer_buffer_length = size;

    FILL_CONTROL_URB(&pegasus->ctrl_urb, pegasus->usb,
                    usb_rcvctrlpipe(pegasus->usb,0),
                   (UINT8 *)pegasus->dr,
                    dma_data, size, ctrl_callback, pegasus );

    pegasus->flags |= CTRL_URB_SLEEP;
    NU_Set_Events(&pegasus->events, 0, NU_AND);  /* clear event */
    USB_SubmitUrb(&pegasus->ctrl_urb);
```

```
    NU_Retrieve_Events(&pegasus->events, 1, NU_AND,

                      (unsigned long *)&ret, NU_SUSPEND);

    memcpy(data, dma_data, size);

out:

    USB_free(dma_data);

    return  ret;

}
```

In the above example, the device driver first prepare the device request command in <*pegasus->dr*>, which was later referred to by <*urb->setup_packet*>. It request a buffer for DMA transfer by ***USB_malloc()***. Note that ***USB_malloc()*** will allocate a non-cacheable memory buffer. It then created a Control-In pipe by using ***usb_rcvctrlpipe*** macro, and the endpoint number is 0. The device driver the use the ***FILL_CONTROL_URB*** macro facility to fill the URB. The callback function is ***ctrl_callback()***, which is provided by the device driver itself. After submitting the URB, the caller task suspend on waiting the <*pegasus->events*> event set. On completion of this URB, the USB system software will invoke ***ctrl_callback()***, and ***ctrl_callback()*** will set the <*pegasus->events*> event to wake up the caller task.

28.7. Bulk Transfer

IN this section, we will introduce how to make bulk transfers by URBs. The URB provided <***transfer_buffer***> and <***transfer_buffer_length***> to accommodate data to be transferred to or from device. The direction of transfer is determined by the direction bit of bulk pipe. The transfer length is unlimited. If you are familiar with OpenHCI specification, you may understand that the maximum transfer size of a bulk transfer is 4096 bytes. If the transfer length of your URB exceeds 4096 bytes, the USB system software will split it into several transfer units smaller than 4096 bytes. Thus, you can specify unlimited transfer buffer length, only the physical memory can limit the size.

The transfer buffer must be non-cacheable. A designer can use ***USB_malloc()*** to acquire a block of non-cacheable memory.

The USB device driver also has to prepare a callback function to be invoked by the USB system software. The callback function will be invoked on the completion of URB, in spite of success or fail. Generally, the callback function is responsible for waking up the task that delivered the URB. The callback function may also check the status of the URB to determine the transfer is successful or not. The following is an example of bulk transfer

```
/* In Host Controller HISR context */

static VOID write_bulk_callback(URB_T *urb)

{
```

```
    PEGASUS_T       *pegasus = urb->context;
    STATUS           previous_int_value;
    DV_DEVICE_ENTRY  *device;

    _PegasusDevice->tx_ready = 1;
    /* Get a pointer to the device. */
    device = DEV_Get_Dev_By_Name("Pegasus");

    /* Lock out interrupts. */
    previous_int_value = NU_Control_Interrupts(NU_DISABLE_INTERRUPTS);
    DEV_Recover_TX_Buffers(device);

    /* If there is another item on the list, transmit it. */
    if (device->dev_transq.head)
    {
        /* Re-enable interrupts */
        NU_Control_Interrupts(previous_int_value);
        /* Transmit the next packet. */
        PegasusTransmit(device, device->dev_transq.head);
    }
    /* Re-enable interrupts. */
    NU_Control_Interrupts(previous_int_value);

    if (urb->status)
        USB_printf("write_bulk_callback - TX error status: %d\n",
                   urb->status);
}
```

```
STATUS  PegasusTransmit(DV_DEVICE_ENTRY *dev, NET_BUFFER *netBuffer)
{
    INT     ret, wait=0;
    UINT8   *buf_ptr;
    INT     totalLength = 0;

    while (!_PegasusDevice->tx_ready)
    {
        NU_Sleep(1);                 /* wait on any outgoing Tx */
        if (wait++ > NU_PLUS_Ticks_Per_Second)
        {
            USB_printf("Can't transmit packet!\n");
            return NU_IO_ERROR;
        }
    }

    buf_ptr = _PegasusDevice->tx_buff + 2;
    do
    {
        memcpy(buf_ptr, netBuffer->data_ptr, netBuffer->data_len);
        totalLength += netBuffer->data_len;
        buf_ptr += netBuffer->data_len;

        /* Move on to the next buffer. */
        netBuffer = netBuffer->next_buffer;
    } while (netBuffer != 0);
```

```
    /* The first two bytes record the packet length. */

    buf_ptr = _PegasusDevice->tx_buff;

    buf_ptr[0] = totalLength & 0xff;

    buf_ptr[1] = (totalLength >> 8) & 0xff;


    FILL_BULK_URB(&_PegasusDevice->tx_urb, _PegasusDevice->usb,

                 usb_sndbulkpipe(_PegasusDevice->usb, 2),

                (CHAR *)buf_ptr, PEGASUS_MAX_MTU,

                 write_bulk_callback, _PegasusDevice);


    _PegasusDevice->tx_urb.transfer_buffer_length =

           ((totalLength+2) & 0x3f) ? totalLength+2 : totalLength+3;

    _PegasusDevice->tx_ready = 0;

    USB_SubmitUrb(&_PegasusDevice->tx_urb);

    return NU_SUCCESS;

}
```

28.8. Interrupt Transfer

IN this section, we will introduce how to make interrupt transfers by URBs. The URB provided <***transfer_buffer***> and <***transfer_buffer_length***> to accommodate data to be transferred to or from device, and <***interval***> to specify polling interval of the interrupt transfer. The direction of transfer is determined by the direction bit of interrupt pipe. The transfer length is dependent on target interrupt endpoint.

The transfer buffer must be non-cacheable. A designer can use ***USB_malloc()*** to acquire a block of non-cacheable memory.

The USB device driver also has to prepare a callback function to be invoked by the USB system software. The callback function will be invoked if there's data received in one of the interrupt interval. In the callback function, USB device driver can read <***transfer_buffer***> to retrieve received interrupt data. The USB device driver have not to modify URB or resend URB. The USB library will resend the interrupt URB after callback. The interrupt URB will not stop until hardware failure or explicitly deleted by the USB device driver.

```
static VOID  intr_callback(URB_T *urb)
{
    PEGASUS_T *pegasus = urb->context;
    UINT8    *d;

    if (!pegasus)
        return;

    switch (urb->status)
    {
        case USB_ST_NOERROR:
            break;
        case USB_ST_URB_KILLED:
            return;
        default:
            break;
    }

    d = urb->transfer_buffer;
    if (d[2] & 0x1)
        UART_printf("Rx error - overflow!!\n");
}



    FILL_INT_URB(&_PegasusDevice->intr_urb, _PegasusDevice->usb,
                usb_rcvintpipe(_PegasusDevice->usb, 3),
```

```
                 (CHAR *)&_PegasusDevice->intr_buff[0], 8,
                 intr_callback, _PegasusDevice,
          _PegasusDevice->intr_interval);
    res = USB_SubmitUrb(&_PegasusDevice->intr_urb);
    if (res)
UART_printf("pegasus_open - failed intr_urb %d\n", res);
```

28.9. USB Core Library API

USB_PortInit

Synopsis

INT USB_PortInit (UINT32 u32PortType);

Description

The function is used to specificied USB host port type.

Parameter

u32PortType:

Table 28-10: Members of Pipe Control

u32PortType	Description
HOST_LIKE_PORT0	USB host output from GPIOB[1:0]. It is a host like port
HOST_LIKE_PORT1	USB host output from GPIOA[4:3]. It is a host like port
HOST_NORMAL_PORT0_ONLY	USB host output from normal USB transceiver port 0.
HOST_NORMAL_TWO_PORT	USB host output from normal USB transceiver port 0 and port 1.

Return Value

None

Example

/* In/out through host like port 0 */

USB_PortInit(HOST_LIKE_PORT0);

USB_PortDisable(FALSE, TRUE);

InitUsbSystem();

UMAS_InitUmasDriver();

USB_PortDisable

Synopsis

VOID USB_PortDisable(BOOL bIsDisPort0, BOOL bIsDisPort1);

Description

The function is used to disable USB hoost ports if the port is useless.

Parameter

bIsDisPort0	TRUE to disable port 0. FALSE to enable port 0
bIsDisPort1	TRUE to disable port 1. FALSE to enable port 1

Return Value

None

Example

```
/*  In/out through host like port 0 and diable port 1 */

USB_PortInit(HOST_LIKE_PORT0);

USB_PortDisable(FALSE, TRUE);

InitUsbSystem();

UMAS_InitUmasDriver();
```

InitUsbSystem

Synopsis

INT InitUsbSystem (VOID)

Description

Initialize the USB hardware and USB core library. This function must be invoked before any other functions. The USB library will scan device at this time, but the device will not be activated until the corresponding device driver was registered by USB_RegisterDriver().

Parameter

None

Return Value

0 – Success

Otherwise – Failure

Example

```
/*

Initialize NVTFAT FAT file system, USB core system, and USB mass storage driver

*/

fsInitFileSystem();

USB_PortInit(HOST_LIKE_PORT0);

USB_PortDisable(FALSE, TRUE);

InitUsbSystem();

UMAS_InitUmasDriver();
```

DeInitUsbSystem

Synopsis

INT DeInitUsbSystem(VOID)

Description

De-Initialize the USB hardware and USB core library.

Parameter

None

Return Value

0 – Success

Example

```
/*

Initialize NVTFAT FAT file system, USB core system, and USB mass storage driver

*/

fsInitFileSystem();
```

```
USB_PortInit(HOST_LIKE_PORT0);

USB_PortDisable(FALSE, TRUE);

InitUsbSystem();

UMAS_InitUmasDriver();

……

/* De-Initialize USB core library */

DeInitUsbSystem();
```

UMAS_InitUmasDriver

Synopsis

INT UMAS_InitUmasDriver (VOID)

Description

Initialize the USB mass storage driver. fsInitFileSystem() and InitUsbSystem() must be called prior to this API. Once an USB mass storage device detected, USB core library will initialize it and mount it to NVTFAT file system automatically.

Parameter

None

Return Value

0 – Success

Otherwise – Failure

Example

```
/*

Initialize NVTFAT FAT file system, USB core system, and USB mass storage driver

*/

fsInitFileSystem();

USB_PortInit(HOST_LIKE_PORT0);

USB_PortDisable(FALSE, TRUE);

InitUsbSystem();

