PowerDAQ Programmer Manual

PowerDAQ PD2–MF(S), AO and DIO PCI DAQ boards
Windows 9x/NT/2000, Linux, RTLinux, RTAI and QNX

High-Performance oards for PCI Bus Computers

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Contacting Omega Engineering

✉ Address:

OMEGA Engineering, Inc.

One Omega Drive

Stamford, Connecticut 06907-0047

U.S.A.

☎ Support:

Telephone:	1-800-622-2378
Fax:	1-800-848-4271

💻Internet Access:

Support	support@omega.com
Web site	http://www.omega.com
FTP site	ftp://ftp.omega.com

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PowerDAQ API Overview

PowerDAQ API Overview

General considerations and API structure

Variables naming convention

Error values

PowerDAQ Win32 and Linux APIs functions return error codes on failure.

Win32: if function fails it returns FALSE (0) as a return value and error code (from WinError.h) in pdwError. See WinError.h for details. If you have MS SDK installed you could find WinError.h in C:\MSSDK\include\. If you have Visual Studio installed you can find WinError.h in C:\Program Files\Microsoft Visual Studio\VC98\Include\.

Linux: if function succeeds it returns a zero (sometimes positive) value. If function fails it returns negative value. You can find the meaning of these values by looking into /linux/include/errno.h.

Writing user applications for Microsoft Windows 9x, NT and 2000

The PowerDAQ SDK CD installs the driver and DLLs for Windows 9x, NT and 2000 OSes. These files are crucial to operate any PowerDAQ board:

The following driver/DLL files are installed:

Windows 9x operating System:
Location: \windows\system directory
pwrdaq95.vxd device driver
PwrDAQ32.dll 32-bit DLL
PwrDAQ16.dll 16-bit DLL

Windows NT operating system:
Location: \winnt\system32\drivers
pwrdaq.sys device driver

Location: \winnt\system32
PwrDAQ32.dll 32-bit DLL
Windows 2000 operating system:
Location: \winnt\system32\drivers
pwrdaq2k.sys device driver
Location: \winnt\system32
PwrDAQ32.dll 32-bit DLL

PowerDAQ Libraries

PowerDAQ SDK contains libraries for all major software development tools.

They are located in the /lib directory. The following libraries are supplied for Win32/Win16 platforms:

```
pwrdaq32.lib       - MSVC/MSVS v.5.x, 6.x
pd32bb.lib         - Borland C++ Builder v.3.0 - 5.0
pd16bb.lib         - 16-bit Borland compilers
pd16bc45.lib       - 16-bit Borland C++ 4.5x
pwrdaq16.lib       - 16-bit MSVC 1.5x
```

PowerDAQ Include Files

```
/include
pdfw_def.h       - firmware constant definition file for C/C++
pdfw_def.pas     - firmware constant definition file for
                   Borland Delphi
pdfw_def.bas     - firmware constant definition file for
                   Visual Basic
pwrdaq.h         - driver constants and definitions file for
                   C/C++
pwrdaq.pas       - driver constants and definitions file for
                   Borland Delphi
pwrdaq.bas       - driver constants and definitions file for
                   Visual Basic
pwrdaq32.h       - API function prototypes and structures file
                   for C
pwrdaq32.hpp     - API function prototypes and structures file
                   for C++
pwrdaq32.pas     - API function prototypes and structures file
                   for Borland Delphi
pwrdaq32.bas     - API function prototypes and structures file
                   for Visual Basic
pd_hcaps.h       - boards capabilities definition file for
                   C/C++
pd_hcaps.pas     - boards capabilities definition
                   file for Borland Delphi
pd_hcaps.bas     - boards capabilities definition file for
                   Visual Basic
```

```
vbdll.bas        - auxiliary functions to access PowerDAQ
                   buffer from within VB
Aliases.bas      - auxiliary functions to access PowerDAQ
                   structures from within VB
PdApi.bas        - module used in SimpleTest VB example

/include/vb3
pwrdaq16.bas     - API function prototypes and
                   structures file for Visual Basic v.3.0
pdfw_def.bas     - firmware constant definition file for Visual
                   Basic v.3.0
pd_hcaps.bas     - boards capabilities definition file for
                   Visual Basic v.3.0
daqdefs.bas      - event word definition for Visual Basic v.3.0

/include/16-bit
pwrdaq16.h       - API function prototypes and structures file
                   for 16-bit C/C++
pwrdaq.h         - driver constants and definitions
                   file for 16-bit C/C++
pdd_vb3.h        - auxiliary functions to access PowerDAQ
                   structures from within VB v.3.0
pd_hcaps.h       - boards capabilities definition
                   file for 16-bit C/C++
```

Writing user applications for Linux and Realtime Linux

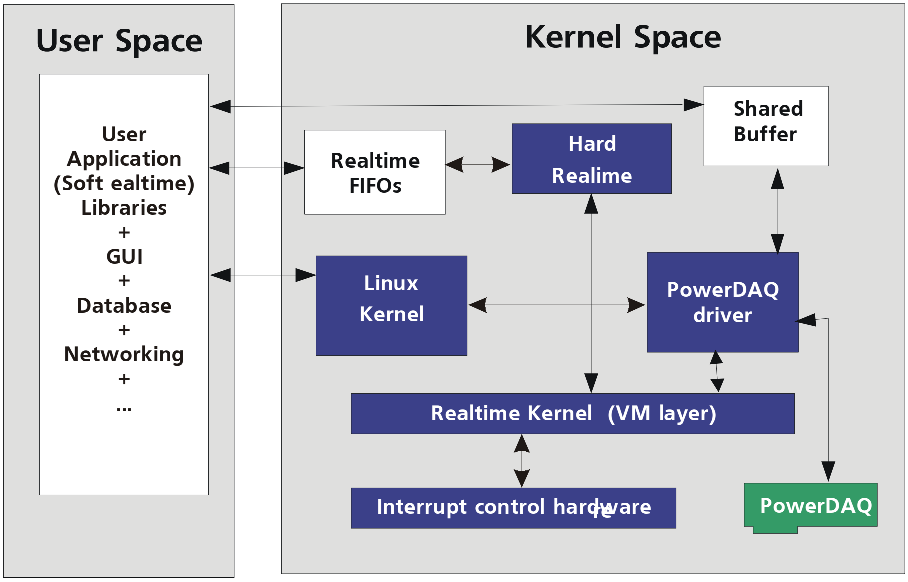
The same driver – pwrdaq.o can be used for both realtime and non-realtime applications.

There are five ways to access the driver:

1. From the user space link your program with powerdaq32.lib
2. From the user space link your program dynamically with the library (install powerdaq32.o as a shared library)
3. From the user space use simple "read" and "write" commands (you can access only basic read/write for analog and digital subsystems this way).
4. Link your realtime module with powerdaq32.o. (_PD_RTL symbol should be defined). Every function call to the PowerDAQ API will be translated into posixio() style calls to the ioctl() entry point of the driver.
5. Call exported functions of the pwrdaq.o module directly. It's the fastest way to call the driver functions however no ownership and race condition checking occurs.

Please refer to README file supplied with the PowerDAQ for Linux tarball.

Typical Realtime Linux spplication architecture is presented on the following picture:



It includes two parts: realtime task that serves realtime processing and a user application part. Realtime tasks communicate with the user application via Realtime FIFOs and shared buffers.

Following breakdown structure outlines Realtime Linux application design:

Functions to Place in Non-Realtime Section

- Boot OS/load modules
- Allocate memory
- Communication with user (User Interface)
- Use of OS services (database, networking, file system)
- Communication with realtime task through realtime FIFOs
- Hardware initialization and reset

Functions to Place in Realtime Section

- Process interrupts
- Get/put data from/to device
- Calculate response (FPU is available)
- Put/get data into/from realtime FIFOs
- Schedule other realtime tasks (periodic and non-periodic)

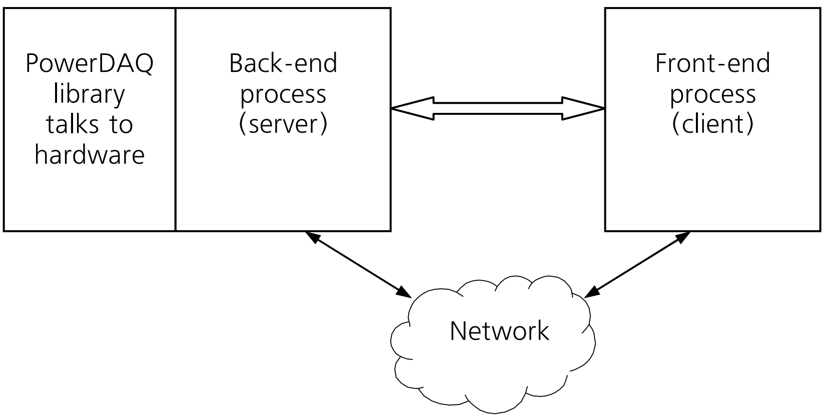
Writing user applications for QNX

PowerDAQ for QNX support includes the following files:

```
pd2_dao.c         - function library for PD2-DIO and PD2-AO
boards
pdfw_def.h        - firmware constant definition
pdfw_if.h         - driver interface definition
pdfw_lib.lib      - library to link with application
pdfw_lib.o        - function library object file
pdfwmain_i.h      - firmware hex file (downloads automatically)
pd-int.h          - PowerDAQ QNX driver definitions (pd_board[]
                    structure and substructures)
powerdaq.h        - PowerDAQ QNX driver definitions to include
                    into the library and applications
win2qnx.h         - Windows DDK types conversion
                    into QNX types
pd.c              - startup code example
pd_ain.c          - software-clocked analog input example
pd_aio.c          - hardware-paced analog input/output control
                    loop
```

Implemting a QNX driver is different than Windows or Linux drivers. QNX allows applicationa with root privileges to access the PCI bus addresses and resources (including interrupts) directly. This is why the driver does not contain read()/write()/ioctl() routines.

The PowerDAQ for QNX driver is implemented as a library to link with user back-end applications (server).



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General Functions

General Functions

Start talking to the board

This group includes functions to open driver, adapter, get number of adapters installed, acquire/release subsystem and close driver and adapter.

Win32	**Linux**			
Function name	Open Driver			
Function	Opens driver and connects user application to it.			
Returns	TRUE (1) if success, FALSE (0) is failure			
Syntax:				
Win32 API	BOOL PdDriverOpen(PHANDLE phDriver, PDWORD pError, PDWORD pNumAdapters);			
Win16 API	use _PdAdapterOpen() instead (see below)			
Linux API	use _PdAcquireSubsystem() instead (see below)			
RTLinux API	driver is always open upon RT module starts (see below)			
QNX API	use pd_find_devices() (see below)			

Input parameters: None
Output parameters:
PHANDLE phDriver – handle to pwrdaq.sys driver
PDWORD pError – error code on failure
PDWORD pNumAdapters – number of PowerDAQ adapters found in your system

Function is to be called first in the application.

Win32	**Win16**			
Function name	Close Driver			
Function	Closes driver and disconnects user application from it.			
Returns	TRUE (1) if success, FALSE (0) is failure			
Syntax:				
Win32 API	BOOL PdDriverClose(HANDLE hDriver, PDWORD pError);			
Win16 API	use _PdAdapterClose() instead (see below)			
Linux API	use _PdAcquireSubsystem() instead (see below)			
RTLinux API	driver closes automatically on rmmod			
QNX API	use pd_clean_devices (see below)			

Input parameters:
HANDLE hDriver – handle received upon PdDriverOpen() successful call
Output parameters:
PDWORD pError – error code on failure

This is the last function is to be called in the application.

Win32	**Win16**			
Function name	Open Adapter			
Function	Initializes the specified PowerDAQ board and returns a handle to it.			
Returns	TRUE (1) if success, FALSE (0) is failure			
Syntax:				
Win32 API	BOOL _PdAdapterOpen(DWORD dwAdapter, PDWORD pError, PHANDLE phAdapter);			
Win16 API	BOOL _PdAdapterOpen(HWND hWnd, DWORD dwAdapter, LPDWORD lpError, LPHANDLE lphAdapter);			
Linux API	use _PdAcquireSubsystem() instead (see below)			
RTLinux API	adapter is always open upon RT module starts (see below)			
QNX API	use pd_find_devices() (see below)			

Win32:
Input parameters:
DWORD dwAdapter – number of adapter to open [0..31]
Output parameters:
PHANDLE phAdapter – handle to adapter
PDWORD pError – error code on failure

Win16:
Input parameters:
HWND hWnd – handle to the main window of 16-bit application that process messages
DWORD dwAdapter – number of adapter to open [0..31]
Output parameters:
LPHANDLE lphAdapter – handle to adapter
LPDWORD lpError – error code on failure

Call this function after driver is open but before acquiring any subsystem.

Win32	**Win16**			
Function name	Close Adapter			
Function	Deinitializes the specified PowerDAQ board.			
Returns	TRUE (1) if success, FALSE (0) is failure			
Syntax:				
Win32 API	BOOL _PdAdapterClose(HANDLE hAdapter, PDWORD pError);			
Win16 API	BOOL _PdAdapterClose(HANDLE hAdapter, PDWORD pError);			
Linux API	use _PdAcquireSubsystem() instead (see below)			
RTLinux API	driver closes automatically on rmmod			
QNX API	use pd_clean_devices() (see below)			

Input parameters:
HANDLE hAdapter – handle to adapter received from _PdAdapterOpen
Output parameters:
PDWORD pError – error code on failure

Win32	**Win16**	**Linux**		
Function name	Get Driver Version			
Function	Returns SDK number			
Returns	TRUE (1) if success, FALSE (0) is failure			
Syntax:				
Win32 API	BOOL PdGetVersion(HANDLE hDriver, PDWORD pError, PPWRDAQ_VERSION pVersion);			
Win16 API	BOOL PdGetVersion(LPDWORD lpError, LPPWRDAQ_VERSION lpVersion);			
Linux API	int PdGetVersion(PPWRDAQ_VERSION pVersion)			
RTLinux API	access pd_board structure directly			
QNX API	access pd_board structure directly			

Win32:
Input parameters:
HANDLE hDriver – number of adapter to open [0..31]
Output parameters:
PPWRDAQ_VERSION pVersion – version information structure
PDWORD pError – error code on failure

Win16:
Output parameters:
LPPWRDAQ_VERSION lpVersion – version information structure
LPDWORD lpError – error code on failure

PWRDAQ_VERSION (for Win32 API defined in pwrdaq32.h):

```
//
// Driver version and timestamp, along with some system facts
//
typedef struct _PWRDAQ_VERSION
{
    DWORD   SystemSize;
    BOOL    NtServerSystem;
    ULONG   NumberProcessors;
    DWORD   MajorVersion;
    DWORD   MinorVersion;
    char    BuildType;
    char    BuildTimeStamp[40];
} PWRDAQ_VERSION, * PPWRDAQ_VERSION;
```

Win32	**Win16**	**Linux**		
Function name	Get PCI Configuration			
Function	Returns data from board's PCI configuration space			
Returns	TRUE (1) if success, FALSE (0) is failure			
Syntax:				
Win32 API	BOOL PdGetPciConfiguration(HANDLE hAdapter, PDWORD pError, PPWRDAQ_PCI_CONFIG pPciConfig);			
Win16 API	BOOL PdGetPciConfiguration(HANDLE hAdapter, LPDWORD lpError, LPPWRDAQ_PCI_CONFIG lpPciConfig);			
Linux API	int PdGetPciConfiguration(int handle, PPWRDAQ_PCI_CONFIG pPciConfig)			
RTLinux API	access pd_board structure directly			
QNX API	access pd_board structure directly			

Win32/Win16:
Input parameters:
HANDLE hAdapter – handle to adapter
Output parameters:
PPWRDAQ_PCI_CONGIG – structure holds PCI configuration space information
PDWORD pError – error code on failure

Linux
Input parameters:
int handle – subsystem handle (open BoardLevel subsystem)
Output parameters:

PPWRDAQ_PCI_CONGIG – structure holds PCI configuration space information
Function returns 0 on success or negative error code

Win16	**Linux**			
Function name	Get Number of Adapters			
Function	Returns number of adapters installed in system			
Returns	TRUE (1) if success, FALSE (0) is failure			
Syntax:				
Win32 API	use PdDriverOpen() to get number of adapters installed			
Win16 API	BOOL PdGetNumberOfAdapters(LPDWORD lpError, LPDWORD lpNumAdapters);			
Linux API	int PdGetNumberAdapters(void);			
RTLinux API	use extern int num_pd_boards			
QNX API	use int pd_find_devices()			

Win16:
Input parameters: None
Output parameters:
PDWORD pError – error code on failure
PDWORD lpNumAdapters – number of adapters installed

Linux:
Input parameters: None
Returns: number of adapters installed, 0 if no adapters were found, negative on error

Win32	**Win16**	**Linux**		
Function name	Acquire Subsystem			
Function	Get/Release subsystem to/from use			
Returns	TRUE (1) if success, FALSE (0) is failure			
Syntax:				
Win32 API	BOOL PdAdapterAcquireSubsystem(HANDLE hAdapter, DWORD *pError, DWORD dwSubsystem, DWORD dwAcquire);			
Win16 API	BOOL PdAdapterAcquireSubsystem(HANDLE hAdapter, LPDWORD lpError, DWORD dwSubsystem, DWORD dwAcquire);			
Linux API	int PdAcquireSubsystem(int board, int dwSubsystem, int Action);			
RTLinux API	N/A			
QNX API	N/A			

Win32/Win16:
Input parameters:
HANDLE hAdapter – handle to open adapter
DWORD dwSubsystem – subsystem to acquire.
DWORD dwAcuqire – 1 to acquire subsystem, 0 to release it.

Output parameters:
PDWORD pError – error code on failure

Linux:
Input parameters:
int board – board number [0..3]. Call PdGetNumberAdapters() for number of PowerDAQ boards installed
int dwSubsystem – subsystem to acquire
int Action – 1 to acquire subsystem, 0 to release it

Returns: 0 on success, negative error number on failure

dwSubsystem can be one of the follows (as defined in typedef enum _PD_SUBSYSTEM):
{BoardLevel, AnalogIn, AnalogOut, DigitalIn, DigitalOut, CounterTimer, CalDiag}

QNX				
Function name	Get boards in use			
Function	Find and get installed board(s) in use			
Returns	Number of boards found, negative on error			
Syntax:				
QNX API	int pd_find_devices()			

Call this function first in your application.
It perfoms the following:
finds PowerDAQ adapters on the PCI bus
map PCI memory
fill pd_board structure with information about addresses, interrupt line, etc.
download firmware
download calibration values

QNX driver doesn't have special functions to access pd_board structure. It's assumed that user application accesses it directly. Please refer to pd-int.h for pd_board structure.
The most important fields are the follows:

```
typedef struct
{
   struct pci_dev *dev;    // pointer to PCI device structure
   void *address;          // effective address of
// board's memory region
   u32 size;               // size of the region
   int irq;                // interrlupt line
[...]
   u16 caps_idx;           // board type index in pd_hcaps.h
[...]
   PD_EEPROM Eeprom;       // working copy of on-board EEPROM
   PD_PCI_CONFIG PCI_Config;      // working copy of board's
// PCI config space
[...]
} pd_board_t;
```

Note: pd_board[0] contains information about the first PowerDAQ board found. The library supports a maximum of 4 boards. If you need to use more boards in one system you need to increase the value of PD_MAX_BOARDS (defined in pd-int.h).

QNX				
Function name	Get boards in use			
Function	Find and get installed board(s) in use			
Returns	0 on success, negative on error			
Syntax:				
QNX API	int pd_clean_devices()			

Call this function last in your application.
It shuts down all the boards.

Adapter capabilities information functions

Adapter capabilities functions provide information about adapters installed and parameters of their subsystems.

Win32				
Function name	Get Adapter Information			
Function	Get pointer to the structure contains adapter capabilities			
Returns	TRUE (1) if success, FALSE (0) is failure			
Syntax:				
Win32 API	BOOL _PdGetAdapterInfo(DWORD dwBoardNum, DWORD* dwError, PAdapter_Info Adp_Info);			

Input parameters:
DWORD dwBoardNum – Board number [0..N]
Output parameters:
DWORD* dwError – error code
PAdapter_Info Adp_Info - pointer to the structure to store data (allocated by application)

PAdapter_Info is a structure contains basic board and subsystem information. Each subsystem has it's own entry of SubSys_Info type.

```
typedef struct ADAPTER_Info_STRUCT
{
DWORD          dwBoardID;         // board ID
DWORD          atType;            // Adapter type
char           lpBoardName[20];   // Name of the specified
                                  // board
char           lpSerialNum[20];  // Serial Number
SubSys_Info    SSI[MAXSS];        // Subsystem description
array
```

```
} Adapter_Info, *PAdapter_Info;
```

Using atType it's ease to find board type. atType is defined as follows:

```
#define    atPD2MF   (1 << 0)
#define    atPD2MFS  (1 << 1)
#define    atPDMF    (1 << 2)
#define    atPDMFS   (1 << 3)
#define    atPD2AO   (1 << 4)
#define    atPD2DIO  (1 << 5)
#define    atMF      (atPD2MF | atPD2MFS | atPDMF | atPDMFS )
```

The following structure is identical for each subsystem and defines it's parameters.

```
typedef struct SUBSYS_Info_STRUCT
{
      DWORD  dwChannels;       // Number of channels of the
subsystem type, main string
      DWORD  dwChBits;          //*NEW* how wide is the
channel
      DWORD  dwRate;            // Maximum output rate

      DWORD  dwMaxGains;        // = MAXGAINS
      float  fGains[MAXGAINS];  // Array of gains

      // Information to convert values
      DWORD  dwMaxRanges;         // = MAXRANGES
      float  fRangeLow[MAXRANGES]; // Low part of range
      float  fRangeHigh[MAXRANGES];// High part of the range
      float  fFactor[MAXRANGES];   // Value to multiply raw
data to
      float  fOffset[MAXRANGES];   // Value to subtract from
raw data
      WORD   wXorMask;                  // Xor mask
      WORD   wAndMask;                 // And mask

      DWORD  dwFifoSize;             // FIFO Size (in samples)
for subsystem
      DWORD  dwChListSize;         // Max number of entries in
channel list

}  SubSys_Info,  *PSubSys_Info;
```

fRangeLow, fRangeHigh, fFactor, fOffset, wXorMask and wAndMask are used to convert raw data ftom A/D board into voltage.
Use formula:
V = ((RawData & wAndMask)^wXorMask)*fFactor – fOffset;

Win32				
Function name	Reread Adapter Information			
Function	Get pointer to the structure contains adapter capabilities			
Returns	TRUE (1) if success, FALSE (0) is failure			
Syntax:				
Win32 API	BOOL __PdGetAdapterInfo(DWORD dwBoardNum, DWORD* dwError, PAdapter_Info Adp_Info);			

This is an extended version of _PdGetAdapterInfo function. The function is similar to the previous but takes data directly from EEPROM and Primary Boot instead of structures stored in DLL.

Win32				
Function name	Get Pointer to Board Capabilities Structure			
Function	Get pointer to the structure contains adapter capabilities			
Returns	TRUE (1) if success, FALSE (0) is failure			
Syntax:				
Win32 API	BOOL _PdGetCapsPtrA(HANDLE hAdapter, DWORD* pdwError, PDAQ_Information* pDaqInf);			

Input parameter:
HANDLE hAdapter – handle to the adapter
Output parameters:
DWORD* pdwError – error code

Function returns pointer to DAQ_Information structure for dwBoardID board (stored in PCI Configuration Space) using handle to adapter.

```
typedef struct DAQ_Information_STRUCT {
          WORD    iBoardID;      // board ID
          LPSTR   lpBoardName;  // Name of the specified board
          LPSTR   lpBusType;    // Bus type
          LPSTR  lpDSPRAM;      // Type of DSP and volume of
RAM
          LPSTR   lpChannels;   // Number of channels of the
all types,
                                // main string
          LPSTR   lpTrigCaps;   // AIn triggering capabilities
          LPSTR   lpAInRanges;  // AIn ranges
          LPSTR   lpAInGains;   // AIn gains
          LPSTR   lpTransferTypes;      // Types of suported
transfer methods
          DWORD   iMaxAInRate;  // Max AIn rate (pacer clock)
```

```
          LPSTR   lpAOutRanges; // AOut ranges
          DWORD   iMaxAOutRate; // Max AOut rate (pacer clock)
          LPSTR   lpUCTType;    // Type of used UCT
          DWORD   iMaxUCTRate;  // Max UCT rate
          DWORD   iMaxDIORate;  // Max DIO rate
          WORD    wXorMask;     // Xor mask
          WORD    wAndMask;     // And mask

} DAQ_Information, * PDAQ_Information;
```

This structure contains unparsed strings with mnemonic representation of the board capabilities (defined in pd_hcaps.h). Use _PdParseCaps() to obtain numerical value of specified board's property.

