AIO338xU

Analog Input and Multi-Function Digital I/O Card

Software Manual (V2.1)

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Correction record

Version	Record
1.0	First publish
V1.0->V1.1	Modify the order of the contents (flow chart)
V1.1->V2.0	disable the software key function with return value always true
V2.0->V2.1	dll v2.1 and later add arbitrary waveform function ***AIO3380U_DA_Arbitrary_Waveform_Start( )*** ***AIO3380U_DA_Arbitrary_Waveform_Stop( )*** ***AIO3380U_DA_Arbitrary_Waveform_data_set( )*** ***AIO3380U_DA_Arbitrary_Waveform_data_read( )***

Contents

1. Difference between AIO3380 and AIO3380U

Although AIO3380U is a recommended replacement of AIO3380 but it exist some differences. The driver package has provided the same function name leading with AIO3380 for the new AIO3380U card. The instructions in red color are the instructions not fully compatible with AIO3380 card; the black color instructions are fully compatible. (Detailed instruction descriptions please refer the AIO3380 software manual). **We do not recommend using the AIO3380 functions with AIO3380U hardware in new design.**

	Function Name	Description
1	AIO3380_initial( )	AIO3380 Initial
2	AIO3380_close( )	AIO3380 Close
3	AIO3380_info( )	Read the I/O address of specific card
4	AIO3380_get_DeviceHandle( )	Read device handle
5	AIO3380_initial_calibration( )	Read the factory calibrated data for the future calibration
6	AIO3380_smart_AtoD( )	Read A/D in smart mode (convert to scale)
7	AIO3380_set_AD_command( )	write command to AD chip, start A/D conversion
8	AIO3380_start_AD_conversion( )	Not available
9	AIO3380_read_AD_status( )	Read AD status
10	AIO3380_read_AD_data( )	read AD conversion data
11	AIO3380_AD_calibration( )	To calibrate the conversion data with factory pre-calibrated data
12	AIO3380_smart_AtoD_no_calibr( )	Read A/D value and convert to scale.
13	AIO3380_smart_DtoA( )	output D/A data
14	AIO3380_set_DA_data( )	setup DA data
15	AIO3380_Readback_DA_data( )	readback setup DA data
16	AIO3380_start_DA_conversion( )	Not available
17	AIO3380_set_port_dir( )	setup port direction
18	AIO3380_read_port_dir( )	readback port direction setting
19	AIO3380_read_port( )	Read I/O port data
20	AIO3380_read_point( )	Read a specific point data of I/O port
21	AIO3380_set_port( )	Write data to output port
22	AIO3380_set_point( )	Write bit data to output port
23	AIO3380_set_dedicate_IO( )	Set IO00, IO01, IO10, IO11 as dedicate I/O or general I/O
24	AIO3380_readback_dedicate_IO_status( )	Readback the mode previously set for dedicated IO
25	AIO3380_set_timer( )	To set timer / counter at timer mode
26	AIO3380_set_counter( )	To set timer / counter at counter mode

27	AIO3380_set_pwm( )	Set timer/counter at PWM mode
28	AIO3380_set_clock_frequency( )	Not available
29	AIO3380_load_GPT( )	Write data to GPT(general purpose timer/counter register)
30	AIO3380_read_GPT( )	Read GPT(general purpose timer/counter register) data
31	AIO3380_GPT_enable( )	Enable/disable timer/counter function
32	AIO3380_one_shot_command( )	Generate an one shot
33	AIO3380_set_gate_CNTR( )	Set gated counter function
34	AIO3380_read_parameter( )	Read parameter from timer/counter
35	AIO3380_enable_IRQ( )	Enable interrupt of timer/counter
36	AIO3380_link_IRQ_process( )	Link IRQ process
37	AIO3380_disable_IRQ( )	Disable interrupt of timer/counter
38	AIO3380_read_IRQ_status( )	Readback IRQ status
39	AIO3380_set_password( )	Set password
40	AIO3380_change_password( )	Change password
41	AIO3380_clear_password( )	Clear password
42	AIO3380_unlock_security( )	Unlock security function
43	AIO3380_read_security_status( )	Read security status

Instructions that are different from the previous AIO3380 card

- **AIO3380_set_timer**

Format : **u32 status = AIO3380_set_timer(u8 CardID,u8 TimerID, u8 To_mode)**

Purpose: To set timer / counter at timer mode and configure its timer output function.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW
TimerID	u8	timer/counter designation 0: timer/counter0 1: timer/counter1
To_mode	u8	designation of timer output mode: 0: To will pulse low for 1us when terminal count is reached 1: To will pulse low for 2us when terminal count is reached 2: To will toggle whenever terminal count is reached 3: no output function

Note: Time base is only 1us only.

- **AIO3380_set_counter**

Format : **u32 status = AIO3380_set_counter(u8 CardID, u8 TimerID, u8 To_mode, u8 Ti_mode)**

Purpose: To set timer / counter at counter mode and configure its counter input and counter output function.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW
TimerID	u8	timer/counter designation 0: timer/counter0 1: timer/counter1
To_mode	u8	counter output mode designation: 0: To will pulse low for 1us when terminal count is reached 1: To will pulse low for 2us when terminal count is reached 2: To will toggle whenever terminal count is reached 3: no output function
Ti_mode	u8	counter input mode designation: 0: not available 1: not available 2: Counter decrease 1 while Ti is high to low transition 3: Counter decrease 1 while Ti is low to high transition

Notes:

1. Counter/Timer0 input is at IO00, Counter/Timer1 input is at IO01.
2. Counter/Timer0 output is at IO10, Counter/Timer1 output is at IO11, and before using this function, port should be configured as dedicated port by AIO3380_set_dedicate_IO( ).

- **AIO3380_set_pwm**

Format : **u32 status = AIO3380_set_pwm(u8 CardID,u8 TimerID)**

Purpose: To set timer/counter at PWM mode and map the PWM output to port1 bit n for timer/counter n.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW
TimerID	u8	timer/counter designation 0: timer/counter0 1: timer/counter1

Note: Each timer/counter has 32 bit register length, if you program as PWM mode, the register is divided as 2 16 bit width, the lower 16 bit work as the PWM duty width and the upper 16 bit work as PWM frequency register.

- **AIO3380_one_shot_command**

Format : **status=AIO3380_one_shot_command (u8 CardID,u8 TimerID, u16 duration_time)**

Purpose: To generate an one shot output from timer0/1 at programmed duration

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW
TimerID	u8	timer/counter designation 0: timer/counter 0 , output at DIO10 1: timer/counter 1 , output at DIO11
duration_time	u16	the duration time constant of one shot. Duration time = time constant *1us

Notes:

Counter/Timer0 output is at IO10, Counter/Timer1 output is at IO11, and before using this function, port should be configured as dedicated port by AIO3380_set_dedicate_IO( ).

- **AIO3380_set_gate_CNTR**

Format : **u32 status = AIO3380_set_gate_CNTR(u8 CardID,u8 TimerID,u8 enable)**

Purpose: To enable/disable gated timer/counter function and the gated input for timer0/timer1.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW
TimerID	u8	port designation 0: timer/counter0 1: timer/counter1
enable	u8	0: disable gated timer/counter function 1: enable or resume timer/counter function for Counter/Timer0, the gate input : DIO00: counter input DIO02: gate input, high enables counting for Counter/Timer1, the gate input : DIO01: counter input DIO03: gate input, high enables counting

2. How to install the software of AIO3380U

2.1 Install the PCI driver

The PCI card is a plug and play card, once you add a new card the on window system will detect while it is booting. Please follow the following steps to install your new card.

In WinXP/7 and up system you should: (take Win XP as example)

1. Make sure the power is off
2. Plug in the interface card
3. Power on
4. A hardware install wizard will appear and tell you it finds a new PCI card
5. Do not response to the wizard, just Install the file (..\AIO3382_4U\Software\WinXP_7\ or if you download from website please execute the file AIO3380U_Install.exe to get the file)
6. After installation, power off
7. Power on, it's ready to use

Note: AIO3382U, AIO3382UA, AIO3382UB, AIO3384U, AIO3384UAA, AIO3384UAB, AIO3384UBB use the same driver and dll.

For more detail of step by step installation guide, please refer the file "installation.pdf " on the CD come with the product or register as a member of our user's club at:

http://automation.com.tw/

to download the complementary documents.

3. Where to find the file you need

WinXP/7 and up

The directory will be located at

.. \ JS Automation \AIO3380U\API (header files and lib files for VB,VC,BCB,C#)

.. \ JS Automation \AIO3380U\Driver (backup copy of AIO3380U drivers)

.. \ JS Automation \AIO3380U\exe (demo program and source code)

The system driver is located at **..\system32\Drivers** and the DLL is located at **..\system**.

For your easy startup, the demo program with source code demonstrates the card functions and help file.

4. About the AIO3380U software

AIO3380U software includes a set of dynamic link library (DLL) and system driver that you can utilize to control the I/O card's ports and points separately.

Your AIO3380U software package includes setup driver, tutorial example and test program that help you how to setup and run appropriately, as well as an executable file which you can use to test each of the AIO3380U functions within Windows' operation system environment.

4.1 What you need to get started

To set up and use your AIO3380U software, you need the following:

- AIO3380U software
- AIO3380U hardware
  Main board
  Wiring board (Option)

4.2 Software programming choices

You have several options to choose from when you are programming AIO3380U software. You can use Borland C/C++, Microsoft Visual C/C++, Microsoft Visual Basic, or any other Windows-based compiler that can call into Windows dynamic link libraries (DLLs) for use with the AIO3380U software.

5. AIO3380U Language support

The AIO3380U software library is a DLL used with WinXP/7 and up. You can use these DLL with any Windows integrating development environment that can call Windows DLLs.

5.1 Building applications with the AIO3380U software library

The AIO3380U function reference topic contains general information about building AIO3380U applications, describes the nature of the AIO3380U files used in building AIO3380U applications, and explains the basics of making applications using the following tools:

Applications tools

- Microsoft Visual C/C++
- Borland C/C++
- Microsoft Visual C#
- Microsoft Visual Basic
- Microsoft VB.net

If you are not using one of the tools listed, consult your development tool reference manual for details on creating applications that call DLLs.