UMAS_InitUmasDriver();
```

USB_RegisterDriver

Synopsis

INT USB_RegisterDriver (USB_DRIVER_T *driver)

Description

Register a device driver with the USB library. In this function, USB library will also try to associate the newly registered device driver with all connected USB devices that have no device driver associated with it. Note that a connected USB device can be detected by USB library but may not work until it was associated with its corresponding device driver.

Parameter

driver	The USB device driver to be registered with USB core library

Return Value

0 – Success

Otherwise – Failure

Example

```
static USB_DRIVER_T  usblp_driver =

{

    "usblp",

    usblp_probe,

    usblp_disconnect,

    {NULL,NULL},

    {0},

    NULL,

    usblp_ids,

    NULL,

    NULL

};



INT  UsbPrinter_Init() {
```

```
        if (USB_RegisterDriver(&usblp_driver)) return -1;

        return 0;

}
```

USB_DeregisterDriver

Synopsis

VOID USB_DeregisterDriver(USB_DRIVER_T *driver)

Description

Deregister a device driver.

Parameter

driver	The device driver to be deregistered

Return Value

0 – Success

Otherwise – Failure

Example

```
VOID  UsbPrinter_Exit()

{

        USB_DeregisterDriver(&usblp_driver);

}
```

USB_AllocateUrb

Synopsis

URB_T *USB_AllocateUrb(INT iso_packets)

Description

Creates an urb for the USB driver to use and returns a pointer to it. The driver should call USB_FreeUrb() when it is finished with the urb

Parameter

iso_packets	The number of isochronous frames in a single URB. For other transfer types, this value must be zero.

Return Value

NULL - Failure

Otherwise - A pointer to the newly allocated URB

Example

```
_W99683_Camera->sbuf[i].urb = USB_AllocateUrb(FRAMES_PER_DESC);

if (_W99683_Camera->sbuf[i].urb == NULL)

  {

      UART_printf("%s - USB_AllocateUrb(%d.) failed.\n", proc,

                 FRAMES_PER_DESC);

             Return -1;

   };
```

USB_FreeUrb

Synopsis

VOID USB_FreeUrb(URB_T *urb)

Description

Frees the memory used by a urb.

Parameter

None

Return Value

None

Example

None

USB_SubmitUrb

Synopsis

INT USB_SubmitUrb(URB_T *urb)

Description

Submit a URB for executing data transfer

Parameter

urb Pointer to the URB to be serviced.

Return Value

0 – Success

Otherwise – Failure

Example

```
/* prepare URB */

FILL_BULK_URB(&_PegasusDevice->tx_urb, _PegasusDevice->usb,

           usb_sndbulkpipe(_PegasusDevice->usb, 2),(CHAR *)buf_ptr,
PEGASUS_MAX_MTU,

           write_bulk_callback, _PegasusDevice);



/* set the data length to be transferred */

_PegasusDevice->tx_urb.transfer_buffer_length =

                          ((totalLength+2) & 0x3f) ? totalLength+2 : totalLength+3;

_PegasusDevice->tx_ready = 0;



/* submit URB */

if (USB_SubmitUrb(&_PegasusDevice->tx_urb) != 0)

{

    UART_printf("Warning - failed tx_urb %d\n", ret);

    return NU_IO_ERROR;

}
```

USB_UnlinkUrb

Synopsis

INT USB_UnlinkUrb(URB_T *urb)

Description

Unlink a URB which has been submitted but not finished

Parameter

urb pointer to the URB to be unlinked

Return Value

0 – Success

Otherwise – Failure

Example

```
       INT  PegasusClose()
{
    _PegasusDevice->flags &= ~PEGASUS_RUNNING;

    if (!(_PegasusDevice->flags & PEGASUS_UNPLUG))
        disable_net_traffic(_PegasusDevice);

    USB_UnlinkUrb(&_PegasusDevice->rx_urb);
    USB_UnlinkUrb(&_PegasusDevice->tx_urb);
    USB_UnlinkUrb(&_PegasusDevice->ctrl_urb);
#ifdef  PEGASUS_USE_INTR
    USB_UnlinkUrb( &_PegasusDevice->intr_urb );
#endif
    return 0;
}
```

USB_SendBulkMessage

Synopsis

```
INT    USB_SendBulkMessage(USB_DEV_T *dev,
                           UINT32 pipe,
                           VOID *data,
                           INT len,
                           INT *actual_length,
                           INT timeout)
```

Description

Builds a bulk urb, sends it off and waits for completion. This function sends a simple bulk message to a specified endpoint and waits for the message to complete, or timeout. Don't use this function from within an interrupt context.

Parameter

dev	pointer to the usb device to send the message to
pipe	endpoint "pipe" to send the message to
data	pointer to the data to send
len	length in bytes of the data to send
actual_length	pointer to a location to put the actual length transferred in bytes
timeout	time to wait for the message to complete before timing out (if 0 the wait is forever)

Return Value

0 – Success

Otherwise – Failure

Example

```
        if (!pb->pipe)

        pipe = usb_rcvbulkpipe (s->usbdev, 2);

        else

        pipe = usb_sndbulkpipe (s->usbdev, 2);

        ret = USB_SendBulkMessage(s->usbdev, pipe, pb->data, pb->size,
&actual_length, 100);

        if (ret<0) {

        err("dabusb: usb_bulk_msg failed(%d)",ret);

        if (usb_set_interface (s->usbdev, _DABUSB_IF, 1) < 0) {

                err("set_interface failed");

                return -EINVAL;

        }

        }

USB_malloc
```

Synopsis

VOID *USB_malloc(INT wanted_size,

INT boundary)

Description

Allocate a non-cacheable memory block started from assigned boundary. The total size of the USB library managed memory block is 256KB.

Parameter

wanted_size	The wanted size of non-cacheable memory block
boundary	The start address boundary of the memory block. It cab be BOUNDARY_BYTE, BOUNDARY_HALF_WORD, BOUNDARY_WORD, BOUNDARY32, BOUNDARY64, BOUNDARY128, BOUNDARY256, BOUNDARY512, BOUNDARY1024, BOUNDARY2048, BOUNDARY4096.

Return Value

NULL	Failed, there is not enough memory or USB library is not started
Otherwise	pointer to the newly allocated memory block

Example

```
             UINT8  *dma_data;


dma_data = USB_malloc(len, BOUNDARY_WORD);

             if (dma_data == NULL) {

     NU_printf("usblp_ctrl_msg - Memory not enough!\n");

     return -1;

             }

             retval = USB_SendControlMessage(usblp->dev,

        dir ? usb_rcvctrlpipe(usblp->dev, 0) : usb_sndctrlpipe(usblp->dev, 0),

         request, USB_TYPE_CLASS | dir | recip, value, usblp->ifnum, dma_data,

        len, HZ * 5);

                          memcpy(buf, dma_data, len);

             USB_free(dma_data);
```

USB_free

Synopsis

VOID USB_free(VOID *alloc_addr)

Description

Free the memory block allocated by USB_malloc().

Parameter

alloc_addr pointer to the USB_malloc() allocated memory block to be freed.

Return Value

None

Example

Same as USB_malloc()

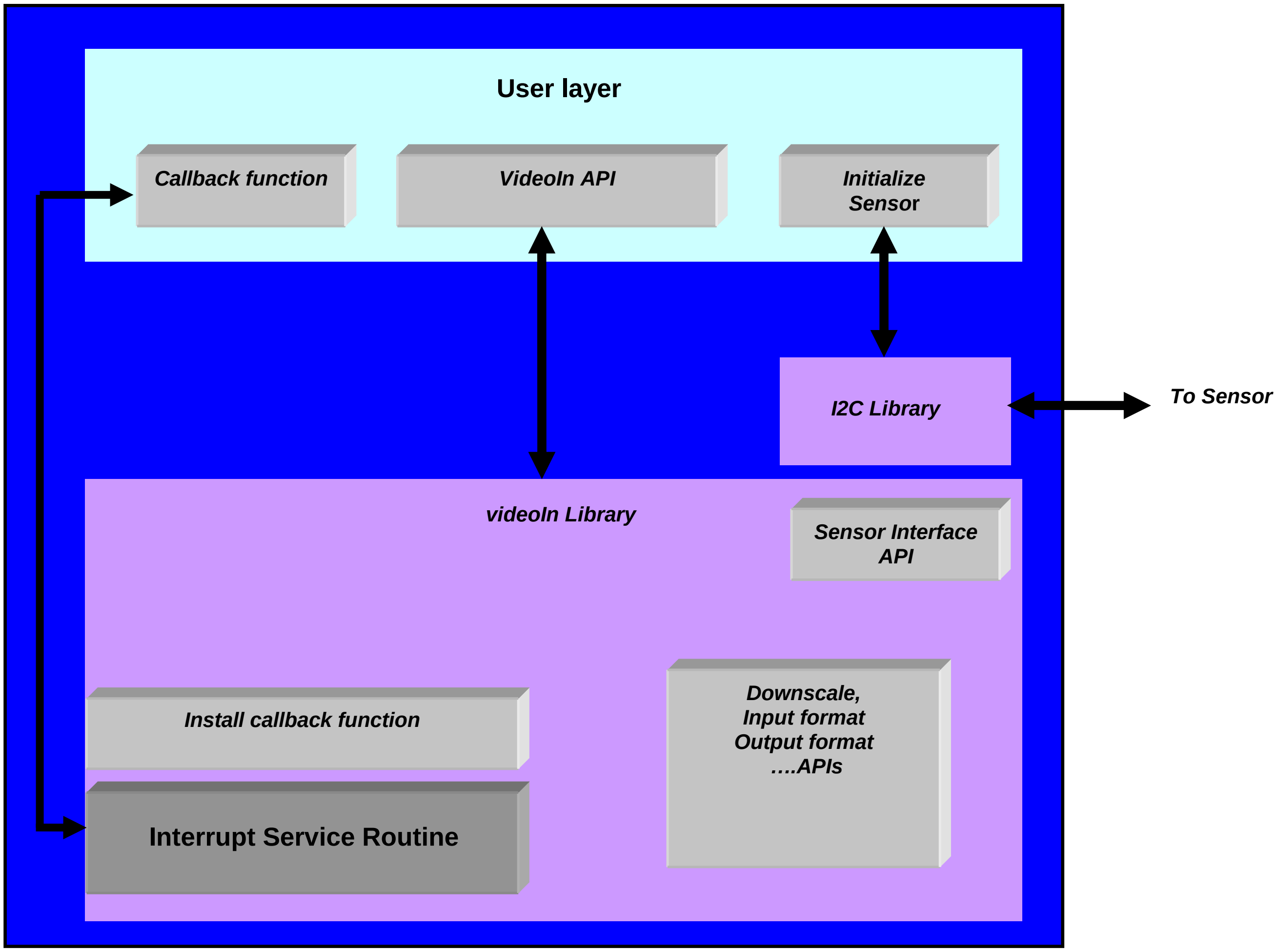
29. VIDEOIN Library Overview

29.1. Features

The VIDEOIN Library has the following features:

- Programmable sensor input format YCbCr422/RGB565.
- Programmable output packet format YCbCr422/RGB565/RGB555/Y-only to frame buffer.
- Programmable output planar format YUV422/YUV420/macro block YUV420 to frame buffer
- Support to enable or disable planar and packet pipes for encode and preview respectively.
- Programmable different downscale factor for planar and packet pipes.
- Support cropping image.
- Programmable CCIR601 and CCIR656 input interface.
- Programmable input polarity of pixel clock, h-sync and v-sync.
- Support indoor motion detection.
- Max support 2 sensor ports.

29.2. VIDEOIN Library Description



To initialize this sensor, just call the I2C library. However, programmer has to enable sensor clock before initialize sensor through I2C bus.

29.3. VIDEOLIN Library API

register_vin_device

Synopsis

INT32 register_vin_device(UINT32 u32port, VINDEV_T* pVinDev);

Description

The function has to be called before calling other videoIn APIs. It gets back a instant base on the specified port. All of the API functions will be operation base on the instant.

Parameter

u32Port	1: Capture port 1
	2: Capture port 2

Return Value

-1 or Successful

Example