Win32				
Function name	Get Pointer to Board Capabilities Structure			
Function	Get pointer to the structure contains adapter capabilities			
Returns	Pointer to DAQ_information or NULL on error			
Syntax:				
Win32 API	DAQ_Information* _PdGetCapsPtr(DWORD dwBoardID);			

Function returns pointer to DAQ_information structure for dwBoardID board ID (stored in PCI Configuration Space as SubVendorID). If dwBoardID is incorrect function returns NULL.

Win32				
Function name	Parse Capabilities			
Function	Get pointer to the structure contains adapter capabilities			
Returns	Integer value of parameter			
Syntax:				
Win32 API	DWORD _PdParseCaps(DWORD dwBoardID, DWORD dwSubsystem, DWORD dwProperty);			

Function parses analog input channel definition string in DAQ_Information structure

Input parameters:

dwBoardID – board ID from PCI Config.Space
dwSubsystem – subsystem (AnalogIn, ...)
dwProperty – property of subsystem to retrieve:

PDHCAPS_BITS — subsystem bit width
PDHCAPS_FIRSTCHAN — first channel available
PDHCAPS_LASTCHAN — last channel available
PDHCAPS_CHANNELS — number of channels available

Data conversion functions

These functions convert data from the raw values to volts or vice-versa. Please see data format of particular board in appropriate "User Manual". The supplied functions take care of the board type you'd like to convert data from.

Win32	**Linux**
Function name	Raw to Volt
Function	Convert raw values received in analog input buffer to volts
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)
Syntax:	
Win32 API	BOOL PdAInRawToVolts(HANDLE hAdapter, DWORD dwAInCfg, WORD* wRawData, double* fVoltage, DWORD dwCount);
Linux API	int PdAInRawToVolts(int board, DWORD dwAInCfg, WORD* wRawData, double* fVoltage, DWORD dwCount);

Input parameters:
HANDLE hAdapter – handle to adapter (Win32)
int board – file descriptor of the subsystem (Linux)
DWORD dwAInCfg – analog input configuration used
WORD* wRawData – pointer to array of WORDs contains raw data
double* fVoltage – pointer to array of doubles to store converted values (in Volts)
DWORD dwCount – number of values to convert

The function doesn't care if any gain setting were applied. You shall divide result array to gain used.

Win32	**Linux**			
Function name	Volts to Raw			
Function	Convert volt values to raw acceptable for analog output			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL PdAOutVoltsToRaw(HANDLE hAdapter, DWORD dwAOutCfg, double* fVoltage, DWORD* wRawData, DWORD dwCount);			
Linux API	BOOL PdAOutVoltsToRaw(int board, DWORD dwAOutCfg, double* fVoltage, DWORD* wRawData, DWORD dwCount);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win32)
int board – file descriptor of the subsystem (Linux)
DWORD dwAOutCfg – analog output configuration used (use 0 as for now)
double* fVoltage – pointer to array of doubles of values to convert (in Volts)
WORD* wRawData – pointer to array of WORDs to store raw values
DWORD dwCount – number of values to convert

Win32	**Linux**			
Function name	Raw scans to Volt			
Function	Convert raw scans received in analog input buffer to volts			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL PdAInScanToVolts(HANDLE hAdapter, DWORD dwAInCfg, DWORD dwChListSize, DWORD* dwChList, WORD* wRawData, double* fVoltage, DWORD dwScans);			
Linux API	int PdAInScanToVolts(int board, DWORD dwAInCfg, DWORD dwChListSize, DWORD* dwChList, WORD* wRawData, double* fVoltage, DWORD dwScans);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win32)

int board – file descriptor of the subsystem (Linux)
DWORD dwAInCfg – analog input configuration used
DWORD dwChListSize – size of channel list used
DWORD* dwChList – channel list array
WORD* wRawData – pointer to array of WORDs contains raw data
double* fVoltage – pointer to array of doubles to store converted values (in Volts)
DWORD dwScans – number of scans to convert

Function converts raw values to its voltage equivalent taking in account gains used.

Win32	**Linux**			
Function name	Volts to Raw 16			
Function	Convert volt values to raw acceptable for analog output (16-bit format)			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL PdAOVoltsToRaw16(HANDLE hAdapter, double* fVoltage, WORD* wRawData, DWORD dwCount);			
Linux API	int PdAOVoltsToRaw16(int board, double* fVoltage, WORD* wRawData, DWORD dwCount);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win32)
int board – file descriptor of the subsystem (Linux)
double* fVoltage – pointer to array of doubles of values to convert (in Volts)
WORD* wRawData – pointer to array of WORDs to store raw values
DWORD dwCount – number of values to convert

Use this function when you need to convert array of float point voltage values into raw format suitable to put into the analog output buffer. Use buffering in 16-bit mode (with fixed or arbitrary channel list).

Win32	**Linux**			
Function name	Volts to Raw 32			
Function	Convert volt values to raw acceptable for analog output (32-bit format)			

Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)
Syntax:	
Win32 API	BOOL PdAOVoltsToRaw32(HANDLE hAdapter, double* fVoltage, DWORD* wRawData, DWORD dwCount);
Linux API	int PdAOVoltsToRaw32(int board, double* fVoltage, DWORD* wRawData, DWORD dwCount);

Input parameters:
HANDLE hAdapter – handle to adapter (Win32)
int board – file descriptor of the subsystem (Linux)
double* fVoltage – pointer to array of doubles of values to convert (in Volts)
WORD* wRawData – pointer to array of DWORDs to store raw values
DWORD dwCount – number of values to convert

Use this function when you need to convert array of float point voltage values into raw format suitable to put into the analog output buffer. Use buffering in 16-bit mode with arbitrary channel list if you need to modify it.

Win32	**Linux**			
Function name	Volts to Raw CL			
Function	Convert volt values to raw acceptable for analog output (32-bit format with channel data)			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL PdAOVoltsToRawCl(HANDLE hAdapter, DWORD dwChListSize, DWORD* dwChList, double* fVoltage, DWORD* wRawData, DWORD dwCount);			
Linux API	int PdAOVoltsToRawCl(int board, DWORD dwChListSize, DWORD* dwChList, double* fVoltage, DWORD* wRawData, DWORD dwCount);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win32)
int board – file descriptor of the subsystem (Linux)
DWORD dwChListSize – size of analog output channel list
DWORD* dwChList – channel list
double* fVoltage – pointer to array of doubles of values to convert (in Volts)

WORD* wRawData – pointer to array of DWORDs to store raw values
DWORD dwCount – number of values to convert

Use this function when you need to convert array of float point voltage values into raw format suitable to put into the analog output buffer. Use buffering in 16-bit mode with arbitrary channel list if you need to modify it.

Buffer Management Functions

Buffer management functions are crucial for any subsystem that supports asynchronous (buffered, event-driven) mode of operation.

Win32	**Linux**			**r3**
Function name	Acquire Buffer			
Function	Acquire and allocate buffer to use with specified subsystem			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAcquireBuffer(HANDLE hAdapter, DWORD* pError, void** pBuffer, DWORD dwFrames, DWORD dwFrameScans, DWORD dwScanSamples, DWORD dwSubsystem, DWORD dwMode);			
Linux API	int _PdAcquireBuffer(int hanlde, DWORD* pError, void** pBuffer, DWORD dwFrames, DWORD dwFrameScans, DWORD dwScanSamples, DWORD dwSubsystem, DWORD dwMode);			

Function allocates data buffer and registers it for subsystem and mode specified.

Input parameters:
HANDLE hAdapter – handle to adapter
DWORD *pError – error code if failure
void** pBuf – pointer to store pointer to allocated buffer
DWORD dwFrames – number of frames in the buffer
DWORD dwFrameScans – size of the frame in scans
DWORD dwScanSamples – number of samples in the scan
DWORD dwSubsystem – subsystem to associate the buffer
DWORD dwMode – mode to use: straight, cycled, recycled

Notes: *The buffer is adjusted for optimal bus-mastering, scatter/gather operation. buffer size in samples = dwFrames * dwFrameScans * dwScanSamples*

Depends on board type sample size is the follows:
PDx-MFx analog input: sample size is WORD
PDx-MFx analog output: sample size is WORD, dwScanSamples = 2
PD2-AO: sample size is WORD
PD2-DIO: sample size is WORD for DOut and WORD for DIn
dwSubsystem can be one of the follows: {AnalogIn, AnalogOut, DigitalIn, DigitalOut, CounterTimer}.

dwMode:
AIB_BUFFERWRAPPED (BUF_BUFFERWRAPPED) - cycle buffer
AIB_BUFFERRECYCLED (BUF_BUFFERRECYCLED) - recycled mode
BUF_DWORDVALUES - use DWORD values
BUF_FIXEDDMA - use fixed size DMA transfer

Special mode:
If BUF_DWORDVALUES is set DWORD buffer is allocated for output operations and driver transfers data "as is" to the board.

Win32	**Linux**			**r3**
Function name	Release Buffer			
Function	Release allocated buffer from use with specified subsystem			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdReleaseBuffer(HANDLE hAdapter, PDWORD pError, DWORD dwSubsystem, void* pBuffer);			
Linux API	int _PdReleaseBuffer(HANDLE hAdapter, PDWORD pError, DWORD dwSubsystem, void* pBuffer);			

This function unregisters buffer with a subsystem and deallocates it. Buffer was allocated by previous call of _PdAcquireBuffer().

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD dwSubsystem – subsystem to associate the buffer

void* pBuffer – pointer to buffer allocated
PDWORD pError – error code on failure

Win32	Win16			
Function name	Allocate Buffer			
Function	Allocates buffer with specified parameters			
Returns	1 if success, 0 if failure			
Syntax:				
Win32 API	BOOL _PdAllocateBuffer(PWORD *pBuffer, DWORD dwFrames, DWORD dwScans, DWORD dwScanSize, PDWORD pError);			
Win16 API	BOOL _PdAllocateBuffer(LPWORD *lpBuffer, DWORD dwFrames, DWORD dwScans, DWORD dwScanSize, LPDWORD lpError);			

This is a compatibility function. Use _PdAcquireBuffer() in new Win32 and Linux applications.

Input parameters:
PWORD* pBuffer – pointer to pointer to allocated buffer
DWORD dwFrames – number of frames in the buffer
DWORD dwScans – size of the frame in scans
DWORD dwScanSize – number of samples in the scan
PDWORD pError – error code on failure
Output parameter:
Function stores address of the new buffer in pBuffer.

Note: *Win16 uses "huge" pointer to the buffer, thus it's not limited by 16-bit segment size. Linux applications allocate buffer by calling PdRegisterBuffer()*

Win32	Win16	Linux		
Function name	Register Buffer			
Function	Registers buffer with specified parameters			
Returns	1 if success, 0 if failure (Linux: number of bytes allocated, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdRegisterBuffer(HANDLE hAdapter, PDWORD pError, PWORD pBuffer, DWORD dwSubsystem, BOOL bWrapAround);			

Win16 API	BOOL _export _loadds _PdRegisterBuffer(HANDLE hAdapter, LPDWORD lpError, LPWORD lpBuffer, DWORD dwSubsystem, DWORD dwMode);
Linux	int _PdRegisterBuffer(int handle,PWORD* pBuffer, DWORD dwSubsystem, DWORD dwFramesBfr, DWORD dwScansFrm, DWORD dwScanSize, DWORD dwMode);

Input parameters (Win):
HANDLE hAdapter – handle to adapter (Win)
PDWORD pError – error code on failure
PWORD pBuffer – pointer to store buffer address
DWORD dwSubsystem – subsystem to associate the buffer
DWORD dwMode – mode to use: straight, cycled, recycled
dwMode:
0 – straight (one-shot) buffer
AIB_BUFFERWRAPPED - cycled buffer
AIB_BUFFERRECYCLED - recycled mode

Input Parameters (Linux):
int handle – file descriptor of the subsystem (Linux)
PWORD* pBuffer – pointer to store buffer address
DWORD dwSubsystem – subsystem (AnalogIn or AnalogOut)
DWORD dwFramesBfr – number of frames in buffer
DWORD dwScansFrm – number of scans in the frame
DWORD dwScanSize – channel list (scan) size
DWORD bWrapAround – buffering mode
buffering modes:
 0 - single run (acquisition stops after buffer becomes full)
 AIB_BUFFERWRAPPED - circular buffer
 AIB_BUFFERRECYCLED - circular buffer with frame recycling

Return: actual number of bytes allocated or negative value on error

Linux specific:

A. Kernel space mode (powerdaq32rt.c):
Driver allocates buffer itself and returns a pointer to it

B. User space modes (powerdaq32.c):
This function can be used in two modes:

1. ALLOCMMAPBUF is undefined. This is "copy_to_user" mode
Memory is allocated using regular malloc(). Driver copies data from it's internal buffer, so when _PdAInGetScans() is called you can use one of

two modes: AIN_SCANRETMODE_RAW and AIN_SCANRETMODE_VOLTS

2. ALLOCMMAPBUF is defined. This is "pass through" mode and is the default.
Memory is allocated at the kernel space and then mmaped to the user space.
Only AIN_SCANRETMODE_MMAP in _PdAInGetScans() can be used
Driver doesn't touch data after DMA operation from the board has taken place.

Win32	**Win16**			
Function name	Free Buffer			
Function	Frees previously allocated buffer			
Returns	1 if success, 0 if failure			
Syntax:				
Win32 API	BOOL _PdFreeBuffer(PWORD pBuffer, PDWORD pError);			
Win16 API	BOOL _PdFreeBuffer(LPWORD lpBuffer, LPDWORD lpError);			

Input parameters (Win):
PWORD pBuffer – pointer to store buffer address
PDWORD pError – error code on failure

Win32	**Win16**	**Linux**		
Function name	Unregister Buffer			
Function	Unregister previously registered buffer			
Returns	1 if success, 0 if failure (Linux: 0 –success, negative value – failure)			
Syntax:				
Win32 API	BOOL _PdUnregisterBuffer(HANDLE hAdapter, PDWORD pError, PWORD pBuffer);			
Win16 API	BOOL _PdUnregisterBuffer(HANDLE hAdapter, LPDWORD lpError, LPWORD lpBuffer);			
Linux	int _PdUnregisterBuffer(int handle, PWORD pBuf, DWORD dwSubSystem);			

Input parameters (Win):
HANDLE hAdapter – handle to adapter
PWORD pBuffer – pointer to store buffer address
PDWORD pError – error code on failure

Input parameters (Linux):
int handle – file descriptor of the subsystem (Linux)
PWORD pBufer – pointer to store buffer address

Win32	**Win16**
Function name	Get Buffer Status
Function	Fills PD_DAQBUF_STATUS_INFO with current buffer status information
Returns	1 if success, 0 if failure
Syntax:	
Win32 API	BOOL _PdGetDaqBufStatus(HANDLE hAdapter, DWORD *pError, PPD_DAQBUF_STATUS_INFO pDaqBufStatus);
Win16 API	BOOL _PdGetDaqBufStatus(HANDLE hAdapter, LPDWORD lpError, LPPD_DAQBUF_STATUS_INFO lpDaqBufStatus);

This is a rarely used information function. It will get buffer status information without retrieving actual data from the buffer. It can be used in conjunction with _PdAInGetScans() and _PdxxxGetBufState() calls. Buffer shall be allocated and registered to a subsystem before calling this function.

Input parameters (Win):
HANDLE hAdapter – handle to adapter
DWORD* pError – error code on failure
PPD_DAQBUF_STATUS_INFO pDaqBufStatus – pointer where to store buffer status

Structure PD_DAQBUF_STATUS_INFO (defined in pwrdaq.h) consists of:

```
typedef struct _PD_DAQBUF_STATUS_INFO
{
ULONG              dwAdapterId;    // INPUT: Adapter ID
    PD_SUBSYSTEM  Subsystem;      // INPUT: subsystem
    //------------
    ULONG         dwSubsysState; // current subsystem state
    ULONG         dwScanIndex;   // buffer index of first scan
    ULONG         dwNumValidValues; // number of valid values
available
    ULONG         dwNumValidScans;  // number of valid scans
available
    ULONG         dwNumValidFrames; // number of valid frames
available
```

```
    ULONG          dwWrapCount;        // total num times
buffer wrapped - reserved
    ULONG          dwFirstTimestamp;   // first sample
timestamp
    ULONG          dwLastTimestamp;    // last sample timestamp
} PD_DAQBUF_STATUS_INFO, * PPD_DAQBUF_STATUS_INFO;
```

Win32	**Win16**			
Function name	Clear Daq Buffer			
Function	Clears all data from the acquisition buffer			
Returns	1 if success, 0 if failure			
Syntax:				
Win32 API	BOOL _PdClearDaqBuf(HANDLE hAdapter, DWORD *pError, PD_SUBSYSTEM Subsystem);			
Win16 API	BOOL _PdClearDaqBuf(HANDLE hAdapter, LPDWORD lpError, DWORD Subsystem);			

This is a rarely used function. It clears all data in the buffer by moving the tail pointer of the buffer to the head. Use it when the buffer is set up in Cycle/Recycle mode and you want to eliminate all the data acquired to this point of time and start with a new buffer.

Win16				
Function name	Read Word From Buffer			
Function	Read one sample from the buffer			
Returns	Sample			
Syntax:				
Win16 API	WORD _PdReadWordFromBuffer(LPWORD lpBuffer, DWORD dwOffset);			

Input parameters:
LPWORD lpBuffer – pointer to previously allocated buffer
DWORD dwOffset – offset in this buffer to retrieve sample from

Function returns sample from the buffer pointed by lpBuffer at offset dwOffset
This helper function is written to eliminate the need to use pointers in Microsoft Visual Basic 3.0.

Win16				
Function name	Write Word To Buffer			
Function	Write one sample to the buffer			
Returns	None			
Syntax:				
Win16 API	VOID _PdWriteWordToBuffer(LPWORD lpBuffer, DWORD dwOffset, WORD wValue);			

Input parameters:
LPWORD lpBuffer – pointer to previously allocated buffer
DWORD dwOffset – offset in this buffer to retrieve sample from
WORD wValue – word value to write

Function writes sample to the buffer pointed by lpBuffer at offset dwOffset
This helper function is written to eliminate the need to use pointers in Microsoft Visual Basic 3.0.

Win16				
Function name	_Vb3AllocateBuffer			
Function name	_Vb3FreeBuffer			
Function name	_Vb3RegisterBuffer			
Function name	_Vb3UnregisterBuffer			
Function name	_Vb3ReadWordFromBuffer			
Function name	_Vb3WriteWordToBuffer			
Function name	_Vb3GetVersion			
Function name	_Vb3GetPciConfiguration			
Function name	_Vb3AdapterEepromRead			

These are helper functions written to eliminate the need to use pointers in Microsoft Visual Basic 3.0.

On-board EEPROM access and calibration functions

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	Read EEPROM			
Function	Reads on-board EEPROM			
Returns	1 if success, 0 if failure (Linux: bytes read on success or negative on error)			

Syntax:	
Win32 API	BOOL _PdAdapterEepromRead(HANDLE hAdapter, DWORD *pError, DWORD dwMaxSize, WORD *pwReadBuf, DWORD *pdwWords);
Win16 API	BOOL _PdAdapterEepromRead(HANDLE hAdapter, LPDWORD lpError, DWORD dwMaxSize, LPWORD lpwReadBuf, LPDWORD lpdwWords);
Linux	int _PdAdapterEepromRead(int handle, DWORD dwMaxSize, WORD *pwReadBuf, DWORD *pdwWORDs);
RTLinux	int pd_adapter_eeprom_read(int handle, u32 dwMaxSize, uint16_t *pwReadBuf);
QNX	int pd_adapter_eeprom_read(int board, u32 dwMaxSize, uint16_t *pwReadBuf);

Input paramters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD* pError – error code on failure
DWORD dwMaxSize – maximum number of WORDs to read
WORD* pwReadBuffer – buffer to store EEPROM to (must be long enough to accomodate dwMaxSize WORDs)
DWORD* pdwWORDs – number of WORDs actually read

The best way to use this function is to create structure of PWRDAQ_EEPROM type and read data into it.

```
typedef struct _PWRDAQ_EEPROM
{  struct
    {
        BYTE    ADCFifoSize;
        BYTE    CLFifoSize;
        BYTE    SerialNumber[PD_SERIALNUMBER_SIZE];
        BYTE    ManufactureDate[PD_DATE_SIZE];
        BYTE    CalibrationDate[PD_DATE_SIZE];
        DWORD   Revision;
        WORD    FirstUseDate;
        WORD    CalibrArea[PD_CAL_AREA_SIZE];
        WORD    FWModeSelect;
        WORD    StartupArea[PD_SST_AREA_SIZE];
    } Header;
    WORD WordValues[1];
} PWRDAQ_EEPROM, * PPWRDAQ_EEPROM;
```

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	Write EEPROM			
Function	Writes on-board EEPROM			
Returns	1 if success, 0 if failure (Linux: bytes written on success or negative on error)			
Syntax:				
Win32 API	BOOL _PdAdapterEepromWrite(HANDLE hAdapter, DWORD *pError, WORD *pwWriteBuf, DWORD dwSize);			
Win16 API	BOOL _PdAdapterEepromWrite(HANDLE hAdapter, LPDWORD lpError, LPWORD lpwWriteBuf, DWORD dwSize);			
Linux	int _PdAdapterEepromWrite(int handle,WORD *pwWriteBuf, DWORD dwSize);			
RTLinux	int pd_adapter_eeprom_write(int board, u32 dwBufSize, u16* pwWriteBuf);			
QNX	int pd_adapter_eeprom_write(int board, u32 dwBufSize, u16* pwWriteBuf);			

This function requires three parameters: handle (or file descriptor) to adapter, pointer to WORD buffer with the data to write and number of WORDs to write.

Warning:
Writing improper data into the on-board EEPROM causes board and system failure and void the product warranty. To restore operability of the product, it will require re-certification and calibration at the factory. Standard repair charges apply.

***Note:** CalDiag subsystem must be acquired before using this function*

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	Write Cal DACs			
Function	Writes value into specified on-board calibration DACs			
Returns	1 if success, 0 if failure (Linux: 0 on success or negative on error)			
Syntax:				
Win32 API	BOOL _PdCalDACWrite(HANDLE hAdapter, DWORD *pError, DWORD dwCalDACValue);			
Win16 API	BOOL _PdCalDACWrite(HANDLE hAdapter, DWORD *pError, DWORD dwCalDACValue);			

Linux	int _PdCalDACWrite(int handle, DWORD dwCalDACValue);
RTLinux	int pd_cal_dac_write(int board, u32 dwCalDACValue);
QNX	int pd_cal_dac_write(int board, u32 dwCalDACValue);

The Cal DAC Write command writes the DAC select address and value to the specified calibration DAC. This function updates the driver's AIn configuration and driver calibration table.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD* pError – error code
DWORD dwCalDACValue – Cal DAC adrs and value to output
bits 0-7: 8-bit value to output
bits 8-10: 3-bit DAC output select
bit 11: Cal DAC 0/1 select

"int _PdCalDACSet(int handle, int nDAC, int nOut, int nValue);" is a wrapper to this function written to ease CalDAC operations.

Note: *CalDiag subsystem must be acquired before using this function*

Event and interrupt control functions

Win32	Win16	Linux	RTLinux	QNX
Function name	Enable Interrupts			
Function	Enables PCI interrupt			
Returns	1 if success, 0 if failure (Linux: 0 on success or negative on error)			
Syntax:				
Win32 API	BOOL _PdAdapterEnableInterrupt(HANDLE hAdapter, DWORD *pError, DWORD dwEnable);			
Win16 API	BOOL _PdAdapterEnableInterrupt(HANDLE hAdapter, LPDWORD lpError, DWORD dwEnable);			
Linux	int _PdAdapterEnableInterrupt(int handle, DWORD dwEnable);			
RTLinux	int pd_adapter_enable_interrupt(int board, u32 val);			
QNX	int pd_adapter_enable_interrupt(int board, u32 val);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)

int handle – handle to adapter (Linux)
DWORD dwEnable – 0: disable, 1: enable Irq

Enable or Disable board interrupt generation. During interrupt generation, the PCI INTA line is asserted to request servicing of board events.

Interrupt generation is disabled following the assertion of an interrupt and must be explicitly called to re-enable assertion of subsequent interrupts. This command does not service the interrupt, i.e., it does not clear an asserted PCI INTA line.

Note: *Do not use this function in buffered mode.*

Win/Linux	**RTLInux**	**QNX**		
Function name	Acknowledge Interrupt			
Function	Acknowledge board interrupt			
Returns	1 if success, 0 if failure (Linux: 0 on success or negative on error)			
Syntax:				
Win/Linux	BOOL _PdAdapterAcknowledgeInterrupt(HANDLE hAdapter, DWORD *pError)			
RTLinux	u32 pd_dsp_acknowledge_interrupt(int board);			
QNX	u32 pd_dsp_acknowledge_interrupt(int board);			

The acknowledge interrupt command clears and disables the Host PC interrupt.
Servicing an interrupt does not re-enable the interrupt. After all events have been processed, the interrupt should be re-enabled by calling the pd_adapter_enable_interrupt () function.