5.2 AIO3380U Windows libraries

The AIO3380U for Windows function library is a DLL called **AIO3380U.dll**. Since a DLL is used, AIO3380U functions are not linked into the executable files of applications. Only the information about the AIO3380U functions in the AIO3380U import libraries is stored in the executable files.

Import libraries contain information about their DLL-exported functions. They indicate the presence and location of the DLL routines. Depending on the development tools you are using, you can make your compiler and linker aware of the DLL functions through import libraries or through function declarations.

Refer to **Table 1** to determine to which files you need to link and which to include in your development to use the AIO3380U functions in AIO3380U.dll.

Header Files and Import Libraries for Different Development Environments		
Language	**Header File**	**Import Library**
Microsoft Visual C/C++	AIO3380U.h	AIO3380UVC.lib
Borland C/C++	AIO3380U.h	AIO3380UBC.lib
Microsoft Visual C#	AIO3380U.cs	
Microsoft Visual Basic	AIO3380U.bas	
Microsoft VB.net	AIO3380U.vb	

Table 1

6. Function format and language difference

6.1 Function format

Every AIO3380U function is consist of the following format:

Status = function_name (parameter 1, parameter 2, … parameter n)

Each function returns a value in the **Status** global variable that indicates the success or failure of the function. A returned **Status** equal to zero that indicates the function executed successfully. A non-zero status indicates failure that the function did not execute successfully because of an error, or executed with an error.

Note : **Status** is a 32-bit unsigned integer.

The first parameter to almost every AIO3380U function is the parameter **CardID** which is located the driver of AIO3380U board you want to use those given operation. The **CardID** is assigned by DIP/ROTARY SW. You can utilize multiple devices with different card CardID within one application; to do so, simply pass the appropriate **CardID** to each function.

Note: **CardID** is set by DIP/ROTARY SW (**0x0-0xF**)

6.2 Variable data types

Every function description has a parameter table that lists the data types for each parameter. The following sections describe the notation used in those parameter tables and throughout the manual for variable data types.

Primary Type Names					
Name	**Description**	**Range**	**C/C++**	**Visual BASIC**	**Pascal (Borland Delphi)**
u8	8-bit ASCII character	0 to 255	char	Not supported by BASIC. For functions that require character arrays, use string types instead.	Byte
i16	16-bit signed integer	-32,768 to 32,767	short	Integer (for example: deviceNum%)	SmallInt
u16	16-bit unsigned integer	0 to 65,535	unsigned short for 32-bit compilers	Not supported by BASIC. For functions that require unsigned integers, use the signed integer type instead. See the i16 description.	Word
i32	32-bit signed integer	-2,147,483,648 to 2,147,483,647	long	Long (for example: count&)	LongInt
u32	32-bit unsigned integer	0 to 4,294,967,295	unsigned long	Not supported by BASIC. For functions that require unsigned long integers, use the signed long integer type instead. See the i32 description.	Cardinal (in 32-bit operating systems). Refer to the i32 description.
f32	32-bit single-precision floating-point value	-3.402823E+38 to 3.402823E+38	float	Single (for example: num!)	Single
f64	64-bit double-precision floating-point value	-1.797683134862315E+308 to 1.797683134862315E+308	double	Double (for example: voltage Number)	Double

Table 2

6.3 Programming language considerations

Apart from the data type differences, there are a few language-dependent considerations you need to be aware of when you use the AIO3380U API. Read the following sections that apply to your programming language.

Note: Be sure to include the declaration functions of AIO3380U prototypes by including the appropriate AIO3380U header file in your source code. Refer to Building Applications with the AIO3380U Software Library for the header file appropriate to your compiler.

6.3.1 C/C++

For C or C++ programmers, parameters listed as Input/Output parameters or Output parameters are pass-by-reference parameters, which means a pointer points to the destination variable should be passed into the function. For example, the Read Port function has the following format:

```
Status = AIO3380U_TTL_IO_port_read(CardID, port, *data);
```

where **CardID** and **port** are input parameters, and **data** is an output parameter. Consider the following example:

```
u8 CardID, port;
u8 data,
u32 Status;
Status = AIO3380U_TTL_IO_port_read (CardID, port, data);
```

6.3.2 Visual basic

The file AIO3380U.bas contains definitions for constants required for obtaining AIO Card information and declared functions and variable as global variables. You should use these constants symbols in the AIO3380U.bas, do not use the numerical values.

In Visual Basic, you can add the entire AIO3380U.bas file into your project. Then you can use any of the constants defined in this file and call these constants in any module of your program. To add the AIO3380U.bas file for your project in Visual Basic 4.0, go to the **File** menu and select the **Add File... option**. Select AIO3380U.bas, which is browsed in the AIO3380U \ API directory. Then, select **Open** to add the file to the project.

To add the AIO3380U.bas file to your project in Visual Basic 5.0 and 6.0, go to the **Project** menu and select **Add Module**. Click on the Existing tab page. **Select** AIO3380U.bas, which is in the AIO3380U \ API directory. Then, select **Open** to add the file to the project.

6.3.3 Borland C++ builder

To use Borland C++ builder as development tool, you should generate a .lib file from the .dll file by implib.exe.

implib AIO3380UBC.lib AIO3380U.dll

Then add the **AIO3380UBC.lib** to your project and add

#include “AIO3380U.h” to main program.

Now you may use the dll functions in your program. For example, the Read Port function has the following format:

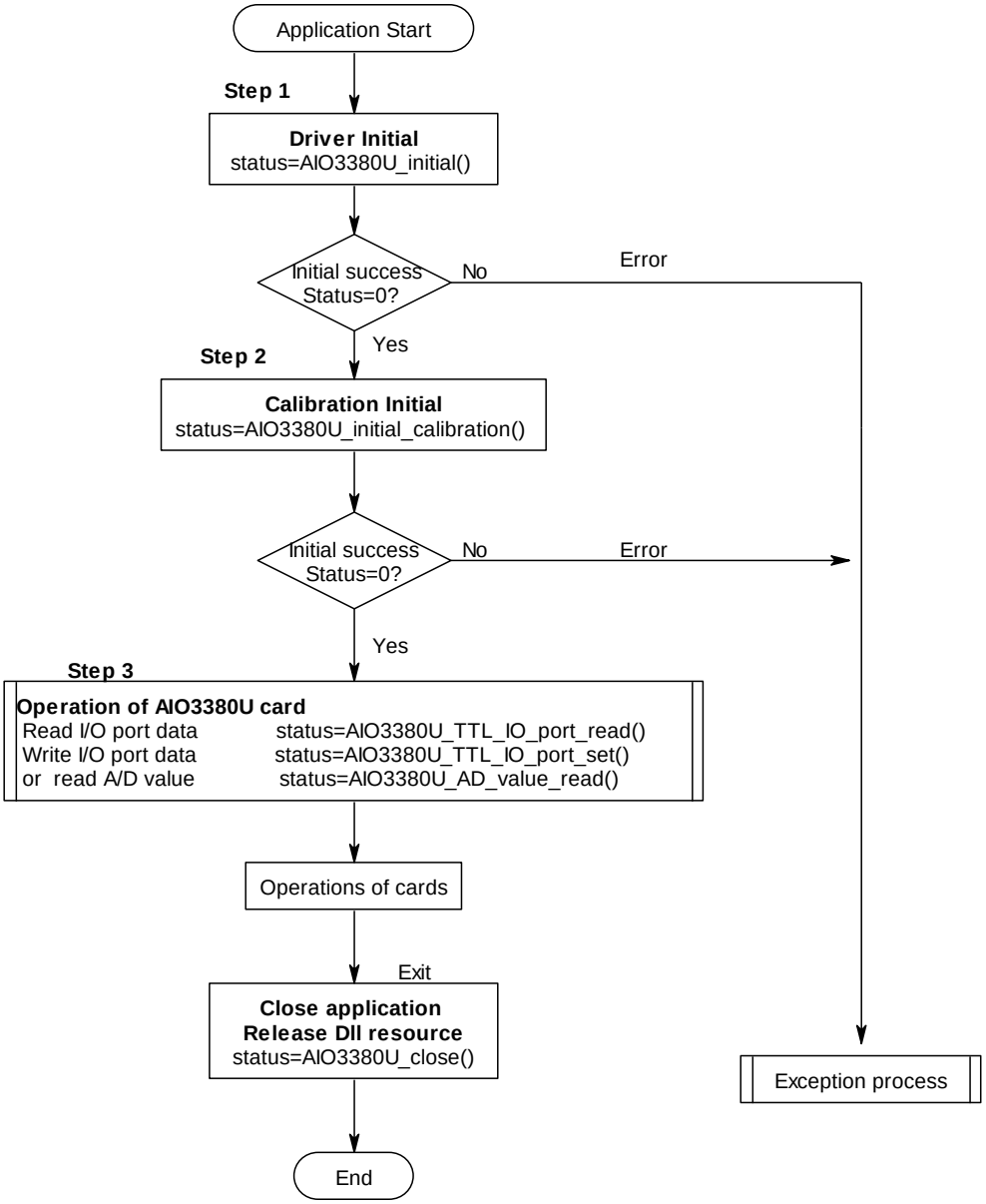
```
Status = AIO3380U_TTL_IO_port_read(CardID, port, *data);
```

where **CardID** and **port** are input parameters, and **data** is an output parameter. Consider the following example:

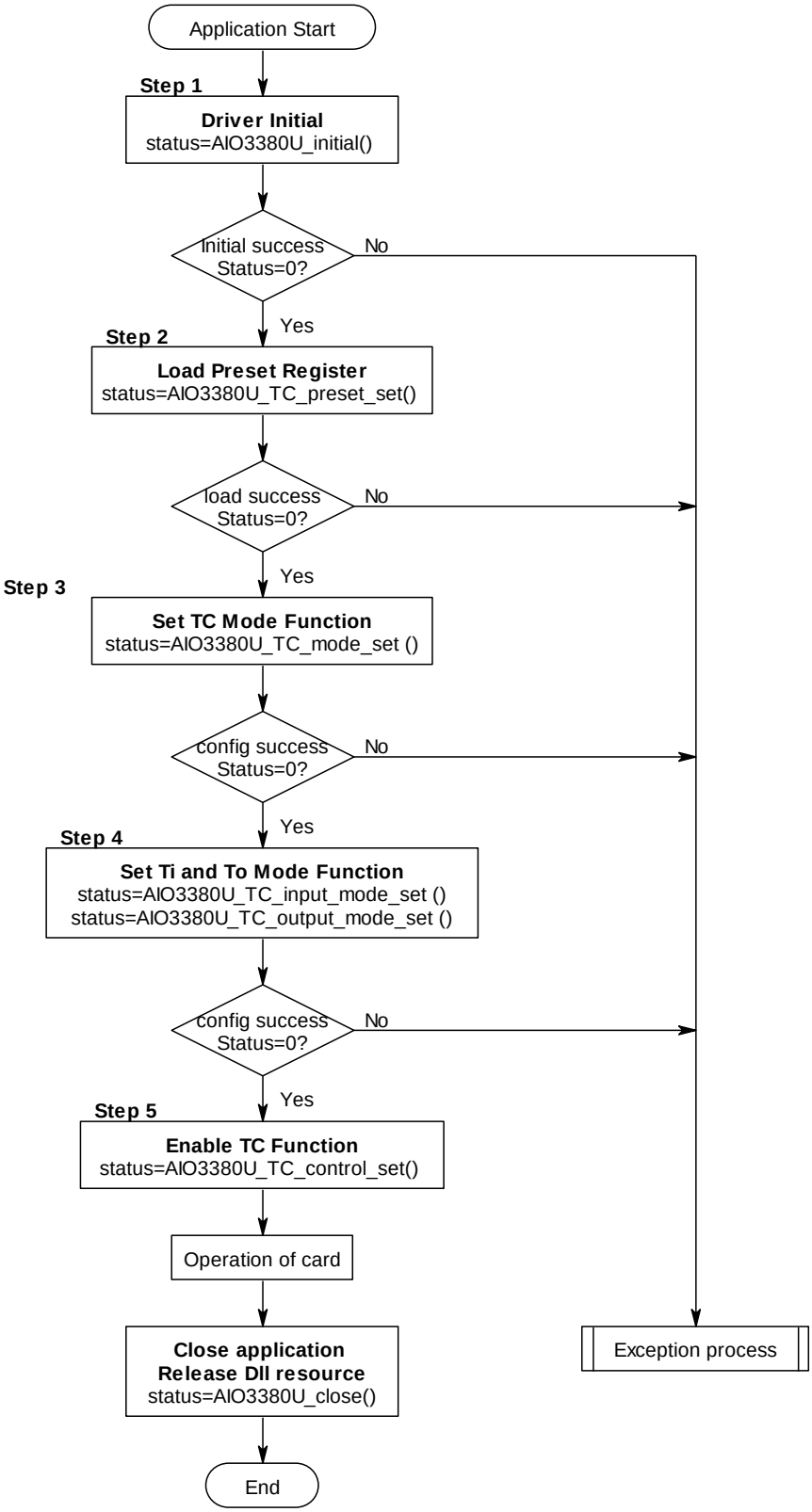
```
u8 CardID, port;
u8 data;
u32 Status;
Status =AIO3380U_TTL_IO_port_read (CardID, port, data);
```

7. Flow chart of application implementation

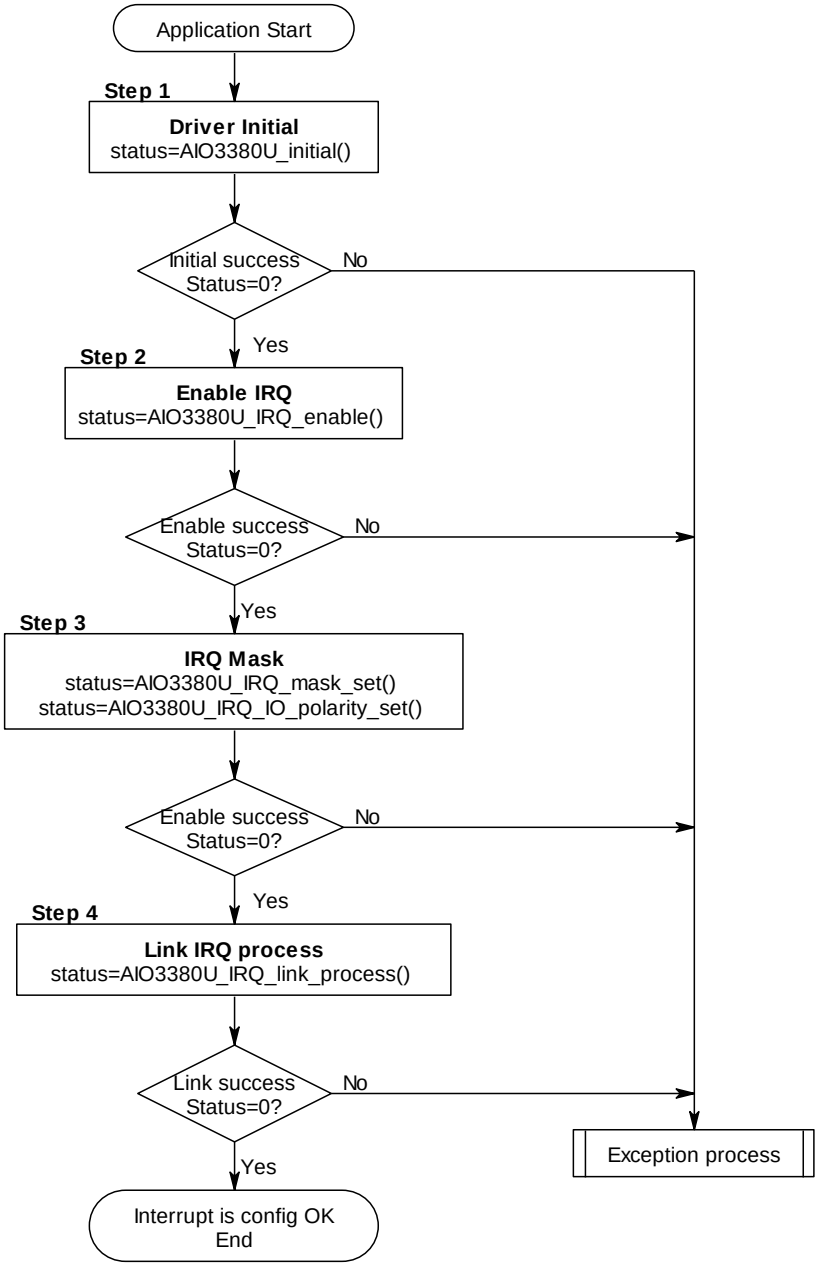
7.1 AIO3380U Flow chart of application implementation



7.2 AIO3380U Flow chart of Timer / Counter / PWM application



7.3 AIO3380U Flow chart of interrupt



8. Software overview and dll function

These topics describe the features and functionality of the AIO3380U boards and briefly describes the AIO3380U functions.

8.1 Initialization and close

You need to initialize system resource each time you start to run your application.

AIO3380U_initial( ) will do.

Before you want to A/D conversion, the factory pre-calibrated data should be initialized for A/D conversion.

AIO3380U_initial_calibration( ) will read factory calibrated data to working area.

Once you want to close your application, call

AIO3380U_close( ) to release all the resource.

If you want to know the physical address assigned by OS. use

AIO3380U_info( ) to get the address.

- **AIO3380U_initial**

Format : **u32 status =AIO3380U_initial(void)**

Purpose: Initial the AIO3380U resource when start the Windows applications.

- **AIO3380U_initial_calibration**

Format : **u32 status =AIO3380U_initial_calibration(u8 CardID)**

Purpose: Read the factory pre-calibrated data for the future calibration.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW

- **AIO3380U_close**

Format : **u32 status =AIO3380U_close(void);**

Purpose: Release the AIO3380U resource when close the Windows applications.

- **AIO3380U_info**

Format : **u32 status =AIO3380U_info(u8 CardID,u16 *address)**

Purpose: Read the physical I/O address assigned by O.S..

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW

Output:

Name	Type	Description
address	u16	physical I/O address assigned by OS

8.2 Analog input

The AIO338xU now are 8 channels 16 bit AD cards. There are different channel D/A numbers for AIO3382U (2 channels) and AIO3384U (4 channels).

You must configure the input range of the specific channel by:

AIO3380U_AD_config_set( ) and read back the configuration for verification by:

AIO3380U_AD_config_read( )

To read the input voltage value with the factory pre-calibrated data by:

AIO3380U_AD_value_read( ), it can be also read without the calibration by

AIO3380U_AD_value_read_no_calibration( )

If your application only need the raw AD data, you can read AD data by:

AIO3380U_AD_data_read_no_calibration( )

If your environment is noisy or you need to get more accurate data, you can use the integral function built in dll by:

AIO3380U_AD_integral_start( ) to start the embedded integration of the system.

AIO3380U_AD_integral_all_read( ) to read all channels.

AIO3380U_AD_integral_stop( ) to stop integration function.

- **AIO3380U_AD_config_set**

Format : u32 status = AIO3380U_AD_config_set(u8 CardID,u8 channel,u8 mode)

Purpose: Set A/D configuration.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW
channel	u8	A/D channel number 0~7: 8 channels AD
mode	u8	scale range: 0: 0V ~ 5V, 0~20mA and 4~20mA 1: -5V ~ +5V 2: 0V ~ 10V 3: -10V ~ +10V 4: 0~20mA 5: 4~20mA 255 : AD stop operation.

Note: 0~5V, 0~20mA or 4~20mA are set by hardware but software must configure to meet. For the first time after power on or the first time after application opened, you should configure the AD mode as the hardware setting else **incorrect** reading will be.

- **AIO3380U_AD_config_read**

Format : **u32 status = AIO3380U_AD_config_read(u8 CardID,u8 channel,u8 *mode)**

Purpose: Read A/D config.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW
channel	u8	A/D channel number 0~7: 8 channels AD

Output:

Name	Type	Description
mode	u8	scale range: 0: 0V ~ 5V, 0~20mA and 4~20mA 1: -5V ~ +5V (Default) 2: 0V ~ 10V 3: -10V ~ +10V 4: 0~20mA 5: 4~20mA 255 : AD stop operation.

- **AIO3380U_AD_value_read**

Format : **u32 status = AIO3380U_AD_value_read(u8 CardID, u8 channel, f32 *value)**

Purpose: Read voltage value with pre-calibration data.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW
channel	u8	A/D channel number 0~7: 8 channels AD

Output:

Name	Type	Description
value	f32	Voltage value based on the AD converted and calibrated data. Say if the AD scale range is set at 0~5V then the voltage value returned will be in the 0~5 range.

