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## The “sl\_api (batch)” Server/Loader example.

Rev 3.3 JT 14/03/02 (changed for HEPC9)

The “sl\_api\batch” program explains how the Server/Loader could be used to boot a network of DSP processors, while using a separate user program to communicate with the ROOT node.

There are 2 general approaches:

1. Use the Server/Loader to boot the network (use -rl options, but not the -s option!). Then start as a second program the user program, which opens the API and communicates with the program loaded onto the DSPs by the Server/Loader. This user program must NOT reset the board! This method is used in the sample in sub-directory "batch". You can run it using the "my32.bat" batch-file.
2. Use the Server/Loader library to reset and load the network of DSPs, then use the API to communicate with the loaded program. In this case, both Server/Loader and API are used within one executable file. This method is used in the sample in sub-directory "exe". You can run it using the "my32.bat" batch-file.

The DSP code in the “sl\_api” example uses HERON-API to control the Config line and the Digital Outputs. It then uses HERON-API to send a message to the host program over the HERON FIFO.

The use of HERON-API means that the example is easily changed to use any HERON C6000 module. HERON-API uses DSP/BIOS internally so must be built using Code Composer Studio.

This document describes how to make the project and build the DSP application.

### History

Example revision 2.0 made for HERON-API V2.3

Example revision 3.0 made for CCS V1.2

Example revision 3.1 made for Server/Loader V3.2

Example revision 3.2 made for Server/Loader V3.3

Example revision 3.3 made for Server/Loader V4.0 (support for HEPC9 added)

## **Example software**

The example that we supply consists of two parts. There's C code that makes up a DSP example program. This DSP code consists of just one C file called "test.c". It needs to be built using Code Composer Studio and uses the HERON-API software that has been installed on your PC when you did the "install drivers and tools" from your CD.

The other part is C++ code that makes up a PC host example program. A PC host example executable is provided, so that you can test that you have a working DSP program, before you start creating your own PC host example program. The PC C++ code consists of one C++ file called "mysl.cpp".

There is another example that shows how to use the Server/Loader library. This is located in directory "..\..\sl\_api\exe". Both "sl\_api" examples show how to use the Server/Loader to boot a system of processors and FPGAs. After booting, a custom host PC program takes over to implement custom I/O between the processors and the host PC. In the case of this "batch" example, the standard Server/Loader is used to boot the system. A separate PC host program is then started that communicates with (DSPs) on the system. This PC host program is what makes up the host PC example. In the case of the other example ("..\..\sl\_api\exe"), the Server/Loader is integrated in the host PC program. You thus only need to start 1 program, which then uses the Server/Loader library to boot the system. It then continues, using the API for communications with (DSPs on) the system.

## **Hardware setup**

The example shows the communication between a HERON module and the host. This means that the HERON module must be connected to the host via a HERON FIFO.

With a HEART based board, such as the HEPC9, such a (duplex) connection must be created using HEART. This can be done with the Server/Loader, by adding some HEART statements in the network file. The "Create new HERON-API project" plug-in will automatically do this for you; this is explained in more detail later.

When using an HEPC8, a HERON module must be slot 1 of the HEPC8. The module must have its default routing jumpers set to 1, so that it boots from the host.

If you are running the demo on a different hardware configuration, you will need to change the #defines in the DSP source code to reflect the connections that you have, and also the network file that describes the connections to the Server/Loader.

## **DSP/BIOS**

DSP/BIOS is the multi-threading environment provided as part of the Code Composer development Environment. It also provides services for configuring processor features such as hardware interrupts and timers.

As DSP/BIOS is included in Code Composer Studio, along with the Compile tools for the C6000, all users of HERON hardware will be able to use it.

This example is configured and built using Code Composer and DSP/BIOS.

## **HERON API**

HERON\_API is the hardware independence layer that we provide to access HERON FIFOs and other features of the HERON modules. It allows the DMA engines of the processor to be used when transferring to and from the FIFOS without knowledge of the FIFO hardware, or the DMA engines.

## **Starting**

We assume that a user of this example has previously installed Code Composer and followed the confidence checks. They should also be familiar with using Code Composer.

## **Configuring the example**

You need to create both the DSP example program and the PC host example program. To help you, we have included a working PC host example program, so that you can test your DSP program. The PC host example program is located in the “win32” sub-directory of the “sl\_api\batch” example directory. It is advised that you first create the DSP program. You can then check if the DSP program you created works by using “my32.bat” (uses the provided host PC program).