Note: *The Windows and Linux driver takes care of interrupt processing. Do not use this function in conjunction with them.*

Win32				
Function name	Set Private Event			
Function	Creates event object and register it with the driver			
Returns	1 if success, 0 if failure			
Syntax:				
Win32 API	BOOL _PdSetPrivateEvent(HANDLE hAdapter, HANDLE *phNotifyEvent);			

Input parameters:
HANDLE hAdapter – handle to adapter
HANDLE *phNotifyEvent – handle to notification event

The Set Private Event function creates a notification event and sets the driver to signal the event upon assertion of a user event.
To utilize the set event in applications you should use Win32 API functions: WaitForSingleObject() or WaitForMultipleObjects().

Set event pulses when an event situation occurs in any of the board subsystems. It's up to the developer to figure out which subsystem and which event situation caused hNotifyEvent to be set by driver.
To set an event dedicated for a particular subsystem use _PdAInSetPrivateEvent(), _PdAOutSetPrivateEvent(),_PdDInSetPrivateEvent(),_PdDOutSetPrivateEvent(),_PdCTSetPrivateEvent() functions.

Linux specific:
Linux driver provides two ways of event notification: using SIGIO and blocking read().
See _PdSetAsyncNotify() and _PdWaitForEvent() for details.

Win32				
Function name	Clear Private Event			
Function	Frees event object and unregister it with the driver			
Returns	1 if success, 0 if failure			
Syntax:				
Win32 API	BOOL _PdClearPrivateEvent(HANDLE hAdapter, HANDLE *phNotifyEvent);			

Input parameters:
HANDLE hAdapter – handle to adapter
HANDLE *phNotifyEvent – handle to notification event

The Clear Private Event function disables signaling of an event by the driver and closes the notification event handle.
This function is to be used in conjunction with _PdSetPrivateEvent().

Linux				
Function name	Set Asynchronous Notification			
Function	Sets asynchronous SIGIO notification routine			
Returns	Negative error code or 0 on success			
Syntax:				
Linux API	int _PdSetAsyncNotify(int handle, struct sigaction *io_act, void (*sig_proc)(int));			

Sets up an event notification handler for a user process. It is freed automatically upon subsystem release or process termination.

Input parameters:
int handle – handle to adapter
struct sigaction *io_act – structure to store sigaction information
void (*sig_proc)(int) – function to call upon SIGIO signal

Linux				
Function name	Wait For Event			
Function	Blocking call waits for events to happen on specified subsystem			
Returns	Negative error code or 0 on success			
Syntax:				
Linux API	int _PdWaitForEvent(int handle, u32 subsystem);			

Returns when any event on a specified subsystem occurs.

Input parameters:
int handle – handle to adapter
u32 subsystem

Win32	**Win16**	**Linux**		
Function name	Set User Events			
Function	Sets event to notify for specified subsystem			
Returns	1 if success, 0 if failure (Linux: 0 in success, negative value on failure)			
Syntax:				
Win32 API	BOOL _PdSetUserEvents(HANDLE hAdapter, DWORD *pError, PD_SUBSYSTEM Subsystem, DWORD dwEvents);			

Win16 API	BOOL _PdSetUserEvents(HANDLE hAdapter, LPDWORD lpError, DWORD Subsystem, DWORD dwEvents);
Linux API	int _PdSetUserEvents(int handle, PD_SUBSYSTEM Subsystem, DWORD dwEvents);

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
PD_SUBSYSTEM Subsystem – subsystem type
DWORD dwEvents – user events to set

The Set User Events function enables event notification of a specified user defined DAQ events.

dwEvent:
1 – enable event notification upon assertion of this event and clear event status bit.
0 – no change to event configuration or status.

Setting an event for notification enables the hardware or driver event for notification upon assertion and clears the event status bit. Once the event asserts and the status bit is set, the DLL/User notification is triggered and the event is automatically disabled from notification and must be set again before DLL/User can be notified of its subsequent assertion.

User events operate in latched mode and must be cleared either by calling PdSetUserEvents or PdClearUserEvents to clear the event status bits.

Following events are defined for AnalogIn and AnalogOut subsystems:

```
              AIn AOut
eStartTrig      +   +     Start trigger received, operation
                          started
eStopTrig       +   +     Stop trigger received, operation
stopped
eInputTrig      -   -     Subsystem specific input trigger (if
any)
eDataAvailable  +   -     New data available
eScanDone       -   -     Scan done (for future use)
eFrameDone      +   +     One or more frames are done
                          (or half of DAC FIFO is done)
eFrameRecycled  +   -     Cyclic buffer frame recycled
                          (i.e. an unread frame is over-written
                          by the new data)
eBufferDone     +   +     Buffer done
eBufferWrapped  +   -     Cyclic buffer wrapped
```

```
eConvError      +   -    Conversion clock error - pulse came
before board
                         is ready to process it
eScanError      +   -    Scan clock error
eBufferError    +   +    Buffer over/under run error
eStopped        +   +    Operation stopped (possibly because of
                         error)
eTimeout        +   -    Operation timed out
eAllEvents      +   +    Set/clear all events
```

Following events are defined for DIO and UC subsystems:

```
              DIn UCT
eDInEvent      +   -    Digital Input event
eUct0Event     -   +    Uct0 countdown event
eUct1Event     -   +    Uct1 countdown event
eUct2Event     -   +    Uct2 countdown event
```

Notes: *Events are available for AnalogIn, AnalogOut, DigitalIn, DigitalOut and CounterTimer and should be set separately*

Win32	**Win16**	**Linux**		
Function name	Clear User Events			
Function	Clears event to notify for specified subsystem			
Returns	1 if success, 0 if failure (Linux: 0 in success, negative value on failure)			
Syntax:				
Win32 API	BOOL _PdClearUserEvents(HANDLE hAdapter, DWORD *pError, PD_SUBSYSTEM Subsystem, DWORD dwEvents);			
Win16 API	BOOL _PdClearUserEvents(HANDLE hAdapter, LPDWORD lpError, DWORD Subsystem, DWORD dwEvents);			
Linux API	int _PdClearUserEvents(int handle, PD_SUBSYSTEM Subsystem, DWORD dwEvents);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
PD_SUBSYSTEM Subsystem – subsystem type
DWORD dwEvents – user events to clear

dwEvent:
1 – disable event notification of this event and clear the event status bit.
0 – no change to event configuration or status.

The Clear User Events function clears and disables event notification of a specified user defined DAQ events.

Clearing an event from notification disables the hardware or driver event for notification upon assertion and clears the event status bit. All DLL calls waiting on the events that are cleared are signalled.

This function can also be called to clear event status bits on events that are checked by polling and were not enabled for notification.

Notes: *See _PdSetUserEvents for events definition*

Win32	**Win16**	**Linux**		
Function name	Get User Events			
Function	Gets event to notify for specified subsystem			
Returns	1 if success, 0 if failure (Linux: 0 in success, negative value on failure)			
Syntax:				
Win32 API	BOOL _PdGetUserEvents(HANDLE hAdapter, DWORD *pError, PD_SUBSYSTEM Subsystem, PDWORD pdwEvents);			
Win16 API	BOOL _PdGetUserEvents(HANDLE hAdapter, LPDWORD lpError, DWORD Subsystem, PDWORD pdwEvents);			
Linux API	int _PdGetUserEvents(int handle, PD_SUBSYSTEM Subsystem, DWORD* pdwEvents);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – error code
PD_SUBSYSTEM Subsystem – subsystem type
PDWORD pdwEvents – pointer to DWORD to store event state

dwEvent:
0 – event had not asserted
1 – event asserted

The Get User Events function gets the current user event status. The event configuration and status are not changed.

User events are not automatically re-enabled. Clearing and thus re-enabling of user events is initiated by the DLL.

Notes: *This function gets the current event status, not the queued events. See _PdSetUserEvents for events definition*

Win32	**Win16**	**Linux**		
Function name	Immediate Update			
Function	Imitate interrupt request from the board to update state of the I/O buffers			
Returns	1 if success, 0 if failure (Linux: 0 in success, negative value on failure)			
Syntax:				
Win32 API	BOOL _PdImmediateUpdate(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdImmediateUpdate(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdImmediateUpdate(int handle);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – error code

The Immediate Update function immediately updates the adapter status, events, gets all samples acquired from adapter and updates the latest sample counts.
Driver handles _PdImmediateUpdate acts likes an interrupt from the board, so all event notification mechnisms will correctly.

Notes: *Use this function in the following circumstances:*

1. Acquistion rates less than 10 kS/s. Driver transfers data when the onboard AD FIFO becomes half-full. In other words data will not appear in the buffer until 512 samples (if default 1kS FIFO is installed) are acquired. Therefore, if you select a frame size as big as 50 samples and your rate is 100Hz you'll get 11 frames per event each 5.5 s. Thus, if you want to achieve better response time, include _PdImmediateUpdate call in a timer loop.

2. When you want to clock acquisition externally and the clock frequency may vary it is suggstested to call _PdImmediateUpdate periodically to see if there any scans available

3. _PdImmediateUpdate consumes some processor time. It's not recommended to call this function more then 10 times a second at the high acquisition rates (>100kS/s). With a low rate it seems reasonable to call _PdImmediateUpdate with up to 1000Hz rate.

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	Get Board Status			
Function	Get combined board status – all subsystem			
Returns	1 if success, 0 if failure (Linux: 0 in success, negative value on failure)			
Syntax:				
Win32 API	BOOL _PdAdapterGetBoardStatus(HANDLE hAdapter, DWORD *pError, DWORD *pdwStatusBuf);			
Win16 API	BOOL _PdAdapterGetBoardStatus(HANDLE hAdapter, DWORD *pError, DWORD *pdwStatusBuf);			
Linux API	int _PdAdapterGetBoardStatus(int handle, PTEvents pEvents);			
RTLinux	int pd_adapter_get_board_status(int board, PTEvents pEvent);			
QNX	int pd_adapter_get_board_status(int board, PTEvents pEvent);			

Input Parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor associated with any subsystem (Linux)
DWORD *pError – pointer to last error status
DWORD *pdwStatusBuf – pointer to buffer to store event words
PTEvent pEvent – 5 DWORD structure to accommodate board status.

The get board status command returns the status and events of all subsystems, but does not disable or clear any asserted board event bits.

All error conditions are included in the board events.

Function fills dwStatusBuf array with following information (offsets are in bytes):

[+0] BrdStatus
[+4] combined registers PD_UDEIntr and PD_AUEStat
[+8] combined registers PD_AIOIntr1 and PD_AIOIntr2
[+12] AInIntrStat
[+16] AOutIntrStat

Notes: *The get board status command does not clear, enable, or disable the PC Host interrupt or board events.*

The size of pdwStatusBuf should be 5 DWORDs.
This routine is optimized for fastest execution possible.

Combined `UDEIntrStat` and `AOMEGA ENGINEERINGntrStat (ADOMEGA ENGINEERINGntrStat)`
Register bits:

```
#define UTB_Uct0Im      (1L<<0) // UCT 0 Interrupt mask
#define UTB_Uct1Im      (1L<<1) // UCT 1 Interrupt mask
#define UTB_Uct2Im      (1L<<2) // UCT 2 Interrupt mask

#define UTB_Uct0IntrSC  (1L<<3) // UCT 0 Interrupt Status/Clear
#define UTB_Uct1IntrSC  (1L<<4) // UCT 1 Interrupt Status/Clear
#define UTB_Uct2IntrSC  (1L<<5) // UCT 2 Interrupt Status/Clear

#define DIB_IntrIm      (1L<<6) // DIn Interrupt mask
#define DIB_IntrSC      (1L<<7) // DIn Interrupt Status/Clear

#define BRDB_ExTrigIm   (1L<<8) // External Trigger Interrupt
mask
#define BRDB_ExTrigReSC (1L<<9) // Ext Trigger Rising Edge
Interrupt Status/Clear
#define BRDB_ExTrigFeSC (1L<<10) // Ext Trigger Falling Edge
Interrupt
                                 // Status/Clear
                                // Status only bits:
#define AIB_FNE      (1L<<11) // 1 = ADC FIFO Not Empty
#define AIB_FHF      (1L<<12) // 1 = ADC FIFO Half Full
#define AIB_FF       (1L<<13) // 1 = ADC FIFO Full
#define AIB_CVDone   (1L<<14) // 1 = ADC Conversion Done
#define AIB_CLDone   (1L<<15) // 1 = ADC Channel List Done
#define UTB_Uct0Out  (1L<<16) // Current state of UCT0 output
#define UTB_Uct1Out  (1L<<17) // Current state of UCT1 output
#define UTB_Uct2Out  (1L<<18) // Current state of UCT2 output

#define BRDB_ExTrigLevel (1L<<19)// Current state of External
                                   Trigger
                                 // input
```

Combined AIOInt1 and AIOInt2 (**AIOIntr**) register
Register bits:

```
#define AIB_FHFIm       (1L<<1)  // AIn FIFO Half Full
                                    Interrupt mask
#define AIB_CLDoneIm    (1L<<2)  // AIn CL Done Interrupt mask
                                 // Status/Clear
#define AIB_FHFSC       (1L<<4)  // AIn FIFO Half Full
Interrupt
                                 // Status/Clear
#define AIB_CLDoneSC    (1L<<5)  // AIn CL Done Interrupt
Status/Clear
//------------------
#define AIB_FFIm        (1L<<8)  // AIn FIFO Full Interrupt
mask
#define AIB_CVStrtErrIm (1L<<9)  // AIn CV Start Error
Interrupt mask
#define AIB_CLStrtErrIm (1L<<10) // AIn CL Start Error
Interrupt mask
#define AIB_OTRLowIm    (1L<<11) // AIn OTR Low Error Interrupt
mask
#define AIB_OTRHighIm   (1L<<12) // AIn OTR High Error
Interrupt mask
#define AIB_FFSC        (1L<<13) // AIn FIFO Full Interrupt
Status/Clear
#define AIB_CVStrtErrSC (1L<<14) // AIn CV Start Error
Interrupt
                                 // Status/Clear
#define AIB_CLStrtErrSC (1L<<15) // AIn CL Start Error
Interrupt
                                 // Status/Clear
#define AIB_OTRLowSC    (1L<<16) // AIn OTR Low Error Interrupt
                                 // Status/Clear
#define AIB_OTRHighSC   (1L<<17) // AIn OTR High Error
Interrupt
                                 // Status/Clear
```

AInIntrStat Register bits:

```
#define AIB_StartIm     (1L<<0)  // AIn Sample Acquisition
Started Int mask
#define AIB_StopIm      (1L<<1)  // AIn Sample Acquisition
Stopped Int mask
#define AIB_SampleIm    (1L<<2)  // AIn One or More Samples
Acquired Int mask
#define AIB_ScanDoneIm  (1L<<3)  // AIn One or More CL Scans
Acquired Int mask
```

```
#define AIB_ErrIm       (1L<<4)  // AIn Subsystem Error Int
mask
#define AIB_BMDoneIm    (1L<<5)  // AIn Bus Master Blocks
Transferred Int mask
#define AIB_BMErrIm     (1L<<6)  // Bus Master Data Transfer
Error Int mask
#define AIB_BMEmptyIm   (1L<<7)  // Bus Master PRD Table Empty
Error Int mask
//-----------------
#define AIB_StartSC     (1L<<8)  // AIn Sample Acquisition
Started Status/Clear
#define AIB_StopSC      (1L<<9)  // AIn Sample Acquisition
Stopped Status/Clear
#define AIB_SampleSC    (1L<<10) // AIn One or More Samples
Acquired Status/Clear
#define AIB_ScanDoneSC  (1L<<11) // AIn One or More CL Scans
Acquired Status/Clear
#define AIB_ErrSC       (1L<<12) // AIn Subsystem Error
Status/Clear
#define AIB_BMDoneSC    (1L<<13) // AIn Bus Master Blocks
Transferred
// Status/Clear
#define AIB_BMErrSC     (1L<<14) // Bus Master Data Transfer
Error Status/Clear
#define AIB_BMEmptySC   (1L<<15) // Bus Master PRD Table Empty
Error Status/Clear
//-----------------
// Status only bits:
#define AIB_Enabled     (1L<<16) // AIn Enabled Status
#define AIB_Active      (1L<<17) // AIn Active (Started) Status
#define AIB_BMEnabled   (1L<<18) // AIn Bus Master Enabled
Status
#define AIB_BMActive (1L<<19) // AIn Bus Master Active
(Started)Status
```

AOutIntrStat Register bits:

```
#define AOB_StartIm     (1L<<0)  // AOut Conversion Started Int
mask
#define AOB_StopIm      (1L<<1)  // AOut Conversion Stopped Int
mask
#define AOB_ScanDoneIm  (1L<<2)  // AOut Single Conversion/Scan
Done Int mask
#define AOB_HalfDoneIm  (1L<<3)  // AOut Half Buffer Done Int
mask

#define AOB_BufDoneIm   (1L<<4)  // AOut Buffer Done Int mask
#define AOB_BlkXDoneIm  (1L<<5)
#define AOB_BlkYDoneIm  (1L<<6)
```

```
#define AOB_UndRunErrIm (1L<<7)  // AOut Buffer Underrun Error
Int mask

//-----------------
#define AOB_CVStrtErrIm (1L<<8)  // AOut Conversion Start Error
Int mask
#define AOB_StartSC     (1L<<9)  // AOut Conversion Started
Status/Clear
#define AOB_StopSC      (1L<<10)  // AOut Conversion Stopped
Status/Clear
#define AOB_ScanDoneSC  (1L<<11) // AOut Single Conversion/Scan
Done Status/Clear

#define AOB_HalfDoneSC  (1L<<12) // AOut Half Buffer Done
Status/Clear
#define AOB_BufDoneSC   (1L<<13) // AOut Buffer Done
Status/Clear
#define AOB_BlkXDoneSC  (1L<<14)
#define AOB_BlkYDoneSC  (1L<<15)
//-----------------

#define AOB_UndRunErrSC (1L<<16) // AOut Buffer Underrun Error
Status/Clear
#define AOB_CVStrtErrSC (1L<<17) // AOut Conversion Start Error
Status/Clear

// Status only bits:
#define AOB_Enabled     (1L<<18) // AOut Enabled Status
#define AOB_Active      (1L<<19) // AOut Active (Started)
Status
#define AOB_BufFull     (1L<<20) // AOut Buffer Full Error
Status
#define AOB_QEMPTY      (1L<<21) // AOut Queue Empty Status
#define AOB_QHF         (1L<<22) // AOut Queue Half Full Status
#define AOB_QFULL       (1L<<23) // AOut Queue Full Status
```

***Note:** this function is used automatically in buffered (asynchronous) mode under Windows and Linux.*

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	Get Board Status			
Function	Get combined board status – all subsystem			
Returns	1 if success, 0 if failure (Linux: 0 in success, negative value on failure)			
Syntax:				
Win32 API	BOOL _PdAdapterSetBoardEvents1(HANDLE hAdapter, DWORD *pError, DWORD dwEvents);			

Win16 API	BOOL _PdAdapterSetBoardEvents1(HANDLE hAdapter, DWORD *pError, DWORD dwEvents);
Linux API	int _PdAdapterSetBoardEvents1(int handle, DWORD dwEvents);
RTLinux	int pd_adapter_set_board_event1(int board, u32 dwEvents);
QNX	int pd_adapter_set_board_event1(int board, u32 dwEvents);

Input Parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor associated with any subsystem (Linux)
DWORD *pError – pointer to last error status
DWORD dwEvents – value of ADOMEGA ENGINEERINGntrStat Event configuration word (see _PdGetBoardStatus)

The set board events 1 command sets selected ADOMEGA ENGINEERINGntr register event bits enabling/disabling and/or clearing individual board level interrupt events, thereby re-enabling the event interrupts.

Interrupt Mask (Im) bits: 0 = disable, 1 = enable interrupt
Status/Clear (SC) bits: 0 = clear interrupt, 1 = unchanged

Notes:
1. This function is rarely used to call directly under Windows and Linux. Do not call this function when buffered mode is used
2. The set board events 1 command does not clear, enable, or disable the PC Host interrupt

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	Get Board Status			
Function	Get combined board status – all subsystem			
Returns	1 if success, 0 if failure (Linux: 0 in success, negative value on failure)			
Syntax:				
Win32 API	BOOL _PdAdapterSetBoardEvents2(HANDLE hAdapter, DWORD *pError, DWORD dwEvents);			
Win16 API	BOOL _PdAdapterSetBoardEvents2(HANDLE hAdapter, DWORD *pError, DWORD dwEvents);			
Linux API	int _PdAdapterSetBoardEvents2(int handle, DWORD dwEvents);			
RTLinux	int pd_adapter_set_board_event2(int board, u32 dwEvents);			

QNX	int pd_adapter_set_board_event2(int board, u32 dwEvents);

Input Parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor associated with any subsystem (Linux)
DWORD *pError – pointer to last error status
DWORD dwEvents – value of AIOUntrStat Event configuration word (see _PdGetBoardStatus)

The set board events 2 command sets selected AIOIntr1 and AIOIntr2 register event bits enabling/disabling and/or clearing individual board level interrupt events, thereby re-enabling the event interrupts.

Interrupt Mask (Im) bits: 0 = disable, 1 = enable interrupt
Status/Clear (SC) bits: 0 = clear interrupt, 1 = unchanged

How to use the function:
1. Keep a copy of the latest dwEvents word written.
2. Boolean OR the dwEvents word to set all status (SC) bits to 1.

3. To disable interrupts, change corresponding interrupt mask bits (Im) to 0, to enable, change mask bits to 1.

4. To clear interrupt status bits (SC), re-enabling the interrupts, set the corresponding bits to 0.

5. Save a copy of the new dwEvents word and issue command to set events.

Notes:
1. This function is rarely used to call directly under Windows and Linux. Do not call this function when buffered mode is used.
2. The set board events command does not clear, enable, or disable the PC Host interrupt.

3

Analog Input Subsystem Functions

Analog Input Subsystem Functions

Analog Input immediate mode functions

Analog input immediate (or synchronous) mode functions allow to access to all resources of the PowerDAQ analog input subsystem.
The following commands are included:

- to reset analog input subsystem state
- set up configuration (including input range and mode, type of clocking and triggering),
- clock conversion and channel list start
- clock start/stop trigger line
- retrieve samples from ADC FIFO
- set DMA transfer size and transfer samples using DMA
- clear and reset both FIFOs

Data stream formats.

Each two consecutive bytes contain a single sample from the A/D converter. Data is stored repeatedly sample by sample for all channels in the channel list. (Tables shows a PowerDAQ 16-bit board data format. For PowerDAQ 12-bit boards, only 12 LSBs (Least Significant Bits) are valid. PowerDAQ II boards automatically place zeroes in any unused bit locations.)

Data Format Table for a 16-bit Board

1st channel sample	2nd channel sample	...	last channel sample	1st channel sample

bit15	bit14	bit13	bit12	bit11	bit10	bit9	bit	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0

PowerDAQ II 12-bit data format

bit15	bit14	bit13	bit12	bit11	bit10	bit9	bit8	bit7	bit6	bit5	bit4	0x0	0x0	0x0	0x0

PowerDAQ II 14-bit data format

bit15	bit14	bit13	bit12	bit11	bit10	bit9	bit8	bit7	bit6	bit5	bit4	bit3	bit2	0x0	0x0

PowerDAQ II 16-bit data format

bit15	bit14	bit13	bit12	bit11	bit10	bit9	bit8	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0

The following calculations should be performed to convert the raw, stored hexadecimal data to scaled (Voltage) data:

Determine the value of a single bit ("bit weight") in Volts depending on the input range.

	12-bit PowerDAQ (span)/4096	12,14 and 16-bit PowerDAQ II, 16-bit PowerDAQ (span)/65535
0 - 5V unipolar (5V span)	0.001221 Volts/bit	0.000076295 Volts/bit
0 - 10V unipolar (10V span)	0.002442 Volts/bit	0.000152590 Volts/bit
+/-5V bipolar (10V span)	0.002442 Volts/bit	0.000152590 Volts/bit
+/-10V bipolar (20V span)	0.004884 Volts/bit	0.000305180 Volts/bit

Table 1: Bit Weight vs. Input Range

Determine the "zero offset" which depends on the input range selected.

5V, 10V unipolar	0
+/-5V biploar	-5V
+/-10V biploar	-10V

Table 2: Displacement vs. Input Range

1. Perform an arithmetical AND with 0h0FFF for 12-bit PowerDAQ boards (Go to the step 4 for 16-bit PowerDAQ and all PowerDAQ II boards)

2. Perform an arithmetical XOR with 0h0800 for PowerDAQ 12-bit boards and with 0h8000 for all PowerDAQ II and PowerDAQ 16-bit boards

3. Multiply by the “bit weight” from step 1

4. Add the “zero offset” from step 2

5. If a gain other than 1 was used for a selected channel, divide the value received by the gain factor (Doing this step last guarantees the maximal data accuracy.)