Note: Use *AIO3380U_initial_calibration( )* to load calibration data first then the further calibration will be effective.

- **AIO3380U_AD_value_read_no_calibration**

Format : **u32 status = AIO3380U_AD_value_read_no_calibration (u8 CardID, u8 channel, f32 *value)**

Purpose: Read voltage value.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW
channel	u8	A/D channel number 0~7: 8 channels AD

Output:

Name	Type	Description
value	f32	Voltage value based on the AD converted data only. Say if the AD scale range is set at 0~10V then the voltage value returned will be in the 0~10 range.

- **AIO3380U_AD_data_read_no_calibration**

Format : **u32 status = AIO3380U_AD_data_read_no_calibration (u8 CardID, u8 channel, u16 *data)**

Purpose: Read A/D data.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW
channel	u8	A/D channel number 0~7: 8 channels AD

Output:

Name	Type	Description
data	u16	AD 16 bit data, 0~65535: if unipolar AD mode, 0~5V or 0~10V range 0~32767: if bipolar AD mode, in 0~5V or 0~10V range 65535~32768: if bipolar AD mode, in 0~ -5V or 0 ~ -10V range

- **AIO3380U_AD_integral_start**

Format : u32 status = AIO3380U_AD_integral_start(u8 CardID,u8 mode)

Purpose: start AD conversion with integral constant.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by jumper setting
mode	u8	0: immediately access, no integration 1: integration time 100ms 2: integration time 200ms 3: integration time 300ms 4: integration time 400ms 5: integration time 500ms 6: integration time 600ms 7: integration time 700ms 8: integration time 800ms 9: integration time 900ms 10: integration time 1s

- **AIO3380U_AD_integral_all_read**

Format : u32 status = AIO3380U_AD_integral_all_read(u8 CardID,u16 data[8])

Purpose: read integral result of AD conversion data.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by jumper setting

Output:

Name	Type	Description
data[8]	u16	Channel 0 ~7 AD data

Note:

To read all channels in integral

Start integral mode by **AIO3380U_AD_integral_start.** (AD interrupt is not allowed to use)

Read all channels by AIO3380U_AD_integral_all_read.

Stop AD integration function by **AIO3380U_AD_integral_stop.**

- **AIO3380U_AD_integral_stop**

Format : **u32 status = AIO3380U_AD_integral_stop(u8 CardID)**

Purpose: stop AD integral conversion.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by jumper setting

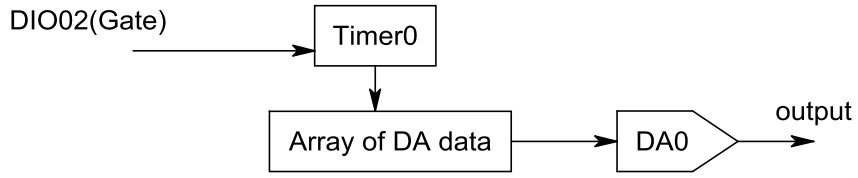
8.3 Analog output

The AIO3382U provides 2 channels 17 bit DA and AIO3384U has 4 channels 17 bit DA. You can command the DA output in 16 bit magnitude with an extra sign bit to control the output polarity.

AIO3380U_DA_set( ) to output DA data.

AIO3380U_DA_read( ) to read back DA data you send.

If the DA data varies with the time and you can program the data as you need, now you can have an arbitrary waveform generator. The function model shown as follows:



The limit is the response time of the computer and your imagination.

AIO3380U_DA_Arbitrary_Waveform_data_set( ) can be used to setup the data you want to output as the time elapse.

AIO3380U_DA_Arbitrary_Waveform_data_read( ) for read back checking.

After the data has been setup, you can start the waveform generator by:

AIO3380U_DA_Arbitrary_Waveform_Start( ) and stop by:

AIO3380U_DA_Arbitrary_Waveform_Stop( )

Note: Arbitrary waveform generation will use timer0 as time base and DA0 as waveform output port.

- **AIO3380U_DA_set**

Format : u32 status = AIO3380U_DA_set(u8 CardID,u8 channel, u16 data,u8 sign)

Purpose: DA output

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by jumper setting
channel	u8	DA channel no. (0~1 for AIO3382U) (0~3 for AIO3384U)
data	u16	data to be input -10V ~+10V : 0~65535, sign= 0 or 1 0~20mA, 4~20mA: 0~65535 , sign= 0 (must be)
sign	u8	0: output is positive voltage 1: output is negative voltage

- **AIO3380U_DA_read**

Format : **u32 status = AIO3380U_DA_read(u8 CardID,u8 channel, u16 *data, u8 * sign)**

Purpose: read back DA data

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by jumper setting
channel	u8	DA channel no. (0~1 for AIO3382U) (0~3 for AIO3384U)

Output:

Name	Type	Description
data	u16	data to be output -10V ~+10V : 0~65535, sign= 0 or 1 0~20mA, 4~20mA: 0~65535 , sign= 0 (must be)
sign	u8	0: output is positive voltage 1: output is negative voltage

- **AIO3380U_DA_Arbitrary_Waveform_data_set**

Format : **u32 status = AIO3380U_DA_Arbitrary_Waveform_data_set(u8 CardID , _da_data *data , _da_config *config)**

Purpose: Set DA arbitrary waveform data and configuration.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY switch

data	_da_data	struct _da_data
		{
		u16 da_counter; //valid data number
		u16 da_value[10000]; //0~65535 DA value
		u8 da_sign[10000]; //0: positive voltage
		//1: negative voltage
		}
		Note:
		the maximum data number will be 10,000; each can have polarity (positive or negative voltage) attribute. The da_counter indicates the real meaningful data number you fill.

config	_da_config	Struct _da_config
		{
		u8 retrigger;
		//0 : single cycle(default)
		//1 : always run (the last data will continued with the first // data.
		u8 stop_mode;
		//0 : halt function (default) ,
		//1 : halt fuinction on last data
		//2 : halt function and DA output with stop_da_value.
		u16 stop_da_value;
		//DA output data for stop_mode=2 (default 0V)
		u8 stop_da_sign;
		//polarity of stop_da_value (default 0:positive)
		u8 gate_mode;
		//0 : no gate(default)
		//1 : gated, DIO02 is gate input,
		//if internal logic of DIO02 is active high, it will start
		//timer and low will halt the timer counting.
		u8 gate_polarity;

		u32 timer;
		// DAoutput sample time on
		//time base 1us, timer constant no less than 100
		}

Note:

1. The arbitrary waveform function will use timer0 as function time base. You cannot use timer0 during the arbitrary waveform function working.
2. Timer constant needs a value no less than100 (us) to avoid system performance lag.
3. DA0 is the dedicated output of waveform.

- **AIO3380U_DA_Arbitrary_Waveform_data_read**

Format : u32 status = AIO3380U_DA_Arbitrary_Waveform_data_read(u8 CardID , _da_data *data , _da_config *config)

Purpose: Read DA arbitrary waveform data and configuration.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY switch

Output:

Name	Type	Description

data	_da_data	struct _da_data
		{
		u16 da_counter; //valid data number
		u16 da_value[10000]; //0~65535 DA value
		u8 da_sign[10000]; //0: positive voltage
		//1: negative voltage
		}
		Note:
		the maximum data number will be 10,000; each can have polarity (positive or negative voltage) attribute.
		The da_counter indicates the real meaningful data number you fill.

config	_da_config	Struct _da_config { u8 retrigger; //0 : single cycle(default) //1 : always run (the last data will continued with the first // data. u8 stop_mode; //0 : halt function (default) ,

		//1 : halt fuinction on last data
		//2 : halt function and DA output with stop_da_value.
		u16 stop_da_value;
		//DA output data for stop_mode=2 (default 0V)
		u8 stop_da_sign;
		//polarity of stop_da_value (default 0:positive)
		u8 gate_mode;
		//0 : no gate(default)
		//1 : gated, DIO02 is gate input,
		//if internal logic of DIO02 is active high, it will start
		//timer and low will halt the timer counting.
		u8 gate_polarity;
		u32 timer;
		// DAoutput sample time on
		//time base 1us, timer constant no less than 100
		}

- **AIO3380U_DA_Arbitrary_Waveform_Start**

Format : **u32 status = AIO3380U_DA_Arbitrary_Waveform_Start(u8 CardID)**

Purpose: DA arbitrary waveform output starts.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by jumper setting

Note: DA arbitrary waveform output starts means output the waveform from the first data stored.

- **AIO3380U_DA_Arbitrary_Waveform_Stop**

Format : **u32 status = AIO3380U_DA_Arbitrary_Waveform_Stop(u8 CardID)**

Purpose: DA arbitrary waveform output stops.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by jumper setting

Note: DA arbitrary waveform output stops will depends on the configuration of stop_mode set.

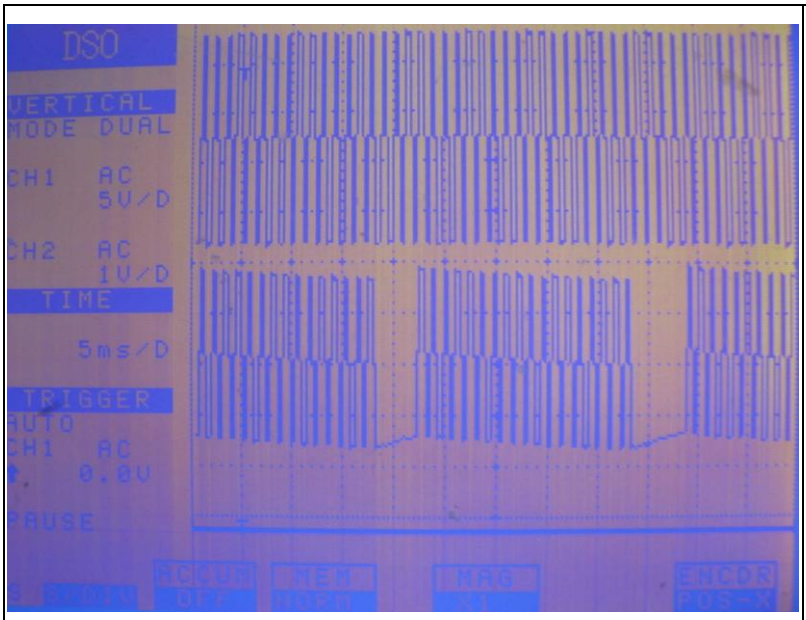
8.4 TTL I/O Port R/W

In general, TTL I/O port can be input or output as configured. To work as input, the AIO3380U series cards provides input digital debounce function.