```
VINDEV_T Vin;

VINDEV_T* pVin;

INT32 i32ErrCode;

i32ErrCode = register_vin_device(1, &Vin); /* Register capture 1 */

if(i32ErrCode<0){

        sysprintf("Register vin 0 device fail\n");

        return -1;

}

pVin = &Vin;

pVin->Init(TRUE, eSYS_UPLL, 24000, eVIDEOIN_SNR_CCIR601);
```

Init

Synopsis

void (*Init)(BOOL bIsEnableSnrClock,

IDEOIN_SNR_SRC eSnrSrc,

NT32 u32SensorFreqKHz,

VIDEOIN_DEV_TYPE eDevType)

Description

The function has to be called before calling other videoIn APIs exception function-**register_vin_device**(). It enables sensor clock. So before initialize sensor, the sensor clock has to be also enabled. It is also specified the multiple pin function for the specified device type.

Parameter

bIsEnableSnrClock	TRUE to enable sensor clock. FALSE to disable sensor clock.
eSnrSrc	eSYS_UPLL or eSYS_ALL
u32SensorFreq	Speciofied the senor clock to be initialized by I2C. Unit: KHz
eDevType	Input device type. Please refer Table 29-1: Input device multiple function pins

Table 29-1: Input device multiple function pins

eDevType	Value	Description
eVIDEOIN_SNR_CCIR656	0	Sensor input CCIR665 format. The device type is only used if capture port 1. Sensor interface is through GPIOB port.
eVIDEOIN_SNR_CCIR601	1	Sensor input CCIR601 format. The device type is only used if capture port 1. Sensor interface is through GPIOB port.
eVIDEOIN_TVD_CCIR656	2	TV decoder input CCIR656. The device type is only used if capture port 1. Sensor interface is through GPIOB port.
eVIDEOIN_TVD_CCIR601	3	TV decoder input CCIR601. The device type is only used if capture port 1. Sensor interface is through GPIOB port.
eVIDEOIN_2ND_SNR_CCIR656	4	Sensor input CCIR665 format. The device type is only used if capture port 2. Sensor interface is through GPIOC/GPA/GPE port.
eVIDEOIN_2ND_SNR_CCIR601	5	Sensor input CCIR601 format. The device type is only used if capture port 2. Sensor interface is through GPIOC/GPA/GPE port.
eVIDEOIN_2ND_TVD_CCIR656	6	TV decoder input CCIR656. The device type is only used if capture port 2. Sensor interface is through GPIOC/GPA/GPE port.
eVIDEOIN_2ND_TVD_CCIR601	7	TV decoder input CCIR601. The device type is only used if capture port 2. Sensor interface is through GPIOC/GPA/GPE port..
eVIDEOIN_3RD_SNR_CCIR656	8	Sensor input CCIR665 format. The device type is only used if capture port 2. Sensor interface is through GPIOC/GPA/GPD port.
eVIDEOIN_3RD_SNR_CCIR601	9	Sensor input CCIR601 format. The device type is only used if capture port 2. Sensor interface is through GPIOC/GPA/GPD port.

eVIDEOIN_3RD_TVD_CCIR656	10	TV decoder input CCIR656. The device type is only used if capture port 2. Sensor interface is through GPIOC/GPA/GPD port.
eVIDEOIN_3RD_TVD_CCIR601	11	TV decoder input CCIR601. The device type is only used if capture port 2. Sensor interface is through GPIOC/GPA/GPD port.

Return Value

None

Example

```
VINDEV_T Vin;

VINDEV_T* pVin;

INT32 i32ErrCode;

i32ErrCode = register_vin_device(1, &Vin);     /* Register capture 1 */

if(i32ErrCode<0){

        sysprintf("Register vin 0 device fail\n");

        return -1;

}

pVin = &Vin;

pVin->Init(TRUE, eSYS_UPLL, 24000, eVIDEOIN_SNR_CCIR601);
```

Open

Synopsis

INT32 (*Open)(UINT32 u32EngFreqKHz,
UINT32 u32SensorFreqKHz)

Description

Open videoin device.

Parameter

u32EngFreqKHz	It is useless.
u32SensorFreq	Sensor works frequency. Unit: KHz

Return Value

0 – Success

Example

```
VINDEV_T Vin;

VINDEV_T* pVin;

INT32 i32ErrCode;

i32ErrCode = register_vin_device(1, &Vin);     /* Register capture 1 */

if(i32ErrCode<0){

        sysprintf("Register vin 0 device fail\n");

        return -1;

}

pVin = &Vin;

pVin->Init(TRUE, eSYS_UPLL, 24000, eVIDEOIN_SNR_CCIR601);

pVin->Open(48000, 24000); /* Sensor clock 24MHz */
```

Close

Synopsis

void (*Close)(void)

Description

Close videoIn device.

Parameter

None

Return Value

None

Example

```
VINDEV_T Vin;

VINDEV_T* pVin;

INT32 i32ErrCode;

i32ErrCode = register_vin_device(1, &Vin);     /* Register capture 1 */
```

```
if(i32ErrCode<0){
        sysprintf("Register vin 0 device fail\n");
        return -1;
}
pVin = &Vin;
pVin->Init(TRUE, eSYS_UPLL, 24000, eVIDEOIN_SNR_CCIR601);
pVin->Open(48000, 24000); /* Sensor clock 24MHz */
…….
pVin->Close();
```

SetPipeEnable

Synopsis

void (*SetPipeEnable)(BOOL bEngEnable, E_VIDEOIN_PIPE ePipeEnable)

Description

Enable or disable engine and specified which pipes is enabled or disabled

Parameter

bEngEnable	TRUE: Enable VideoIn engine FALSE: Disable VideoIn engine
ePipeEnable	Pipes enable or disable. Please refer Table 29-2: Pipes Type

Table 29-2: Pipes Type

eDevType	Value	Description
eVIDEOIN_BOTH_PIPE_DISABLE	0	Both planar and packet pipes are disabled
eVIDEOIN_PLANAR	1	Enable planar pipe only
eVIDEOIN_PACKET	2	Enable packet pipe only
eVIDEOIN_BOTH_PIPE_ENABLE	3	Both planar and packet pipes are enabled

Return Value

None

Example

```
VINDEV_T Vin;
VINDEV_T* pVin;
INT32 i32ErrCode;
i32ErrCode = register_vin_device(1, &Vin);     /* Register capture 1 */
if(i32ErrCode<0){
        sysprintf("Register vin 0 device fail\n");
        return -1;
}
pVin = &Vin;
pVin->Init(TRUE, eSYS_UPLL, 24000, eVIDEOIN_SNR_CCIR601);
pVin->Open(48000, 24000); /* Sensor clock 24MHz */
pVin->SetPipeEnable(TRUE, /* Engine enable */
                        eVIDEOIN_BOTH_PIPE_ENABLE); /* Both pipes enable */
…….
pVin->Close();
```

InstallCallback

Synopsis

INT32 (*InstallCallback)(E_VIDEOIN_INT_TYPE eIntType,
PFN_VIDEOIN_CALLBACK pfnCallback,
PFN_VIDEOIN_CALLBACK *pfnOldCallback)

Description

Install call back function for user layer. The function let the videoIn library call back to upper lay to inform user the frame end event. And pass some information to user layer.

Parameter

eIntType Interrupt type. Please refer Table 29-3: Interrupt type

Table 29-3: Interrupt type

eIntType	Value	Description
eVIDEOIN_MDINT	0x100000	Motion Detection Interrupt
eVIDEOIN_ADDRMINT	0x80000	Address match interrupt. It is only

		support packet pip
eVIDEOIN_MEINT	0x20000	Memory Error.
eVIDEOIN_VINT	0x10000	Frame end interrupt

`

pfnCallback Function pointer for callback function.

pfnOldCallback Old callback function.

Return Value

Successful or E_VIDEOIN_INVALID_INT.

Example

```
/* Install call back function for frame end */
void VideoIn_InterruptHandler(UINT8 u8PacketBufID,
                              UINT8 u8PlanarBufID,
                              UINT8 u8FrameRate,
                              UINT8 u8Filed)
{//Frame end
        ….
}
…..
pVin->Open(48000, 24000); /* Sensor clock 24MHz */
pVin->InstallCallback(eVIDEOIN_VINT,        /* Frame end interrupt */

(PFN_VIDEOIN_CALLBACK)VideoIn_InterruptHandler,
                      &pfnOldCallback       );  /* Installed callback */
pVin->EnableInt(eVIDEOIN_VINT);      /* Enable frame end interrupt */
pVin->SetPipeEnable(TRUE, /* Engine enable */
                      eVIDEOIN_BOTH_PIPE_ENABLE); /* Both pipes enable */
…….
pVin->Close();
```

EnableInt

Synopsis

INT32 (*EnableInt)(E_VIDEOIN_INT_TYPE eIntType)

Description

Enable specified interrupt type.

Parameter

eIntType	Reference	Please refer Table 29-3: Interrupt type

Table 29-3: Interrupt type

Return Value

Successful or E_VIDEOIN_INVALID_INT

Example