## **How to create the DSP program**

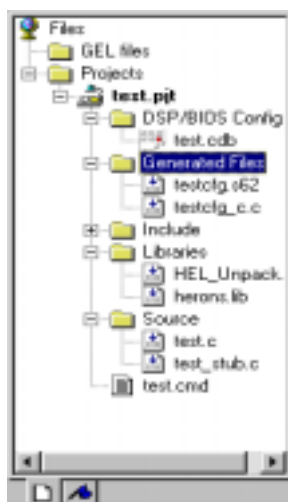
HUNT ENGINEERING provide several Code Composer Plug-in tools that allow you to make your development faster. The first is one that sets up Code Composer ready for your hardware, so you don't need to configure device drivers etc. and can be found from the Start → Programs → HUNT ENGINEERING → AutoConfigure CCS. We assume that this is already set up, but the plug-in also copies cdb files etc into the correct locations.

When you start with the “batch” example, copy the source files from the CD into a new directory.

To create a new CCS project, use the “Create new HERON-API project” plug-in. How to use this plug-in is explained in detail in the C6x “Starting Development” example. This is available via the HUNT ENGINEERING CD: Getting Started → to start using C6000 modules and tools look here → Starting your development. This will open the “starting\_development.pdf” document. Read this first – if you have not already done so.

To create the example CCS project:

- Start Code Composer Studio
- Choose Tools→HUNT ENGINEERING→Create new Heron-API project.
- Use the “Browse” button to browse to your “sl\_api\batch” example directory.
- Change “Files of type” to “Project Name (use \*.c, \*.cpp as template).
- Select the “test.c” file.
- Click the “Open” button.
- Verify that in the “Project Name” edit box you have the correct path and name. E.g. something like “c:\examples\c6x\sl\_api\batch\test”. The “c:\examples\c6x” part may differ in your case, depending on where you stored the “sl\_api\batch” example.
- Create the project by clicking on “Create New Project”.
- At the “HERON Module Select” window select the HERON module you create the project for.
- The plug-in will ask whether the project should be created for the Server/Loader. Answer “Yes”.



The plug-in creates and includes a file called “test\_stub.c”. This file ‘links’ the Server/Loader DSP library with the HERON-API library. (This allows the Server/Loader DSP library to be independent of the HERON-API library). The CDB files as delivered with the HERON-API installation have a task

'TSK0' with entry point '\_maintask'. Therefore, the project is ready to be compiled. You can now build the demo by choosing Project → Rebuild all. There should be no errors.

Finally, note that files that have the same name as the project are automatically added to the project, e.g. if the project is called "test.prj", then if a file "test.c" exists in the same directory, the plug-in will automatically add it to the project. If no such C file exists, the plug-in will generate a template C file with the name "test.c".