Debounce is the function to filter the input jitters. From the microscope view of a switch input, you will see the contact does not come to close or release to open clearly. In most cases, it will contact-release-contact-release… for many times then go to steady state (ON or OFF). If you do not have the debounce function, you will read the input at high state and then next read will get low state, this maybe an error data for your decision of contact input.

Debounce can be implemented by hardware or software. Analog hardware debounce circuit will have fixed time constant to filter out the significant input signal, if you want to change the response time; the only way is to change the circuit device.

If digital debounce is implemented, maybe several filter frequency you can choose. To choose the filter frequency, please keep the Nyquist–Shannon sampling theorem in mind: **filter sample frequency must at least twice of the input frequency.** The following sample is a bad selection of debounce filter, the input frequency is not as low as les than half of the sample frequency and the output will generate a beat frequency.

<table>
<tr><td> 
</td><td><- Input frequency at 835Hz

<- Output of digital filter,
Please note the beat frequency.</td></tr>
<tr><td colspan="2">Digital debounce circuit work at 1KHZ sample rate and observe the output of filter from 835Hz input.</td></tr>
</table>

Software debounce will consumes the CPU time a lot, we do not recommend to use except for you really know you want.

To configure the port as input or output by:

AIO3380U_TTL_IO_config_set ( ) and read back the configuration by:

AIO3380U_TTL_IO_config_read ( ).

The TTL I/O port can use:

AIO3380U_TTL_IO_port_set ( ) to output data and input data by:

AIO3380U_TTL_IO_port_read( ).

For the point output, use:

AIO3380U_TTL_IO_point_set ( ) and point input by:

AIO3380U_TTL_IO_point_read ( ).

At noisy environment to debounce the signal or to debounce the mechanical contact input, use:

AIO3380U_TTL_IO_debounce_time_set ( ) to set the adequate time constant to drop out the noise and read back to check the setting by:

AIO3380U_TTL_IO_debounce_time_read( ).

- **AIO3380U_TTL_IO_config_set**

Format : u32 status =AIO3380U_TTL_IO_config_set (u8 CardID, u8 port, u8 configuration)

Purpose: Sets port configuration.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by Rotary SW
port	u8	port number 0: port0 (DIO0x) 1: port1 (DIO1x)
configuration	u8	0: input port (default) 1: output port

- **AIO3380U_TTL_IO_config_read**

Format : **u32 status =AIO3380U_TTL_IO_config_read (u8 CardID, u8 port, u8 *configuration)**

Purpose: read port configuration.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by Rotary SW
port	u8	port number 0: port0 (DIO0x) 1: port1 (DIO1x)

Output:

Name	Type	Description
configuration	u8	0: input port (default) 1: output port

- **AIO3380U_TTL_IO_port_set**

Format : **u32 status = AIO3380U_TTL_IO_port_set (u8 CardID,u8 port, u8 data)**

Purpose: Sets the port data.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by Rotary SW
port	u8	port number 0: port0 (DIO0x) 1: port1 (DIO1x)
data	u8	bitmap of output values bit0: DIOn0 … bit7: DIOn7

- **AIO3380U_TTL_IO_port_read**

Format : **u32 status = AIO3380U_TTL_IO_port_read (u8 CardID , u8 port , u8 *data)**

Purpose: Read the port data.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by Rotary SW
port	u8	port number 0: port0 (DIO0x) 1: port1 (DIO1x)

Output:

Name	Type	Description
data	u8	bitmap of output/input values bit0: DIOn0 … bit7: DIOn7

- **AIO3380U_TTL_IO_point_set**

Format : **u32 status =AIO3380U_TTL_IO_point_set (u8 CardID, u8 port, u8 point, u8 state)**

Purpose: Sets the bit data of output port.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by Rotary SW
port	u8	port number 0: port0 (DIO0x) 1: port1 (DIO1x)
point	u8	point number 0~7 for bit0~bit7 (DIOn0 ~ DIOn7)
state	u8	point of output state

- **AIO3380U_TTL_IO_point_read**

Format : u32 status = AIO3380U_TTL_IO_point_read (u8 CardID, u8 port, u8 point, u8 *state)

Purpose: Read the output port state .

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by Rotary SW
port	u8	port number 0: port0 (DIO0x) 1: port1 (DIO1x)
point	u8	point number of input 0~7 for bit0~bit7 (DIOn0 ~ DIOn7)

Output:

Name	Type	Description
state	u8	point of output/input state

- **AIO3380U_TTL_IO_debounce_time_set**

Format : u32 status = AIO3380U_TTL_IO_debounce_time_set (u8 CardID,u8 port , u8 debounce_time)

Purpose: debounce time of the TTL I/O port signal

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by Rotary SW
port	u8	port number 0: port0 (DIO0x) 1: port1 (DIO1x)
debounce_time	u8	Debounce time selection: 0: no debounce 1: filter out duration less than 10ms (100Hz, default) 2: filter out duration less than 5ms (200Hz) 3: filter out duration less than 1ms (1KHZ)

Note: only valid for port configured as input

- **AIO3380U_TTL_IO_debounce_time_read**

Format : u32 status = AIO3380U_TTL_IO_debounce_time_read (u8 CardID,u8 port , u8 *debounce_time)

Purpose: To read back configuration of debounce mode

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by Rotary SW
port	u8	port number 0: port0 (DIO0x) 1: port1 (DIO1x)

Output:

Name	Type	Description
debounce_time	u8	Debounce time selection: 0: no debounce 1: filter out duration less than 10ms (default) 2: filter out duration less than 5ms 3: filter out duration less than 1ms

8.5 Counter / Timer / PWM function

Many control applications need timer as time base for digital sampled data control systems. The timer consists a counter to count the time base clock on the fly and generate interrupt on a periodic time interval. If the counter do not count the time base but count the signals from external world, we call it "counter".

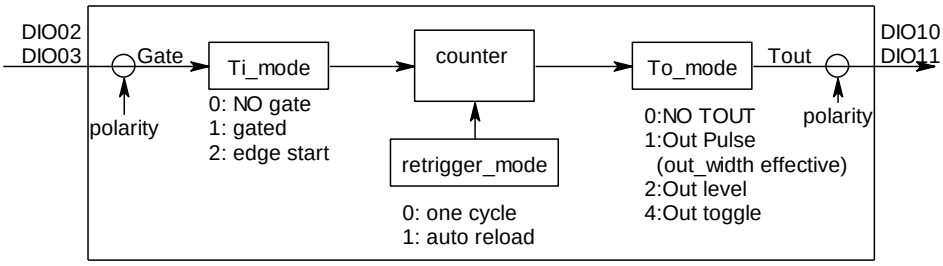
A timer/counter may be multi-functions, if the input signal and control mode and the output can be programmed as various kind of working mode.

Input signal debounce

The timer / counter input comes from DIO00 ~ DIO03 the signal maybe occasionally contaminated by noise. AIO3380U series card provides wide range of filter frequency from 100Hz up to 1KHz (to drop out noise pulse less than 1ms), even the quadrature signals comes from mechanical contacts the counter can still operate very nice. If you will use faster signals, you can program the debounce as **no debounce** to pass the signal directly to counter. But take care of the noise induced by the environment and wiring, we recommended you to use a high speed isolation type encoder counter card such as LSI3101 (up to 8M counter speed) or LSI3101A (up to 16M counter speed) of JS Automation Corp to get better performance.

Timer function

The timer model used in AIO3380U series is as follows:



In this model, the timer can work in one cycle mode and auto reload mode.

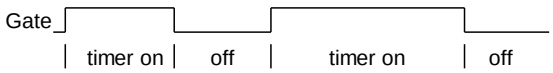
one cycle mode: the timer will stop when the timer time up.

auto reload mode (sometimes called continuous mode): the time will reload the time constant while time up.

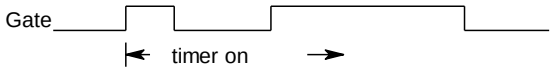
In the timer input control block:

NO gate: the timer do not control by any input.

gated : the timer only working on the gate input active and stops counting while gate is inactive.



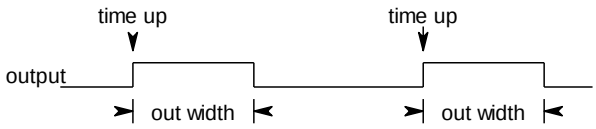
Edge start: the timer will start timing while the gate input transition from inactive to active.



In the timer output block:

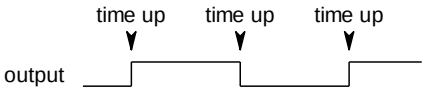
NO TOUT: the timer has no output to control (but timer time up interrupt is available).

Out_pulse: while the timer time up, it will trigger an output pulse and pulse width is controlled by out_width register at 1us time base.



Out_level: while the timer time up, it will trigger the output active.

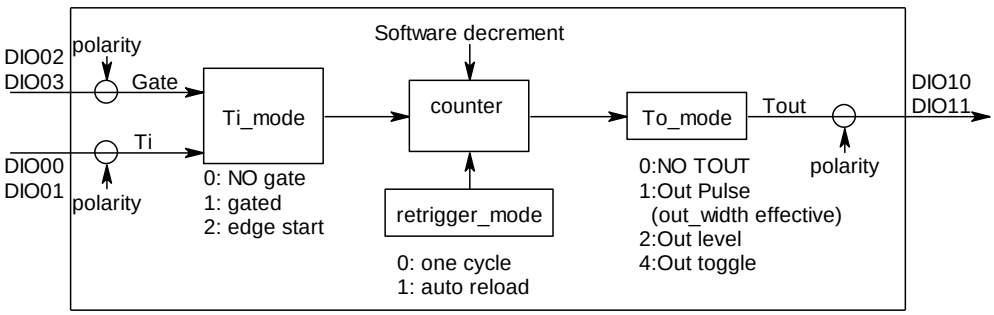
Out_toggle: while the timer time up, it will trigger the output toggled.



polarity: set the input/output active high or active low

Counter function

The counter model used in AIO3380U series is as follows:



In this model, the counter can work in one cycle mode and auto reload mode.

one cycle mode: the counter will stop when the counter cross zero.

auto reload mode (sometimes called continuous mode): the counter will reload the counter constant while time up.