6. To convert voltage into analog output value you can use following formulas:

For 12-bit PowerDAQ board:
Value = (((HexData AND 0xFFF) XOR 0x800) * BitWeight + Displacement) / Gain

For all other models
Value = ((HexData XOR 0x8000) * BitWeight + Displacement) / Gain

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	AIn Reset			
Function	Reset analog input subsystem			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInReset(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdAInReset(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdAInReset(int board, DWORD *pError);			
RTLinux API	int pd_ain_reset(int board);			
QNX	int pd_ain_reset(int board);			

This function resets the analog input subsystem: trigger and clock settings, channel list, ADC FIFOs, all state machines. To continue analog input operation after this function has been called you have to re-configure the board.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)

Output parameters:
DWORD* pError – error code on failure

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	AIn Set Config			
Function	Sets analog input subsystem configuration for immediate mode			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInSetCfg(HANDLE hAdapter, DWORD *pError, DWORD dwAInCfg, DWORD dwAInPreTrig, DWORD dwAInPostTrig);			
Win16 API	BOOL _PdAInSetCfg(HANDLE hAdapter, LPDWORD lpError, DWORD dwAInCfg, DWORD dwAInPreTrig, DWORD dwAInPostTrig);			
Linux API	int _PdAInSetCfg(int handle, DWORD dwAInCfg, DWORD dwAInPreTrig, DWORD dwAInPostTrig);			
RTLinux API	int pd_ain_set_config(int board, u32 dwAInCfg, u32 AInPreTrig, u32 AInPostTrig);			
QNX	int pd_ain_set_config(int board, u32 dwAInCfg, u32 AInPreTrig, u32 AInPostTrig);			

This function sets analog input subsystem configuration: input mode, trigger and clock settings. This command is valid only when the AIn subsystem is in the configuration state (acquisition disabled).

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD dwAInCfg - analog input configuration word

AIn Subsystem Configuration (AInCfg) Bits:

```
 AIB_INPMODE        // AIn Input Mode (Single-
Ended/Differential if set)
 AIB_INPTYPE        // AIn Input Type (Unipolar/Bipolar if set)
 AIB_INPRANGE       // AIn Input Range (5V/10V if set)
 AIB_CVSTART0       // AIn Conv Start Clk Source (2 bits)
 AIB_CVSTART1       // 00 - SW, 01 - internal, 10 - external,
11 - Continuous
 AIB_EXTCVS         // AIn External Conv Start (Pacer) Clk Edge
(falling edge if set)
```

```
 AIB_CLSTART0       // AIn Ch List Start (Burst) Clk Source (2
bits)
 AIB_CLSTART1       // 00 - SW, 01 - internal, 10 - external,
11 - Continuous
 AIB_EXTCLS         // AIn External Ch List Start (Scan) Clk
Edge (falling edge if set)
 AIB_INTCVSBASE     // AIn Internal Conv Start Clk Base
(11MHz/33Mhz if set)
 AIB_INTCLSBASE     // AIn Internal Ch List Start Clk Base
(11MHz/33Mhz if set)
 AIB_STARTTRIG0     // AIn Start Trigger Source (2 bits)
(SW/External if set)
 AIB_STARTTRIG1     // rising edge / falling edge if set
 AIB_STOPTRIG0      // AIn Stop Trigger Source (2 bits)
(SW/External if set)
 AIB_STOPTRIG1      // rising edge / falling edge if set
```

DWORD dwAInPreTrig – reserved. Always 0
DWORD dwAOutPreTrig – reserved. Always 0

Output parameters:
DWORD* pError – error code on failure

Mode and range table selection:

Input Mode	Constant
Single-Ended, 0..5V	0
Single-Ended, 0..10V	AIB_INPRANGE
Single-Ended, -5..+5V	AIB_INPTYPE
Single-Ended, -10..+10V	AIB_INPTYPE + AIB_INPRANGE
Differential, 0..5V	AIB_INPMODE
Differential, 0..10V	AIB_INPMODE + AIB_INPRANGE
Differential, -5..+5V	AIB_INPMODE + AIB_INPTYPE
Differential, -10..+10V	AIB_INPMODE + AIB_INPTYPE + AIB_INPRANGE

Triggering mode table selection:

The Analog input subsystem needs a trigger signal to start and stop acquisition. The Trigger signal is selectable. It can be either software command or an external pulse. External trigger is edge-sensitive. You can select rising or falling edge to be active. If the board is set up to start on an external trigger, all clocks will be ignored until the pulse is detected. Acquisition continues until the stop trigger is detected.

Trigger type	Configuration
Start trigger rising edge	AOB_STARTTRIG0
Start trigger falling edge	AOB_STARTTRIG0 + AOB_STARTTRIG1
Stop trigger rising edge	AOB_STOPTRIG0
Stop trigger falling edge	AOB_ STOPTRIG0+ AOB_ STOPTRIG1
Software trigger	0 (default mode is software trigger if bits are not set)

Clocking

The PowerDAQ board has two selectable base frequencies (11 MHz and 33 MHz) to clock acquisition. Lower frequencies are obtained by dividing the base frequency by a 24-bit number (from 1 to 16M).

To calculate the result frequency use the following formula:
Acquisition Rate = Base Frequency / (divisor + 1)

To calculate the divisor use:
Divisor = (Base Frequency/Acquisition Rate)-1

Acquisition is clocked by two signals: conversion start (CV Start) and channel list start (CL Start). You require both of these signals to start acquisition.

There are four selectable sources for these clocks:
Software command
Internal timebase
External clock
Continuous clocking (or self-retriggerable clock)

Additionally for internal or external clocks, an active edge (rising or falling) can be selected.

***Note**: The PowerDAQ board will generate an error condition each time a clock signal is applied, before the board is ready to process it. For example, if you clock the board with a clock frequency higher than the rated aggregate rate, the board reports a CV/CL start error.*

The CV Start clock starts the A/D conversion. The CL Start clock starts the channel list execution. The CV Start clocks are ignored until the CL Start pulse is sensed. If any clock is switched to continuous clocking, it re-triggers itself immediately after board is ready to process it.

Clock combination		Typical use	Configuration
CL Clock source	**CV Clock source**		
SW	Continuous	Acquire one set of data points (one scan). SW clock causes channel list to be executed once. The board will wait until next CL clock comes before restarting.	AIB_CVSTART0+ AIB_CVSTART1
Internal	Continuous	Continuous acquisition with accurate timebase. After each CL Clock pulse, the channel list is executed at the maximum acquisition rate. This is the most useful mode.	AIB_CLSTART0+ AIB_CVSTART0+ AIB_CVSTART1
External	Continuous	Continuous acquisition when each run of the channel list is triggered by the external signal. This mode is used to synchronize external events with scans.	AIB_CLSTART1+ AIB_CVSTART0+ AIB_CVSTART1
Continuous	Continuous	Performs acquisition at maximum speed possible. Less accurate than using the timebase.	AIB_CLSTART0+ AIB_CLSTART1+ AIB_CVSTART0+ AIB_CVSTART1
Continuous or SW	Internal	Preferable for MF boards. Do not used for MFS board. You can select the specific time between conversions. Use this type of clocking when you want to increase settling time between acquisitions especially when your signal source has high output impedance.	AIB_CLSTART0+ AIB_CLSTART1+ AIB_CVSTART0+ or AIB_CVSTART0

Continuous	External	MF boards only. Useful when one channel is acquired and you want to start acquisition exactly at the external pulse edge.	AIB_CLSTART0+ AIB_CLSTART1+ AIB_CVSTART1
Internal	Internal	Rarely used. MF boards only. Useful with slow scan rates and you need to provide exact time between conversions.	AIB_CLSTART0+ AIB_CVSTART0
External	External	Rarely used. Gives full control of the boards timing to the external device	AIB_CLSTART1+ AIB_CVSTART1
SW	SW	Rarely used. Gives full control of the boards timing to your software	0

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	AIn Set Conversion Clock			
Function	Sets analog input subsystem conversion clock frequency			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInSetCvClk(HANDLE hAdapter, DWORD *pError, DWORD dwClkDiv);			
Win16 API	BOOL _PdAInSetCvClk(HANDLE hAdapter, LPDWORD lpError, DWORD dwClkDiv);			
Linux API	int _PdAInSetCvClk(int handle, DWORD dwClkDiv);			
RTLinux API	int pd_ain_set_cv_clock(int board, u32 clock_divisor);			
QNX	int pd_ain_set_cv_clock(int board, u32 clock_divisor);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD dwClkDiv - AIn conversion start clock divider

The function set internal AIn Conversion Start (pacer) clock configures the DSP Timer (TMR0) to generate a clock signal using the specified divider from either a 11.0 MHz or 33.0 MHz base clock frequency (selected in _PdAInSetCfg).

- Configure AIn Conv Start clock Source to Internal in purpose to utilize internal AIn Conversion Start (pacer) clock: AIB_CVSTART0
- Use AIB_INTCVSBASE to switch between Internal Conversion Start Clock Base (11MHz/33Mhz if the bit is set)
- Divisor = ([Base Frequency] / [Desired Sampling Rate]) - 1;

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	AIn Set Scan Clock			
Function	Sets analog input subsystem scan clock frequency			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInSetClClk(HANDLE hAdapter, DWORD *pError, DWORD dwClkDiv);			
Win16 API	BOOL _PdAInSetClClk(HANDLE hAdapter, LPDWORD lpError, DWORD dwClkDiv);			
Linux API	Int _PdAInSetClClk(int handle, DWORD dwClkDiv);			
RTLinux API	Int pd_ain_set_cl_clock(int board, u32 clock_divisor);			
QNX	Int pd_ain_set_cl_clock(int board, u32 clock_divisor);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD dwClkDiv - AIn scan start clock divider

The set internal AIn Channel List Start (scan) clock configures the DSP Timer (TMR1) to generate a clock signal using the specified divider from either a 11.0 MHz or 33.0 MHz base clock frequency (selected in _PdAInSetCfg).

- Configure AIn CL Start clock Source to Internal in purpose to utilize internal AIn Conversion Start (scan) clock: AIB_CLSTART0
- Use AIB_INTCLSBASE to switch between Internal Conversion Start Clock Base (11MHz/33Mhz if the bit is set)
- Divisor = ([Base Frequency] / [Desired Sampling Rate]) - 1;

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	AIn Set Channel List			
Function	Sets analog input subsystem channel list			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInSetChList(HANDLE hAdapter, DWORD *pError, DWORD dwCh, DWORD *pdwChList);			
Win16 API	BOOL _PdAInSetChList(HANDLE hAdapter, LPDWORD lpError, DWORD dwCh, LPDWORD lpdwChList);			
Linux API	int _PdAInSetChList(int handle, DWORD dwCh, DWORD *pdwChList);			
RTLinux API	int pd_ain_set_channel_list(int board, u32 num_entries, u32 list[]);			
QNX	int pd_ain_set_channel_list(int board, u32 num_entries, u32 list[]);			

Input parameters (Win, Linux):
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD dwCh – number of channels in list
DWORD *pdwChList – channel list data array

Input parameters (RTLinux, QNX):
int board – file descriptor of the subsystem (Linux)
u32 num_entries – number of channels in list
u32 list[] – channel list data array

The set channel list command programs the ADC Channel/Gain List. The ADC Channel List can contain from 1 to 256 channel entries in the base configuration with 4096 entries as an option. Writing a Channel List block clears and overwrites the previous settings. Writing a channel list with 0 channel entries clears the channel list. There is no limit to the number of entries that can be written to the channel list FIFO. You need to check CL size is your application (up to 256 entries).

Configuration data word for each channel includes the channel mux selection, gain, and slow bit setting.

Following macros are useful to program channel list (powerdaq.h)

```
// Macros for constructing Channel List entries.
#define CHAN(c)     ((c) & 0x3f)
#define GAIN(g)     (((g) & 0x3) << 6)
#define SLOW        (1<<8)
#define CHLIST_ENT(c,g,s) (CHAN(c) | GAIN(g) | ((s) ? SLOW :
0))
```

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	AIn Set Enable Conversion Bit			
Function	Sets analog input subsystem enable conversion bit			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInEnableConv(HANDLE hAdapter, DWORD *pError, DWORD dwEnable);			
Win16 API	BOOL _PdAInEnableConv(HANDLE hAdapter, LPDWORD lpError, DWORD dwEnable);			
Linux API	int _PdAInEnableConv(int handle, DWORD dwEnable);			
RTLinux API	int pd_ain_set_enable_conversion(int board, int enable);			
QNX	int pd_ain_set_enable_conversion(int board, int enable);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD dwEnable – 0: disable, 1: enable AIn conversions

The enable AIn conversions command enables or disables AIn conversions irrespective of the AIn Conversion Start or AIn Channel List Start signals. This command permits completing AIn configuration before the subsystem responds to the Start trigger set up in AIn Set Configuration call.

When dwEnable = 0 AIn subsystem Start Trigger is disabled and ignored. Conversion in progress will not be interrupted but the start trigger is disabled from retriggering the subsystem again. When dwEnable = 1 AIn subsystem Start Trigger is enabled and data acquisition will start on the first valid AIn start trigger.

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	AIn Set Events			
Function	Sets analog input subsystem events (when to fire irq)			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInSetEvent(HANDLE hAdapter, DWORD *pError, DWORD dwEvents);			
Win16 API	BOOL _PdAInSetEvent(HANDLE hAdapter, LPDWORD lpError, DWORD dwEvents);			
Linux API	int _PdAInSetEvents(int handle, DWORD dwEvents);			
RTLinux API	int pd_ain_set_events (int board, u32 dwEvents);			
QNX	int pd_ain_set_events (int board, u32 dwEvents);			

Input parameters (Win, Linux):
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD dwEvents – AInIntrStat Event configuration word

Set selected AIn AInIntrStat event bits enabling/disabling and/or clearing individual firmware level events, thereby re-enabling the event interrupts.
AInIntrStat Bit Settings:
AIB_xxxxIm bits: 0 = disable, 1 = enable interrupt
AIB_xxxxSC bits: 0 = clear interrupt, 1 = no change

Note: Used automatically inside the driver in buffered mode, rarely used in user code in immediate mode.
AInIntrStat event word format is defined in pdfw_def.h

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	AIn Get Status			
Function	Gets analog input subsystem status			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInGetStatus(HANDLE hAdapter, DWORD *pError, DWORD *pdwStatus);			
Win16 API	BOOL _PdAInGetStatus(HANDLE hAdapter, LPDWORD lpError, LPDWORD lpdwStatus);			
Linux API	int _PdAInGetStatus(int board);			
RTLinux API	int pd_ain_get_status(int board, u32* status);			
QNX	int pd_ain_get_status(int board, u32* status);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD* dwStatus – AIn Event/Status word
DWORD* pError – error code

The AIn Get Status command obtains the current status and events, including error events, of the AOut subsystem. Used automatically inside the driver in buffered mode, rarely used in user code in immediate mode. See pdfw_def.h for the AInIntrStat event word format.

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	AIn Software Start Trigger			
Function	Pulse start trigger line when analog input is configured to use software trigger start			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInSwStartTrig(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdAInSwStartTrig(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdAInSwStartTrig(int board);			
RTLinux API	int pd_ain_sw_start_trigger(int board);			
QNX	int pd_ain_sw_start_trigger(int board);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD* pError – error code

The SW AIn start trigger command triggers the AIn Start event to start sample acquisition.AIn Start trigger should be in software mode (bits are not set, see _PdAInSetCfg how to set up start trigger).

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	AIn Software Stop Trigger			
Function	Pulse stop trigger line when analog input is configured to use software trigger start			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInSwStopTrig(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdAInSwStopTrig(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdAInSwStopTrig(HANDLE hAdapter, DWORD *pError);			
RTLinux API	int pd_ain_sw_stop_trigger(int board);			
QNX	int pd_ain_sw_stop_trigger(int board);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD* pError – error code

The SW AIn stop trigger command triggers the AIn Stop event to stop sample acquisition. AIn Stop trigger should be in software mode (bits are not set, see _PdAInSetCfg how to set up start trigger). If clocks are not disabled, SW stop trigger allows board to complete started channel list. This means that you can use start/stop trigger to control acquisition without risk of losing samples.

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	AIn Software Conversion Clock			
Function	Pulse conversion clock line once when analog input is configured to use software conversion clock start			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInSwCvStart(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdAInSwCvStart(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdAInSwCvStart(int board);			
RTLinux API	int pd_ain_sw_cv_start(int board);			
QNX	int pd_ain_sw_cv_start(int board);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD* pError – error code

The SW AIn conversion start command pulses the ADC Conversion Start signal. AIn CV clock should be configured into software clock mode (see _PdAInSetCfg for details).

Note: Do not expect to receive samples immediately after issuing this command. It takes 1/Rate seconds to convert data. You should put a delay between software clocking and retrieving data from the FIFO.

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	AIn Software Channel List (scan) Clock			
Function	Pulse channel list (scan) clock line once when analog input is configured to use software conversion clock start			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInSwClStart(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdAInSwClStart(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdAInSwClStart(int board);			
RTLinux API	int pd_ain_sw_cl_start(int board);			
QNX	int pd_ain_sw_cl_start(int board);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD* pError – error code

The SW AIn channel list start command pulses the ADC Conversion Start signal. AIn CL clock should be configured into software clock mode (see _PdAInSetCfg for details).

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	AIn Channel List Reset			
Function	Resets channel list (set to the first channel programmed)			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInResetCl(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdAInResetCl(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdAInResetCl(int board);			
RTLinux API	int pd_ain_reset_cl(int board);			
QNX	int pd_ain_reset_cl(int board);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD* pError – error code

The reset AIn channel list command resets the ADC channel list to the first channel in the list. This command is similar to the SW Channel List Start, but does not enable the list for conversions.

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	Clear ADC FIFO			
Function	Discard all samples from ADC FIFO			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInClearData(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdAInClearData(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdAInResetClearData(int board);			
RTLinux API	int pd_ain_clear_data(int board);			
QNX	int pd_ain_clear_data(int board);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD* pError – error code

The clear all AIn data command clears the ADC FIFO and all AIn data storage buffers.

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	Get Value			
Function	Retrieves one sample stored in ADC FIFO			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInGetValue(HANDLE hAdapter, DWORD *pError, WORD *pwSample);			
Win16 API	BOOL _PdAInGetValue(HANDLE hAdapter, LPDWORD lpError, LPWORD lpwSample);			
Linux API	int _PdAInGetValue(int handle, WORD *pwSample);			
RTLinux API	int pd_ain_get_value(int board, u16* value);			
QNX	int pd_ain_get_value(int board, u16* value);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD* pError – error code on failure
WORD* pwSample – pointer to store sample

The AIn Get Single Value command reads a single value from the ADC FIFO. Please refer to “User Manual” for data representation.

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	Get Samples			
Function	Retrieves all sample stored in ADC FIFO			
Returns	1 if success, 0 if failure (Linux, QNX: number of samples received, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInGetSamples(HANDLE hAdapter, DWORD *pError, DWORD dwMaxBufSize, WORD *pwBuf, DWORD *pdwSamples);			
Win16 API	BOOL _PdAInGetSamples(HANDLE hAdapter, LPDWORD lpError, DWORD dwMaxBufSize, LPWORD lpwBuf, LPDWORD lpdwSamples);			
Linux API	int _PdAInGetSamples(int handle,DWORD dwMaxBufSize, WORD *pwBuf, DWORD *pdwSamples);			

RTLinux API	int pd_ain_get_samples(int board, int max_samples, uint16_t buffer[]);
QNX	int pd_ain_get_samples(int board, int max_samples, uint16_t buffer[]);

Input parameters (Win):
HANDLE hAdapter – handle to adapter
DWORD* pError – error code on failure
DWORD dwMaxBufSize – maximal number of samples to receive
WORD* pwBuf – buffer to store data
DWORD* pdwSamples – pointer to store the number of samples transferred

Input parameters (Linux):
int handle – file descriptor of the subsystem
DWORD dwMaxBufSize - maximal number of samples to receive
WORD* pwBuf – buffer to store data
DWORD* pdwSamples – pointer to store the number of samples transferred

Input parameters (RTLinux, QNX):
int board – board number
int max_samples - maximal number of samples to receive
uint16_t buffer[] buffer to store data
Returns: number of samples transferred of negative value on error
Output parameter:
Number of samples transferred.

The AIn Get Samples command reads upto nMaxBufSize samples from the ADC FIFO until it is empty. Each sample is stored in 16 bits (signed short format).

Win32		Linux	RTLinux	QNX
Function name	Get Samples using DMA transfer			
Function	Retrieves sample stored in ADC FIFO			
Returns	1 if success, 0 if failure (Linux, QNX: number of samples received, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInGetXFerSamples(HANDLE hAdapter, DWORD *pError, DWORD dwMaxBufSize, WORD *pwBuf, DWORD *pdwSamples);			

Linux API	int _PdAInGetSamples(int handle,DWORD dwMaxBufSize, WORD *pwBuf, DWORD *pdwSamples);
RTLinux API	int pd_ain_get_xfer_samples(int board, uint16_t* buffer);
QNX	int pd_ain_get_xfer_samples(int board, uint16_t* buffer);

Input parameters (Win):
HANDLE hAdapter – handle to adapter
DWORD* pError – error code on failure
DWORD dwMaxBufSize – maximal number of samples to receive
WORD* pwBuf – buffer to store data
DWORD* pdwSamples – pointer to store the number of samples transferred

Input parameters (Linux):
int handle – file descriptor of the subsystem
DWORD dwMaxBufSize - maximal number of samples to receive
WORD* pwBuf – buffer to store data
DWORD* pdwSamples – pointer to store the number of samples transferred

Input parameters (RTLinux, QNX):
int board – board number
int max_samples - maximal number of samples to receive
uint16_t buffer[] buffer to store data
Returns: number of samples transferred of negative value on error

Output parameter:
Number of samples transferred.

The AIn Get Samples command reads upto nMaxBufSize samples from the ADC FIFO until it is empty.

Differences between _PdAInGetSamples and _PdAInGetXFerSamples:

_PdAInGetSamples transfers sample-by-sample from the ADC FIFO and checks the FIFO empty flag every time. _PdAInGetXFerSamples transfers data from the ADC FIFO using DMA in bursts. The transfer size can be selected using the _PdAInSetXferSize function. The selected size must be less or equal to the number of samples stored in the ADC FIFO at the time you call _PdAInGetXFerSamples. If the FIFO does not contain enough samples, the buffer is padded with the last available sample.

_PdAInGetXFerSamples is a good function to use for RT-Linux or QNX real-time tasks, when the number of samples to retrieve is predefined.

Win32		**Linux**	**RTLinux**	**QNX**
Function name	Get Samples using DMA transfer			
Function	Retrieves sample stored in ADC FIFO			
Returns	1 if success, 0 if failure (Linux, QNX: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInSetXferSize (HANDLE hAdapter, DWORD *pError, DWORD pdwSamples);			
Linux API	int _PdAInSetXferSize(int handle, DWORD size)			
RTLinux API	int pd_ain_set_xfer_size(int board, u32 size);			
QNX	int pd_ain_set_xfer_size(int board, u32 size);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
DWORD size – size of the DMA transfer (16, 32, ..., [ADC FIFO Size])

Set up DMA transfer burst size. It can only be a power of two starting from 2. There is no need to use XFer is you are transferring less then 16 samples.

Warning: Do not use this function with asynchronous (buffered) mode. It will hang up your PC. Use _PdAInReset to return to default settings

Analog Input buffered mode functions

Buffered mode analog input is available for Windows and Linux platforms. It uses a big buffer (Advanced Circular Buffer – ACB) allocated in virtual memory and locked into physical pages to store data. It allows you to process very high acquisition rates on non-realtime OSes. QNX and RTLinux driver implementations do not support buffered mode due to it realtime nature.
Analog Input buffered mode function set includes:

- Buffer management functions (see chapter 2).
- Initialization/Cleanup functions
- Event management functions
- Data retreiving functions

See _PdAInSetCfg() for analog input configuration information and "PowerDAQ User Manual".

Win32	**Win16**	**Linux**		
Function name	AIn Async Init			
Function	Initialize analog input asynchronous (buffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInAsyncInit(HANDLE hAdapter, DWORD *pError, ULONG dwAInCfg, ULONG dwAInPreTrigCount, ULONG dwAInPostTrigCount, ULONG dwAInCvClkDiv, ULONG dwAInClClkDiv, ULONG dwEventsNotify, ULONG dwChListChan, PULONG pdwChList);			
Win16 API	BOOL _PdAInAsyncInit(HANDLE hAdapter, LPDWORD lpError, DWORD dwAInCfg, DWORD dwAInPreTrigCount, DWORD dwAInPostTrigCount, DWORD dwAInCvClkDiv, DWORD dwAInClClkDiv, DWORD dwEventsNotify, DWORD dwChListChan, LPDWORD lpdwChList);			
Linux API	int _PdAInAsyncInit(int handle, ULONG dwAInCfg, ULONG dwAInPreTrigCount, ULONG dwAInPostTrigCount, ULONG dwAInCvClkDiv, ULONG dwAInClClkDiv, ULONG dwEventsNotify, ULONG dwChListChan, PULONG pdwChList);			

The AIn Initialize Asynchronous Buffered Acquisition function initializes the configuration.