```
pVin->Open(48000, 24000); /* Sensor clock 24MHz */

pVin->InstallCallback(eVIDEOIN_VINT,        /* Frame end interrupt */

(PFN_VIDEOIN_CALLBACK)VideoIn_InterruptHandler,

                      &pfnOldCallback       );  /* Installed callback */

pVin->EnableInt(eVIDEOIN_VINT);      /* Enable frame end interrupt */

pVin->SetPipeEnable(TRUE, /* Engine enable */

                      eVIDEOIN_BOTH_PIPE_ENABLE); /* Both pipes enable */

…….

pVin->Close();
```

DisableInt

Synopsis

INT32 (*DisableInt)(E_VIDEOIN_INT_TYPE eIntType)

Description

Disable specified interrupt type.

Parameter

eIntType	Reference	Please refer Table 29-3: Interrupt type

Table 29-3: Interrupt type

Return Value

Successful or E_VIDEOIN_INVALID_INT

Example

```
pVin->Open(48000, 24000); /* Sensor clock 24MHz */

pVin->InstallCallback(eVIDEOIN_VINT,        /* Frame end interrupt */

(PFN_VIDEOIN_CALLBACK)VideoIn_InterruptHandler,

                     &pfnOldCallback       );  /* Installed callback */

pVin->EnableInt(eVIDEOIN_VINT);      /* Enable frame end interrupt */

pVin->EnableInt(eVIDEOIN_MDINT);     /* Enable motion detection interrupt */

pVin->SetPipeEnable(TRUE, /* Engine enable */

                     eVIDEOIN_BOTH_PIPE_ENABLE); /* Both pipes enable */

…….

pVin->DisableInt(eVIDEOIN_MDINT);    /* Enable motion detection interrupt */
```

SetInputType

Synopsis

void (*SetInputType)(UINT32 u32FieldEnable,
E_VIDEOIN_TYPE eInputType,
BOOL bFieldSwap)

Description

Specified the input device type. It also specified which fields enable and fileds swap if need in TV decorder input type.

Parameter

u32FieldEnable	0, 1, 2 or 3. It is only useful if TV decoder. 0: both field disable. 1: field one enable. 2: field two enable. 3: noth fields enable.
eInputType	Input device type. Please refer Table 29-4: Inpu Device Type
bFieldSwap	Both field swap. It is only useful if TV decoder. TRUE: swap FALSE: unswap

Table 29-4: Inpu Device Type

eIntType	Value	Description
eVIDEOIN_TYPE_CCIR601	0	Input device is CCIR601
eVIDEOIN_TYPE_CCIR656	1	Input device is CCIR656

Return Value

None

Example

```
pVin->Open(48000, 24000); /* Sensor clock 24MHz */
pVin->InstallCallback(eVIDEOIN_VINT,        /* Frame end interrupt */

(PFN_VIDEOIN_CALLBACK)VideoIn_InterruptHandler,
                      &pfnOldCallback       );  /* Installed callback */
pVin->EnableInt(eVIDEOIN_VINT);      /* Enable frame end interrupt */
pVin->EnableInt(eVIDEOIN_MDINT);     /* Enable motion detection interrupt */
pVin->SetInputType(3,
                      eVIDEOIN_TYPE_CCIR656,
                      FALSE);
pVin->SetPlanarFormat(eVIDEOIN_PLANAR_YUV422); /* planar YUV422 */
pVin->SetPipeEnable(TRUE, /* Engine enable */
               eVIDEOIN_BOTH_PIPE_ENABLE); /* Both pipes enable */
```

SetSensorPolarity

Synopsis

void (*SetSensorPolarity)(BOOL bVsync,
BOOL bHsync,
BOOL bPixelClk)

Description

Specified the polarity for vertical synchronation, horizontal synchronation and pixel clock signals.

Parameter

bVsync	TRUE: Vertical synchronation period is heigh level
	FALSE: Vertical synchronation period is low level
bHsync	TRUE: Horizontal synchronation period is heigh level
	FALSE: Horizontal synchronation period is low level
bPixelClk	TRUE: Latch data in rising edge
	FALSE: Latch data in falling edge

Example

```
pVin->Open(48000, 24000); /* Sensor clock 24MHz */

pVin->SetSensorPolarity(FALSE,


                      FALSE,

                      TRUE);

pVin->InstallCallback(eVIDEOIN_VINT,        /* Frame end interrupt */


(PFN_VIDEOIN_CALLBACK)VideoIn_InterruptHandler,

                      &pfnOldCallback       );  /* Installed callback */
```

SetDataFormatAndOrder

Synopsis

void (*SetDataFormatAndOrder)(E_VIDEOIN_ORDER eInputOrder,
E_VIDEOIN_IN_FORMAT eInputFormat,
E_VIDEOIN_OUT_FORMAT eOutputFormat);

Description

Specified the sensor input format and input order. And specified the packet output format

Parameter

eInputOrder	Sensor data input order. Please refer Table 29-5:Input Order
eInputFormat	Sensor data format. Please refer Table 29-6:Input Format
eOutputFormat	Packet pipe output format. Please refer Table 29-7:Packet Output Format

Table 29-5:Input Order

eInputOrder	Value	**Description**
eVIDEOIN_IN_UYVY	0	Input order is UYVYUYVY…

eVIDEOIN_IN_YUYV	1	Input order is YUYVYUYV…
eVIDEOIN_IN_VYUY	2	Input order is VYUYVYUY…
eVIDEOIN_IN_YVYU	3	Input order is YVYUYVYU…

Table 29-6:Input Format

eInputOrder	Value	**Description**
eVIDEOIN_IN_YUV422	0	YUV422 format
eVIDEOIN_IN_RGB565	1	RGB565 format

Table 29-7:Packet Output Format

eInputOrder	Value	**Description**
eVIDEOIN_OUT_YUV422	0	Packet YUV422
eVIDEOIN_OUT_ONLY_Y	1	Packet Y only
eVIDEOIN_OUT_RGB555	2	Packet RGB555
eVIDEOIN_OUT_RGB565	3	Packet RGB565

Example

```
pVin->Open(48000, 24000); /* Sensor clock 24MHz */
pVin->SetSensorPolarity(FALSE,
                      FALSE,
                      TRUE);
pVin->InstallCallback(eVIDEOIN_VINT,        /* Frame end interrupt */
(PFN_VIDEOIN_CALLBACK)VideoIn_InterruptHandler,
                      &pfnOldCallback       );  /* Installed callback */
```

SetCropWinSize

Synopsis

void (*SetCropWinSize)(UINT32 u32height, UINT32 u32width)

Description

Specified the cropping size

Parameter

u32height	The height of cropping window. The values should less than or equal to height of sensor dimension.
u32width	The width of cropping window. The values should less than or equal to width of sensor dimension.

Return Value

None

Example

```
pVin->Open(48000, 24000); /* Sensor clock 24MHz */

pVin->InstallCallback(eVIDEOIN_VINT,       /* Frame end interrupt */

       (PFN_VIDEOIN_CALLBACK)VideoIn_InterruptHandler,

                             &pfnOldCallback       );  /* Installed callback */

pVin->EnableInt(eVIDEOIN_VINT);     /* Enable frame end interrupt */

pVin->EnableInt(eVIDEOIN_MDINT);    /* Enable motion detection interrupt */

       pVin->SetCropWinSize(480,
                             640);

       pVin->SetCropWinStartAddr(0, /* VerticalStart start position*/

                                    0);     /* HorizontalStart start position*/
```

SetCropWinStartAddr

Synopsis

void (*SetCropWinStartAddr)(UINT32 u32VerticalStart,
UINT32 u32HorizontalStart)

Description

Specified the cropping start position

Parameter

u32VerticalStart	The start position of Y axis.
u32HorizontalStart	The start position of X axis.

Return Value

None

Example

```
               pVin->Open(48000, 24000); /* Sensor clock 24MHz */

       pVin->InstallCallback(eVIDEOIN_VINT,        /* Frame end interrupt */

       (PFN_VIDEOIN_CALLBACK)VideoIn_InterruptHandler,

                             &pfnOldCallback       );  /* Installed callback */

       pVin->EnableInt(eVIDEOIN_VINT);      /* Enable frame end interrupt */

       pVin->EnableInt(eVIDEOIN_MDINT);     /* Enable motion detection interrupt */

       pVin->SetCropWinSize(480,
                                    640);

       pVin->SetCropWinStartAddr(0, /* VerticalStart start position*/

                                    0);     /* HorizontalStart start position*/
```

PreviewPipeSize

Synopsis

void (*PreviewPipeSize)(UINT16 u16height,
UINT16 u16width)

Description

Specified the packet pipe dimension for preview

Parameter

u16height	The height of packet pipe.
u16width	The width of packet pipe.

Return Value

None

Example

```
               pVin->Open(48000, 24000); /* Sensor clock 24MHz */

       pVin->InstallCallback(eVIDEOIN_VINT,        /* Frame end interrupt */

       (PFN_VIDEOIN_CALLBACK)VideoIn_InterruptHandler,

                             &pfnOldCallback       );  /* Installed callback */

pVin->EnableInt(eVIDEOIN_VINT);      /* Enable frame end interrupt */

pVin->EnableInt(eVIDEOIN_MDINT);     /* Enable motion detection interrupt */
```

```
       pVin->SetCropWinSize(960,
                                  1280);

       pVin->SetCropWinStartAddr(0, /* VerticalStart start position*/

                                  0);     /* HorizontalStart start position*/

       pVin->PreviewPipeSize(480,
                                  640);

                              pVin->EncodePipeSize(960,
                                                                      1280);
```

EncodePipeSize

Synopsis

void (*EncodePipeSize)(UINT16 u16height,
UINT16 u16width)

Description

Specified the planar pipe dimension for encoding.

Parameter

u16height	The height of planar pipe.
u16width	The width of planar pipe.

Return Value

None

Example

```
pVin->Open(48000, 24000); /* Sensor clock 24MHz */

pVin->InstallCallback(eVIDEOIN_VINT,       /* Frame end interrupt */

       (PFN_VIDEOIN_CALLBACK)VideoIn_InterruptHandler,

                              &pfnOldCallback       );  /* Installed callback */

pVin->EnableInt(eVIDEOIN_VINT);     /* Enable frame end interrupt */

pVin->EnableInt(eVIDEOIN_MDINT);    /* Enable motion detection interrupt */

pVin->SetCropWinSize(960,
       1280);

pVin->SetCropWinStartAddr(0,        /* VerticalStart start position*/

                                             0);     /* HorizontalStart start
position*/
```

```
pVin->PreviewPipeSize(480,
                              640);

pVin->EncodePipeSize(960,
                                             1280);
```

SetStride

Synopsis

void (*SetStride)(UINT32 u32packetstride,
                  UINT32 u32planarstride)

Description

Specified the stride of packet and planar pipes.

Parameter

u32packetstride	The stride of packet.
u32planarstride	The stride of planar.

Return Value

None

Example