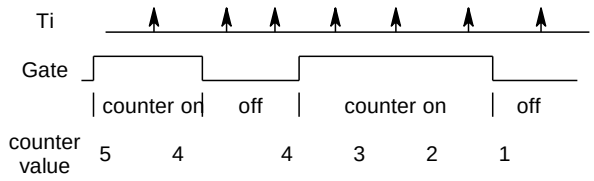
Software decrement: the counter value will decrement by software trigger.

In the counter input control block:

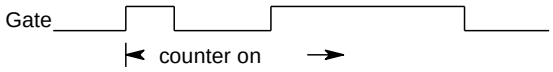
NO gate: the counter do not control by any input.

gated : while gate input is active and the counter signal input also active the counter will decrement by 1 and stops counting while gate is inactive.

Take the following diagram as example, the counter is initialized at 5 and working in gated mode, while the Ti (counter signal input) is active and gate is also active, the counter will decrease by one.



Edge start: the counter will start counting function while the gate input transition from inactive to active.



In the counter output block: (refer the timer function)

NO TOUT: the counter has no output to control (but counter cross zero interrupt is available).

Out_pulse: while the counter cross zero, it will trigger a output pulse and pulse width is controlled by out_width register at 1us time base.

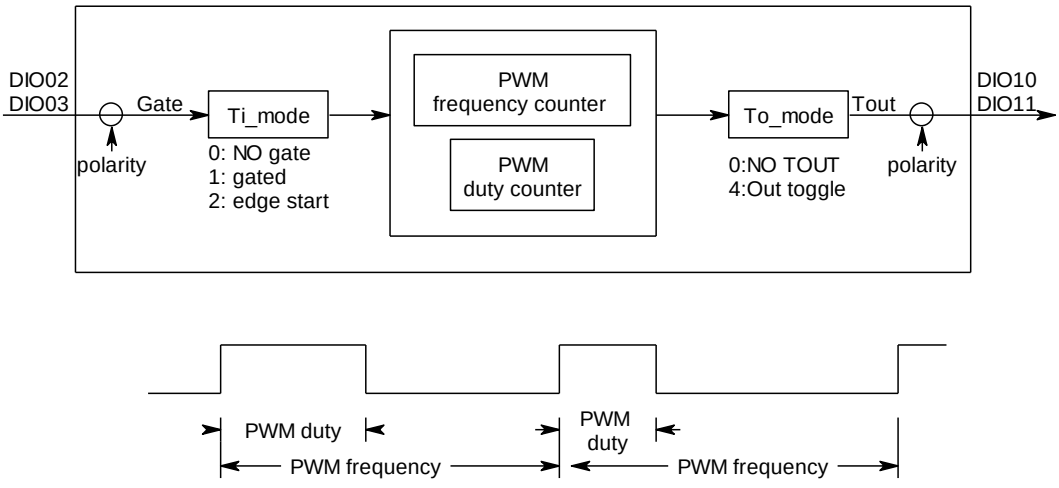
Out_level: while the counter cross zero, it will trigger the output active.

Out_toggle: while the counter cross zero, it will trigger the output toggled.

polarity: set the input/output active high or active low

PWM function

The PWM model used in AIO3380U series is as follows:



In this model, the PWM counter can only work in auto reload mode.

auto reload mode (sometimes called continuous mode): the time will reload the time constant while time up.

In the PWM counter input control block: (refer the counter function)

NO gate: the PWM counter do not control by any input.

gated : while gate input is active the PWM counter will start working and stops while gate is inactive.

Edge start: the PWM counter will start counting function while the gate input transition from inactive to active.

In the PWM counter output block: (refer the timer function)

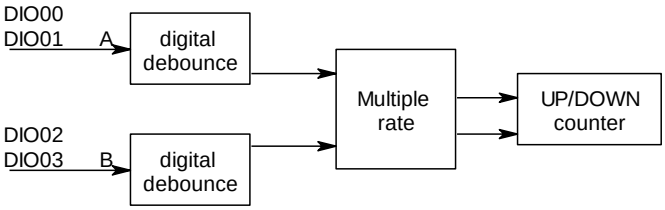
NO TOUT: the PWM counter has no output to control.

Out_toggle: while the PWM counter cross zero, it will trigger the output toggled.

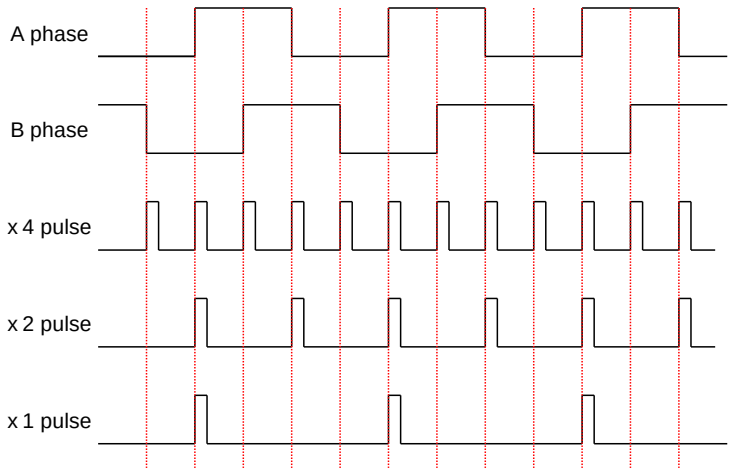
polarity: set the input/output active high or active low

quadrature encoder counter

In spite of the flexible multi-function timer/counter, the quadrature encoder counter is another type of application. The AIO3380U series also has the build in function for quadrature encoder input counting.



On the above diagram, you can see the digital debounce function filter out the unwanted high frequency then pass the signal to the multiple rate circuit to determine the pulse and direction, finally the counter counts the pulses.



The left diagram shown that A phase leads B, if we take A leads B as up count and the counting pulse of up count will depends on the multiple rate.

DLL functions of timer / counter

Timer/counter function can work in general mode: as timer, as counter or as PWM generator and in special mode: quadrature counter mode.

In the general timer/counter mode, DIO00, DIO02 and DIO10 can be configured as dedicated I/O for timer1 / counter1 and DIO01, DIO03 and DIO11 can be configured as dedicated I/O for timer2 /

counter2.

To configure the working mode use

AIO3380U_timer_set( ) to configure as timer and its output mode

AIO3380U_counter_set( ) to configure as counter and its input and output mode

AIO3380U_PWM_set( ) to configure as PWM generator.

AIO3380U_quadrature_set( ) to configure as quadrature counter.

To start/stop the operation by:

AIO3380U_TC_start( )

AIO3380U_TC_stop( )

To read or load dedicated timer/counter registers, use

AIO3380U_TC_set( ) set TC dedicated registers

AIO3380U_TC_read( ) read TC dedicated registers

If you want to change the input polarity, using

AIO3380U_TC_input_polarity_set( ) and read back to verify by:

AIO3380U_TC_input_polarity_read( )

If you want to change the output polarity, using

AIO3380U_TC_output_polarity_set( ) and read back to verify by:

AIO3380U_TC_output_polarity_read( )

- **AIO3380U_timer_set**

Format : u32 status = AIO3380U_timer_set (u8 CardID, u8 TimerID, Timer_struct *TC_struct)

Purpose: To setup timer operation mode or update timer

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY switch
TimerID	u8	0: timer/counter0 1: timer/counter1

TC_struct	struct	struct TC_struct
		{
		u8 TiGate_MODE,
		// 0: NO_GATE
		//Always count without gate function,
		//DIO02 / DIO03 is digital input.
		// 1:GATED
		//DIO02 / DIO03 is gate input,
		//after command start_TC,
		//if internal logic active high will start timer and
		//low will halt the timer counting.
		// 2: EDGE_START
		//DIO02 / DIO03 is gate input,
		//after command start_TC,
		//if internal logic active high will start timer
		
		u32 time_constant,
		// Timer constant based on 1us clock
		
		u8 Tout_mode,
		// 0: NO_TOUT ,
		// DIO10 / DIO11: use as general digital output
		// 1: OUT_PULSE
		//DIO10 / DIO11: timer cross zero output pulse.
		//(out_width effective)
		// 2: OUT_LEVEL
		//DIO10 / DIO11: timer cross zero output will //make.
		// 4:OUT_TOGGLE
		//DIO10 / DIO11: timer cross zero toggles output

		u16 Tout_width,
		// Output pulse width based on 1us clock, only
		//valid in Tout_mode is OUT_PULSE
		
		u8 cont_single,
		// 0: SINGLE_CYCLE
		//single cycle mode, timer will stop operation
		//when time constant count down to zero.
		// 1: ALWAYS_RUN
		//continuous operation mode, timer will reload
		//time constant and continue operation when
		//time constant count down to zero.
		}

- **AIO3380U_counter_set**

Format : u32 status = AIO3380U_counter_set (u8 CardID, u8 TimerID, Counter_struct *TC_struct)

Purpose: To setup counter operation mode or update counter

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY switch
TimerID	u8	0: timer/counter0 1: timer/counter1

TC_struct	struct	struct TC_struct
		{
		u8 TiGate_MODE,
		// 0: NO_GATE
		//Always count without gate function,
		//Timer/counter0, Timer/counter1:
		//DIO00, DIO01 is counter pulse input
		//DIO02, DIO03 is digital input.
		