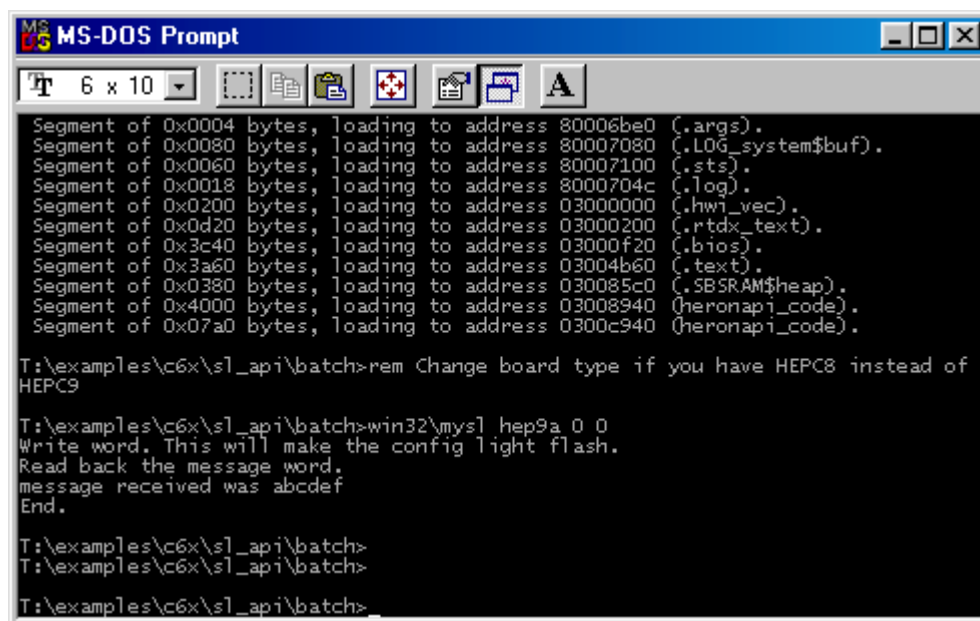
### Loading and Running the Example

The DSP JTAG chain must be released before you can successfully run the demo. If you are still running Code Composer Studio the processors will be halted. Perform a Debug → Run Free (on all processors). If you have already exited Code Composer Studio, but have not done a "Run Free", then run the API JTAG reset function. This can be done as follows: Start → Programs → HUNT ENGINEERING → API JTAG reset.

The example can be run with "my32.bat". The plug-in will also have created a "w32.bat" batch file. However, you cannot use the "w32.bat" batch file with this example. If you have a HEPC8, you must first edit "my32.bat" to change "hep9a" to "hep8a". This is what the batch file looks like:

```
%HESL_DIR%\bin\win32\win32sl -I%HESL_DIR%\lib -rl%1 network
rem Change board type if you have HEPC8 instead of HEPC9
win32\mysl hep9a 0 0
```

As you can see from this, the standard Server/Loader is used to boot the system. Then our custom host PC program starts to do some custom I/O with a DSP processor in the system. In the case of an HEPC8, the DSP HERON module must be in slot 1 of the HEPC8.



```
MS-DOS Prompt
T: 6 x 10
Segment of 0x0004 bytes, loading to address 80006be0 (.args).
Segment of 0x0080 bytes, loading to address 80007080 (.LOG_system$buf).
Segment of 0x0060 bytes, loading to address 80007100 (.sts).
Segment of 0x0018 bytes, loading to address 8000704c (.log).
Segment of 0x0200 bytes, loading to address 03000000 (.hwi_vec).
Segment of 0x0d20 bytes, loading to address 03000200 (.rtdx_text).
Segment of 0x3c40 bytes, loading to address 03000f20 (.bios).
Segment of 0x3a60 bytes, loading to address 03004b60 (.text).
Segment of 0x0380 bytes, loading to address 030085c0 (.SBSRAM$heap).
Segment of 0x4000 bytes, loading to address 03008940 (heronapi_code).
Segment of 0x07a0 bytes, loading to address 0300c940 (heronapi_code).

T:\examples\c6x\s1_api\batch>rem Change board type if you have HEPC8 instead of
HEPC9

T:\examples\c6x\s1_api\batch>win32\mysl hep9a 0 0
Write word. This will make the config light flash.
Read back the message word.
message received was abcdef
End.

T:\examples\c6x\s1_api\batch>
T:\examples\c6x\s1_api\batch>
T:\examples\c6x\s1_api\batch>
```

In the above picture, "my32.bat" was run using the verbose option ("my32 v"). The example claims that it "will make the config line flash". Please note that this is only the case when there's precisely 1 DSP HERON module in the system.

The next step is to create your host PC example program. This is explained after the next two sections.

### Heart

For HEART based systems, such as the HEPC9, it is useful to know how the FIFO links have been created – in this example. If you open the network file as created by the "Create new HERON-API project" plug-in, you can see that 2 HEART connections have been defined between the DSP module and the host interface (next page):

```

#-----
# Nodes description
# ND  BD_nb  ND_NAME  ND_Type  CC-id  HERON-ID  filename(s)
#-----
#      c6    0      HERON    ROOT      (0)    00000003  test.out
#-----
# The actual HEART programming statements. Used by both Server/Loader and
# HeartConf.
#      from:slot  fifo  to:slot  fifo  timeslots
#-----
#      heart      host1  0      heron  0      1
#      heart      heron  0      host1  0      1

```

The Server/Loader will automatically serve modules that have a duplex connection created between a DSP module and the host interface. If there's no connection, or the connection is simplex (one-way), then the Server/Loader is unable to execute "stdio" requests from that DSP module.

The "Create new HERON-API project" plug-in will always create a network file (if there's not a network file present already) with 1 DSP HERON module defined and connected to the host. In the case of this simple example this network file is sufficient. But for more complex situations you will have to add or edit the generated network file.