```
pVin->SetCropWinSize(960,
                              1280);

pVin->SetCropWinStartAddr(0,        /* VerticalStart start position*/

                                     0);     /* HorizontalStart start position*/

pVin->PreviewPipeSize(480,
                              640);

pVin->EncodePipeSize(960,
                                             1280);

pVin->SetStride(640, 1280);
```

GetStride

Synopsis

void (*GetStride)(PUINT32 pu32packetstride,
                  PUINT32 pu32planarstride)

Description

Get the stride of packet and planar pipes.

Parameter

pu32packetstride	The stride of packet.
pu32planarstride	The stride of planar.

Return Value

None

Example

```
      UINT32 u32PacketStride, u32PlanarStride;

pVin->SetCropWinSize(960,
                            1280);

pVin->SetCropWinStartAddr(0,        /* VerticalStart start position*/

                                    0);     /* HorizontalStart start position*/

pVin->PreviewPipeSize(480,
                            640);

pVin->EncodePipeSize(960,
                                          1280);

pVin->GetStride(&u32PacketStride, &u32PlanarStride);

pVin->SetStride(u32PacketStride, 1280);
```

SetPlanarFormat

Synopsis

void (*SetPlanarFormat)(E_VIDEOIN_PLANAR_FORMAT ePlanarFmt)

Description

Specified the planar format.

Parameter

ePlanarFmt Planar format. Please reference Table 29-8 Planar Format

Table 29-8 Planar Format

eIntType	Value	**Description**
eVIDEOIN_PLANAR_YUV422	0	Planar YUV422
eVIDEOIN_PLANAR_YUV420	1	Planar YUV420
eVIDEOIN_MACRO_PLANAR_YUV420	2	Planar macro block YUV420

Return Value

None

Example

```
/* Disable frame end interrupt */

      pVin->Open(48000, 24000); /* Sensor clock 24MHz */

      pVin->InstallCallback(eVIDEOIN_VINT,        /* Frame end interrupt */

      (PFN_VIDEOIN_CALLBACK)VideoIn_InterruptHandler,

                            &pfnOldCallback       );  /* Installed callback */

      pVin->EnableInt(eVIDEOIN_VINT);      /* Enable frame end interrupt */

      pVin->EnableInt(eVIDEOIN_MDINT);/*Enable motion detection interrupt */

      pVin->SetPlanarFormat(eVIDEOIN_PLANAR_YUV422); /* planar YUV422 */

      pVin->SetPipeEnable(TRUE, /* Engine enable */

                    eVIDEOIN_BOTH_PIPE_ENABLE); /* Both pipes enable */

      …….

      pVin->DisableInt(eVIDEOIN_MDINT);    /*Enable motion detection interrupt*/
```

SetBaseStartAddress

Synopsis

INT32 (*SetBaseStartAddress)(E_VIDEOIN_PIPE ePipe,
E_VIDEOIN_BUFFER eBuf,
UINT32 u32BaseStartAddr)

Description

Specified planar and packet buffer base address.

Parameter

ePipe	eVIDEOIN_PLANAR or eVIDEOIN_PACKET. Please refer Table 29-2: Pipes Type
eBuf	Buffer number. Please refer Table 29-9:Buffer Number

u32BaseStartAddr Buffer base address.

Table 29-9:Buffer Number

eIntType	Value	Description
eVIDEOIN_BUF0	0	Planar Y Buffer
eVIDEOIN_BUF1	1	Planar U Buffer
eVIDEOIN_BUF2	2	Planar V Buffer

Example

```
/* Disable frame end interrupt */
      pVin->Open(48000, 24000); /* Sensor clock 24MHz */
      pVin->InstallCallback(eVIDEOIN_VINT,       /* Frame end interrupt */

      (PFN_VIDEOIN_CALLBACK)VideoIn_InterruptHandler,
                            &pfnOldCallback      );  /* Installed callback */
      pVin->EnableInt(eVIDEOIN_VINT);      /* Enable frame end interrupt */
      pVin->EnableInt(eVIDEOIN_MDINT);     /* Enable motion detection interrupt */
      pVin->SetPlanarFormat(eVIDEOIN_PLANAR_YUV422); /* planar YUV422 */
      pVin->SetPipeEnable(TRUE, /* Engine enable */
                            eVIDEOIN_BOTH_PIPE_ENABLE); /* Both pipes enable */
      /* Specified Packet Buffer */
      pVin->SetBaseStartAddress(eVIDEOIN_PACKET,
                                   0,
                                   (UINT32)((UINT32)pu8FrameBuffer0);
      /* Specified Planar Y/U/V Buffer */
      pVin->SetBaseStartAddress(eVIDEOIN_PLANAR,
                                   0,     /* 0 means Y Buffer */
                                   (UINT32)u8PlanarFrameBuffer);
      pVin->SetBaseStartAddress(eVIDEOIN_PLANAR,
                                   1,     /* 1 means U Buffer */
```

```
                                        (UINT32)u8PlanarFrameBuffer+
                                        OPT_ENCODE_WIDTH*OPT_ENCODE_HEIGHT);

    pVin->SetPlanarFormat(eVIDEOIN_PLANAR_YUV422);

    pVin->SetBaseStartAddress(eVIDEOIN_PLANAR,
                                2,      /* 2 means V Buffer */
                                (UINT32)u8PlanarFrameBuffer+
                                        OPT_ENCODE_WIDTH*OPT_ENCODE_HEIGHT+
                                        OPT_ENCODE_WIDTH*OPT_ENCODE_HEIGHT/2);
```

SetOperationMode

Synopsis

void (*SetOperationMode)(BOOL bIsOneSutterMode)

Description

VideoIn engine works in one shutter mode or continuous mode.

Parameter

bIsOneSutterMode	VideoIn engine operation mode TRUE: One shutter mode. FALSE: Continuous mode.

Return Value

None

Example

```
    pVin->Open(48000, 24000); /* Sensor clock 24MHz */
    …..
        pVin->SetOperationMode(TRUE);               /* Take one frame */
    while(pVin->SetOperationMode()==TRUE);/* VideoIn engine still keeps working*/
        /* VideoIn engine is stopped here */
    /* Fed frame buffer to JPEG codec engine*/
    ….
```

```
/* Restart VideoIn engine */

pVin->SetPipeEnable(TRUE, eVIDEOIN_BOTH_PIPE_ENABLE);
```

GetOperationMode

Synopsis

BOOL (*GetOperationMode)(void)

Description

Check VideoIn engine is stopped after set it into one shutter mde. It is only valid after set VideoIn engine into one shutter mode. If VideoIn engine operation in continuous mode, it is invalid.

Parameter

None

Return Value

TRUE: VideoIn is still keeping working

FALSE: VideoIn engine is stopped after one shutter.

Example

```
pVin->Open(48000, 24000); /* Sensor clock 24MHz */

…..

        pVin->SetOperationMode(TRUE);               /* Take one frame */

while(pVin->SetOperationMode()==TRUE);/* VideoIn engine still keeps working*/
        /* VideoIn engine is stopped here */

/* Fed frame buffer to JPEG codec engine*/

….

/* Restart VideoIn engine */

pVin->SetPipeEnable(TRUE, eVIDEOIN_BOTH_PIPE_ENABLE);
```

SetColorEffect

Synopsis

INT32 (*SetColorEffect)(E_VIDEOIN_CEF eColorMode);

Description

Set color effect mode.

Parameter

eColorMode Color effect mode

Return Value

Successful

Example

```
pVin->Open(48000, 24000); /* Sensor clock 24MHz */

pVin->SetColorEffect(eVIDEOIN_CEF_POSTERIZE);

pVin->SetColorEffectParameter(0xFC, 0xFC, 0xFC);
```

SetColorEffectParameter

Synopsis

INT32 (*SetColorEffectParameter)(UINT8 u8YComp,
UINT8 u8UComp,
UINT8 u8VComp);

Description

Set color effect parameter.

Parameter

u8YComp	Y component
u8UComp	U Component
u8VComp	V Component

Return Value

Successful or E_VIDEOIN_WRONG_COLOR_PARAMETER

Example

```
pVin->Open(48000, 24000); /* Sensor clock 24MHz */

pVin->SetColorEffect(eVIDEOIN_CEF_POSTERIZE);

pVin->SetColorEffectParameter(0xFC, 0xFC, 0xFC);
```

SetMotionDet

Synopsis

INT32 (*SetMotionDet)(BOOL bEnable,
BOOL bBlockSize,

BOOL bSaveMode)

Description

Enable motion detection and set relate parameter.

Parameter

bEnable	Enable or disable motion detection TRUE: Enable FALSE: Disable
bBlockSize	Block size TRUE: Block size 8x8 FALSE: Block size 16x16
bSaveMode	Save format for motion detection TRUE: 1 bit DIFF + 7 Y differential FALSE: 1 bit Diff only

Return Value

None

Example

```
	pVin->Open(48000, 24000); /* Sensor clock 24MHz */

	/* Enable motion detection with block size 8x8 and 1 bit DIFF+7 Y 
differential */

	pVin-> SetMotionDet(TRUE, TRUE, TRUE);

	/* Threshold = 0x20 */

	/* Output DIFF buffer in address 2MB */

	/* Temp Y buffer in address 2.5MB */

	pVin-> SetMotionDetEx(0x20, 0x200000, 0x280000);
```

SetMotionDetEx

Synopsis

INT32 (*SetMotionDetEx)(UINT32 u32Threshold,
UINT32 u32OutBuffer
UINT32 u32LumBuffer)

Description

Set motion detection relate parameter.

Parameter

u32Threshold	Threshold between 2 motion detection frames
u32OutBuffer	DIFF output buffer address
u32LumBuffer	Motion detection temporatory Y component output buffer address

Return Value

None

Example

```
       pVin->Open(48000, 24000); /* Sensor clock 24MHz */

       /* Enable motion detection with block size 8x8 and 1 bit DIFF+7 Y 
differential */

       pVin->SetMotionDet(TRUE, TRUE, TRUE);