		// 1:GATED
		//DIO00, DIO01 is counter pulse input (Ti)
		//DIO02, DIO03 is gate input, internal logic active
		//high will pass the counter Ti pulse to counter //after command start_TC
		
		// 2: EDGE_START
		//DIO00, DIO01 is counter pulse input (Ti)
		//DIO02, DIO03 is gate input, internal logic active
		//high will start topass the counter Ti pulse to //counter after command start_TC
		
		u32 counter_constant,
		// Counter constant
		
		u8 Tout_mode,
		// 0: NO_TOUT
		// Timer/counter0, Timer/counter1:
		// OUT10, OUT11 use as general digital output
		
		// 1: OUT_PULSE

		//OUT10, OUT11: timer cross zero output pulse.
		//(out_width effective)
		
		// 2: OUT_LEVEL
		//OUT10, OUT11: timer cross zero output will //make.
		// 4:OUT_TOGGLE
		//OUT10, OUT11: timer cross zero toggles output
		
		u16 Tout_width,
		// Output pulse width based on 1us clock, only
		//valid in Tout_mode is OUT_PULSE
		
		u8 cont_single
		// 0: SINGLE_CYCLE
		//single cycle mode, counter will stop operation //when time constant count down to zero.
		// 1: ALWAYS_RUN
		// continuous operation mode, counter will reload //time constant and continue operation when time //constant count down to zero.
		}

- **AIO3380U_PWM_set**

Format : u32 status = AIO3380U_PWM_set(u8 CardID, u8 TimerID, PWM_struct *PWM_struct)

Purpose: To setup PWM operation mode or update PWM.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY switch
TimerID	u8	0: timer/counter0 1: timer/counter1

PWM_struct	struct	PWM_struct
		{
		u8 TiGate_MODE,
		// 0: NO_GATE
		//Always count without gate function,
		//Timer/counter0, Timer/counter1:
		//DIO00, DIO01 is counter pulse input
		//DIO02, DIO03 is digital input.
		
		// 1:GATED
		//DIO00, DIO01 is counter pulse input (Ti)
		//DIO02, DIO03 is gate input, internal logic active
		//high will pass the counter Ti pulse to counter
		//after command start_TC
		
		u16 PWM_freq;
		// PWM frequency clock count based on 33MHz
		// clock
		
		u16 PWM_duty;
		//PWM duty clock count based on 33MHz clock
		
		//OUT10, OUT11 use as PWM output
		}

Note:

1. PWM base clock is based on33MHz, say if you want your PWM frequency is 20KHz, please put the PWM_freq = (33MHz/20KHz) = 1650
2. PWM duty must less than PWM_freq for proper operation, from the example above, the PWM_duty value can be 1 ~ 1649. For 50% duty, the PWM_duty will be 1650/2 = 825

- **AIO3380U_quadrature_set**

Format : u32 status = AIO3380U_quadrature_set (u8 CardID,u8 TimerID, u8 Multiple_rate)

Purpose: To setup quadrature counter operation mode

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY switch
TimerID	u8	0: timer/counter0 1: timer/counter1
Multiple_rate	u8	Only valid for quadrature mode, in other mode, this parameter is ignored. 0: MULTIPLE_4 (default) A,B phase input multiple rate is 4 1: MULTIPLE_2 A,B phase input multiple rate is 2 2: MULTIPLE_1 A,B phase input multiple rate is 1

- **AIO3380U_TC_start**

Format : u32 status = AIO3380U_TC_start (u8 CardID,u8 TimerID)

Purpose: To start timer/counter/PWM/quadrature counter operation mode

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY switch
TimerID	u8	0: timer/counter0 1: timer/counter1

- **AIO3380U_TC_stop**

Format : u32 status = AIO3380U_TC_stop (u8 CardID, u8 TimerID)

Purpose: To stop timer/counter/PWM/quadrature counter operation mode

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY switch
TimerID	u8	0: timer/counter0 1: timer/counter1

- **AIO3380U_TC_set**

Format : **u32 status=AIO3380U_TC_set (u8 CardID, u8 TimerID, u8 index, u32 data)**

Purpose: To set data to counter/timer register

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW
TimerID	u8	0: timer/counter0 1: timer/counter1
index	u8	0: TC_CONTROL 1: TC_MODE 2: TiGate_MODE 3: To_MODE 4: RETRIGGER_MODE 5: PRELOAD 6: COUNTER 7:OUT_WIDTH 8: MULTIPLE_RATE
data	u32	register data to be set

Note:

1. please refer the next segment “Note: Meaning of setting or return value of different index”
2. Write to IRQ_STATUS will reset the corresponding bit. Say, if write with bit0=1, the status bit0 will reset but other bit will not effect.

- **AIO3380U_TC_read**

Format : **u32 status=AIO3380U_TC_read (u8 CardID, u8 TimerID, u8 index,u32 *data)**

Purpose: To read data from counter/timer

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW
TimerID	u8	0: timer/counter0 1: timer/counter1
index	u8	0: TC_CONTROL 1: TC_MODE 2: TiGate_MODE 3: Tout_MODE 4: RETRIGGER_MODE 5: PRELOAD 6: COUNTER 7:OUT_WIDTH 8: MULTIPLE_RATE

Output:

Name	Type	Description
data	u32	Data read back

Note: Meaning of setting or return value of different index

index	register	value	meaning
0	TC_CONTROL	0	STOP, stop operation of TC
		1	START, start operation of TC
1	TC_MODE	0	TIMER_MODE
		1	COUNTER_MODE
		3	SW_DEC (a write will software decrease counter by 1 and return to COUNTER_MODE.)
		4	PWM_MODE
		8	QUADRATURE_MODE
2	TiGate_MODE	0	NO_GATE
		1	GATED
		2	EDGE_START
3	Tout_MODE	0	NO_TOUT
		1	OUT_PULSE
		2	OUT_LEVEL
		4	OUT_TOGGLE
4	RETRIGGER_MODE	0	SINGLE_CYCLE
		1	ALWAYS_RUN
5	PRELOAD	1~0xffffffff	Counter or timer or PWM preload value
6	COUNTER	1~0xffffffff	Set (write): will write preload and counter Read : will read counter on the fly
7	OUT_WIDTH	1~0xffff	Output pulse width based on 1us
8	MULTIPLE_RATE	0	0: MULTIPLE_4 (default) A,B phase input multiple rate is 4
		1	1: MULTIPLE_2 A,B phase input multiple rate is 2
		2	2: MULTIPLE_1 A,B phase input multiple rate is 1

- **AIO3380U_TC_input_polarity_set**

Format : **u32 status = AIO3380U_TC_input_polarity_set (u8 CardID,u8 TimerID, u8 input,u8 polarity)**

Purpose: Set TC input polarity.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW
TimerID	u8	timer/counter designation 0: timer/counter0 1: timer/counter1
input	u8	input: 0: Gate. 1: Ti (clock input).
polarity	u8	polarity values: 0: means normal. 1: means invert.

Note: timer/counter0, Port 0,bit 0 clock input , bit 2 gate input.
timer/counter1, Port 0,bit 1 clock input , bit 3 gate input.

- **AIO3380U_TC_input_polarity_read**

Format : **u32 status = AIO3380U_TC_input_polarity_read (u8 CardID,u8 TimerID, u8 input,u8 *polarity)**

Purpose: Read TC input polarity.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW
TimerID	u8	timer/counter designation 0: timer/counter0 1: timer/counter1
input	u8	input: 0: Gate. 1: Ti (clock input).

Output:

Name	Type	Description
polarity	u8	polarity values: 0: means normal. 1: means invert.

- **AIO3380U_TC_output_polarity_set**

Format : **u32 status = AIO3380U_TC_output_polarity_set (u8 CardID,u8 TimerID, u8 polarity)**

Purpose: Set TC output polarity

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW
TimerID	u8	timer/counter designation 0: timer/counter0 1: timer/counter1
polarity	u8	TC output polarity: 0: means normal 1: means invert

Note:

timer/counter0, Port 1,bit 0 Signal output.

timer/counter1, Port 1,bit 1 Signal output.

- **AIO3380U_TC_output_polarity_read**

Format : **u32 status = AIO3380U_TC_output_polarity_read (u8 CardID,u8 TimerID, u8 * polarity)**

Purpose: Read TC output polarity

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW
TimerID	u8	timer/counter designation 0: timer/counter0 1: timer/counter1

Output:

Name	Type	Description
polarity	u8	TC output polarity: 0: means normal 1: means invert

8.6 Interrupt function

Interrupt is a efficient method to quick response without occupy too much system resource.

AIO3380U provide timer/counter and TTL port0 as interrupt source, to use interrupt function use

AIO3380U_IRQ_link_process( ) to link your irq service routine,

AIO3380U_IRQ_enable ( ) to enable it and

AIO3380U_IRQ_disable ( ) to disable it.

AIO3380U_IRQ_mask_set() to mask off the undesired source;

AIO3380U_IRQ_mask_read( ) to read back for verify the mask setting

AIO3380U_IRQ_IO_polarity_set( ) to set the polarity of port0 IRQ generation.

AIO3380U_IRQ_IO_polarity_read( ) to read back for verifying.

After you enable and link interrupt, you can enable/disable timer/counter function or enable/disable interrupt function as you need.

To check the irq status

AIO3380U _IRQ_status_read ( ) will do.

- **AIO3380U_IRQ_link_process**

Format : u32 status = AIO3380U_IRQ_link_process(u8 CardID,
void (__stdcall *callbackAddr(u8 CardID))

Purpose: To link the interrupt source with the callback function.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW
callbackAddr	void	the address of your callback function

- **AIO3380U_IRQ_enable**

Format : u32 status = AIO3380U_IRQ_enable (u8 CardID,HANDLE *phEvent)

Purpose: Enable interrupt.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW

Output:

Name	Type	Description
phEvent	HANDLE	The returned handle of event

- **AIO3380U_IRQ_disable**

Format : u32 status = AIO3380U_IRQ_disable (u8 CardID)

Purpose: To disable interrupt.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW

- **AIO3380U_IRQ_mask_set**

Format : u32 status = AIO3380U_IRQ_mask_set(u8 CardID,u16 mask)

Purpose: Set IRQ mask.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW
mask	u16	b0: 0, disable DIO00 as interrupt source 1, enable DIO00 as interrupt source … b6: 0, disable DIO06 as interrupt source 1, enable DIO06 as interrupt source b7: 0, disable DIO07 as interrupt source 1, enable DIO07 as interrupt source b8: 0, disable TC0 counter counts to zero as interrupt source 1, enable TC0 counter counts to zero as interrupt source b9: 0, disable TC1 counter counts to zero as interrupt source 1, enable TC1 counter counts to zero as interrupt source

- **AIO3380U_IRQ_mask_read**

Format : **u32 status = AIO3380U_IRQ_mask_read(u8 CardID,u16 *mask)**

Purpose: Read IRQ mask.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW

Output:

Name	Type	Description
mask	u16	b0: 0, disable DIO00 as interrupt source 1, enable DIO00 as interrupt source … b6: 0, disable DIO06 as interrupt source 1, enable DIO06 as interrupt source b7: 0, disable DIO07 as interrupt source 1, enable DIO07 as interrupt source b8: 0, disable TC0 counter counts to zero as interrupt source 1, enable TC0 counter counts to zero as interrupt source b9: 0, disable TC1 counter counts to zero as interrupt source 1, enable TC1 counter counts to zero as interrupt source

- **AIO3380U_IRQ_IO_polarity_set**

Format : u32 status =AIO3380U_IRQ_IO_polarity_set (u8 CardID, u8 polarity)

Purpose: Sets the I/O polarity of TTL port0

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by Rotary SW
polarity	u8	port0 polarity values: 0: any bit of port0 form low to high (default) can generate IRQ 1: any bit of port0 from high to low can generate IRQ

- **AIO3380U_IRQ_IO_polarity_read**

Format : u32 status = AIO3380U_IRQ_IO_polarity_read (u8 CardID, u8 * polarity)

Purpose: Read the I/O IRQ polarity of the TTL port0.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by Rotary SW

Output:

Name	Type	Description
polarity	u8	port0 polarity values: 0: any bit of port0 form low to high(default) can generate IRQ 1: any bit of port0 from high to low can generate IRQ

- **AIO3380U_IRQ_status_read**

Format : **u32 status = AIO3380U_IRQ_status_read(u8 CardID,u16 * status)**

Purpose: To read IRQ state

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW

Output:

Name	Type	Description
status	u16	Bit 0: DIO00 generate IRQ. … Bit 7: DIO07 generate IRQ. Bit 8: timer/counter0 generate IRQ. Bit 9: timer/counter1 generate IRQ.

Note: This command will also clear the on board IRQ_status register, the second read will not be correct.

8.7 Security function

From the dll version 2.0 and later, we remove the software key function owing to some customers complained about the card locked on some unknown occasion. We only remain the functions to comply with the existing programs but the returned value always true.

Since AIO3380U is a general purpose card, anyone who can buy from JS automation corp. or her distributors. Your program is the fruit of your intelligence, un-authorized copy maybe prevent by the security function enabled.

You can use

AIO3380U_password_set( ) to set password and start the security function. Use

AIO3380U_password_change( ) to change it.

If you don't want to use security function after the password being setup,

AIO3380U_password_clear( ) will reset to the virgin state.

Once the password is set, any function call of the dll's (except for the security functions) will be blocked until the

AIO3380U_security_unlock( ) unlock the security.

You can also use

AIO3380U_security_status_read( ) to check the current status of security.

- **AIO3380U_password_set**

Format : **u32 status = AIO3380U_password_set(u8 CardID,u16 password[5])**

Purpose: To set password and if the password is not all "0", security function will be enabled.

Note: If the password is all "0", the security function is disabled.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW
password[5]	u16	Password, 5 words

- **AIO3380U_password_change**

Format : **u32 status = AIO3380U_password_change(u8 CardID,u16 Oldpassword[5], u16 password[5])**

Purpose: To replace old password with new password.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW
Oldpassword [5]	u16	The previous password
password[5]	u16	The new password to be set

- **AIO3380U_password_clear**

Format : **u32 status = AIO3380U_password_clear(u8 CardID,u16 password[5])**

Purpose: To clear password, to set password to all "0", i.e. disable security function.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW
password[5]	u16	The password previous set

- **AIO3380U_security_unlock**

Format : **u32 status = AIO3380U_security_unlock(u8 CardID,u16 password[5])**

Purpose: To unlock security function and enable the further operation of this card

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW
password[5]	u16	The password previous set

- **AIO3380U_security_status_read**

Format : **u32 status = AIO3380U_security_status_read(u8 CardID,u8 *lock_status, u8 *security_enable)**

Purpose: To read security status for checking if the card security function is unlocked.

Parameters:

Input:

Name	Type	Description
CardID	u8	assigned by DIP/ROTARY SW

Output:

Name	Type	Description
lock_status	u8	0: security unlocked 1: locked 2: dead lock (must return to original maker to unlock)
security_enable	u8	0: security function disabled 1: security function enabled

8.8 Error conditions

These error types may indicate an internal hardware problem on the board. Error Codes summary contains a detailed listing of the error status returned by AIO3380U functions.

9. Dll list

	Function Name	Description
1.	AIO3380U_initial( )	Card initial.
2.	AIO3380U_initial_calibration( )	AD calibration initial.
3.	AIO3380U_close( )	Card Close.
4.	AIO3380U_info( )	Read Card Address.
5.	AIO3380U_AD_config_set( )	Set AD config.
6.	AIO3380U_AD_config_read( )	Read AD config.
7.	AIO3380U_AD_value_read( )	Read AD calibration value.
8.	AIO3380U_AD_value_read_no_calibration( )	Read AD value.
9.	AIO3380U_AD_data_read_no_calibration( )	Read AD data.
10.	AIO3380U_AD_integral_start( )	start AD conversion with integral constant
11.	AIO3380U_AD_integral_all_read( )	read integral result of AD conversion data.
12.	AIO3380U_AD_integral_stop( )	stop AD integral conversion
13.	AIO3380U_DA_set( )	DA output
14.	AIO3380U_DA_read( )	read back DA data
15.	AIO3380U_DA_Arbitrary_Waveform_data _set( )	Set DA arbitrary waveform data and configuration
16.	AIO3380U_DA_Arbitrary_Waveform_data _read( )	Read DA arbitrary waveform data and configuration
17.	AIO3380U_DA_Arbitrary_Waveform_Start( )	DA arbitrary waveform output starts
18.	AIO3380U_DA_Arbitrary_Waveform_Stop( )	DA arbitrary waveform output stop
19.	AIO3380U_TTL_IO_config_set( )	Set port config (input or output)
20.	AIO3380U_TTL_IO_config_read( )	Read port config (input or output)
21.	AIO3380U_TTL_IO_port_set( )	Write data to port
22.	AIO3380U_TTL_IO_port_read( )	Read port data
23.	AIO3380U_TTL_IO_point_set( )	Write bit of data to port
24.	AIO3380U_TTL_IO_point_read( )	Read data of a specific point
25.	AIO3380U_TTL_IO_debounce_time_set( )	Write Ti point debounce time.
26.	AIO3380U_TTL_IO_debounce_time_read( )	Read debounce time.
27.	AIO3380U_timer_set( )	setup timer operation mode or update timer
28.	AIO3380U_counter_set( )	setup counter operation mode or update counter
29.	AIO3380U_PWM_set( )	setup PWM operation mode or update PWM
30.	AIO3380U_quadrature_set( )	setup quadrature counter operation mode
31.	AIO3380U_TC_start( )	start timer/counter/PWM/quadrature counter operation mode
32.	AIO3380U_TC_stop( )	stop timer/counter/PWM/quadrature counter

		operation mode
33.	AIO3380U_TC_set( )	set data to counter/timer register
34.	AIO3380U_TC_read( )	read data from counter/timer register
35.	AIO3380U_TC_input_polarity_set( )	Set TC input polarity
36.	AIO3380U_TC_input_polarity_read( )	Read back TC input polarity setting
37.	AIO3380U_TC_output_polarity_set( )	Set TC output polarity
38.	AIO3380U_TC_output_polarity_read( )	Read back TC output polarity setting
39.	AIO3380U_IRQ_link_process( )	Link process IRQ.
40.	AIO3380U_IRQ_enable( )	Enable IRQ.
41.	AIO3380U_IRQ_disable ( )	Disable IRQ.
42.	AIO3380U_IRQ_mask_set( )	Set mask.
43.	AIO3380U_IRQ_mask_read( )	Read mask.
44.	AIO3380U_IRQ_IO_polarity_set( )	Set IO polarity.
45.	AIO3380U_IRQ_IO_polarity_read( )	Read IO polarity.
46.	AIO3380U_IRQ_status_read ( )	Read IRQ status.
47.	AIO3380U_password_set( )	Set password
48.	AIO3380U_password_change( )	Change password
49.	AIO3380U_password_clear( )	Clear password
50.	AIO3380U_security_unlock( )	Unlock security function
51.	AIO3380U_security_status_read( )	Read security status

10. AIO3380U Error codes summary

10.1 AIO3380U Error codes table

Error Code	Symbolic Name	Description
0	JSDRV_NO_ERROR	Success, No error.
2	JSDRV_INIT_ERROR	Driver initial error
3	JSDRV_UNLOCK_ERROR	Security unclock failure
4	JSDRV_LOCK_COUNTER_ERROR	Dead lock, unclock failure more than 10 times
5	SDRV_SET_SECURITY_ERROR	Password overwrite error
100	DEVICE_RW_ERROR	Device Read/Write error
101	JSDRV_NO_CARD	No AIO3380U card on the system.
102	JSDRV_DUPLICATE_ID	AIO3380U CardID duplicate error.
104	JSDRV_PAR_ERROR	Bad parameter or illegal parameter
300	JSDIO_ID_ERROR	Function input parameter error. CardID setting error, CardID doesn't match the DIP/ROTARY SW setting
301	JSAIO_MODE_ERROR	Mode parameter error. Parameter out of range.
302	JSAIO_CHANNEL_ERROR	Channel parameter error. Parameter out of range.
305	JSAIO_CONVERSION_ERROR	Conversion time over. Maybe no hardware or bad hardware.
306	JSAIO_CONVERSION_BUSY	A/D is busy in conversion
400	JSAIO_PORT_ERROR	Port parameter error. Parameter out of range.
401	JSAIO_STATE_ERROR	State parameter error. Parameter out of range.
402	JSAIO_POINT_ERROR	Point parameter error. Parameter out of range.
403	JSAIO_EEPROM_RW_ERROR	Eeprom R/W error
405	JSAIO_CALIBRATION_ERROR	Calibration error. Maybe out of range.
406	JSAIO_TIMERID_ERROR	TimerID parameter error. Parameter out of range.
407	JSAIO_TO_MODE_ERROR	To_mode parameter error. Parameter out of range.
408	JSAIO_TI_MODE_ERROR	Ti_mode parameter error. Parameter out of range.
409	JSAIO_PARAMETER_ERROR	Parameter error.

		Parameter out of range.
500	JSAIO_EVENT_ERROR	Event error. Maybe no event created.