### Manually Setting up the Project

For your information (or if there is some problem) here is how to set up the project yourself:-

Make sure that you have copied all of the .cdb files from the directory %HEAPI\_DIR%\heron\_api\cmd into the directory C6000\bios\include under the directory where your Code Composer Studio installation is (usually c:\ti).

In Code Composer, select 'Project → new' and choose the path for your project. The name must be test for this demo.

Select 'File → New → DSP/BIOS Config' and choose the correct .cdb file for your hardware. This will have a name that uses your HERON module number and possibly an option that is available for that module.

In the DSP/BIOS config tool, right click on Global properties, and check that the CLKOUT property is set to the frequency of your processor module. This is used by DSP/BIOS to calculate the correct settings for the timer period.

This .cdb file has some items set up which are for HERON-API. DO NOT CHANGE THESE!

For this example you need to set up a Task that is called TSK0. Under its properties set its function to be "\_maintask".

Use 'File → Save' to save the cdb file to the project directory as test.cdb.

Saving the .cdb file will generate a .cmd file, but that file will not place the sections heronapi\_code and heronapi\_data. For this reason there is a .cmd file supplied by us, in the directory %HEAPI\_DIR%\heron\_api\cmd that will be called by your heron module number and have \_slbios.cmd at the end, i.e. heronx\_slbios.cmd. You need to copy this to your project directory. This cmd file also adds the stio62s.lib to the project. It is done here as it must be in the project before the rts6201.lib which also defines the standard I/O functions.

Now add the source file to the project and the .cdb, and also the heronx\_slbios.cmd. Edit the .cmd file that you have inserted and change the .cmd file that it includes to replace the \*\*\*\*\* by the name of your .cdb file, i.e. change \*\*\*\*\*cfg.cmd to be testcfg.cmd. Because Code Composer Studio does not support the use of environmental variables in the library path you also need to change the line that has %HESL\_DIR% to have the actual path name of where you installed the Server/Loader.

Add the HERON\_API library "herons.lib" from the directory %HEAPI\_DIR%\heron\_api\lib to the project.

Go to Project Options and add %HEAPI\_DIR%\heron\_api\inc and %HESL\_DIR%\inc to the include path.

Select -o3 optimisation from the compiler optimisation menu.

The default .cdb file will actually place all code into external memory, and switch on the program cache. This is a good general purpose setting, but might need to be changed for your actual application.

Next, you need to add the file “stub.c” to the project (Project→Add Files to Project, select “stub.c” that resides in the example directory that you created). Edit this file and make sure that the proper heron file is included (e.g. if you have a HERON1 module, ensure that “stub.c” has “#include <heron1.h>”, if you have a HERON4 module, ensure that “stub.c” has “#include <heron4.h>”, and so on).

You can now build the demo by choosing Project → re-build all. There should be no errors.

## How to compile the host example for Win32 (with Microsoft Visual C/C++)

In order to rebuild this example it is necessary to use Microsoft Visual C++ V6 running under Windows 95/98 or NT/W2K. The resulting program can only be run

- in a Windows 95/98 DOS Box (Console Window)
- in a Windows NT DOS Box (Console Window)

The following instructions assume that you are familiar with using the Microsoft Developer Studio and how to manipulate the workspace:

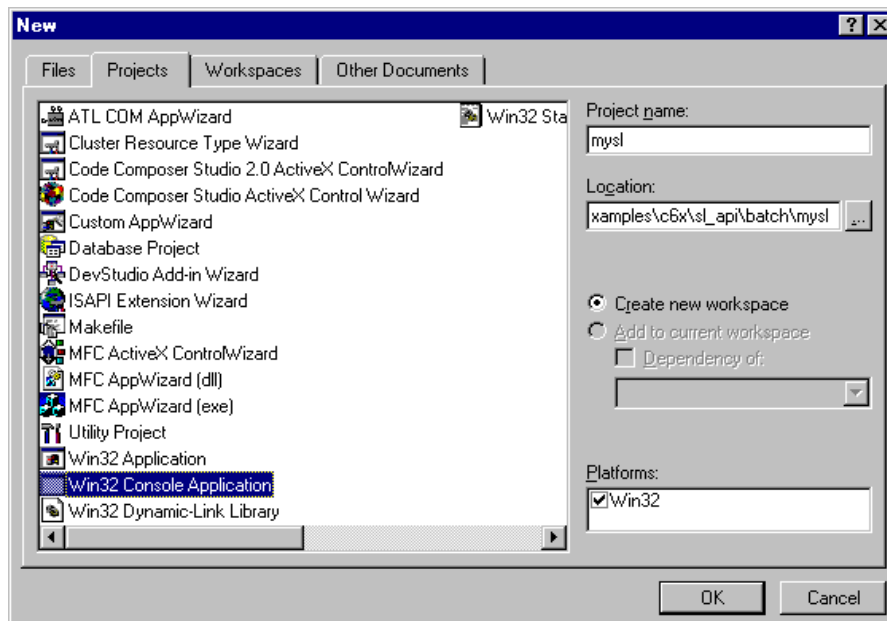
### 1) Create a new workspace.

