DAPcell Manual

*DAPcell Server Description
and Installation Guide*

Version 8.10

Microstar Laboratories, Inc.

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Part Number MSDAPCELLM810

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1. Introduction

DAPcell is a client-server software package that provides extensive services for Data Acquisition Processor applications. DAPcell 8.10 supports Windows 10 operating system version 1709 and later and Windows 11.

DAPcell software comes in four versions: DAPcell Server, DAPcell Local Server, DAPcell Basic Server, and DAPcell Client.

DAPcell Server, DAPcell Local Server, and DAPcell Basic Server include both client and server software and provide the same basic features and service interface as one another. In addition to the basic features, DAPcell Server and DAPcell Local Server offer more advanced features such as the built-in fast disk logging. DAPcell Local Server and DAPcell Basic Server support clients on the local workstation while DAPcell Server supports clients on the local workstation as well as on any workstation over a local area network (LAN).

DAPcell Client software is a client-only package, providing a consistent interface between applications on client machines and servers, local or remote. It works with all server variants.

A LAN connects remote clients of DAPcell to servers. DAPcell Server supports the Microsoft Windows Networks, using the TCP/IP protocol and some other protocols such as the named pipe protocol.

A DAPcell server supports a maximum of 64 Data Acquisition Processors on one machine. Multiple DAPcell servers can be installed on a network. A DAPcell client can simultaneously connect to up to 16 DAPcell servers. However, serious consideration must be taken to limit the number of DAPcell servers on a network so that the network traffic load allows acceptable DAPcell performance.

DAPcell clients support 32-bit Windows applications in 32-bit Windows environments and both 32-bit and 64-bit Windows applications in 64-bit Windows environments.

Microstar Laboratories provides software for developing 32-bit Windows Data Acquisition Processor applications, using Microsoft Visual C++ (4.0 or later) or Borland C++ (5.0 or later), and for developing 64-bit Windows Data Acquisition Processor applications, using Microsoft Visual C++ (8.0 or later). In addition, most of the existing 32-bit Windows Data Acquisition Processor applications run unmodified with DAPcell in 32-bit Windows.

Please note the following restrictions for DAPcell:

- It is compatible with x86 and x64 PC platforms only.

- It supports Microsoft Windows 10 version 1709 and later and Windows 11.

- It supports only Data Acquisition Processors with PCI and USB bus interfaces.

- It supports DAPL 2000 1.30 or later and DAPL 3000.

Software Components

DAPcell server software consists of a kernel-mode/user-mode driver and a user-mode service. The driver operates on the Data Acquisition Processor hardware; and the service offers the functionality that an application needs to communicate with the Data Acquisition Processor.

DAPcell client software provides a consistent interface for communication between applications and DAPcell server services.

Following is a list of the files that constitute DAPcell:

File	Description
`DAPcellService.exe`	— Server service program
`DAPcellDriverKernel.sys`	— Server kernel-mode driver
`DAPcellDriverUser.dll`	— Server user-mode driver
`DAPcellDriverUserHelper.dll`	Server user-mode driver support library
`DAPcellServiceUtil.dll`	— Server service support library
`Dapio32.dll`	— Client library
`DAPcellControlPanel.cpl`	— DAPcell control panel extension program
`DAPcellControlApplication.exe`	— DAPcell control panel extension support program

The kernel-mode and user-mode drivers are mutually exclusive. The user-mode driver support library is only present when the user-mode driver is installed.

DAPcellDriverKernel.sys

The kernel-mode driver for DAPcell is `DAPcellDriverKernel.sys`. The driver is required to provide hardware access to both PCI and USB Data Acquisition Processors. `DAPcellDriverKernel.sys` automatically starts when Windows starts and one or more enabled Data Acquisition Processors are present. It remains active across sessions until no enabled Data Acquisition Processors are present or until Windows shuts down.

DAPcellDriverUser.dll

The user-mode driver for DAPcell is `DAPcellDriverUser.dll`. This driver supports only USB Data Acquisition Processors. `DAPcellDriverUser.dll` automatically loads when Windows starts and one or more enabled USB Data Acquisition Processors are present. It remains active across sessions until no enabled USB Data Acquisition Processor is present or until Windows shuts down. For `DAPcellDriverUser.dll` to function correctly, a copy of its support library `DAPcellDriverUserHelper.dll` must be present as well.