This function does NO checking on the hardware configuration parameters, it is the responsibility of the DLL to verify that the parameters are valid for the device type being configured. It program must pass correct parameters to the function based on the hardware used.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure

DWORD dwAInCfg – analog input configuration DWORD (see pdfw_def.h)

AIn Subsystem Configuration (AInCfg) Bits (see _PdAInSetCfg for additional information):

AIB_INPMODE – AIn Input Mode (Single-Ended/Differential if set)
AIB_INPTYPE – AIn Input Type (Unipolar/Bipolar if set)
AIB_INPRANGE – AIn Input Range (5V/10V if set)
AIB_CVSTART0 – AIn Conv Start Clk Source (2 bits)
AIB_CVSTART1 – 00 - SW, 01 - internal, 10 - external, 11 - Continuous
AIB_EXTCVS – AIn External Conv Start (Pacer) Clk Edge (falling edge if set)
AIB_CLSTART0 – AIn Ch List Start (Burst) Clk Source (2 bits)
AIB_CLSTART1 – 00 - SW, 01 - internal, 10 - external, 11 - Continuous
AIB_EXTCLS – AIn External Ch List Start (Burst) Clk Edge
(falling edge if set)
AIB_INTCVSBASE – AIn Internal Conv Start Clk Base (11MHz/33Mhz if set)
AIB_INTCLSBASE – AIn Internal Ch List Start Clk Base (11MHz/33Mhz if set)
AIB_STARTTRIG0 – AIn Start Trigger Source (2 bits) (SW/External if set)
AIB_STARTTRIG1 – rising edge / falling edge if set
AIB_STOPTRIG0 – AIn Stop Trigger Source (2 bits) (SW/External if set)
AIB_STOPTRIG1 – rising edge / falling edge if set

All other bits are to be used internally

DWORD dwAInPreTrigCount - reserved, keep it 0
DWORD dwAInPostTrigCount – reserved, keep it 0

DWORD dwAInCvClkDiv - sets the value for the conversion (CV) clock divider. The CV clock can come from either an 11 MHz or 33 MHz base frequency. The divider then reduces this frequency down to a specific sampling frequency. Due to a feature in the DSP counter operation, the divider value needs to be one count less than the value you want to utilize. dwAInCvClkDiv = (base frequency / acquisition rate) – 1 (I.e. If you want a divider value of 23, you should set the dwAInCvClkDiv parameter to 22.)

DWORD dwAInClClkDiv - sets the value for the channel list (CL) clock divider. The CL clock can come from either an 11 MHz or 33 MHz base frequency. The divider then reduces this frequency down to a specific scan frequency. Due to a feature in the DSP counter operation, the divider value needs to be one count lower than the value you want to utilize

If the selected frequency is higher than the possible conversion or scan rate, the board ignores pulses coming before it is ready to process the next sample/scan.

DWORD dwEventsNotify - this flag tells the driver upon which events it should notify the application. Each bit of the value references a specific event as listed in the table below.

Event configuration:

EStartTrig – Start trigger received, operation started
eStopTrig – Stop trigger received, operation stopped
eInputTrig – Subsystem specific input trigger (if any)
eDataAvailable – New data available
eScanDone – Scan done (for future use)
eFrameDone – One or more frames are done
eFrameRecycled – Cyclic buffer frame recycled
(i.e. an unread frame is over-written by new data)
eBufferDone – Buffer done
eBufferWrapped – Cyclic buffer wrapped
eConvError – Conversion clock error - pulse came before board is ready to process it
eScanError – Scan clock error
eBufferError – Buffer over/under run error
eStopped – Operation stopped (possibly because of error)
eTimeout – Operation timed out
eAllEvents – Set/clear all events

DWORD dwAInScanSize - indicates the number of channels in each scan
PDWORD pdwChList - specify the pointer to the channel list array.

Win32	**Win16**	**Linux**		
Function name	AIn Async Term			
Function	Terminate analog input asynchronous (buffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInAsyncTerm(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdAInAsyncTerm(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdAInAsyncTerm(int handle);			

The AIn Terminate Asynchronous Buffered Acquisition function terminates and releases the memory allocated for buffered acquisition.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure

Win32	**Win16**	**Linux**		
Function name	AIn Async Start			
Function	Starts analog input asynchronous (buffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInAsyncStart(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdAInAsyncStart(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdAInAsyncStart(int handle);			

The AIn Start Asynchronous Buffered Acquisition function starts buffered acquisition.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure

Win32	**Win16**	**Linux**		
Function name	AIn Async Stop			
Function	Stops analog input asynchronous (buffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInAsyncStop(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdAInAsyncStop(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdAInAsyncStop(int handle);			

The AIn Stop Asynchronous Buffered Acquisition function stops buffered acquisition.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure

Win32	**Linux**			**r3**
Function name	Get AIn Buffer State			
Function	Returns current state of analog input buffered operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInGetBufState(HANDLE hAdapter, DWORD *pError, DWORD NumScans, DWORD *pScanIndex, DWORD *pNumValidScans);			
Linux API	int _PdAInGetBufState(int handle, DWORD NumScans, DWORD *pScanIndex, DWORD *pNumValidScans);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure
DWORD NumScans – number of scans to get [1..MaxScansInBuffer]
DWORD *pScanIndex – pointer to buffer index of first scan
DWORD *pNumValidScans – pointer to number of valid scans available

The AIn Get Scans function returns the oldest scan index in the DAQ buffer and releases (recycles) frame(s) of scans that had been obtained previously.
pScanIndex and pNumValidScans are in scans.

To find out offset of the first sample available use:
WORD* pOffset = pInBuffer + pScanIndex*dwScanSize

If the circular buffer is used and head of the buffer is less than the tail, the first call to this function returns scans from the tail position to the end of the buffer. Subsequent calls return scans from the beginning of the buffer until the head. The user application always receives non-wrapped chunks of data.

Assume that the buffer has four frames, 256 scans each. Total capacity of the buffer is 1024 scans. Wraparound mode is used. _PdAInGetBufState() each time when driver reports eFrameDone event.

Case #	**Head**	**Tail**	**Requested**	**ScanIndex**	**ValidScans**
1	0	255	1024	0	266
2	266	511	256	266	256
3	522	255	1024	522	502
	0	255	1024	0	256

Case 1. Head is less than the tail. All available scans are requested. Function returns 256+ scans (256 scans of the first frame plus whatever number of scans acquired between time of notification and _PdAInGetBufState call. In this example, use 10).

Case 2. Head is less than the tail. Exactly one frame of scans is requested. Function returns exactly 256 scans.

Case 3. Head is bigger than the tail. Buffer is wrapped around. First call to the function returns all scans available from the tail to the end of the buffer. Consecutive calls to the function returns remainder from the beginning of the buffer to the current tail.

Win32	**Linux**			
Function name	Get AIn Buffer State			
Function	Returns current state of analog input buffered operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInGetScans(HANDLE hAdapter, DWORD *pError, DWORD NumScans, DWORD *pScanIndex, DWORD *pNumValidScans);			
Linux API	int _PdAInGetScans(int handle, DWORD NumScans, DWORD *pScanIndex, DWORD *pNumValidScans);			

This function is identical to _PdAInGetBufState() and is is used for compatibility.

Win32				
Function name	Set AIn Private Event			
Returns	1 if success, 0 if failure			
Syntax:				
Win32 API	BOOL _PdAInSetPrivateEvent(HANDLE hAdapter, HANDLE *phNotifyEvent);			

Input parameters:
HANDLE hAdapter – handle to adapter
HANDLE *phNotifyEvent – handle to notification event

The Set Private Event function creates a notification event and sets the driver to signal the event upon assertion of a user event.
WaitForSingleObject() or WaitForMultipleObjects().

Set event pulses when event situation occurs in analog input subsystem.

Linux specific:
Linux driver provides two ways of event notification: using SIGIO and blocking read().
See _PdSetAsyncNotify() and _PdWaitForEvent() for details.

Win32				
Function name	Clear AIn Private Event			
Function	Frees event object and unregisters it with the driver			
Returns	1 if success, 0 if failure			
Syntax:				
Win32 API	BOOL _PdAInClearPrivateEvent(HANDLE hAdapter, HANDLE *phNotifyEvent);			

Input parameters:
HANDLE hAdapter – handle to adapter
HANDLE *phNotifyEvent – handle to notification event

The Clear Private Event function disables signaling of the event by the driver and closes the notification event handle. This function is to be used in conjunction with _PdAInSetPrivateEvent().

4

Analog Output Subsystem Functions

Analog Output Subsystem Functions

Analog Output immediate mode functions (PD2-MF/S boards only)

Analog output immediate (or synchronous) mode functions allow access to all resources of the PowerDAQ MF(S) analog input subsystem.

Function set includes commands:

- to reset analog output subsystem state
- set up configuration (including type of clocking and triggering),
- clock conversion start
- clock start/stop trigger line
- put samples into DAC FIFO
- set DMA transfer size and transfer samples using DMA

Note: *PowerDAQ II AO boards have a separate set of functions with _PdAO prefix. Do not use functions with _PdAOut prefix for PD2-AO-xx boards excluding some circumstances defined in this manual. See chapters 4.3 and 4.4 if you have a PD2-AO-xx board.*

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	AOut Reset			
Function	Reset analog output subsystem			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAOutReset(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdAOutReset(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdAOutReset(int board, DWORD *pError);			
RTLinux API	int pd_aout_reset(int board);			
QNX	int pd_aout_reset(int board);			

This function resets the analog output subsystem: trigger and clock settings, DAC FIFOs, and all state machines. To continue analog input operation after this function has been called you have to set up the board again. This will reset voltages at both analog outputs to 0 (zero).

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)

Output parameters:
DWORD* pError – error code on failure

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	AOut Set Configuration			
Function	Configures analog output subsystem			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAOutSetCfg(HANDLE hAdapter, DWORD *pError, DWORD dwAOutCfg, DWORD dwAOutPostTrig);			
Win16 API	BOOL _export _loadds _PdAOutSetCfg(HANDLE hAdapter, LPDWORD lpError, DWORD dwAOutCfg, DWORD dwAOutPostTrig);			
Linux API	Int _PdAOutSetCfg(int handle, DWORD dwAOutCfg, DWORD dwAOutPostTrig);			
RTLinux API	Int pd_aout_set_config(int board, u32 config, u32 posttrig);			
QNX	Int pd_aout_set_config(int board, u32 config, u32 posttrig);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD* pError – error code on failure
DWORD dwAOutCfg – analog output configuration DWORD
DWORD dwAOutPostTrig – reserved, pass 0 to the function

The set AOut configuration command sets the operating configuration of the AOut subsystem. This command is valid only when the AOut subsystem is in the configuration state (acquisition disabled).

AOut Subsystem Configuration (AInCfg) Bits:

AOB_CVSTART0 – AOut Conv (Pacer) Start Clk Source (2 bits)
AOB_CVSTART1 – 00 - SW, 01 - internal, 10 - external

AOB_EXTCVS – AOut External Conversion (Pacer) Clock Edge (Rising edge if zero/falling edge if set)
AOB_STARTTRIG0 – AOut Start Trigger Source (2 bits) (SW/external if set)
AOB_STARTTRIG1 – (rising edge if zero/falling edge if set)
AOB_STOPTRIG0 – AOut Stop Trigger Source (2 bits) (SW/external if set)
AOB_STOPTRIG1 – (rising edge if zero/falling edge if set)
AOB_REGENERATE – Switch to regenerate mode - use DAC FIFO as circular buffer
AOB_AOUT32 – Set this bit if you would like to use regenerate mode with PD2-AO-xx board
AOB_INTCVSBASE – AOut Internal Conv Start Clk Base (11MHz/33Mhz if set)

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	AOut Set Conversion Clock			
Function	Sets analog output subsystem conversion clock frequency			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAOutSetCvClk(HANDLE hAdapter, DWORD *pError, DWORD dwClkDiv);			
Win16 API	BOOL _PdAOutSetCvClk(HANDLE hAdapter, LPDWORD lpError, DWORD dwClkDiv);			
Linux API	int _PdAOutSetCvClk(int handle, DWORD dwClkDiv);			
RTLinux API	int pd_aout_set_cv_clock(int board, u32 clock_divisor);			
QNX	int pd_aout_set_cv_clock(int board, u32 clock_divisor);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD dwClkDiv - APit conversion start clock divider

This function sets the internal AOut Conversion Start (pacer) clock, configures the DSP Timer (TMR2) to generate a clock signal using the specified divider from 11.0 MHz base clock frequency.

- Configure AOut Conv Start clock Source to Internal to utilize internal Conversion Start (pacer) clock: AOB_CVSTART0
- Divisor = ([11MHz] / [Desired Sampling Rate]) - 1;

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	AOut Get Status			
Function	Gets analog output subsystem status			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAOutGetStatus(HANDLE hAdapter, DWORD *pError, DWORD *pdwStatus);			
Win16 API	BOOL _PdAOutGetStatus(HANDLE hAdapter, LPDWORD lpError, LPDWORD lpdwStatus);			
Linux API	int _PdAOutGetStatus(int board);			
RTLinux API	int pd_aout_get_status(int board, u32* status);			
QNX	int pd_aout_get_status(int board, u32* status);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD* pError – error code
DWORD* dwStatus – AOut Event/Status word

The AOut Get Status command obtains the current status and events, including error events, of the AOut subsystem. This function is used automatically inside the driver in buffered mode, rarely used in user code in immediate mode.
See pdfw_def.h for the AOutIntrStat event word format.

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	AOut Set Enable Conversion Bit			
Function	Sets analog output subsystem enable conversion bit			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAOutEnableConv(HANDLE hAdapter, DWORD *pError, DWORD dwEnable);			
Win16 API	BOOL _PdAOutEnableConv(HANDLE hAdapter, LPDWORD lpError, DWORD dwEnable);			
Linux API	int _PdAOutEnableConv(int handle, DWORD dwEnable);			
RTLinux API	int pd_aout_set_enable_conversion(int board, int enable);			

QNX	int pd_aout_set_enable_conversion(int board, int enable);

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD* pError – error code
DWORD dwEnable – 0: disable, 1: enable AOut conversions

The enable AOut conversions command enables or disables AOut conversions irrespective of the AOut Conversion Clock signal or Start Trigger. During configuration and following
an error condition the AOut conversion process is disabled and must be re-enabled to perform subsequent conversions.

This command permits the completing AOut configuration before the subsystem responds to the Start trigger.

PD_AONCVEN = 0: AOut subsystem Start Trigger is disabled and ignored. Conversion in progress will not be interrupted but the start trigger is disabled from retriggering the subsystem again.

PD_AONCVEN = 1: AOut subsystem Start Trigger is enabled and D/A output will start on the first valid AOut start trigger.

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	AOut Software Start Trigger			
Function	Pulse start trigger line when analog input is configured to use software trigger start			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAInSwStartTrig(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdAInSwStartTrig(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdAInSwStartTrig(int board);			
RTLinux API	int pd_ain_sw_start_trigger(int board);			
QNX	int pd_ain_sw_start_trigger(int board);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)

DWORD* pError – error code

The SW AOut start trigger command triggers the AOut Start event to start value output.
Software trigger should be selected in _PdAOutSetCfg Block mode only.
The SW AOut start trigger command triggers the AOut Start event to start D/A conversion. AOut Start trigger should be in software mode (bits are not set, see _PdAOutSetCfg how to set up start trigger).

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	AOut Software Stop Trigger			
Function	Pulse stop trigger line when analog input is configured to use software trigger start			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAOutSwStopTrig(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdAOutSwStopTrig(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdAOutSwStopTrig(HANDLE hAdapter, DWORD *pError);			
RTLinux API	int pd_aout_sw_stop_trigger(int board);			
QNX	int pd_aout_sw_stop_trigger(int board);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD* pError – error code

The SW AOut stop trigger command triggers the AOut Stop event to stop D/A conversion. AIn Stop trigger should be set in software mode (bits are not set, see _PdAOutSetCfg how to set up start trigger).

Software trigger should be selected in _PdAOutSetCfg block mode only

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	AOut Software Conversion Clock			
Function	Pulse conversion clock line once when analog input is configured to use software conversion clock start			

Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)
Syntax:	
Win32 API	BOOL _PdAOutSwCvStart(HANDLE hAdapter, DWORD *pError);
Win16 API	BOOL _PdAOutSwCvStart(HANDLE hAdapter, LPDWORD lpError);
Linux API	int _PdAOutSwCvStart(int board);
RTLinux API	int pd_aout_sw_cv_start(int board);
QNX	int pd_aout_sw_cv_start(int board);

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD* pError – error code

The SW AOut conversion start command pulses the D/A Conversion Start signal. Analog output will be set up into buffered mode and the buffer will be loaded using _PdAOutPutBlock(). AOut CV clock should be configured to software clock mode (see _PdAOutSetCfg for details). To use this function you should select SW clock in _PdAOutSetCfg, load buffer using _PdAOutPutValues with the appropriate number of values and then clock them out (convert to analog) one by one.

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	Clear DAC FIFO			
Function	Discard all samples from the DAC FIFO			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAOutClearData(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdAOutClearData(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdAOutResetClearData(int board);			
RTLinux API	int pd_aout_clear_data(int board);			
QNX	int pd_aout_clear_data(int board);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD* pError – error code

The clear all AOut data command clears the DAC latch and all AOut data storage buffers.

Win32	Win16	Linux	RTLinux	QNX
Function name	AOut Put Value			
Function	Output one 24-bit value into both AOut channels			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAOutPutValue(HANDLE hAdapter, DWORD *pError, DWORD dwValue);			
Win16 API	BOOL _PdAOutPutValue(HANDLE hAdapter, LPDWORD lpError, DWORD dwValue);			
Linux API	int _PdAOutPutValue(int handle, DWORD dwValue);			
RTLinux API	int pd_aout_put_value(int board, u32 dwValue);			
QNX	int pd_aout_put_value(int board, u32 dwValue);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD* pError – error code
DWORD dwValue – value to write

The AOut put single value command writes a single value to be converted and output by the specified DAC.

This function works only with PD2-MF(S) boards. To set up the output value for PD2-AO series, use _PdAO32Write().

There is a fixed Channel List for the analog output on the PD2-MF(S) boards. The channel list always contains channel 0 and 1 and are updated simultaneously.

***Note:** The two channels are updated at the same time, therefore you have to configure both DACs to the same mode of operation.*

Data Format

31 … 24	23 … 12	11 … 0
Unused 1	12-bit output data for Aout1 1	12-bit output data for Aout 0

Analog Output Data Format

The analog outputs have a fixed output range of +/- 10V. Data representation is straight binary. To convert voltage into binary codes use the following formula.

HexValue = ((Voltage + 10.0V) / 20.0) * 0xFFF

The two Hex values for Aout channel 0 and 1 respectively can be combined to write to the analog output as follows:

Value_To_Write = (HexValue1 << 12) OR (HexValue0)

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	AOut Put Block			
Function	Output one 24-bit value into both AOut channels			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAOutPutBlock(HANDLE hAdapter, DWORD *pError, DWORD dwValues, DWORD *pdwBuf, DWORD *pdwCount);			
Win16 API	BOOL _PdAOutPutBlock(HANDLE hAdapter, LPDWORD lpError, DWORD dwValues, LPDWORD lpdwBuf, LPDWORD lpdwCount);			
Linux API	int _PdAOutPutBlock(int handle, DWORD dwValues, DWORD *pdwBuf, DWORD *pdwCount);			
RTLinux API	int pd_aout_put_block(int board, u32 dwNumValues, u32* pdwBuf, u32* pdwCount);			
QNX	int pd_aout_put_block(int board, u32 dwNumValues, u32* pdwBuf, u32* pdwCount);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD* pError – error code
DWORD dwNumValues – number of values in buf to output
DWORD *pdwBuf – buffer containing values to output
DWORD *pdwCount – number of values successfully written

The AOut put block command writes a block of values to the DAC FIFO

This function can be used either with PD2-MF(S) or PD2-AO series boards. To use it with PD2-AO boards AOB_AOUT32 bit should be set in AOut configuration word. The DAC FIFO size is 2048 samples. If the DAC FIFO is not empty, the function returns the number of values it was able to write until the FIFO becomes full.

Analog Output asynchronous mode functions (PD2–MFx board)

Buffered mode analog output is available for Windows and Linux platforms. It uses a large buffer (Advanced Circular Buffer – ACB) allocated in virtual memory and locked into physical pages to store data. It allows high D/A rates on non-realtime OSes. QNX and RTLinux driver implementations do not support buffered mode due to its' realtime nature. Analog Input buffered mode function set includes:

- Buffer management functions (see chapter 2).
- Initialization/Cleanup functions
- Event management functions
- Data transferring functions

See _PdAOutSetCfg() for analog output configuration information and "PowerDAQ MF(S) User Manual".

Win32	**Linux**			**r3**
Function name	AOut Async Init			
Function	Initialize analog output asynchronous (buffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAOAsyncInit(HANDLE hAdapter, DWORD pError, DWORD dwAOutCfg, DWORD dwAOutCvClkDiv, DWORD dwEventNotify, DWORD dwChListSize, PDWORD pdwChList);			
Linux API	int _PdAOAsyncInit(int handle, DWORD dwAOutCfg, DWORD dwAOutCvClkDiv, DWORD dwEventNotify, DWORD dwChListSize, PDWORD pdwChList);			

Initialize Asynchronous Buffered Acquisition function initializes the configuration.

This driver function does NO checking on the hardware configuration parameters, it is the responsibility of the DLL to verify that the parameters are valid for the device type being configured.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code
DWORD dwAOutCfg – AIn configuration word
DWORD dwAOutCvClkDiv – conv. start clk div.
DWORD dwEventsNotify – subsys user events notif.

dwAOutCfg represents a variety of configuration parameters (see pdfw_def.h):

AOut Subsystem Configuration (AInCfg) Bits:

AOB_CVSTART0 – AOut Conv (Pacer) Start Clk Source (2 bits)
AOB_CVSTART1 – 00 - SW, 01 - internal, 10 - external
AOB_EXTCVS – AOut External Conv (Pacer) Clock Edge rising edge/falling edge if set
AOB_STARTTRIG0 – AOut Start Trigger Source (2 bits) (SW/external falling edge if set)
AOB_STARTTRIG1 – not use
AOB_STOPTRIG0 – AOut Stop Trigger Source (2 bits) (SW/external falling edge if set)
AOB_STOPTRIG1 – not use
AOB_REGENERATE – Switch to regenerate mode - use DAC FIFO as circular buffer
AOB_INTCVSBASE – DOut Internal Conv Start Clk Base (11MHz/33Mhz if set)

If waveform size is less then 2048 values uploads all values directly to the DAC FIFO using _PdAOutPutValues. If the size is bigger then 2048 values, driver will upload needed number of values when DAC FIFO becomes half-full. No events generated but eBufferError.

All other bits are used internally

dwAOutCvClkDiv sets the value for the conversion (CV) clock divider. The CV clock can come from 11 MHz base frequency. The divider then reduces this frequency down to a specific conversion frequency. Due to a

feature in the DSP counter operation, the divider value needs to be one count less than the value you want to use.
dwAInCvClkDiv - (base frequency / acquisition rate) – 1
(Example: If you want a divider value of 23, you should set the dwAOutCvClkDiv parameter to 22.)

If the selected frequency is higher then the possible conversion rate, the board ignores pulses received until it is ready to process next sample

dwEventsNotify flag tells the driver upon which events it should notify the application. Each bit of the value references a specific event as listed in the table below

Event configuration:

```
eStartTrig      Start trigger received, operation started
eStopTrig       Stop trigger received, operation stopped
eFrameDone      One or more frames are done
eBufferDone     Buffer done
eBufferWrapped  Cyclic buffer wrapped
eConvError      Conversion clock error - pulse came before
                board is ready to process it
eBufferError    Buffer over/under run error
eStopped        Operation stopped (possibly because of error)
eAllEvents      Set/clear all events
```

Notes: *PDx-MFx analog output only; See _PdAOutPutValue for analog output format*

Win32	**Win16**	**Linux**		**r3**
Function name	AOut Async Term			
Function	Terminate analog outbuffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAOutAsyncTerm(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdAOutAsyncTerm(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdAOutAsyncTerm(int handle);			

Terminate Asynchronous Buffered Acquisition function terminates and releases memory allocated for buffered output.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure

Note: *PDx-MFx analog output only*

Win32	**Win16**	**Linux**		**r3**
Function name	AOut Async Start			
Function	Starts analog output asynchronous (buffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAOutAsyncStart(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdAOutAsyncStart(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdAOutAsyncStart(int handle);			

The AO Start Asynchronous Buffered Operation function starts buffered output.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure

Win32	**Win16**	**Linux**		**r3**
Function name	AOut Async Stop			
Function	Stops analog output asynchronous (buffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAOutAsyncStop(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdAOutAsyncStop(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdAOutAsyncStop(int handle);			

The AIn Stop Asynchronous Buffered Operation function stops buffered output.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure

Win32	**Linux**	**Linux**		
Function name	Get AOut Buffer State			
Function	Returns current state of analog output buffered operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAOutGetBufState(HANDLE hAdapter, DWORD *pError, DWORD NumScans, DWORD *pScanIndex, DWORD *pNumValidScans);			
Linux API	int _PdAOutGetBufState(int handle, DWORD NumScans, DWORD *pScanIndex, DWORD *pNumValidScans);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure
DWORD NumScans – number of scans to get [1..MaxScansInBuffer]
DWORD *pScanIndex – pointer to buffer index of first scan
DWORD *pNumValidScans – pointer to number of valid scans available

This function gets the current state of the analog output buffer and informs the application of how many samples can be accepted and where to put them.