File → New

In the left-hand pane, select “Win32 Console Application”.

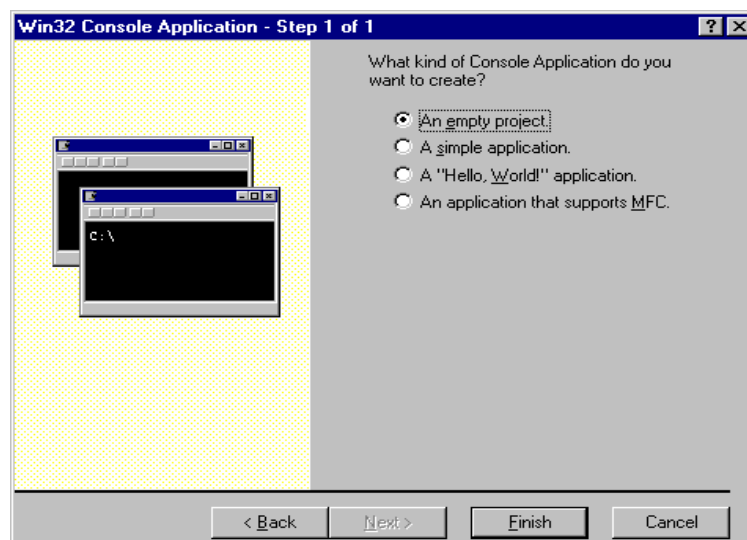
On the right, at “Location”, select your example directory, e.g. “c:\examples\c6x\sl\_api\batch”.

On the right, at “Project name”, choose a name, e.g. “mysl”.



Click “OK”.

A new window appears, select “An empty project”.



Click “Finish”.

Another window appears, click “OK” to confirm.

## 2) Add source files.

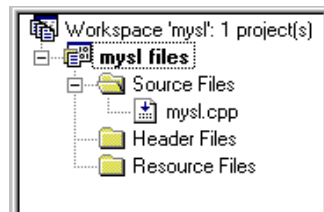
There's only 1 source file to add: "mysl.cpp".

Project → Add To Project → Files, now browse to the "sl\_api\batch" example directory.

Select the "mysl.cpp" source file.

Click "OK".

You can verify that the source file has been added, by looking in the workspace window on the left. Open the workspace by clicking on the '+' before "mysl files" (if you chose a project name other than "mysl", you should read your project name in place of "mysl"). Next, open "Source File". The "mysl.cpp" file should be listed there.



## 3) Add the HUNT ENGINEERING API library.

The HUNT ENGINEERING API library is called "hendrv.lib" ("hebdrv.lib" for Borland C/C++).

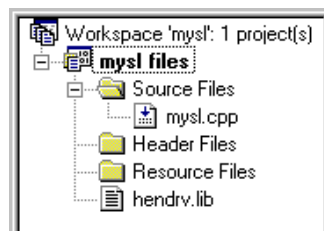
Project → Add To Project → Files, now browse to the API installation directory, e.g. "c:\heapi".

Change the field "Files of type" to "Library Files (\*.lib)".

Select the "hendrv.lib" library file.

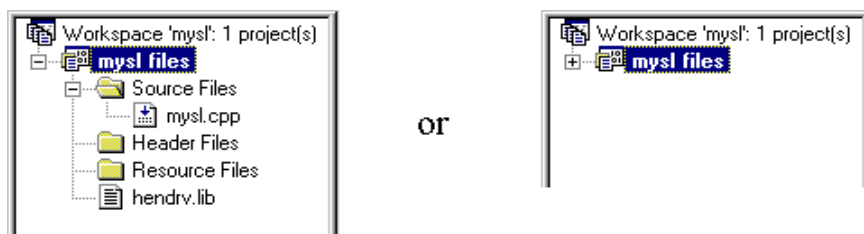
Click "OK".