DAPcellControlPanel.cpl

A DAPcell control panel extension program `DAPcellControlPanel.cpl` is installed in the Windows Control Panel with the name of "Data Acquisition Processors". This program serves as a DAPcell service manager, providing control over clients and servers through up to six screens: the Control screen, the Browser screen, the Disk I/O screen, the Mapping screen, the Modules screen, and the Tools screen.

The Control screen provides user control over the local DAPcell server, such as starting and stopping the server, adjusting the server's execution priority, or altering the permission level for remote clients to control the server. A configuration change in this screen usually does not take effect until the server is restarted.

The Browser screen allows users to search for, display, configure, and control the Data Acquisition Processors and their servers installed on a local machine or over the network.

The Disk I/O screen lets users control the disk I/O behavior of DAPcell and DAPcell Local servers. A user can specify default disk I/O directories and their network shares or alter the remote disk I/O permission level.

The Mapping screen provides easy user access to a utility program that helps create mappings between pre-defined DAPcell DAP names and customized names.

The Modules screen provides users with easy control over installation of DAPL downloadable modules.

The Tools screen provides access to utilities that help monitor the behavior of each included Data Acquisition Processor, such as checking the current consumption level of memory.

DAPcellControlApplication.exe is the supporting program that helps this control panel extension to fulfill the above tasks.

See the document for `DAPcellControlPanel` for more information about the control panel program.

DAPcell Service

The DAPcell server is implemented as a Windows service. The DAPcell Service is a user-mode program that implements the functionality that DAPcell offers. By default, the Service automatically starts when Windows starts and remains active across sessions until Windows shuts down.

The DAPcell Service initialization involves both the Service software initialization and the Data Acquisition Processor hardware initialization. Data Acquisition Processor communication establishes as soon as initialization completes.

The DAPcell Service software initialization allocates system resources and constructs service control structures. The Service starts only if it has successfully completed its service control construction. If an error occurs during the initialization, the Service logs the error and exits.

The DAPcell Service enumerates and initializes Data Acquisition Processors whenever they become available on the system. The initialization of a Data Acquisition Processor may involve loading a fresh copy of the DAPL operating system to the Processor. A Data Acquisition Processor will not function without the DAPL operating system. If the initialization of a Data Acquisition Processor fails, the Service logs a warning and stays. However, no communication with that Data Acquisition Processor will be possible.

The DAPcell Service can be active without any installed and initialized Data Acquisition Processor.

After being started, the DAPcell Service can be stopped and restarted from the `Control Panel` using the DAPcell control panel extension program. The Service should only be stopped and restarted if necessary. For example, after an ill-formed application causes the Service to stop functioning, stopping and restarting the Service may help it recover from the error.

Each time the DAPcell Service starts, it may reset and/or reinitialize the local Data Acquisition Processors. If an active Data Acquisition Processor is reinitialized, programs and data that have been running on that Data Acquisition Processor are permanently lost.

During its initialization, the DAPcell Service typically logs errors or warnings to the Windows system event log. It also displays some of them on the screen.

2. DAPcell Installation

The DAPcell installation can be broken down into four progressive steps:

1. Setting Up a LAN for DAPcell
2. Installing DAPcell Required Network Components
3. Installing the DAPcell Server Software on Server Workstations
4. Installing the DAPcell Client Software on Client Workstations

Installing the DAPcell Local Server or DAPcell Basic Server requires only step (3).

The success of an installation step usually depends on the success of the preceding step. It is important to verify that each installation step is successful before proceeding to the next one.

Setting Up a LAN for DAPcell

Note: This section assumes some familiarity with procedures of LAN installation and configuration.

Setting up a LAN for DAPcell follows the normal procedures of setting up a LAN for file sharing. However, DAPcell-specific issues do exist. These issues are discussed below.

Network Protocols

A network employs at least one common network protocol to establish communication. DAPcell typically shares the main common protocol. It is possible for DAPcell to use a protocol of its own or to use multiple protocols, however, multiple protocols require additional drivers and services, which could incur extra system overhead and network traffic.