       /* Threshold = 0x20 */

       /* Output DIFF buffer in address 2MB */

       /* Temporatory Y buffer in address 2.5MB */

       pVin->SetMotionDetEx(0x20, 0x200000, 0x280000);
```

SetStandardCCIR656

Synopsis

void (*SetStandardCCIR656)((BOOL bIsStandard)

Description

The fuction is only used for Hinix HI-702 sensor CCIR656 mode. Because it is not standard CCIR656.

Parameter

bIsStandard	Input device support standard CCIR656 mode or not.
	TRUE: Support standard CCIR656 mode
	FALSE: Support Hi-702 CCIR656 mide

Return Value

None

Example

pVin->Open(48000, 24000); /* Sensor clock 24MHz */

/* Support standard CCIR656 */

pVin-> SetStandardCCIR656 (TRUE);

SetShadowRegister

Synopsis

void (*SetShadowRegister)(void)

Description

Some register can not be updated in capturing image such as downscale, cropping start position and cropping window size and buffer start address. For the reason, there are some shadow register for those register as mention above. After update those register as above, set shadow register bit will update those registers in frame end.

Parameter

None

Return Value

None

Example

```
pVin->Open(48000, 24000); /* Sensor clock 24MHz */

pVin->InstallCallback(eVIDEOIN_VINT,        /* Frame end interrupt */


(PFN_VIDEOIN_CALLBACK)VideoIn_InterruptHandler,

                      &pfnOldCallback       );  /* Installed callback */

pVin->EnableInt(eVIDEOIN_VINT);      /* Enable frame end interrupt */

pVin->EnableInt(eVIDEOIN_MDINT);     /*Enable motion detection interrupt*/

pVin->SetCropWinSize(960,
                             1280);

pVin->SetCropWinStartAddr(0,  /* VerticalStart start position*/

                             0);     /* HorizontalStart start position*/

pVin->PreviewPipeSize(480,
                             640);

pVin->EncodePipeSize(960,
                             1280);
```

```
        pVin->SetShadowRegister();
```

29.4. Error Code Table

Code Name	Value	Description
E_VIDEOIN_INVALID_INT	0xFFFF1001	Invalid interrupt chanel
E_VIDEOIN_INVALID_BUF	0xFFFF1002	Invalid buffer
E_VIDEOIN_INVALID_PIPE	0xFFFF1003	Invalid pipe
E_VIDEOIN_INVALID_COLOR_MODE	0xFFFF1004	Invalid color mode
E_VIDEOIN_WRONG_COLOR_PARAMETER	0xFFFF1005	Invalid color parameter

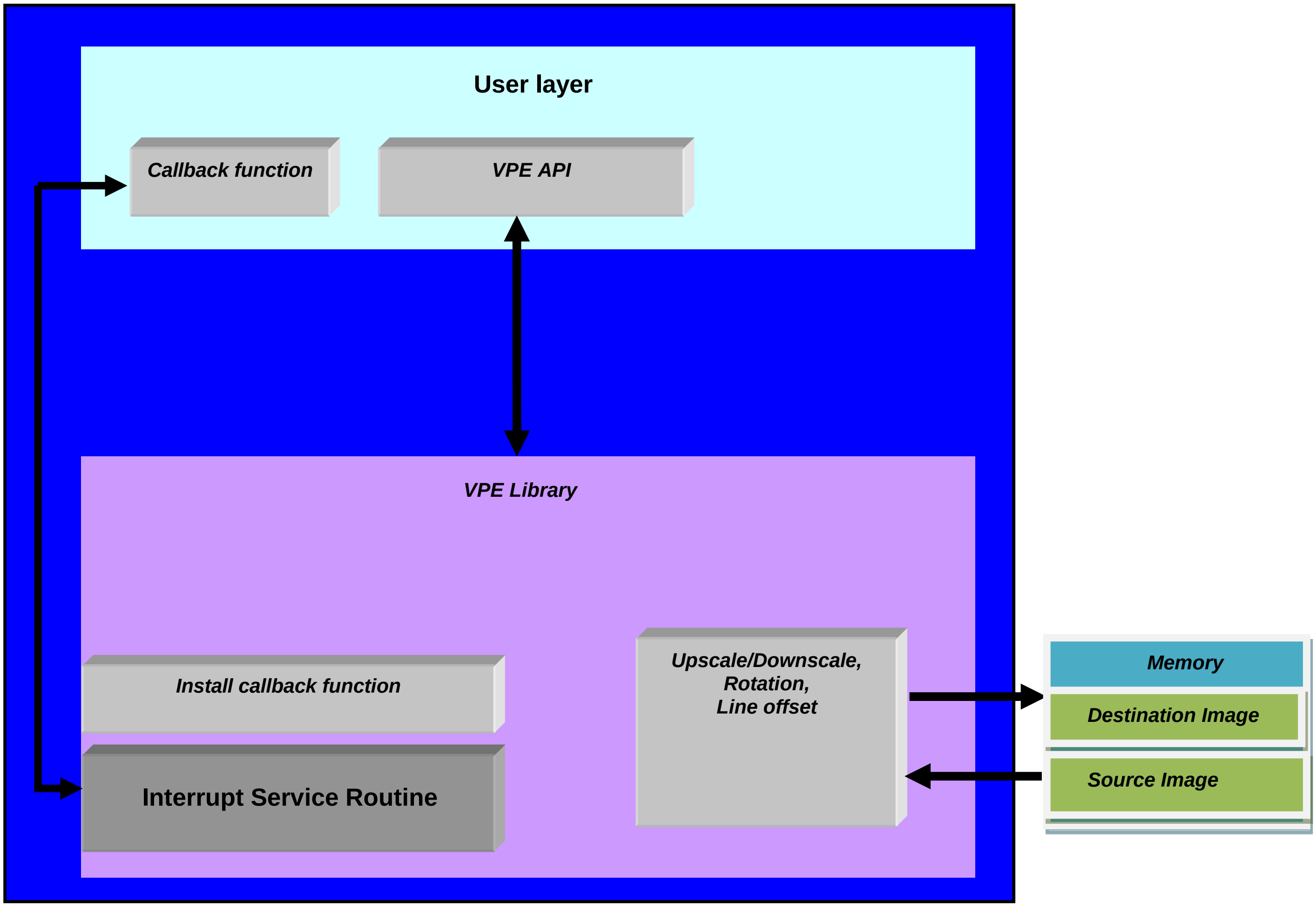
30. VPE Library Overview

30.1. Features

The VPE Library has the following features:

- Support format conversion
  1. Input format
     - Y only
     - Planar YUV420
     - Planar YUV411
     - Planar YUV422
     - Planar YUV422 Transpose
     - Planar YUV444
     - Packet YUV422
     - Packet RGB555
     - Packet RGB565
     - Packet RGB888
  2. Output format
     - Packet YUV422
     - Packet RGB555
     - Packet RGB565
     - Packet RGB888
- Support rotation
  1. Normal
  2. Right
  3. Left
  4. Upside down
  5. Horizontal mirror
  6. 180 degree
- Support MMU or Non-MMU mode.
  1. MMU.
     - Block base mode with better memory usage.
  2. Non-MMU mode
     - Line base mode with better performance.
- Support source and destination line offset
- Support limited on the fly mode with codec.

30.2. VPE Library Description



30.3. VPE Library API

vpeOpen

Synopsis

ERRCODE

vpeOpen(void)

Description

Open VPE library.

Parameter

None

Return Value

Successful or error code.

Example

```
vpeOpen ();           /* Enable VPE clock and interrupt */
```

vpeClose

Synopsis

ERRCODE vpeClose (void)

Description

Close VPE library.

Parameter

None

Return Value

None

Example

```
vpeOpen();

…

vpeClose();
```

vpeInstallCallback

Synopsis

ERRCODE vpeInstallCallback(E_VPE_INT_TYPE eIntType,
PFN_VPE_CALLBACK pfnCallback,
PFN_VPE_CALLBACK* pfnOldCallback)

Description

Install call back function for user layer. The function let the VPE library call back to upper lay to inform user for registered interrupt event. However, page fault and page missing will be handled in library. Upper layer can ignore both

Parameter

eIntType Interrupt type.

Table 30-1: Interrupt type

eIntType	Value	Description
VPE_INT_COMP	0x0	Conversion complete
VPE_INT_PAGE_FAULT	0x1	Page fault if MMU on.
VPE_INT_PAGE_MISS	0x2	Page miss if MMU on.
VPE_INT_MB_COMP	0x3	Macro block complete if on the fly with codec.
VPE_INT_MB_ERR	0x4	Macro block error if on the fly with codec.
VPE_INT_DMA_ERR	0x5	DMA target abort if MMU on. The interrupt occurrence is only the page table is retrieved by OS and VPE is working. If the interrupt occurrence may memory is distroyed by VPE engine. So the application must write a signal handler for stopping the vpe engine.

`

pfnCallback Function pointer for callback function.

pfnOldCallback Old callback function.

Return Value

Successful or error code.

Example

```
/* Install call back function for comversion done */

vpeOpen();

vpeInstallCallback(VPE_INT_COMP,

                              vpeCompleteCallback,

                      &OldVpeCallback);

vpeEnableInt(VPE_INT_COMP);

vpeEnableInt(VPE_INT_PAGE_FAULT);

vpeEnableInt(VPE_INT_PAGE_MISS);
```

vpeEnableInt

Synopsis

ERRCODE vpeEnableInt(E_VPE_INT_TYPE eIntType)

Description

Enable specified interrupt type.

Parameter

eIntType	Reference	Please refer Table 29-3: Interrupt type

Table 29-3: Interrupt type

Return Value

Successful or error code

Example

```
/* Enable frame end interrupt */

vpeEnableInt(VPE_INT_COMP);

vpeEnableInt(VPE_INT_PAGE_FAULT);

vpeEnableInt(VPE_INT_PAGE_MISS);
```

vpeDisableInt

Synopsis

ERRCODE vpeDisableInt(E_VPE_INT_TYPE eIntType)

Description

Disable specified interrupt type.

Parameter

eIntType	Reference	Please refer Table 29-3: Interrupt type

Table 29-3: Interrupt type

Return Value

Successful or error code

Example