Before starting buffered analog output you have to fill a whole buffer with data. The driver sets eFrameDone event when one or more frames become available for refill. The driver continues to output data from the next frame at this time. After _PdAOutGetBufState() is called, the driver marks the buffer from pScanIndex to pScanIndex+pNumValidScans as refilled.

The AOut Get Buffer State function returns the oldest released index in the DAQ buffer and the size of the data outputed area. pScanIndex and pNumValidScans are in scans.

To find out the offset of the first sample available use:
WORD* pOffset = pInBuffer + pScanIndex*dwScanSize

If a circular buffer is used and head of the buffer is less then the tail, the first call to this function returns scans from the tail position to the end of the buffer. Subsequent calls return scans from the beginning of the buffer until the head. The user application always receives non-wrapped chunks to fill with data.
***Notes:** PDx-MFx analog output only. We can update both of AOut channels at the same time only. The channel list size is always fixed at 2. You have to allocate the buffer using _PdAcquireBuffer with the ScanSize always equal 2.*

Special mode:
If AIB_DWORDVALUES flag in _PdAcquireBuffer() dwMode parameter is selected you have to pack both channels values into one DWORD. Values for both channels are packed in one DWORD. Channel 0 occupies bits from 0 to 11 and channel 1 from 12 to 23.

Win32				
Function name	Set AOut Private Event			
Function	Creates event object for analog input subsystem and register it with the driver			
Returns	1 if success, 0 if failure			
Syntax:				
Win32 API	BOOL _PdAOutSetPrivateEvent(HANDLE hAdapter, HANDLE *phNotifyEvent);			

Input parameters:
HANDLE hAdapter – handle to adapter
HANDLE *phNotifyEvent – handle to notification event

The Set Private Event function creates a notification event and sets the driver to signal the event upon assertion of a user event.
To utilize the set event in applications you should use Win32 API functions: WaitForSingleObject() or WaitForMultipleObjects().
Set event pulses when event situation occurs in analog output subsystem.

Linux specific:
The Linux driver provides two ways of event notification: using SIGIO and blocking read(). See _PdSetAsyncNotify() and _PdWaitForEvent() for details.

Win32				
Function name	Clear AOut Private Event			
Function	Frees event object and unregisters it with the driver			
Returns	1 if success, 0 if failure			
Syntax:				
Win32 API	BOOL _PdAOutClearPrivateEvent(HANDLE hAdapter, HANDLE *phNotifyEvent);			

Input parameters:
HANDLE hAdapter – handle to adapter
HANDLE *phNotifyEvent – handle to notification event

The Clear Private Event function disables signaling of events by the driver and closes the notification event handle. This function is to be used in conjuncation with _PdAOutSetPrivateEvent().

Analog Output immediate mode functions (PD2-AO board)

PowerDAQ PD2-AO family has a separate set of immediate mode functions. These functions will not work with PowerDAQ PD2-MF(S) multifunction boards.
QNX and RTLinux drivers do not have built-in functions for PD2-AO family. You have to include the library with these functions into your module.

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	Reset AO board			
Function	Resets all AO outputs into 0V state			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAO32Reset(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdAO32Reset(HANDLE hAdapter, DWORD *pError);			
Linux API	int _PdAO32Reset(int handle);			
RTLinux API	int _PdAO32Reset(int handle);			
QNX	int _PdAO32Reset(int handle);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)

PDWORD pError – error code on failure

Resets PD2-AOxx subsystem to 0V state.

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	Write to AO board			
Function	Writes value to specified channel of the AO board and convert it immediately			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAO32Write(HANDLE hAdapter, DWORD *pError, WORD wChannel, WORD wValue);			
Win16 API	BOOL _PdAO32Write(HANDLE hAdapter, DWORD *pError, WORD wChannel, WORD wValue);			
Linux API	int _PdAO32Write(int handle, WORD wChannel, WORD wValue);			
RTLinux API	int _PdAO32Write(int handle, WORD wChannel, WORD wValue);			
QNX	int _PdAO32Write(int handle, WORD wChannel, WORD wValue);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure
WORD wChannel – number of channel to write to
WORD wValue – value to write

PD2-AO uses straight binary data encoding where 0x0000 is –10V, 0x7fff – 0V and 0xffff is - +10V

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	WriteHold to AO board			
Function	Writes value to the buffer of specified channel of the AO board and holds it until _PdAO32Update() call			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			

Syntax:	
Win32 API	BOOL _PdAO32WriteHold(HANDLE hAdapter, DWORD *pError, WORD wChannel, WORD wValue);
Win16 API	BOOL _PdAO32WriteHold(HANDLE hAdapter, DWORD *pError, WORD wChannel, WORD wValue);
Linux API	int _PdAO32WriteHold(int handle, WORD wChannel, WORD wValue);
RTLinux API	int _PdAO32WriteHold(int handle, WORD wChannel, WORD wValue);
QNX	int _PdAO32WriteHold(int handle, WORD wChannel, WORD wValue);

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure
WORD wChannel – number of channel to write to
WORD wValue – value to write

PD2-AO uses straight binary data encoding where 0x0000 is –10V, 0x7fff – 0V and 0xffff is - +10V

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	Update AO board			
Function	Updates voltages on analog outputs			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAO32Update (HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdAO32Update (HANDLE hAdapter, DWORD *pError);			
Linux API	int _PdAO32Update (int handle);			
RTLinux API	int _PdAO32Update (int handle);			
QNX	int _PdAO32Update (int handle);			

Update all outputs with previously written values

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure

Use this function in conjuncation with _PdAO32Write. Write values to the DACs you want to update. Values will be stored in these registers. _PdAO32Update outputs stored values to DACs

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	Set Update Channel			
Function	Sets channel number that triggers update line upon write to it			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAO32SetUpdateChannel (HANDLE hAdapter, DWORD *pError, WORD wChannel, BOOL bEnable);			
Win16 API	BOOL _PdAO32SetUpdateChannel (HANDLE hAdapter, DWORD *pError, WORD wChannel, BOOL bEnable);			
Linux API	int _PdAO32SetUpdateChannel (int handle, WORD wChannel, int bEnable);			
RTLinux API	int _PdAO32SetUpdateChannel (int handle, WORD wChannel, int bEnable);			
QNX	int _PdAO32SetUpdateChannel (int handle, WORD wChannel, int bEnable);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure
WORD wChannel – number of channel to select/unselect as update channels
BOOL bEnable – action. 1 – select, 0 - unselect
Set channel number writen to update all values

You can set the channel that will trigger the DACs update line. You might want to write and hold data to all needed registers using _PdAO32WriteHold() and then update them on the last write to the selected register.

Analog Output asynchronous mode functions (PD2-AO board)

Win32	**Linux**			**r3**
Function name	AO Async Init			
Function	Initializate asynchronous operation for PD2-AO series board			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAOAsyncInit(HANDLE hAdapter, PDWORD pError, DWORD dwAOutCfg, DWORD dwAOutCvClkDiv, DWORD dwEventNotify, DWORD dwChListSize, PDWORD pdwChList);			
Linux API	int _PdAOAsyncInit(int handle, PDWORD pError, DWORD dwAOutCfg, DWORD dwAOutCvClkDiv, DWORD dwEventNotify, DWORD dwChListSize, PDWORD pdwChList);			

Initialize Asynchronous Buffered Acquisition function initializes the configuration.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor to open subsystem (Linux)
PDWORD pError – error code
DWORD dwAOutCfg – AIn configuration word
DWORD dwAOutCvClkDiv – conv. start clk div.
DWORD dwEventsNotify – subsys user events notif.
DWORD dwChListSize – size of the channel list
PDWORD pdwChList – channel list data array

This driver function does NO checking on the hardware configuration parameters, it is the responsibility of the DLL to verify that the parameters are valid for the device type being configured.

DWORD dwAOutCfg - this represents a variety of configuration parameters (from pdfw_def.h:)

AOut Subsystem Configuration (AInCfg) Bits:
AOB_CVSTART0 – AOut Conv (Pacer) Start Clk Source (2 bits)
AOB_CVSTART1 – 00 - SW, 01 - internal, 10 - external
AOB_EXTCVS – AOut External Conv (Pacer) Clock Edge rising edge/falling edge if set
AOB_STARTTRIG0 – AOut Start Trigger Source (2 bits) (SW/external rising edge if set)
AOB_STOPTRIG0 – AOut Stop Trigger Source (2 bits) (SW/external rising edge if set)
AOB_REGENERATE – Switch to regenerate mode - use DAC FIFO as circular buffer

If the waveform size is less than 2048 values, upload all values directly to the DAC FIFO using _PdAOutPutValues. If the size is larger than 2048 values, the driver will upload the required number of values when DAC FIFO becomes half-full. No events are generated but eBufferError.

All other bits are used internally.

DWORD dwAOutCvClkDiv - sets the value for the conversion (CV) clock divider.
The CV clock can come from 11 MHz base frequency. The divider then reduces this frequency down to a specific conversion frequency. Due to a feature in the DSP counter operation, the divider value needs to be one count less than the value you want to utilize.
dwAInCvClkDiv - (base frequency / acquisition rate) – 1 (example: If you want a divider value of 23, you should set the dwAOutCvClkDiv parameter to 22.)

If the selected frequency is higher then the possible conversion rate, the board ignores pulses until it is ready to process the next sample.

dwEventsNotify (DWORD) - this flag tells the driver upon which events it should notify the application. Each bit of the value references a specific event as listed in the table below.

Event configuration:
```
eStartTrig     Start trigger received, operation started
eStopTrig      Stop trigger received, operation stopped
eFrameDone     One or more frames are done
eBufferDone    Buffer done
eBufferWrapped Cyclic buffer wrapped
```

```
eConvError     Conversion clock error - pulse came before board
               is ready to process it
eBufferError   Buffer over/under run error
eStopped       Operation stopped (possibly because of error)
eAllEvents     Set/clear all events
```

Channel list for the PD2-AO boards has following format

```
6    5  4          0
+---+--+-----------+
|UA |WH|channel #  |
+---+--+-----------+
```

Update All (UA) bit.
If bit #6 is selected (set to 1) all analog output channels are updated when this channel is written. If no new data was written the previous data is used and output remain unchanged.
Write And Hold (WH) bit.
When bit #5 is selected (set to 1) data written to the DAC is stored in the input buffer. DAC output will be updated when the command is issued.

If the channel list size is equal to zero, data will be transferred into the DAC FIFO unchanged

Notes: *PD2-AO boards only*

Win32	**Linux**			**r3**
Function name	AO Async Term			
Function	Terminate analog output (buffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAOAsyncTerm(HANDLE hAdapter, DWORD *pError);			
Linux API	int _PdAOAsyncTerm(int handle);			

Terminate Asynchronous Buffered Acquisition function terminates buffered output.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure

Note: *PD2-AO-xx analog output on*

Win32	**Linux**			**r3**
Function name	AO Async Start			
Function	Starts analog output asynchronous (buffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAOAsyncStart(HANDLE hAdapter, DWORD *pError);			
Linux API	int _PdAOAsyncStart(int handle);			

The AOut Start Asynchronous Buffered Operation function starts buffered output.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure

Notes: *PD2-AO boards only*

Win32	**Linux**			**r3**
Function name	AO Async Stop			
Function	Stops analog output asynchronous (buffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAOAsyncStop(HANDLE hAdapter, DWORD *pError);			
Linux API	int _PdAOAsyncStop(int handle);			

The AOut Stop Asynchronous Buffered Operation function stops buffered output.

Input parameters:

HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure

***Notes:** PD2-AO boards only*

Win32	**Linux**			**r3**
Function name	Get AO Buffer State			
Function	Returns current state of analog output buffered operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdAOGetBufState(HANDLE hAdapter, DWORD *pError, DWORD NumScans, DWORD *pScanIndex, DWORD *pNumValidScans);			
Linux API	int _PdAOGetBufState(int handle, DWORD NumScans, DWORD *pScanIndex, DWORD *pNumValidScans);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure
DWORD NumScans – number of scans to get [1..MaxScansInBuffer]
DWORD *pScanIndex – pointer to buffer index of first scan
DWORD *pNumValidScans – pointer to number of valid scans available

The function gets the current state of the analog output buffer and informs the application of how many samples can be accepted and where to put them.

Before starting buffered analog output you have to fill a whole buffer with data. The driver sets eFrameDone event when one or more frames become available for refill. The driver continues to output data from the next frame . After _PdAOGetBufState() is called the driver marks the buffer from pScanIndex to pScanIndex+pNumValidScans as refilled.

The AOut Get Buffer State function returns the oldest released index in the DAQ buffer and the size of the outputed data area. pScanIndex and pNumValidScans are in scans.
To find out the offset of the first sample available use:
WORD* pOffset = pInBuffer + pScanIndex*dwScanSize

If the circular buffer is used and the head of the buffer is less then the tail, first call to this function returns the scans from the tail position to the end of the buffer. Subsequent calls return scans from the beginning of the buffer until the head. User applications always receive non-wrapped chunks to fill with data.

Notes: *PD2-AO analog output boards only*

Win32				**r3**
Function name	Set AO Private Event			
Function	Creates event object for analog input subsystem of AO board and register it with the driver			
Returns	1 if success, 0 if failure			
Syntax:				
Win32 API	BOOL _PdAOSetPrivateEvent(HANDLE hAdapter, HANDLE *phNotifyEvent);			

Input parameters:
HANDLE hAdapter – handle to adapter
HANDLE *phNotifyEvent – handle to notification event

The Set Private Event function creates a notification event and sets the driver to signal the event upon assertion of a user event.
To utilize the set event in applications you should use Win32 API functions: WaitForSingleObject() or WaitForMultipleObjects().

Set event pulses when the event situation occurs in analog output subsystem.

Linux specific:
The Linux driver provides two ways of event notification: using SIGIO and blocking read(). See _PdSetAsyncNotify() and _PdWaitForEvent() for details.

Win32				**r3**
Function name	Clear AO Private Event			
Function	Frees event object and unregisters it with the driver			
Returns	1 if success, 0 if failure			
Syntax:				
Win32 API	BOOL _PdAOClearPrivateEvent(HANDLE hAdapter, HANDLE *phNotifyEvent);			

Input parameters:
HANDLE hAdapter – handle to adapter

HANDLE *phNotifyEvent – handle to notification event

The Clear Private Event function disables signaling of the event by the driver and closes the notification event handle. This function is to be used in conjuncation with _PdAOSetPrivateEvent().

Digital I/O Subsystem Functions

Digital I/O Subsystem Functions

Digital Input/Output immediate mode functions (PD2-MFx board)

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	DIn Reset			
Function	Resets Pdx-MFx or PD2-AO digital input subsystem			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDInReset(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdDInReset(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdDInReset(int handle);			
RTLinux API	int pd_din_reset(int board);			
QNX	int pd_din_reset(int board);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status

Command clears all digital input configuration settings and latches.

Notes: *PDx-MFx and PD2-AO boards only. See _PdDIO... functions for PD2-DIO board family*

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	DOut Reset			
Function	Resets Pdx-MFx or PD2-AO digital output subsystem			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDOutReset(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdDOutReset(HANDLE hAdapter, LPDWORD lpError);			

Linux API	int _PdDOutReset(int handle);
RTLinux API	int pd_dout_reset(int board);
QNX	int pd_dout_reset(int board);

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status

Command clears all digital output lines (set to 0).

Notes:
PDx-MFx and PD2-AO boards only. See _PdDIO... functions for PD2-DIO board family

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	DIn Set Config			
Function	Sets digital input subsystem configuration for immediate mode			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDInSetCfg(HANDLE hAdapter, DWORD *pError, DWORD dwDInCfg);			
Win16 API	BOOL _PdDInSetCfg(HANDLE hAdapter, LPDWORD lpError, DWORD dwDInCfg);			
Linux API	int _PdAInSetCfg(int handle, DWORD dwDInCfg);			
RTLinux API	int pd_din_set_config(int board, u32 dwDInCfg);			
QNX	int pd_din_set_config(int board, u32 dwDInCfg);			

The set DIn configuration command sets the operating configuration for the DIn subsystem.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int board – file descriptor of the subsystem (Linux)
DWORD *pError – pointer to last error status
DWORD dwAInCfg - digital input configuration word

Eight lower DIn lines on PD2-MFx boards are edge-sensitive. You can program DIn to generate an interrupt when a particular line changes state. File pdfw_def.h contains the following definition, where x = [0..7]

DIB_xCFG0 DIn Bit x sets rising edge to fire interrupt
DIB_xCFG1 DIn Bit x sets falling edge to fire interrupt
[...]

Notes: *PD2-DIO boards have their own set of functions. See _PdDIOxxx*

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	DIn Get Status			
Function	Gets digital input subsystem input levels and latches			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDInGetStatus(HANDLE hAdapter, DWORD *pError, DWORD* pdwEvents);			
Win16 API	BOOL _PdDInGetStatus(HANDLE hAdapter, LPDWORD lpError, DWORD* pdwEvents);			
Linux API	int _PdDInGetStatus(int handle, DWORD* dwEvents);			
RTLinux API	int pd_din_get_status(int board, u32* dwEvents);			
QNX	int pd_din_get_status(int board, u32* dwEvents);			

The Get DIn Status command obtains the current input levels and the currently latched input change events of all digital input signals.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status
DWORD *pdwEvents – word for storing input status word:
Bits 0 - 7: Digital Input Bit Level (i.e. current level)
Bits 8 - 15: Digital Input Bit Trigger Status (latched data)

Notes: *See pdfw_def.h for details (DIB_LEVELx and DIB_INTRx bits)*
Only one bit of status per line is available. If you programmed the board to generate an interrupt, say, on any edge of line 0, bit 8 will not tell you which edge caused the event.
To find this out you need to analyze bit 0 for current line state and bit 8 for latched event.

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	DIn Read			
Function	Read digital input subsystem input levels			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDInRead(HANDLE hAdapter, DWORD *pError, DWORD* pdwValue);			
Win16 API	BOOL _PdDInRead(HANDLE hAdapter, LPDWORD lpError, DWORD* pdwValue);			
Linux API	int _PdDInRead(int handle, DWORD* pdwValue);			
RTLinux API	int pd_din_read_inputs(int board, u32 *pdwValue);			
QNX	int pd_din_read_inputs(int board, u32 *pdwValue);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status
DWORD *pdwValue – word for storing input lines state

The DIn Read Data command obtains the current input levels of all 16 digital input lines for the PD2-MFx series or 8 digital input lines for PD-MF series or PD2-AO series.

***Note:** PDx-MFx and PD2-AO boards only. See _PdDIO... functions for PD2-DIO board family*

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	DOut Write			
Function	Writes digital output subsystem output levels			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDOutWrite(HANDLE hAdapter, DWORD *pError, DWORD dwValue);			
Win16 API	BOOL _PdDOutWrite(HANDLE hAdapter, LPDWORD lpError, DWORD dwValue);			
Linux API	int _PdDOutWrite(int handle, DWORD dwValue);			
RTLinux API	int pd_dout_write_outputs(int board, u32 dwValue);			
QNX	int pd_dout_write_outputs(int board, u32 dwValue);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status
DWORD dwValue – word for storing input lines state

The DOut Write Data command writes values to all 16 digital output lines for PD2-MFx series or 8 digital input lines for PD-MF or PD2-AO series.

***Note:** PDx-MFx and PD2-AO boards only. See _PdDIO... functions for PD2-DIO board family*

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	DIn Clear Data			
Function	Clears digital input latch			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDInClearData(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdDInClearData(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdDInClearData(int handle);			
RTLinux API	int pd_din_clear_data(int board);			
QNX	int pd_din_clear_data(int board);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status

The clear all DIn latched data command clears all stored DIn data.

***Notes:** Use this function after the program has informed that changes occured on digital line and status was read using _PdDInGtStatus. Calling this funstion will clear bits 8-15 of the status word*
PDx-MFx boards only. See _PdDIO... functions for PD2-DIO board family

Win32				
Function name	Set DIn Private Event			
Function	Creates event object for digital input subsystem and register it with the driver			
Returns	1 if success, 0 if failure			
Syntax:				
Win32 API	BOOL _PdDInSetPrivateEvent(HANDLE hAdapter, HANDLE *phNotifyEvent);			

Input parameters:
HANDLE hAdapter – handle to adapter
HANDLE *phNotifyEvent – handle to notification event

The Set Private Event function creates a notification event and sets the driver to signal the event upon assertion of a user event. Use _PdDInSetCfg() to set up line states you want to be notified on.
To utilize the set event in applications you should use Win32 API functions: WaitForSingleObject() or WaitForMultipleObjects().

Set event pulses when event situation occurs in digital input subsystem.

Linux specific:
The Linux driver provides two ways of event notification: using SIGIO and blocking read(). See _PdSetAsyncNotify() and _PdWaitForEvent() for details.

Win32				
Function name	Clear DIn Private Event			
Function	Frees event object and unregisters it with the driver			
Returns	1 if success, 0 if failure			
Syntax:				
Win32 API	BOOL _PdDInClearPrivateEvent(HANDLE hAdapter, HANDLE *phNotifyEvent);			

Input parameters:
HANDLE hAdapter – handle to adapter
HANDLE *phNotifyEvent – handle to notification event

The Clear Private Event function disables signaling of events by the driver and closes the notification event handle. This function is to be used in conjuncation with _PdDInSetPrivateEvent().

Digital Input/Output immediate mode functions (PD2-DIO board)

Win32	Win16	Linux	RTLinux	QNX
Function name	DIO Reset			
Function	Resets PD2-DIO digital input subsystem			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDIOReset(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdDIOReset(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdDIOReset(int handle);			
RTLinux API	int _PdDIOReset(int board);			
QNX	int _PdDIOReset(int board);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status

Command clears all digital input configuration settings and latches.

Notes: *PD2-DIO boards only. See _PdDIn functions for PD2-MFx or PD2-AO families*

Win32	Win16	Linux	RTLinux	QNX
Function name	DIO Enable Output			
Function	Select input or output state of DIO lines			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDIOEnableOutput(HANDLE hAdapter, DWORD *pError, DWORD dwRegMask);			
Win16 API	BOOL _PdDIOEnableOutput(HANDLE hAdapter, LPDWORD lpError, DWORD dwRegMask);			
Linux API	int _PdDIOEnableOutput(int handle, DWORD dwRegMask);			
RTLinux API	int _PdDIOEnableOutput(int board, u32 dwRegMask);			
QNX	int _PdDIOEnableOutput(int board, u32 dwRegMask);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status
DWORD dwRegMask – mask of the registers to enable output

Function sets the digital lines to input (tri-stated) or output (driven) mode.

dwRegMask selects which of 16-bit register sets DIn and which sets DOut. If register is set in Din, it's tristated. PD2-DIO64 uses only the four lower bits of dwRegMask and PD2-DIO128 – eight of them. Rest of the bits should be set to zero.

dwRegMask format: r7 r6 r5 r4 r3 r2 r1 r0. 1 in the dwRegMask means that the register is selected for output. 0 means that register is selected for input. Example: To select registers 0,1 and 4,5 for output dwRegMask = 0x33 (00110011)

Notes: *PD2-DIO boards only. See _PdDIn functions for PD2-MFx or PD2-AO families*

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	DIO Latch All			
Function	Select input or output state of DIO lines			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDIOLatchAll(HANDLE hAdapter, DWORD *pError, DWORD dwRegister);			
Win16 API	BOOL _PdDIOLatchAll(HANDLE hAdapter, DWORD *pError, DWORD dwRegister);			
Linux API	int _PdDIOLatchAll(int handle, DWORD dwRegister);			
RTLinux API	int _PdDIOLatchAll(int handle, DWORD dwRegister);			
QNX	int _PdDIOLatchAll(int handle, DWORD dwRegister);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status
DWORD dwRegister – number of register to latch (however if registers 0 to 3 are selected function latches bank 0, if registers 4 to 7 are selected it latches bank 1)

Latch the state of all inputs in a bank. This function strobe latch signal and data presents on the input lines is clocked into registers. Use this function to latch all inputs at the same time (simultaneously) and function _PdDIOSimpleRead to read latched registers one by one (without re-latching them).