DAPcell supports the most frequently used network protocol, the TCP/IP protocol. It also supports other common protocols such as the named pipe protocol or the NetBIOS/NetBEUI protocol.

Domain and Workgroup

On the Microsoft Windows Networks, a network cell identifies itself with its unique machine name in a particular domain or workgroup. It is best for DAPcell clients and servers to reside in the same domain or workgroup to minimize the network administrative overhead, thus maximizing the DAPcell performance.

Installing DAPcell-Required Network Components

In most cases, all DAPcell-required network components are already in place once a network has been successfully set up. In some cases, DAPcell requires additional network components in order to work correctly, especially when it uses a protocol different from what the main network uses, or when it uses multiple protocols.

If DAPcell is going to use a different network protocol or multiple network protocols (usually not recommended unless it is absolutely necessary), the protocol components must be installed on both client and server machines.

For information about how to install and configure a network component in Windows, refer to the appropriate Windows document.

Installing the DAPcell Server Software on Server Workstations

After the network components are successfully installed and configured, it is time to install DAPcell on server workstations. Installing DAPcell on server workstations includes installing the DAPcell software and the Data Acquisition Processor hardware.

It is advised to install the DAPcell server software before installing the Data Acquisition Processor hardware. This installation sequence allows Windows to take care of most of the installation automatically without user intervention.

Before installing the DAPcell server software, make sure that the following conditions are met. (1) If the machine has a copy of the earlier version of the software installed, stop any running Data Acquisition applications. (2) New Data Acquisition Processors must not be connected to the server machine until after the new DAPcell software is successfully installed.

To install the DAPcell server software, insert the DAPtools CD into a CD-ROM drive. The Microstar Laboratories Setup Launcher will automatically start. Select the 'DAPcell Server' option to install both the server and client software on the server machine. The rest of the process is straightforward and self-explanatory. Note that installing the DAPcell server software requires the administrator privilege.

After the DAPcell server software is successfully installed, the DAPcell service is ready. If you have any Data Acquisition Processors installed with an earlier version of the software, you may need to reboot Windows for these Data Acquisition Processors to be reinstalled.

To install a new PCI Data Acquisition Processor, power down the server machine. Follow the instructions in the hardware manual of the specific Data Acquisition Processor to carefully insert the processor into an available PCI slot. Turn the power back on. Windows will start and finish the installation automatically.

To install a USB Data Acquisition Processor, simply plug the processor in on the server machine. Windows will detect the presence of the processor and finish the installation automatically.

Installing the DAPcell Client Software on Client Workstations

After verifying that DAPcell servers are successfully installed and functioning locally on the server workstations, run the Microstar Laboratories Setup Launcher from the DAPtools CD on remote client machines and select 'DAPcell Client' to install the client software.

Verify the installation by running the Data Acquisition Processor control panel extension program from the Windows Control Panel and select the Browser screen. The Browser window will display all Data Acquisition Processors installed on connected DAPcell servers in the form of a tree view. In some cases, refreshing the browser with the proper network protocol may be necessary.

3. Using DAPcell

DAPcell offers a powerful and consistent interface between applications and the Data Acquisition Processor. Applications and the Data Acquisition Processor communicate through a communication channel structure called the "communication pipe". An application opens a handle to a pipe and then uses the handle to send and receive data through the pipe. A pipe can be opened for reading or writing only once and, once opened for that purpose, the pipe is reserved for I/O access by the application exclusively until the application closes the handle.

Communication Pipes

There are communication pipes on the Data Acquisition Processor; there are also communication pipes on the PC. The pipes on both sides are logically connected on a one-to-one basis. The pipes on the PC can be viewed as extensions to the pipes on the Data Acquisition Processor. Each connected pair of pipes forms a communication channel. In DAPcell, a communication channel uses the name of the corresponding communication pipe on the Data Acquisition Processor.

There are four default communication pipes on each Data Acquisition Processor, `$SysIn`, `$SysOut`, `$BinIn` and `$BinOut`. They are unidirectional pipes for text and binary communications. PC applications typically interact with the Data Acquisition Processor by reading from or writing to one of the communication pipes. When DAPcell starts, it automatically creates the four default communication channels for each Data Acquisition Processor.