```
/* Disable frame end interrupt */

vpeDisableInt(VPE_INT_COMP);
```

vpeIoctl

Synopsis

ERRCODE vpeIoctl (UINT32 u32Cmd,
UINT32 u32Element,
UINT32 u32Arg0,
UINT32 u32Arg1)

Description

VPE IO control function. The function is used to set some parameters for VPE hardware IP.

Parameter

u32Cmd	***Reference***

Table 30-2: IO Control table

VPE_IOCTL_TRIGGER	(Useless)	(Useless)	(Useless)	Trigger VPE
VPE_IOCTL_CHECK_TRIGGER	(Useless)	(Useless)	(Useless)	Check VPE complete Return 0, meaning VPE complete
VPE_IOCTL_SET_MMU_ENTRY	TRUE: Enable MMU operation	TLB entry.	(Useless)	Enable VPE MMU operation.
VPE_IOCTL_SET_TLB_ENTRY	Component entry: 0~7 0 and 4: For packet or Y component 1 and 5: For U component 2 and 6: For V component 3 and 7: For destination image	(Useless)	(Useless)	Specified the component entry if page fault. **It has been handled by library**

u32Element ***Reference***

Table 30-2: IO Control table

VPE_IOCTL_TRIGGER	(Useless)	(Useless)	(Useless)	Trigger VPE
VPE_IOCTL_CHECK_TRIGGER	(Useless)	(Useless)	(Useless)	Check VPE complete Return 0, meaning VPE complete
VPE_IOCTL_SET_MMU_ENTRY	TRUE: Enable MMU operation	TLB entry.	(Useless)	Enable VPE MMU operation.
VPE_IOCTL_SET_TLB_ENTRY	Component entry: 0~7 0 and 4: For packet or Y component 1 and 5: For U component 2 and 6: For V component 3 and 7: For destination image	(Useless)	(Useless)	Specified the component entry if page fault. **It has been handled by library**

u32Arg0 ***Reference***

Table 30-2: IO Control table

VPE_IOCTL_TRIGGER	(Useless)	(Useless)	(Useless)	Trigger VPE
VPE_IOCTL_CHECK_TRIGGER	(Useless)	(Useless)	(Useless)	Check VPE complete Return 0, meaning VPE complete
VPE_IOCTL_SET_MMU_ENTRY	TRUE: Enable MMU operation	TLB entry.	(Useless)	Enable VPE MMU operation.
VPE_IOCTL_SET_TLB_ENTRY	Component entry: 0~7 0 and 4: For packet or Y component 1 and 5: For U component 2 and 6: For V component 3 and 7: For destination image	(Useless)	(Useless)	Specified the component entry if page fault. **It has been handled by library**

u32Arg1 ***Reference***

Table 30-2: IO Control table

VPE_IOCTL_TRIGGER	(Useless)	(Useless)	(Useless)	Trigger VPE
VPE_IOCTL_CHECK_TRIGGER	(Useless)	(Useless)	(Useless)	Check VPE complete Return 0, meaning VPE complete
VPE_IOCTL_SET_MMU_ENTRY	TRUE: Enable MMU operation	TLB entry.	(Useless)	Enable VPE MMU operation.
VPE_IOCTL_SET_TLB_ENTRY	Component entry: 0~7 0 and 4: For packet or Y component 1 and 5: For U component 2 and 6: For V component 3 and 7: For destination image	(Useless)	(Useless)	Specified the component entry if page fault. **It has been handled by library**

u32Cmd	u32Arg0	u32Arg1	u32Arg2	Description
VPE_IOCTL_SET_SRCBUF_ADDR	Source packet buffer start address or planar Y buffer address	Source planar U buffer start address	Source planar V buffer start address	Specified the source buffer base address
VPE_IOCTL_SET_DSTBUF_ADDR	Destination packet buffer start address.	(Useless)	(Useless)	Specified the input order, input format and output format
VPE_IOCTL_SET_SRC_OFFSET	Left offset for source image	Right offset for source image	(Useless)	Specified the left and right offset for source image.
VPE_IOCTL_SET_SRC_DIMENSION	Width of source image	Height of source image	(Useless)	Specified the dimension of source image.
VPE_IOCTL_SET_DST_DIMENSION	Width of destination image	Height of destination image	(Useless)	Specified the dimension of destination image.
VPE_IOCTL_SET_COLOR_RANGE	Source format color range. TRUE: Y 16~235, U and V 16~240. FALSE: soure format is full range.	Destination format color range. TRUE: Conversion to Y 16~235. U and V 16~240. FALSE: Full range for destination format	(Useless)	Specified color range
VPE_IOCTL_SET_FILTER	VPE_SCALE_DDA: Directly drop algorithm VPE_SCALE_BILINEAR: Bilinear algorithm	(Useless)	(Useless)	Specified upscale or downscale algorithm
VPE_IOCTL_SET_FMT	Source format	Destination format	(Useless)	Specified the source format and destination format
VPE_IOCTL_SET_MACRO_BLOCK	Y macro block if on the fly	X macro block if on the fly	(Useless)	It is useful if on the fly with codec.
VPE_IOCTL_HOST_OP	VPE_HOST_FRAME: Block bas mode VPE_HOST_VDEC_LINE: Line base mode	Rotation direction.	(Useless)	Specified the operation mode and ration direction.

Table 30-2: IO Control table

VPE_IOCTL_TRIGGER	(Useless)	(Useless)	(Useless)	Trigger VPE
VPE_IOCTL_CHECK_TRIGGER	(Useless)	(Useless)	(Useless)	Check VPE complete Return 0, meaning VPE complete
VPE_IOCTL_SET_MMU_ENTRY	TRUE: Enable MMU operation	TLB entry.	(Useless)	Enable VPE MMU operation.
VPE_IOCTL_SET_TLB_ENTRY	Component entry: 0~7 0 and 4: For packet or Y component 1 and 5: For U component 2 and 6: For V component 3 and 7: For destination image	(Useless)	(Useless)	Specified the component entry if page fault. **It has been handled by library**

Return Value

None.

Example

```
/* Setup hardware IP through IO ctrol */

vpeIoctl(VPE_IOCTL_SET_MMU_ENTRY,

                     TRUE,                        // MMU Enable

                     (UINT32)_mmuSectionTable,    // TLB Entry

                     0x0);

vpeIoctl(VPE_IOCTL_HOST_OP,

                     VPE_HOST_FRAME,

                     VPE_OP_NORMAL,

                     NULL);



vpeIoctl(VPE_IOCTL_SET_SRCBUF_ADDR,

                     (UINT32)pi8Y,  /* They are virtual address if MMU on */
                     (UINT32)pi8U,

                     (UINT32)pi8V);

vpeIoctl(VPE_IOCTL_SET_FMT,

                     VPE_SRC_PLANAR_YUV420,       /* Src Format */
```

```
                    VPE_DST_PACKET_RGB565,       /* Dst Format */

                           0);

vpeIoctl(VPE_IOCTL_SET_SRC_OFFSET,

                    0,      /* Src Left offset */

                    0,      /* Src right offset */

                    NULL);

vpeIoctl(VPE_IOCTL_SET_DST_OFFSET,

                    0,      /* Dst Left offset */

                    0,      /* Dst right offset */

                    NULL);


vpeIoctl(VPE_IOCTL_SET_SRC_DIMENSION,
                           2048,

                                  1536,

                    NULL);

vpeIoctl(VPE_IOCTL_SET_DST_DIMENSION,

                    640,

                    480,

                    NULL);

vpeIoctl(VPE_IOCTL_SET_COLOR_RANGE,

                    FALSE,                /* Soure image is full range */

                    FALSE,                /* Destination image is full range */

                    NULL);

vpeIoctl(VPE_IOCTL_SET_FILTER,

                    VPE_SCALE_BILINEAR,

                    NULL,

                    NULL);

vpeIoctl(VPE_IOCTL_SET_DST_OFFSET,
```

```
                    0,              //left offset
                    0,              //Right offset
                    NULL);
vpeIoctl(VPE_IOCTL_SET_DSTBUF_ADDR,
                    piDstAddr,
                    NULL,
                    NULL);
             vpeIoctl(VPE_IOCTL_TRIGGER,
                    NULL,
                    NULL,
                    NULL);
do{
      ERRCODE errcode;
      errcode = vpeIoctl(VPE_IOCTL_CHECK_TRIGGER,
                    NULL,
             NULL,
                                                                NULL);
      if(errcode==0)
             break;
}while(1);
```

30.4. Error Code Table

Code Name	Value	Description
ERR_VPE_OPEN	0xFFFF1B01	VPE has been opened
ERR_VPE_CLOSE	0xFFFF1002	VPE has been closed.
ERR_VPE_SRC_FMT	0xFFFF1003	Invalid source format
ERR_VPE_DST_FMT	0xFFFF1004	Invalid destination format
ERR_VPE_OP	0xFFFF1005	Invalid operation mode
ERR_VPE_IOCTL	0xFFFF1006	Invalid ioctl
E_VPE_INVALID_INT	0xFFFF1007	Invalid interrupt

31. VPOST Overview

31.1. VPOST Overview

Display Interface Controller VPOST (include LCD Controller & TV encoder Controller) is used to display the video/image data to LCD device or to generate the composite signal to the TV system. The LCD timing can be synchronize with TV (NTSC/PAL non-interlace timing) or set by the LCD timing control register. The video/image data source may be came from the frame buffer, color bar and register settings. The frame buffer is stored in system memory (SDRAM). The TV picture and LCD picture can display individual image source simultaneously when the timing is synchronized with TV timing.

How to build the VPOST library

Due to lot of panels supported in the VPOST library and some sample code links VPOST library with same name, it does not generate library file for each panel. User can open w55fa93_vpost.h file to define corresponding panel to generate wanted panel library for usage and rename it as required. Below code shows how to generate VPOST library for HannStar HSD043I9W1.