Note:
Function latches data for only one bank (16 x 4 lines). If you use PD2-DIO128 board with two banks you might need to call this function twice - first time for the bank 0 (dwRegister = 0) and second time for the bank 1 (dwRegister = 4)
PD2-DIO boards only. See _PdDIn functions for PD2-MFx or PD2-AO families

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	DIO Simple Read			
Function	Reads value stored in the digital input buffer			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDIOSimpleRead(HANDLE hAdapter, DWORD *pError, DWORD dwRegister, DWORD *pdwValue);			
Win16 API	BOOL _PdDIOSimpleRead(HANDLE hAdapter, DWORD *pError, DWORD dwRegister, DWORD *pdwValue);			
Linux API	int _PdDIOSimpleRead(int handle, DWORD dwRegister, DWORD *pdwValue);			
RTLinux API	int _PdDIOSimpleRead(int handle, DWORD dwRegister, DWORD *pdwValue);			
QNX	int _PdDIOSimpleRead(int handle, DWORD dwRegister, DWORD *pdwValue);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status
DWORD dwRegister – number of register to read

Returns value stored in the latch without strobing of latch signal

Notes: *Function doesn't return tha actual state of DIn lines but rather data stored when latch was strobed last time.*
PD2-DIO boards only. See _PdDIn functions forMFx or AO families

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	DIO Read			
Function	Latches and reads value stored in the digital input buffer			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDIORead(HANDLE hAdapter, DWORD *pError, DWORD dwRegister, DWORD *pdwValue);			
Win16 API	BOOL _PdDIORead(HANDLE hAdapter, DWORD *pError, DWORD dwRegister, DWORD *pdwValue);			
Linux API	int _PdDIORead(int handle, DWORD dwRegister, DWORD *pdwValue);			
RTLinux API	int _PdDIORead(int handle, DWORD dwRegister, DWORD *pdwValue);			
QNX	int _PdDIORead(int handle, DWORD dwRegister, DWORD *pdwValue);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status
DWORD dwRegister – number of register to read

Strobe latch line for the register specified and returns value stored in the latch.

***Notes:** Use this function to retrieve state of the inpupts immediately PD2-DIO boards only. See _PdDIn functions for PD2-MFx or PD2-AO families*

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	DIO Write			
Function	Writes value specified to digital output buffer			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDIOWrite(HANDLE hAdapter, DWORD *pError, DWORD dwRegister, DWORD dwValue);			
Win16 API	BOOL _PdDIOWrite(HANDLE hAdapter, DWORD *pError, DWORD dwRegister, DWORD dwValue);			

Linux API	int _PdDIOWrite(int handle, DWORD dwRegister, DWORD dwValue);
RTLinux API	int _PdDIOWrite(int handle, DWORD dwRegister, DWORD dwValue);
QNX	int _PdDIOWrite(int handle, DWORD dwRegister, DWORD dwValue);

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status
DWORD dwRegister – number of register to read
DWORD dwValue – value (16-bit) to write to the register

Write values to digital output register

Notes: *When used, this function call value is written to the output register. To see actual voltages on the ouputs, specified register shall be configured as output using _PdDIOEnableOutput*
PD2-DIO boards only. See _PdDIn functions for PD2-MFx or PD2-AO families

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	DIO Propagation Enable			
Function	Enables generation of "Write" (Prop) pulse upon write to specified register			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDIOPropEnable(HANDLE hAdapter, DWORD *pError, DWORD dwRegMask);			
Win16 API	BOOL _PdDIOPropEnable(HANDLE hAdapter, DWORD *pError, DWORD dwRegMask);			
Linux API	int _PdDIOPropEnable(int handle, DWORD dwRegister, DWORD dwRegMask);			
RTLinux API	int _PdDIOPropEnable(int handle, DWORD dwRegister, DWORD dwRegMask);			
QNX	int _PdDIOPropEnable(int handle, DWORD dwRegister, DWORD dwRegMask);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)

int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status
DWORD dwRegMask – enable mask

PD2-DIO boards have a special line "Write" ("Propagate") to inform external devices about data that has been writen to the output. You can select "write" to which register causes the "propagate" pulse.
dwRegMask format is <r7 r6 r5 r4 r3 r2 r1 r0> where rx are 16-bit registers. PD2-DIO64 has only fours registers, PD2-DIO128 eight.
1 in the dwRegMask means that write to this register will cause a pulse on the "porpagate" line
0 in the dwRegMask means that write to this register will not affect this line
Example: dwRegMask = 0xF0. It means that any write to the bank 1 will cause pulse on "propagate" line and writes to the bank 0 will not.

Notes: *PD2-DIO boards only. See _PdDIn functions for PD2-MFx or PD2-AO families*

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	DIO External Latch Enable			
Function	Set or clear external latch enable bit for specified bank			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDIOExtLatchEnable(HANDLE hAdapter, DWORD *pError, DWORD dwRegister, BOOL bEnable);			
Win16 API	BOOL _PdDIOExtLatchEnable(HANDLE hAdapter, LPDWORD lpError, DWORD dwRegister, DWORD dwEnable);			
Linux API	int _PdDIOExtLatchEnable(int handle, DWORD dwRegister, BOOL bEnable);			
RTLinux API	int _PdDIOExtLatchEnable(int handle, DWORD dwRegister, BOOL bEnable);			
QNX	int _PdDIOExtLatchEnable(int handle, DWORD dwRegister, BOOL bEnable);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status
DWORD dwRegister – register bank (0 or 4)
DWORD bEnable –

bEnable = 0 - disable external latch line (default)
bEnable = 1 - enable external latch line

You can enable or disable external latch line for each register bank separately. If the "latch" line is enabled, a pulse on this line will cause input registers to store input signal levels. You can use _PdDIOExtLatchRead function to find out what data latched or did not. Use _PdDIOSimpleRead() function to read latched data

Notes: *PD2-DIO boards only. See _PdDIn functions for PD2-MFx or PD2-AO families*

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	DIO External Latch Read			
Function	Reads external latch enable bit for specified bank			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDIOExtLatchRead(HANDLE hAdapter, DWORD *pError, DWORD dwRegister, BOOL *bLatch);			
Win16 API	BOOL _PdDIOExtLatchRead(HANDLE hAdapter, LPDWORD lpError, DWORD dwRegister, BOOL *bLatch);			
Linux API	int _PdDIOExtLatchRead(int handle, DWORD dwRegister, BOOL *bLatch);			
RTLinux API	int _PdDIOExtLatchRead(int handle, DWORD dwRegister, BOOL *bLatch);			
QNX	int _PdDIOExtLatchRead(int handle, DWORD dwRegister, BOOL *bLatch);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status
DWORD dwRegister – register bank (0 or 4)
BOOL* bLatch – pointer to latch state

Returns status of the external latch line. External latch pulse sets external latch status bit to "1". This function clears external latch status bit.

Notes: *PD2-DIO boards only. See _PdDIn functions for PD2-MFx or PD2-AO families*

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	DIO Set Interrupt Mask			
Function	Set bitmask to specify interrupt conditions			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDIOSetIntrMask(HANDLE hAdapter, DWORD *pError, DWORD* dwIntMask);			
Win16 API	BOOL _PdDIOSetIntrMask(HANDLE hAdapter, LPDWORD lpError, DWORD* dwIntMask);			
Linux API	int _PdDIOSetIntrMask(int handle, DWORD* dwIntMask);			
RTLinux API	int _PdDIOSetIntrMask(int handle, DWORD* dwIntMask);			
QNX	int _PdDIOSetIntrMask(int handle, DWORD* dwIntMask);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status
DWORD* dwIntMask – pointer to interrupt mask array (8 DWORDs)

This function sets up an interrupt mask. The PD2-DIO is capable to generate a host interrupt when a selected bit changes its state. dwIntMask is array of 8 DWORDs each of them correspondes to one register of PD2-DIO board. Only lower 16 bits are valid

Notes: *PD2-DIO boards only. See _PdDIn functions for PD2-MFx or PD2-AO families*

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	DIO Get Interrupt Data			
Function	Returns cause of interrupt			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDIOGetIntrMask(HANDLE hAdapter, DWORD *pError, DWORD* dwIntData, DWORD* dwEdgeData);			
Win16 API	BOOL _PdDIOGetIntrMask(HANDLE hAdapter, LPDWORD lpError, DWORD* dwIntData, DWORD* dwEdgeData);			

Linux API	int _PdDIOGetIntrMask(int handle, DWORD* dwIntData, DWORD* dwEdgeData);
RTLinux API	int _PdDIOGetIntrMask(int handle, DWORD* dwIntData, DWORD* dwEdgeData);
QNX	int _PdDIOGetIntrMask(int handle, DWORD* dwIntData, DWORD* dwEdgeData);

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status
DWORD* dwIntData – array to store int data (8 DWORDs)
DWORD* dwEdgeData – array to store edge data (8 DWORDs)

The function returns the cause of an interrupt. dwIntData contains "1" in the position where bits have changed their states. Only LSW is valid. dwEdgeData bits are valid only in the positions where dwIntData contains "1"s. If a bit is "1" - rising edge caused the interrupt, if a bit is "0" - falling edge occurs.

***Notes:** PD2-DIO boards only. See _PdDIn functions for PD2-MFx or PD2-AO families and dwEdgeData and dwIntData with dwIntMask to mask "in significant" bits*
This mode is not compatible with asynchronous mode

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	DIO Enable Interrupt			
Function	Enables or disables interrupt generation on line state change			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDIOIntrEnable(HANDLE hAdapter, DWORD *pError, DWORD dwEnable);			
Win16 API	BOOL _PdDIOIntrEnable(HANDLE hAdapter, DWORD *pError, DWORD dwEnable);			
Linux API	int _PdDIOIntrEnable(int handle, DWORD dwEnable);			
RTLinux API	int _PdDIOIntrEnable(int handle, DWORD dwEnable);			
QNX	int _PdDIOIntrEnable(int handle, DWORD dwEnable);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)

int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status
DWORD dwEnable – 0: disable, 1: enable DIO interrupts

This function enables or disables host interrupt generation for the PD2-DIO board. Use _PdDIOSetIntrMask to set up the DIO interrupt mask

Digital Input asynchronous mode functions (PD2-DIO board)

Buffered mode digital input is available for Windows and Linux platforms. It uses a large buffer (Advanced Circular Buffer – ACB) allocated in virtual memory and locked into physical pages to store data. It allows high acquisition rates on non-realtime OSes. QNX and RTLinux driver implementations do not support buffered mode due to it realtime nature. Digital Input buffered mode function set includes:

- Buffer management functions (see chapter 2).
- Initialization/Cleanup functions
- Event management functions
- Data retriving functions

See "PowerDAQ User Manual" for additional information.

Win32	**Linux**			**r3**
Function name	DIn Async Init			
Function	Initialize digital input asynchronous (buffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDIAsyncInit(HANDLE hAdapter, DWORD *pError, ULONG dwDInCfg, ULONG dwDInCvClkDiv, ULONG dwEventsNotify, ULONG dwChListChan, ULONG dwFirstChan);			
Linux API	int _PdDIAsyncInit(int handle, ULONG dwDInCfg, ULONG dwDInCvClkDiv, ULONG dwEventsNotify, ULONG dwChListChan, ULONG dwFirstChan);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)

DWORD *pError — pointer to last error status
DWORD dwDInCfg — AIn configuration word
DWORD dwDInCvClkDiv — conv. start clk div.
DWORD dwEventsNotify — subsys user events notif.
DWORD dwChListChan — number of channels in list (1,2,4,8)
DWORD dwFirstChannel — channel number to start from

Initialize Asynchronous Buffered Acquisition function initializes the configuration for buffered acquisiton. The channel list is fixed starting from dwFirstChannel and has dwChListChan size. For example, if dwFirstChannel = 1 and dwChListChan = 4 causes scan size equal 4 (channels 1 thru 4).

This driver function does NO checking on the hardware configuration parameters, it is the responsibility of the DLL to verify that the parameters are valid for the device type being configured.

Configuration:
dwDInCfg (DWORD) - this represents a variety of configuration parameters. (from pdfw_def.h)

DIn Subsystem Configuration (AInCfg) Bits:

```
AIB_CVSTART0    // DIn Conv Start Clk Source (2 bits)
AIB_CVSTART1    // 00 - SW, 01 - internal, 10 - external
AIB_EXTCVS      // DIn External Conv Start (Pacer) Clk Edge
                // (falling edge if set)
AIB_INTCVSBASE  // DIn Internal Conv Start Clk Base
(11MHz/33Mhz if set)
AIB_STARTTRIG0  // DIn Start Trigger Source (2 bits)
(SW/External falling edge if set)
AIB_STARTTRIG1  // not use
AIB_STOPTRIG0   // DIn Stop Trigger Source (2 bits)
(SW/External falling edge if set)
AIB_STOPTRIG1   // not use
```

All other bits are internally

dwDInCvClkDiv (DWORD) - sets the value for the conversion (CV) clock divider. The CV clock can come from either an 11 MHz or 33 MHz base frequency. The divider then reduces this frequency down to a specific sampling frequency. Due to a feature in the DSP counter operation, the divider value needs to be one count less than the value you want to utilize. dwDInCvClkDiv - (base frequency / acquisition rate) — 1. (Example: If you want a divider value of 23, you should set the dwAInCvClkDiv parameter to 22.)

If selected the frequency is higher then possible conversion or scan rate, the board ignores pulses come before it is ready to process the next sample/scan.

dwEventsNotify (DWORD) - this flag tells the driver upon which events it should notify the application. Each bit of the value references a specific event as listed in the table below

Event configuration:

```
EstartTrig       Start trigger received, operation started
eStopTrig        Stop trigger received, operation stopped
eDataAvailable   New data available
eFrameDone       One or more frames are done
eFrameRecycled   Cyclic buffer frame recycled (i.e. an unread
                 frame is over-written by new data)
eBufferDone      Buffer done
eBufferWrapped   Cyclic buffer wrapped
eConvError       Conversion clock error - pulse came before
                 board is ready to process it
eBufferError     Buffer over/under run error
eStopped         Operation stopped (possibly because of error)
eTimeout         Operation timed out
eAllEvents       Set/clear all events
```

dwChListChan (DWORD) - indicates the number of channels in each scan

Note: *PD2-DIO boards only*

Win32	**Linux**			**r3**
Function name	DIn Async Term			
Function	Terminate digital input asynchronous (buffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDIAsyncTerm(HANDLE hAdapter, DWORD *pError);			
Linux API	int _PdDIAsyncTerm(int handle);			

The DIn Terminate Asynchronous Buffered Acquisition function terminates buffered acquisition

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure

Note: *PD2-DIO boards only*

Win32	**Linux**			**r3**
Function name	DIn Async Start			
Function	Starts digital input asynchronous (buffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDIAsyncStart(HANDLE hAdapter, DWORD *pError);			
Linux API	int _PdDIAsyncStart(int handle);			

The DIn Start Asynchronous Buffered Acquisition function starts buffered acquisition.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure

Note: *PD2-DIO boards only*

Win32	**Linux**			**r3**
Function name	DIn Async Stop			
Function	Stops digital input asynchronous (buffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDInAsyncStop(HANDLE hAdapter, DWORD *pError);			
Linux API	int _PdDInAsyncStop(int handle);			

The DIn Stop Asynchronous Buffered Acquisition function stops buffered acquisition.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure

Note: *PD2-DIO boards only*

Win32	**Linux**			**r3**
Function name	Get DIn Buffer State			
Function	Returns current state of digital input buffered operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDInGetBufState(HANDLE hAdapter, DWORD *pError, DWORD NumScans, DWORD *pScanIndex, DWORD *pNumValidScans);			
Linux API	int _PdDInGetBufState(int handle, DWORD NumScans, DWORD *pScanIndex, DWORD *pNumValidScans);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure
DWORD NumScans – number of scans to get [1..MaxScansInBuffer]
DWORD *pScanIndex – pointer to buffer index of first scan
DWORD *pNumValidScans – pointer to number of valid scans available

The DIn Get Scans function returns the oldest scan index in the DAQ buffer and releases (recycles) frame(s) of scans that had been obtained previously.
pScanIndex and pNumValidScans are in scans.

To find out the offset of the first sample available use:
WORD* pOffset = pInBuffer + pScanIndex*dwScanSize

If the circular buffer is used and the head of the buffer is less then the tail, the first call to this function returns scans from the tail position to the end of the buffer. Subsequent calls return scans from the beginning of the buffer until the head. The user application always receives non-wrapped chunk of data. Let's assume that the buffer has four frames, 256 scans each. Total capacity of the buffer is 1024 scans. Wraparound mode is used.

_PdDInGetBufState() should be called each time when driver reports eFrameDone event.

Case #	Head	Tail	Requested	ScanIndex	ValidScans
1	0	255	1024	0	266
2	266	511	256	266	256
3	522	255	1024	522	502
	0	255	1024	0	256

Case 1. Head is less than the tail. All available scans are requested. Function returns 256+ scans (256 scans of the first frame plus whatever number of scans acquired between time of notification and _PdDInGetBufState call. In this example let's put it 10).

Case 2. Head is less than the tail. Exactly one frame of scans is requested. Function returns exactly 256 scans.

Case 3. Head is bigger then a tail. Buffer is wrapped around. First call to the function returns all scans available from the tail to the end of the buffer. Consecutive calls to the function returns remainder from the beginning of the buffer to current tail.

Note: *PD2-DIO boards only*

Win32				**r3**
Function name	Set DIn Private Event			
Function	Creates event object for analog input subsystem and register it with the driver			
Returns	1 if success, 0 if failure			
Syntax:				
Win32 API	BOOL _PdDISetPrivateEvent(HANDLE hAdapter, HANDLE *phNotifyEvent);			

Input parameters:
HANDLE hAdapter – handle to adapter
HANDLE *phNotifyEvent – handle to notification event

The Set Private Event function creates a notification event and sets the driver to signal the event upon assertion of a user event.
To utilize the set event in applications you should use Win32 API functions: WaitForSingleObject() or WaitForMultipleObjects().
Set event pulses when event situation occurs in digital input subsystem.

Linux specific:
The Linux driver provides two ways of event notification: using SIGIO and blocking read(). See _PdSetAsyncNotify() and _PdWaitForEvent() for details.

Note: *PD2-DIO boards only*

Win32				
Function name	Clear DIn Private Event			
Function	Frees event object and unregisters it with the driver			
Returns	1 if success, 0 if failure			
Syntax:				
Win32 API	BOOL _PdDIClearPrivateEvent(HANDLE hAdapter, HANDLE *phNotifyEvent);			

Input parameters:
HANDLE hAdapter – handle to adapter
HANDLE *phNotifyEvent – handle to notification event

The Clear Private Event function disables signaling of an event by the driver and closes the notification event handle. This function is to be used in conjuncation with _PdDInSetPrivateEvent().

Note: *PD2-DIO boards only*

Digital Output asynchronous mode functions (PD2–DIO board)

Win32	**Linux**			**r3**
Function name	DOut Async Init			
Function	Initialize digital output asynchronous (buffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDOAsyncInit(HANDLE hAdapter, DWORD pError, DWORD dwDOutCfg, DWORD dwDOutCvClkDiv, DWORD dwEventNotify, DWORD dwChListSize, PDWORD pdwChList);			

Linux API	int _PdDOAsyncInit(int handle, DWORD dwDOutCfg, DWORD dwDOutCvClkDiv, DWORD dwEventNotify, DWORD dwChListSize, PDWORD pdwChList);

Initialize Asynchronous Buffered Acquisition function initializes the configuration.

This driver function does NO checking on the hardware configuration parameters, it is the responsibility of the DLL to verify that the parameters are valid for the device
type being configured.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code
DWORD dwDOutCfg – AIn configuration word
DWORD dwDOutCvClkDiv – conversion start clock divisor
DWORD dwEventsNotify – DOut subsystem user events to notify
DWORD dwChListSize – channel list size
DWORD* pdwChList – array of DWORDs representing channel list

Configuration:
dwDOutCfg (DWORD) - this represents a variety of configuration parameters
(from pdfw_def.h).

DOut Subsystem Configuration (AInCfg) Bits:
AOB_CVSTART0 – DOut Conv (Pacer) Start Clk Source (2 bits)
AOB_CVSTART1 – 00 - SW, 01 - internal, 10 - external
AOB_EXTCVS – DOut External Conv (Pacer) Clock Edge rising edge/falling edge if set
AOB_STARTTRIG0 – DOut Start Trigger Source (2 bits) (SW/external falling edge if set)
AOB_STARTTRIG1 – not use
AOB_STOPTRIG0 – DOut Stop Trigger Source (2 bits) (SW/external falling edge if set)
AOB_STOPTRIG1 – not use
AOB_REGENERATE – Switch to regenerate mode - use DAC FIFO as circular buffer
AOB_INTCVSBASE – DOut Internal Conv Start Clk Base (11MHz/33Mhz if set)

All other bits are to be used internally.

dwDOutCvClkDiv (DWORD) - sets the value for the conversion (CV) clock divider.
The CV clock can come from 11 MHz base frequency. The divider then reduces this frequency down to a specific conversion frequency. Due to a feature in the DSP counter operation, the divider value needs to be one count less than the value you want to utilize.
dwAInCvClkDiv - (base frequency / acquisition rate) – 1. (Example: If you want a divider value of 23, you should set the dwDOutCvClkDiv parameter to 22.)

If selected frequency is higher than the possible conversion rate, board ignores pulses coming in before it is ready to process next sample.

dwEventsNotify (DWORD) - this flag tells the driver upon which events it should notify the application. Each bit of the value references a specific event as listed in the table below

Event configuration:

```
eStartTrig        Start trigger received, operation started
eStopTrig         Stop trigger received, operation stopped
eFrameDone        One or more frames are done
eBufferDone       Buffer done
eBufferWrapped    Cyclic buffer wrapped
eConvError        Conversion clock error - pulse came before
                  board is ready to process it
eBufferError      Buffer over/under run error
eStopped          Operation stopped (possibly because of error)
eAllEvents        Set/clear all events
```

Channel list for the PD2-DIO boards has the following format

```
  2        0
+-------------+
|  channel #  |
+-------------+
```

Notes: *PD2-DIO boards only. If "Fixed DMA" mode is set, dwChListSize represents size of the channel list (it will be a power of 2: 1, 2, 4, 8) and pdwChList points to DWORD where the first scan sequence channel is stored.*

Win32	**Linux**			**r3**
Function name	DOut Async Term			
Function	Terminate analog output (buffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDOAsyncTerm(HANDLE hAdapter, DWORD *pError);			
Linux API	int _PdDOAsyncTerm(int handle);			

Terminate Asynchronous Buffered Output function terminates buffered output.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure

Note: *PD2-DIO boards only*

Win32	**Linux**			**r3**
Function name	DOut Async Start			
Function	Starts analog output asynchronous (buffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDOAsyncStart(HANDLE hAdapter, DWORD *pError);			
Linux API	int _PdDOAsyncStart(int handle);			

The DOut Start Asynchronous Buffered Operation function starts buffered output.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure

Notes: *PD2-DIO boards only*

Win32	**Linux**			**r3**
Function name	DOut Async Stop			
Function	Stops digital output asynchronous (buffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDOAsyncStop(HANDLE hAdapter, DWORD *pError);			
Linux API	int _PdDOAsyncStop(int handle);			

The DOut Stop Asynchronous Buffered Operation function stops buffered output.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure

Notes: *PD2-DIO boards only*

Win32	**Linux**			**r3**
Function name	Get DOut Buffer State			
Function	Returns current state of digital output buffered operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdDOGetBufState(HANDLE hAdapter, DWORD *pError, DWORD NumScans, DWORD *pScanIndex, DWORD *pNumValidScans);			
Linux API	int _PdDOGetBufState(int handle, DWORD NumScans, DWORD *pScanIndex, DWORD *pNumValidScans);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure
DWORD NumScans – number of scans to get [1..MaxScansInBuffer]
DWORD *pScanIndex – pointer to buffer index of first scan

DWORD *pNumValidScans – pointer to number of valid scans available

The function gets current state of digital output buffer and informs the application of how many samples can be accepted and where to put them.

Before starting buffered digital output you have to fill a whole buffer with data. The driver sets eFrameDone event when one or more frames become available for refilling. The driver continues to output data from the next frame at this time. After _PdAOGetBufState() is called, the driver marks the buffer from pScanIndex to pScanIndex+pNumValidScans as filled.

The DO Get Buffer State function returns the oldest released index in the DAQ buffer and the size of already output area. pScanIndex and pNumValidScans are in scans.

To find out offset of the first sample available use:
WORD* pOffset = pInBuffer + pScanIndex*dwScanSize

If the circular buffer is used and the head of the buffer is less than the tail , the first call to this function returns scans from the tail position to the end of the buffer. Subsequent calls return scans from the beginning of the buffer untill the head. The user application always receives non-wrapped chunks to fill with data.