The four default communication channels provide most applications with adequate and complete communications with a Data Acquisition Processor. Additional communication channels can be created through the Data Acquisition Processor control panel program or by using the `DAPIO32` interface function `DapComPipeCreate`. (See the `DAPIO32 Reference Manual` for information about how to use `DapComPipeCreate`.)

UNC (Universal Naming Convention) Pipe Names

DAPcell addresses a pipe on the Data Acquisition Processor (DAP) using the Universal Naming Convention (UNC). A UNC pipe name consists of three portions: a machine name, a Data Acquisition Processor name, and a pipe name. A UNC name is led by two backslashes with each component delimited by one backslash.

A remote machine is represented by its unique network machine name. The local machine is denoted by a period.

The Data Acquisition Processor names are predefined as `Dap0`, `Dap1`, `...`, and `Dap(N-1)` where `N` is the number of Data Acquisition Processors installed on the server.

PCI Data Acquisition Processors are named by the ordering of their PCI bus and slot numbers. A Data Acquisition Processor on a bus with a lower number is named before a Data Acquisition Processor on a bus with a higher number. Within the same bus, a Data Acquisition Processor in a slot of a lower number is named before a Data Acquisition Processor in a slot of a higher number. For example, in a three Data Acquisition Processor system, the Data Acquisition Processor on bus 0 slot 10 is named `Dap0`, the one on bus 1 slot 0 is named `Dap1` and the one on bus 1 slot 3 is named `Dap2`.

USB Data Acquisition Processors are named after any PCI Data Acquisition Processors. Among themselves, USB Data Acquisition Processors are named by the ordering of the USB ports they are connected to. For example, in a three Data Acquisition Processor system with two USB DAPs and one PCI DAP, the PCI DAP is named Dap0, the USB DAP connected to port 3 is named Dap1, and the one connected to port 5 is named Dap2. However, USB port numbers in Windows may not be unique on some system configurations. If two ports happen to bear the same number the ordering between the two DAPs may not be deterministic.

Once a system configuration is established, the names of the installed Data Acquisition Processors are established. The established names will then stay as long as their associated DAPs stay. Adding new DAPs or removing existing DAPs does not alter these names. For example, with the three-DAP configuration described in the previous paragraph, removing Dap1 from the system does not change the names of the remaining two even though it leaves a discontinuity between the names of Dap0 and Dap2, or adding a USB DAP to port 4 gives it a name of Dap3, instead of Dap2 as it is supposed to, because Dap2 already exists. As a result, changing the configuration may cause naming inconsistency, which, however, can be reestablished by using the control panel extension program or by running the SETUP again.

Pipe names are also predefined. On the Data Acquisition Processor, two communication pipes are associated with one integer number and their names differ only in the direction suffix: `In` or `Out`. `$SysIn` and `$SysOut` are the default input and output pipes with the number zero while `$BinIn` and `$BinOut` are the default input and output pipes with the number one. DAPcell supports a maximum of 32 pairs of input and output communication pipes on each Data Acquisition Processor; thus, the largest number that can be associated with a pipe is 31. Except for the two default pairs, all pre-defined pipe names carry both the pipe number and the pipe direction suffix. Following is a list of the 32 supported pairs of communication pipes:

```
$SysIn          $SysOut
$BinIn          $BinOut
Cp2In           Cp2Out
Cp3In           Cp3Out
Cp4In           Cp4Out
                ...
Cp31In          Cp31Out
```

Thus, the communication pipe `$SysIn` of the Data Acquisition Processor `Dap0` on the local machine is represented by the UNC name `\\.\Dap0\$SysIn`, and the pipe `$BinOut` of the Data Acquisition Processor `Dap1` on the remote machine PC101 is referred to as `\\PC101\Dap1\$BinOut`. For example,

```
\\.\Dap0\$SysIn
\\.\Dap0\$SysOut
\\.\Dap0\$BinIn
\\.\Dap0\$BinOut
```

are the four default communication pipes on the Data Acquisition Processor `Dap0` on the local machine, and

```
\\PC101\Dap1\$SysIn
\\PC101\Dap1\$SysOut
\\PC101\Dap1\$BinIn
\\PC101\Dap1\$BinOut
```

are the four default communication pipes on the Data Acquisition Processor `Dap1` on the remote machine PC101.