```
#define HAVE_HANNSTAR_HSD043I9W1

//#define HAVE_HANNSTAR_HSD070IDW1         // 800x480

//#define HAVE_GOWORLD_GW8973

//#define HAVE_GOWORLD_GWMTF9406A

//#define HAVE_GOWORLD_GWMTF9360A

//#define __HAVE_GOWORLD_GWMTF9360A_MODIFY // wait be tested in detail



//#define HAVE_SHARP_LQ035Q1DH02

//#define HAVE_WINTEK_WMF3324



//#define HAVE_AMPIRE_800x600
```

```
//#define HAVE_AMPIRE_800x480


//#define HAVE_HIMAX_HX8346         // MPU 320x240


//#define HAVE_TVOUT_720x480

//#define HAVE_TVOUT_640x480

//#define HAVE_TVOUT_320x240
```

If User’s panel is not listed in the header file, it will need to add related code by User or Nuvoton.

31.2. API Enumeration

Name	Value	Description
E_DRVVPOST_TIMING_TYPE		
eDRVVPOST_SYNC_TV	0x0	LCD timing sync with TV
eDRVVPOST_ASYNC_TV	0x1	LCD timing not sync with TV
E_DRVVPOST_IMAGE_SOURCE		
eDRVVPOST_RESERVED	0x0	Reserved for LC source
eDRVVPOST_FRAME_BUFFER	0x1	LCD source from Frame buffer
eDRVVPOST_REGISTER_SETTING	0x2	LCD source from Register setting color
eDRVVPOST_COLOR_BAR	0x3	LCD source from internal color bar
E_DRVVPOST_IMAGE_SCALING		
eDRVVPOST_DUPLICATED	0x0	Duplicate for TV Line buffer scaling
eDRVVPOST_INTERPOLATION	0x1	Interpolation for TV line buffer scaling
E_DRVVPOST_LCM_TYPE		
eDRVVPOST_HIGH_RESOLUTINO_SYNC	0x0	High resolution LCD device type
eDRVVPOST_SYNC	0x1	Sync-type TFT LCD
eDRVVPOST_MPU	0x3	MPU-type LCD
E_DRVVPOST_MPU_TYPE		

eDRVVPOST_I80	0x0	80-series MPU interface
eDRVVPOST_M68	0x1	68-series MPU interface
E_DRVVPOST_8BIT_SYNCLCM_INTERFACE		
eDRVVPOST_SRGB_YUV422	0x0	YUV422(CCIR601) for 8bit LCD data interface
eDRVVPOST_SRGB_RGBDUMMY	0x1	RGB dummy serial for 8 bit LCD data interface
eDRVVPOST_SRGB_CCIR656	0x2	CCIR656 for 8 bit LCD data interface
eDRVVPOST_SRGB_RGBTHROUGH	0x3	Serial RGB for 8 bit LCD data interface
E_DRVVPOST_CCIR656_MODE		
eDRVVPOST_CCIR656_360	0x0	720Y 360CbCr mode for CCIR656 horizontal active width
eDRVVPOST_CCIR656_320	0x1	640Y 320CbCr mode for CCIR656 horizontal active width
E_DRVVPOST_ENDIAN		
eDRVVPOST_YUV_BIG_ENDIAN	0x0	Big Endian for YCbCr
eDRVVPOST_YUV_LITTLE_ENDIAN	0x1	Little Endian for YCbCr
E_DRVVPOST_SERAIL_SYNCLCM_COLOR_ORDER		
eDRVVPOST_SRGB_RGB	0x0	Data in RGB order
eDRVVPOST_SRGB_BGR	0x1	Data in BGR order
eDRVVPOST_SRGB_GBR	0x2	Data in GBR order
eDRVVPOST_SRGB_RBG	0x3	Data in RBG order
E_DRVVPOST_PARALLEL_SYNCLCM_INTERFACE		
eDRVVPOST_PRGB_16BITS	0x0	16 pin parallel RGB data bus
eDRVVPOST_PRGB_18BITS	0x1	18 pin parallel RGB data bus
eDRVVPOST_PRGB_24BITS	0x2	24 pin parallel RGB data bus
E_DRVVPOST_SYNCLCM_DATABUS		
eDRVVPOST_SYNC_8BITS	0x0	8 bit sync-type LCD
eDRVVPOST_SYNC_9BITS	0x1	9 bit sync-type LCD
eDRVVPOST_SYNC_16BITS	0x2	16 bit sync-type LCD
eDRVVPOST_SYNC_18BITS	0x3	18 bit sync-type LCD
eDRVVPOST_SYNC_24BITS	0x4	24 bit sync-type LCD
E_DRVVPOST_MPULCM_DATABUS		
eDRVVPOST_MPU_8_8	0x0	Transfer in 8-8 format for 16 bit color in 8 bit bus

		width
eDRVVPOST_MPU_2_8_8	0x1	Transfer in 2-8-8 format for 18 bit color in 8 bit bus width
eDRVVPOST_MPU_6_6_6	0x2	Transfer in 6-6-6 format for 18 bit color in 8 bit bus width
eDRVVPOST_MPU_8_8_8	0x3	Transfer in 8-8-8 format for 24 bit color in 8 bit bus width
eDRVVPOST_MPU_9_9	0x4	Transfer in 9-9 format for 18 bit color in 9 bit bus width
eDRVVPOST_MPU_16	0x5	Transfer in 16 format for 16 bit color in 16 bit bus width
eDRVVPOST_MPU_16_2	0x6	Transfer in 16-2 format for 18 bit color in 16 bit bus width
eDRVVPOST_MPU_2_16	0x7	Transfer in 2-16 format for 18 bit color in 16 bit bus width
eDRVVPOST_MPU_16_8	0x8	Transfer in 16-8 format for 24 bit color in 16 bit bus width
eDRVVPOST_MPU_18	0x9	Transfer in 18 format for 18 bit color in 18 bit bus width
eDRVVPOST_MPU_18_6	0xA	Transfer in 18-6 format for 124 bit color in 18 bit bus width
eDRVVPOST_MPU_24	0xB	Transfer in 24 format for 24 bit color in 24 bit bus width
E_DRVVPOST_FRAME_DATA_TYPE		
eDRVVPOST_FRAME_RGB555	0x0	RGB555 Frame buffer data format
eDRVVPOST_FRAME_RGB565	0x1	RGB565 Frame buffer data format
eDRVVPOST_FRAME_RGBX888	0x2	RGB_Dummy888 Frame buffer data format
eDRVVPOST_FRAME_RGB888X	0x3	RGB888_Dummy Frame buffer data format
eDRVVPOST_FRAME_CBYCRY	0x4	Cb0Y0Cr0Y1 Frame buffer data format
eDRVVPOST_FRAME_YCBYCR	0x5	Y0Cb0Y1Cr0 Frame buffer data format
eDRVVPOST_FRAME_CRYCBY	0x6	Cr0Y0Cb0Y1 Frame buffer data format
eDRVVPOST_FRAME_YCRYCB	0x7	Y0Cr0Y1Cb0 Frame buffer data format

E_DRVVPOST_DATABUS		
eDRVVPOST_DATA_8BITS	0x0	8 bits data bus
eDRVVPOST_DATA_9BITS	0x1	9 bits data bus
eDRVVPOST_DATA_16BITS	0x2	16 bits data bus
eDRVVPOST_DATA_18BITS	0x3	18 bits data bus
eDRVVPOST_DATA_24BITS	0x4	24 bits data bus

31.3. API Structure

***Table 31-1**: LCDFORMATEX structure*

Field	Type	Description
ucVASrcFormat	UINT32	User input Display source format
nScreenWidth	UINT32	Driver output LCD width
nScreenHeight	UINT32	Driver output LCD height
nFrameBufferSize	UINT32	Driver output Frame buffer size
ucROT90	UINT8	Rotate 90 degree or not

***Table 31-2**: S_DRVVPOST_SYNCLCM_HTIMING structure*

Field	Type	Description
u8PulseWidth	UINT8	Horizontal sync pulse width
u8BackPorch	UINT8	Horizontal back porch
u8FrontPorch	UINT8	Horizontal front porch

***Table 31-3**: S_DRVVPOST_SYNCLCM_VTIMING structure*

Field	Type	Description
u8PulseWidth	UINT8	Vertical sync pulse width
u8BackPorch	UINT8	Vertical back porch
u8FrontPorch	UINT8	Vertical front porch

***Table 31-4**: S_DRVVPOST_SYNCLCM_WINDOW structure*

Field	Type	Description
u16ClockPerLine	UINT16	Specify the number of pixel clock in each line or row of screen

u16LinePerPanel	UINT16	Specify the number of active lines per screen
u16PixelPerLine	UINT16	Specify the number of pixel in each line or row of screen

***Table 31-5**: S_DRVVPOST_SYNCLCM_POLARITY structure*

Field	Type	Description
bIsVsyncActiveLow	BOOL	Vsync polarity
bIsHsyncActiveLow	BOOL	Hsync polarity
bIsVDenActiveLow	BOOL	VDEN polarity
bIsDClockRisingEdge	BOOL	Clock polarity

***Table 31-6**: S_DRVVPOST_MPULCM_WINDOW structure*

Field	Type	Description
u16LinePerPanel	BOOL	Specify the number of active lines per screen
u16PixelPerLine	BOOL	Specify the number of pixel in each line or row of screen

***Table 31-7**: S_DRVVPOST_MPULCM_WINDOW structure*

Field	Type	Description
u8CSnF2DCt	UINT8	CSn fall edge to Data change clock counter
u8WRnR2CSnRt	UINT8	WRn rising edge to CSn rising clock counter
u8WRnLWt	UINT8	WR Low pulse clock counter
u8CSnF2WRnFt	UINT8	Csn fall edge To WR falling edge clock counter

***Table 31-8**: S_DRVVPOST_MPULCM_TIMING structure*

Field	Type	Description
bIsSyncWithTV	BOOL	MPU timing sync with TV
bIsVsyncSignalOut	BOOL	Specify MPU FrameMark pin as input or output pin
bIsFrameMarkSignalIn	BOOL	Frame Mark detection disable or enable
eSource	E_DRVVPOST_IMAGE_SOURCE	Specify the image source
eType	E_DRVVPOST_LCM_TYPE	Specify the LCM type
eMPUType	E_DRVVPOST_MPU_TYPE	Specify the MPU type
eBus	E_DRVVPOST_MPULCM_DATABUS	Specify the MPU data bus
psWindow	S_DRVVPOST_MPULCM_WINDOW*	Specify MPU window

psTiming	S_DRVVPOST_MPULCM_TIMING*	Specify MPU timing

31.4. API Functions

vpostGetFrameBuffer

Synopsis

void *vpostGetFrameBuffer (void);

Description

Get the display frame buffer address

Parameter

None

Return Value

Display frame buffer address.

Example

None.

vpostSetFrameBuffer

Synopsis

void vpostSetFrameBuffer (
UINT32 pFramebuf
);

Description

Set the display frame buffer address

Parameter

UINT32 pFramebuf

Given frame buffer address

Return Value

None.

Example

None.

vpostLCMInit

Synopsis

INT32
vpostLCMInit (
PLCDFORMATEX plcdformatex,
UINT32 *pFramebuf
);

Description

Initialize the VPOST display device

Parameter

plcdformatex [in]

Input the lcd format information to initialize.

pFramebuf [in]

Input the frame buffer address

Return Value

Successful: Success

ERRCODE: Error

Example

```
__align(32) UINT8 Vpost_Frame[480*272*2];

lcdFormat.ucVASrcFormat = DRVVPOST_FRAME_RGB565;

      lcdFormat.nScreenWidth = 480;

      lcdFormat.nScreenHeight = 272;

      vpostLCMInit(&lcdFormat, (UINT32*)Vpost_Frame);
```

vpostLCMDeinit

Synopsis

INT32

vpostLCMDeinit (void);

Description

The function will stop VPOST operation and turn off VPOST clock.

Parameter

None

Return Value

Successful: Success

ERRCODE: Error

Example

None.

31.5. Error Code Table

Code Name	Value	Description
ERR_NULL_BUF	0xFFF06004	memory location error
ERR_NO_DEVICE	0xFFF06005	No device error
ERR_BAD_PARAMETER	0xFFF06006	Bad parameter error
ERR_POWER_STATE	0xFFF06007	Power state control error

32. Revision History

Version	Date	Description
V1.00.001	May 8, 2013	● Created

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