***Notes**: PD2-DIO digital output only.*

Special mode:
If AIB_DWORDVALUES flag in _PdAcquireBuffer() dwMode parameter is selected you have to pack both channels values into one DWORD. Values for both channels are packed in one DWORD. Channel 0 occupies bits from 0 to 11 and channel 1 from 12 to 23.

Win32				**r3**
Function name	Set DOut Private Event			
Function	Creates event object for analog input subsystem of AO board and register it with the driver			
Returns	1 if success, 0 if failure			
Syntax:				
Win32 API	BOOL _PdDOSetPrivateEvent(HANDLE hAdapter, HANDLE *phNotifyEvent);			

Input parameters:

HANDLE hAdapter – handle to adapter
HANDLE *phNotifyEvent – handle to notification event

The Set Private Event function creates a notification event and sets driver to signal the event upon assertion of a user event.
To utilize the set event in applications you should use Win32 API functions: WaitForSingleObject() or WaitForMultipleObjects().

Set event pulses when the event situation occurs in the digital output subsystem.

Linux specific:
Linux driver provides two ways of event notification: using SIGIO and blocking read().
See _PdSetAsyncNotify() and _PdWaitForEvent() for details.

Win32				**r3**
Function name	Clear DOut Private Event			
Function	Frees event object and unregisters it with the driver			
Returns	1 if success, 0 if failure			
Syntax:				
Win32 API	BOOL _PdDOClearPrivateEvent(HANDLE hAdapter, HANDLE *phNotifyEvent);			

Input parameters:
HANDLE hAdapter – handle to adapter
HANDLE *phNotifyEvent – handle to notification event

The Clear Private Event function disables signaling of events by the driver and closes the notification event handle. This function is to be used in conjuncation with _PdDOSetPrivateEvent().

Counter-Timer Subsystem Functions

Counter–Timer Subsystem Functions

General UCT access functions

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	UCT Reset			
Function	Resets PDx-MFx counter-timer subsystem			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdUctReset(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdUctReset(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdUctReset(int handle);			
RTLinux API	int pd_uct_reset(int board);			
QNX	int pd_uct_reset(int board);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status

Command clears all counter-timer input configuration settings and latches.

Notes: *PDx-MFx boards only.*

Win32	**Linux**			**r3**
Function name	UCT Set Mode			
Function	Sets PDx-MFx counter-timer mode			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdUctSetMode(HANDLE hAdapter, DWORD* pError, DWORD dwCounter, DWORD dwSource, DWORD dwMode);			
Linux API	int _PdUctSetMode(int handle, DWORD dwCounter, DWORD dwSource, DWORD dwMode);			

Preconfigures UCT to use in particular mode.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status
DWORD dwCounter – counter to use
DWORD dwSource – clock and gate sources
DWORD dwMode – mode to use

dwMode – see 82C54 datasheet (modes 0-5)
UCT_MDEVENTCNT - event counting
UCT_MDPULSEGEN - pulse generation
UCT_MDTRAINGEN - pulse train generation
UCT_MDSQWAVEGEN - square wave generation
UCT_MDEVENTGEN - driver event generation

DWORD dwCounter = 0,1 or 2

DWORD dwSource =
UCT_INT1MHZCLK - 1MHz internal timebase
UCT_EXTERNALCLK - external clock
UCT_SWCLK - sw strobes
UCT_UCT0OUTCLK - output of UCT0 as a clock combine clock source with gate source:
UCT_SWGATE - software controls gates
UCT_HWGATE - external gating

Notes: *PDx-MFx boards only. If SW gate is selected it's set to "low". Use _PdUctSwSetGate to control SW gates*

Win32	**Linux**			**r3**
Function name	UCT Write Value			
Function	Writes 16-bit value to specified counter-timer			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdUctWriteValue(HANDLE hAdapter, DWORD* pError, DWORD dwCounter, WORD wValue);			
Linux API	int _PdUctWriteValue(int handle, DWORD dwCounter, WORD wValue);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)

DWORD *pError — pointer to last error status
DWORD dwCounter — counter to use
WORD wValue — value to write

Notes: *PDx-MFx boards only*

Win32	**Linux**			**r3**
Function name	UCT Read Value			
Function	Reads 16-bit value to specified counter-timer			
Returns	1 if success, 0 if failure (Linux: 0 — success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdUctReadValue(HANDLE hAdapter, DWORD* pError, DWORD dwCounter, WORD* wValue);			
Linux API	int _PdUctReadValue(int handle, DWORD dwCounter, WORD* wValue);			

Input parameters:
HANDLE hAdapter — handle to adapter (Win)
int handle — handle to adapter (Linux)
DWORD *pError — pointer to last error status
DWORD dwCounter — counter to use
WORD* wValue — pointer to store read value

Notes: *PDx-MFx boards only*

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	UCT Set Config			
Function	Sets PDx-MFx counter-timer subsystem configuration			
Returns	1 if success, 0 if failure (Linux: 0 — success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdUctSetCfg(HANDLE hAdapter, DWORD *pError, DWORD dwUctCfg);			
Win16 API	BOOL _PdUctSetCfg(HANDLE hAdapter, LPDWORD lpError, DWORD dwUctCfg);			
Linux API	int _PdUctSetCfg(int handle, DWORD dwUctCfg);			
RTLinux API	int pd_uct_set_config(int board, u32 config);			
QNX	int pd_uct_set_config(int board, u32 config);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status
DWORD dwUctCfg – counter-timer configuration word

The set User Counter/Timer configuration command sets the clock and gate for the specified user counter/timer.

UCT configuration bits are defined in pdfw_def.h

UTB_CLK0 – UCT 0 Clock Source (2 bits)
UTB_CLK0_1 – 00 - SW clock; 01 - Internal 1MHz clock; 11 - external clock
UTB_CLK1 – UCT 1 Clock Source (2 bits)
UTB_CLK1_1 – 00 - SW clock; 01 - Internal 1MHz clock; 10 - UCT0 output; 11 - external clock
UTB_CLK2 – UCT 2 Clock Source (2 bits)
UTB_CLK2_1 – 00 - SW clock; 01 - Internal 1MHz clock; 10 - UCT0 output; 11 - external clock
UTB_GATE0 – UCT 0 Gate Source bit: 0 - SW, 1 - external gate
UTB_GATE1 – UCT 1 Gate Source bit: 0 - SW, 1 - external gate
UTB_GATE2 – UCT 2 Gate Source bit: 0 - SW, 1 - external gate
UTB_SWGATE0 – UCT 0 SW Gate Setting bit: 0 - UCT disable, 1 – UCT enable (gate high)
UTB_SWGATE1 – UCT 1 SW Gate Setting bit: 0 - UCT disable, 1 - UCT enable (gate high)
UTB_SWGATE2 – UCT 2 SW Gate Setting bit: 0 - UCT disable, 1 - UCT enable (gate high)

To write a value to the UCT (82C54) you need to have a clock on its input. The best way to do this is to enable the internal 1Mhz clock and disable counting (put gate low)

See datasheet of Intel 82C54 for further details

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	UCT Get Status			
Function	Gets PDx-MFx counter-timer subsystem status			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdUctGetStatus(HANDLE hAdapter, DWORD pError, DWORD dwStatus);			

Win16 API	BOOL _PdUctSetCfg(HANDLE hAdapter, LPDWORD lpError, DWORD* dwStatus);
Linux API	int _PdUctGetStatus(int handle, DWORD* dwStatus);
RTLinux API	int pd_uct_get_config(int board, u32* status);
QNX	int pd_uct_get_config(int board, u32* status);

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status
DWORD dwStatus – pointer to store counter-timer subsystem status

The UCT status command obtains the output levels and latched event bits that signaled an event of the three user counter/timers (0, 1, 2).

UctStatus format:

```
bbb bbb
 |   |__UCTxOut
 |_____UCTxIntrSC
```

UCT status word format is defined in pdfw_def.h:

UTB_LEVEL0 – UCT 0 Output Level
UTB_LEVEL1 – UCT 1 Output Level
UTB_LEVEL2 – UCT 2 Output Level
UTB_INTR0 – UCT 0 Latched Interrupt
UTB_INTR1 – UCT 1 Latched Interrupt
UTB_INTR2 – UCT 2 Latched Interrupt

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	UCT Set Software Gate			
Function	Sets PDx-MFx counter-timer subsystem gate level			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdUctSwSetGate(HANDLE hAdapter, DWORD *pError, DWORD dwGateLevel);			
Win16 API	BOOL _PdUctSwSetGate(HANDLE hAdapter, LPDWORD lpError, DWORD dwGateLevel);			

Linux API	int _PdUctSwSetGate(int handle, DWORD dwGateLevel);
RTLinux API	int pd_uct_set_sw_gate(int board, u32 gate_level);
QNX	int pd_uct_set_sw_gate(int board, u32 gate_level);

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status
DWORD dwGateLevel – counter-timer configuration word

The SW UCT gate setting command sets the UCT gate input levels of the specified User Counter/Timers, thus enabling or disabling counting by software command.

2 1 0 <- counter-timers
Format: [g2 g1 g0] - set 0 to put gate low, 1 to put gate high

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	UCT Sw Strobe			
Function	Clocks PDx-MFx counter-timer once			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdUctSwClkStrobe(HANDLE hAdapter, DWORD *pError);			
Win16 API	BOOL _PdUctSwClkStrobe(HANDLE hAdapter, LPDWORD lpError);			
Linux API	int _PdUctSwClkStrobe(int handle);			
RTLinux API	int pd_uct_sw_strobe(int board);			
QNX	int pd_uct_sw_strobe(int board);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD *pError – pointer to last error status

The SW UCT clock strobe command strobes the UCT clock input of all User Counter/Timers. Counter-timers shall be configured in software strobe mode.

Notes: *PDx-MFx boards only.*

Win32	**Win16**	**Linux**	**RTLinux**	**QNX**
Function name	UCT Write			
Function	Writes directly to UCT 82C54 port			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdUctWrite(HANDLE hAdapter, DWORD *pError, DWORD dwUctWord);			
Win16 API	BOOL _PdUctWrite(HANDLE hAdapter, LPDWORD lpError, DWORD dwUctWord);			
Linux API	int _PdUctWrite(int handle, DWORD dwUctWORD);			
RTLinux API	int pd_uct_write(int board, u32 value);			
QNX	int pd_uct_write(int board, u32 value);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD* pError – error code
DWORD dwUctWord – data and command combined

Description: The UCT Write command writes two or three bytes to the specified user counter/timer registers.

```
dwUctWord format:
31     24       16        8          0
|xxxxxxxx|___MSB__|___LSB__|_control__|
```

Control byte (UCT control word): The PowerDAQ API defines special constants to manipulate the UCT control word.

82C54 Control Word Format (CWF):

```
 bit definitions
 #define UCT_BCD      (1<<0)     // BCD mode (0 - binary 16-
bit counter,
                                 // 1 - BCD cntr)
 #define UCT_M0       (1<<1)     // mode bit
 #define UCT_M1       (1<<2)     // mode bit
 #define UCT_M2       (1<<3)     // mode bit
 #define UCT_RW0      (1<<4)     // read/write mode
 #define UCT_RW1      (1<<5)     // read/write mode
 #define UCT_SC0      (1<<6)     // counter select
 #define UCT_SC1      (1<<7)     // counter select a. counter
select
 #define UCT_SelCtr0  (0)        // select counter 0
```

```
 #define UCT_SelCtr1  (UCT_SC0)  // select counter 1
 #define UCT_SelCtr2  (UCT_SC1)  // select counter 2
 #define UCT_ReadBack (UCT_SC0|UCT_SC1) // Read-Back Command

 b. mode select
 #define UCT_Mode0    (0)        // output high on terminal
// count
 #define UCT_Mode1    (UCT_M0)   // retriggerable one-shot
(use
// gate to retrigger)
 #define UCT_Mode2    (UCT_M1)   // rate generator
 #define UCT_Mode3    (UCT_M0|UCT_M1)  // square wave
generator
 #define UCT_Mode4    (UCT_M2)   // software triggered strobe
 #define UCT_Mode5    (UCT_M0|UCT_M2)  // hardware triggered
strobe

 c. read/write mode
 #define UCT_RWlsb    (UCT_RW0)  // r/w LSB only
 #define UCT_RWmsb    (UCT_RW1)  // r/w MSB only
 #define UCT_RW16bit  (UCT_RW0|UCT_RW1) // r/w LSB first then
MSB
 #define UCT_CtrLatch (0)        // Counter Latch Command
                                 //(read)
```

You need to combine a+b+c to write a command to the counter

To write values to UCT (82C54) you need to have some clock on its input. The best way to do this is to enable the internal 1Mhz clock and disable counting (put gate low)

Notes: *PDx-MFx boards only.*

Win32	Win16	Linux	RTLinux	QNX
Function name	UCT Read			
Function	Reads directly from UCT 82C54 port			
Returns	1 if success, 0 if failure (Linux: 0 – success, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdUctRead(HANDLE hAdapter, DWORD *pError, DWORD dwUctReadCfg, DWORD *pdwUctWord);			
Win16 API	BOOL _PdUctRead(HANDLE hAdapter, LPDWORD lpError, DWORD dwUctReadCfg, LPDWORD lpdwUctWord);			

Linux API	int _PdUctRead(int handle, DWORD dwUctReadCfg, DWORD *pdwUctWORD);
RTLinux API	int pd_uct_read(int board, u32 config, u32* value);
QNX	int pd_uct_read(int board, u32 config, u32* value);

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD* pError – error code
DWORD dwUctReadCfg – UCT Read format word
DWORD *pdwUctWord – UCT Word to store word read

The UCT Read command reads 0, 1, 2, or 3 bytes from the specified user counter/timer registers.

For read operation PDx-MFx UCT subsystem has a control word format:

15   8 7   0
|_FWCW___|_CWF____| , FWCW is a firmware control word

Use following definitions to make dwUctReadCfg a. operation parameters - firmware control word (bits 8-15)

```
#define UCTREAD_CFW     (1<<8)   // use command-word format
(CWF)
                                 //(see _PdUctWrite)
                                 // if this bit is 0 function
                                 // ignores CWF bits
#define UCTREAD_UCT0    (0)      // counter 0 (lines A1, A0)
#define UCTREAD_UCT1    (1<<9)   // counter 1 (lines A1, A0)
#define UCTREAD_UCT2    (2<<9)   // counter 2 (lines A1, A0)
#define UCTREAD_0BYTES  (0)      // read 0 bytes
#define UCTREAD_1BYTE   (1<<11)  // read 1 byte.  data: [LSB]
#define UCTREAD_2BYTES  (2<<11)  // read 2 bytes. data: [MSB,
LSB]
#define UCTREAD_3BYTES  (3<<11)  // read 3 bytes. data:
                                 // [MSB, LSB, StatusByte]
```

b. It is not suggested to program CWF. The simplest way to read from the UCT is to combine flags UCTREAD_UCTx + UCTREAD_yBYTES

if UCTREAD_CFW is "1" you have to supply CWF (if it's "0" FW forms CWF automatically). If you've selected "1" to provide read configuration command yourself you can chose one of the three read methods: {read, counter latch, read-back}.

See Intel 82C54 datasheet for details

Win32				
Function name	Set UCT Private Event			
Function	Creates event object for counter-timer subsystem and register it with the driver			
Returns	1 if success, 0 if failure			
Syntax:				
Win32 API	BOOL _PdUctSetPrivateEvent(HANDLE hAdapter, HANDLE *phNotifyEvent);			

Input parameters:
HANDLE hAdapter – handle to adapter
HANDLE *phNotifyEvent – handle to notification event

The Set Private Event function creates a notification event and sets the driver to signal the event upon assertion of a user event. Use _PdUctSetCfg() to set up line states you want to
be notified on.
To utilize the set event in applications you should use Win32 API functions: WaitForSingleObject() or WaitForMultipleObjects().

Set event pulses when event situation occurs in digital input subsystem.

Linux specific:
The Linux driver provides two ways of event notification: using SIGIO and blocking read(). See _PdSetAsyncNotify() and _PdWaitForEvent() for details.

Notes: *PDx-MFx boards only.*

Win32				
Function name	Clear UCT Private Event			
Function	Frees event object and unregisters it with the driver			
Returns	1 if success, 0 if failure			
Syntax:				
Win32 API	BOOL _PdDInClearPrivateEvent(HANDLE hAdapter, HANDLE *phNotifyEvent);			

Input parameters:
HANDLE hAdapter – handle to adapter

HANDLE *phNotifyEvent – handle to notification event

The Clear Private Event function disables signaling of an event by the driver and closes the notification event handle. This function is to be used in conjunction with _PdUctSetPrivateEvent().

Notes: *PDx-MFx boards only.*

Counter data stream function (PD2–DIO board only)

Buffered mode counter-timer is available for Windows and Linux platforms. It uses a large buffer (Advanced Circular Buffer – ACB) allocated in virtual memory and locked into physical pages to store data. It allows high acquisition rates on non-realtime OSes. QNX and RTLinux driver implementations do not support buffered mode due to it realtime nature. See examples of streaming data using DSP counter-timer in "PD2-DIO User Manual"
Digital Input buffered mode function set includes:

- Buffer management functions (see chapter 2).
- Initialization/Cleanup functions
- Event management functions
- Data retriving functions

See "PowerDAQ User Manual" for additional information.

Win32	**Linux**			**r3**
Function name	DSP CT Async Init			
Function	Initialize DSP counter-timer for asynchronous (buffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdCTAsyncInit(HANDLE hAdapter, DWORD *pError, ULONG dwCTCfg, ULONG dwCTCvClkDiv, ULONG dwEventsNotify, ULONG dwChListChan);			
Linux API	int _PdCTAsyncInit(int handle, ULONG dwCTCfg, ULONG dwCTCvClkDiv, ULONG dwEventsNotify, ULONG dwChListChan);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – handle to adapter (Linux)
DWORD* pError – error code
DWORD dwCTCfg – CT configuration word
DWORD dwCTCvClkDiv – conv. start clk div.
DWORD dwEventsNotify – subsys user events notif.
DWORD dwChListChan – number of channels in list

Initialize Asynchronous Buffered Acquisition function for DSP CT. Initializes the configuration and program the DSP for buffered acquisiton.

Notes: This driver function does NO checking on the hardware configuration parameters, it is the responsibility of the DLL to verify that the parameters are valid for the device type being configured.

Configuration:
DWORD dwCTCfg – this represents a variety of configuration parameters (from pdfw_def.h):

CT Subsystem Configuration (CTCfg) Bits:

```
AIB_CVSTART0       // CT Conv Start Clk Source (2 bits)
AIB_CVSTART1       // 00 - SW, 01 - internal, 10 - external,
                   // 11 - Continuous
AIB_EXTCVS         // CT External Conv Start (Pacer) Clk Edge
                   // (falling edge if set)
AIB_INTCVSBASE     // CT Internal Conv Start Clk Base
                   // (11MHz/33Mhz if set)
AIB_STARTTRIG0     // CT Start Trigger Source (2 bits)
                   // (SW/External if set)
AIB_STARTTRIG1     // rising edge / falling edge if set
AIB_STOPTRIG0      // CT Stop Trigger Source (2 bits)
                   // (SW/External if set)
AIB_STOPTRIG1      // rising edge / falling edge if set
```

All other bits are to be used internally

DWORD dwCTCvClkDiv - sets the value for the conversion (CV) clock divider. The CV clock can come from either an 11 MHz or 33 MHz base frequency. The divider then reduces this frequency down to a specific sampling frequency. Due to a feature in the DSP counter operation, the divider value needs to be one count less than the value you want to utilize. dwCTCvClkDiv = (base frequency / acquisition rate) – 1. (Example: If you want a divider value of 23, you should set the dwCTCvClkDiv parameter to 22.)

If selected frequency is higher than the possible conversion rate, the board ignores pulses coming before it is ready to process the next sample/scan.

dwEventsNotify (DWORD) - this flag tells the driver upon which events it should notify the application. Each bit of the value references a specific event as listed in the table below.

Event configuration:

```
EFrameDone       One or more frames are done
EFrameRecycled   Cyclic buffer frame recycled
                 (i.e. an unread frame is over-written by new
data)
eBufferDone      Buffer done
eBufferWrapped   Cyclic buffer wrapped
eBufferError     Buffer over/under run error
eStopped         Operation stopped (possibly because of error)
eAllEvents       Set/clear all events
```

dwChListChan (DWORD) - indicates the number of channels in each scan. You can use one or two counters (CT1 and/or CT2)

Note: *PD2-DIO only*

Win32	**Linux**			**r3**
Function name	CT Async Term			
Function	Terminate DSP counter-timer (buffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdCTAsyncTerm(HANDLE hAdapter, DWORD *pError);			
Linux API	int _PdCTAsyncTerm(int handle);			

Terminate Asynchronous Buffered Acquisition function terminates buffered output.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure

Note: *PD2-DIO only*

Win32	**Linux**			**r3**
Function name	CT Async Start			
Function	Starts DSP counter-timer asynchronous (buffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdCTAsyncStart(HANDLE hAdapter, DWORD *pError);			
Linux API	int _PdCTAsyncStart(int handle);			

Start Asynchronous Buffered Operation function starts buffered output.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure

Note: *PD2-DIO only*

Win32	**Linux**			**r3**
Function name	CT Async Stop			
Function	Stops DSP counter-timer asynchronous (buffered) operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdCTAsyncStop(HANDLE hAdapter, DWORD *pError);			
Linux API	int _PdCTAsyncStop(int handle);			

Stop Asynchronous Buffered Operation function stops buffered output.

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure

Note: *PD2-DIO only*

Win32	**Linux**			**r3**
Function name	Get CT Buffer State			
Function	Returns current state of DSP counter-timer buffered operation			
Returns	1 if success, 0 if failure (Linux: 0 if succeed, negative if error occurred)			
Syntax:				
Win32 API	BOOL _PdCTGetBufState(HANDLE hAdapter, DWORD *pError, DWORD NumScans, DWORD *pScanIndex, DWORD *pNumValidScans);			
Linux API	int _PdCTGetBufState(int handle, DWORD NumScans, DWORD *pScanIndex, DWORD *pNumValidScans);			

Input parameters:
HANDLE hAdapter – handle to adapter (Win)
int handle – file descriptor of the subsystem (Linux)
PDWORD pError – error code on failure
DWORD NumScans – number of scans to get [1..MaxScansInBuffer]
DWORD *pScanIndex – pointer to buffer index of first scan
DWORD *pNumValidScans – pointer to number of valid scans available

The function gets current state of counter-timer buffer and informs the application of how many samples can be accepted and where to put them.

Before starting buffered counter-timer you have to fill a whole buffer with data. The driver sets eFrameDone event when one or more frames become available for refill. The driver continues to output data from the next frame at this time. After _PdCTGetBufState() is called, the driver marks buffer from pScanIndex to pScanIndex+pNumValidScans as filled again.

The CT Get Buffer State function returns the oldest released index in the DAQ buffer and the size of already output area. pScanIndex and pNumValidScans are in scans.

To find out offset of the first sample available use:
WORD* pOffset = pInBuffer + pScanIndex*dwScanSize

If circular buffer is used and the head of the buffer is less then the tail, the first call to this function returns scans from the tail position to the end of the buffer. Subsequent calls return scans from the beginning of the buffer untill the head. The user application always receives non-wrapped chunks to fill with data.

Notes: *PD2-DIO boards only*

Win32				**r3**
Function name	Set CT Private Event			
Function	Creates event object for DSP counter-timer subsystem of PD2-DIO board and register it with the driver			
Returns	1 if success, 0 if failure			
Syntax:				
Win32 API	BOOL _PdCTSetPrivateEvent(HANDLE hAdapter, HANDLE *phNotifyEvent);			

Input parameters:
HANDLE hAdapter – handle to adapter
HANDLE *phNotifyEvent – handle to notification event

The Set Private Event function creates a notification event and sets the driver to signal the event upon assertion of a user event.
To utilize the set event in applications you should use Win32 API functions: WaitForSingleObject() or WaitForMultipleObjects().

Set event pulses when event situation occurs in counter-timer subsystem.

Linux specific:
Linux driver provides two ways of event notification: using SIGIO and blocking read().
See _PdSetAsyncNotify() and _PdWaitForEvent() for details.

Win32				**r3**
Function name	Clear CT Private Event			
Function	Frees event object and unregisters it with the driver			
Returns	1 if success, 0 if failure			
Syntax:				
Win32 API	BOOL _PdCTClearPrivateEvent(HANDLE hAdapter, HANDLE *phNotifyEvent);			

Input parameters:
HANDLE hAdapter – handle to adapter
HANDLE *phNotifyEvent – handle to notification event

The Clear Private Event function disables signaling of events by the driver and closes the notification event handle. This function is to be used in conjuncation with _PdCTSetPrivateEvent().