Running 32-Bit and 64-Bit Data Acquisition Processor Applications

To run a 32-bit/64-bit Data Acquisition Processor application, simply start the program while DAPcell is active. DAPcell supports the Windows multi-tasking and multi-threading features. More than one Data Acquisition Processor application and more than one thread of an application can run at the same time with the restriction that the sets of communication pipes they read from or write to do not overlap.

DAPcell prevents an application from acquiring read/write access to a communication pipe that has been opened for reading/writing by another application. No two applications can share a communication pipe for reading/writing, but many applications can acquire query access to the same pipe for non-I/O purposes. See the DAPIO32 manual for more information.

DAPcell allows an application to pass an opened handle from one thread to another. The application, however, usually should assign only one thread to do direct I/O access with that handle. Simultaneous I/O access from multiple threads with the same handle may yield unexpected results.

4. Developing 32-Bit and 64-Bit DAP Applications for DAPcell

32-bit and 64-bit applications use the `DAPIO32` interface to communicate with the Data Acquisition Processor. A 32-bit/64-bit Data Acquisition Processor application for DAPcell can be created using any 32-bit/64-bit application development tool that supports Windows DLL calls. The DAPtools CD provides libraries and headers for developing such applications in various programming environments.

When writing 32-bit/64-bit applications for DAPcell, users should always be aware of its potential distributed nature. Two factors are of general interest: a distributed call is relatively expensive and a distributed call over the network can be delayed for an unpredictable amount of time. Therefore, client code that works well locally may not work equally well over a network.

For example, suppose an application expects a Data Acquisition Processor to generate a block of 1024 words of binary data at a rate of 1000 words per second and wants to get the whole block in one single operation. The following two pieces of code may work well on a local system, but neither should be used in a network environment.

```
(1)// Wait until enough data are available
   while (DapInputAvail(hdapBinOut) < 1024*2)
        ;
   // Get and process data
   DapBufferGet(hdapBinOut, 1024*2, pInBuffer);
        ...

(2)// Wait long enough for data to be ready
   Sleep(1200);
   if (DapInputAvail(hdapBinOut) >= 1024*2)
       {   // Get and process data
           DapBufferGet(hdapBinOut, 1024*2, pInBuffer);
            ...
       }
       else
       {   // Something is wrong. Abort the program.
           printf("DAP failed to generate data\n");
           exit(-1);
       }
```

While the first piece of code may hang if something goes wrong with the Data Acquisition Processor, it is also extremely inefficient. Repeatedly calling `DapInputAvail` to a remote server may jam the network traffic for no good reason.

The second piece of code is likely to fail in a distributed system. A network delay may force the code to exit abnormally, even though the remote Data Acquisition Processor is generating data at the required speed.

`DAPIO32` provides facilities to implement the above in a much more efficient and dependable way. Set up a `GetExInfo` structure of type `TDapBufferGetEx` to tell the function `DapBufferGetEx` to get exactly 1024 words of data within a time frame of 1200 ms, with a maximum interval of 2 ms between two consecutive data elements. If anything goes wrong, this function returns with a value less than the requested 1024*2. The timing specifications

here are on the time basis of the remote server where the Data Acquisition Processor is running, free of any errors caused by network delays. All this is done in one single call, reducing the network traffic to minimum. The following C++ example code guarantees to work properly both locally and in a network environment.

```
    TDapBufferGetEx GetExInfo;

    DapStructurePrepare(GetExInfo);
    GetExInfo.iBytesGetMin = 1024*2;  // get at least 1024 words
    GetExInfo.iBytesGetMax = 1024*2; // get at most 1024 words
    GetExInfo.dwTimeOut    = 1200;     // done within 1200 ms
    GetExInfo.dwTimeWait   = 2;          // wait at most 2 ms for the next element

    if (DapBufferGetEx(hdapBinOut, &GetExInfo, pBuffer) == 1024*2)
        {   // Process the data
            //
                ...
        }
    else
        {   // Something is wrong. Abort the program.
            //
            printf("DAP failed to generate data\n");
            exit(-1);
        }
```

For a detailed description of the `DAPIO32` interface, see the `DAPIO32 Reference Manual`.