You can verify that the source file has been added, by looking in the workspace window on the left. In an opened workspace, you can see the library file at the bottom.



## 4) Change the project settings to include API.

In the left-hand project workspace, be sure that "mysl files" is currently selected, or close the workspace.

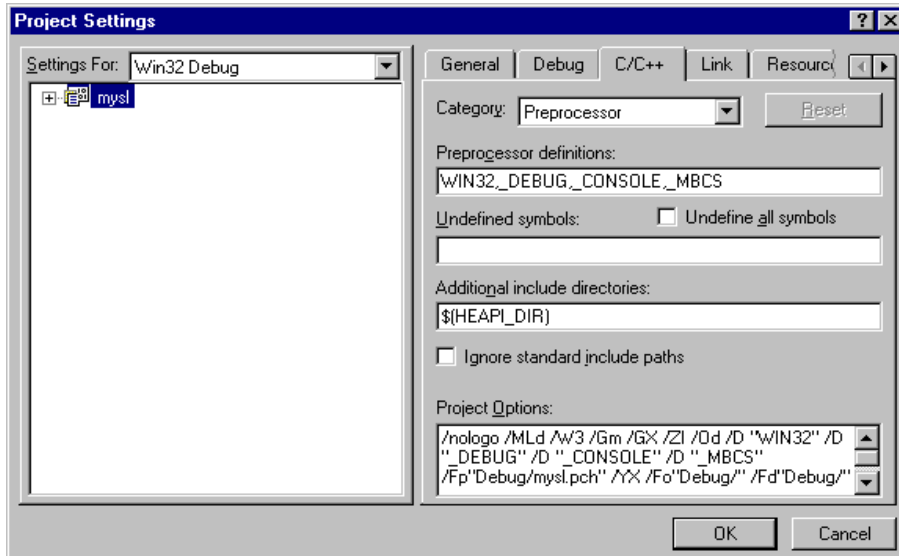


Select "Project → Settings".

Click the "C/C++" tab.

In "Category" at the top of the window, select "Preprocessor".

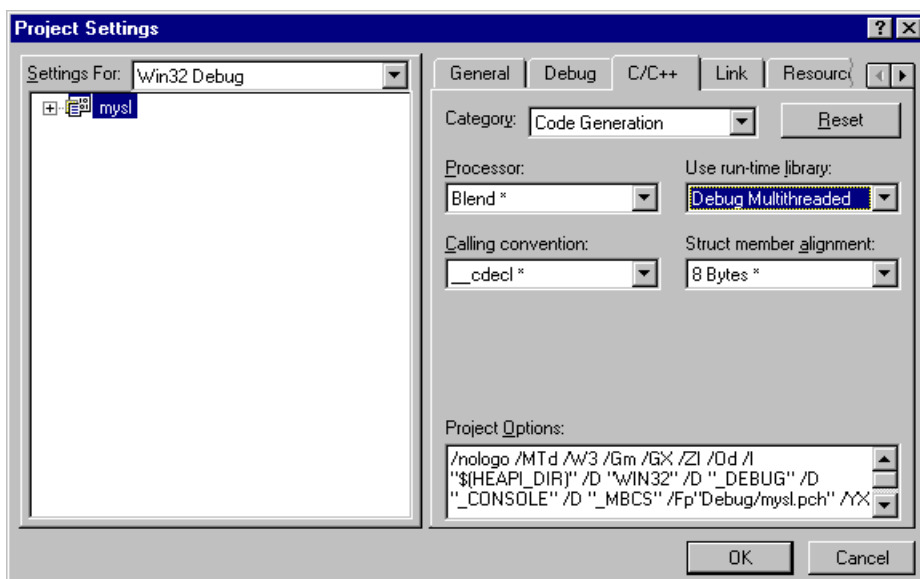
Now add the include directories, “\$(HEAPI\_DIR)” (for the HUNT ENGINEERING API).



No, don't click “OK” yet, next we need to add preprocessor defines.

**5) Make sure that the project is generated with multi-threading support.**

Continuing with the “Project Settings” window, now change category to “Code Generation”. Set the field “Use run-time library” to “Debug Multithreaded” or “Multithreaded”.

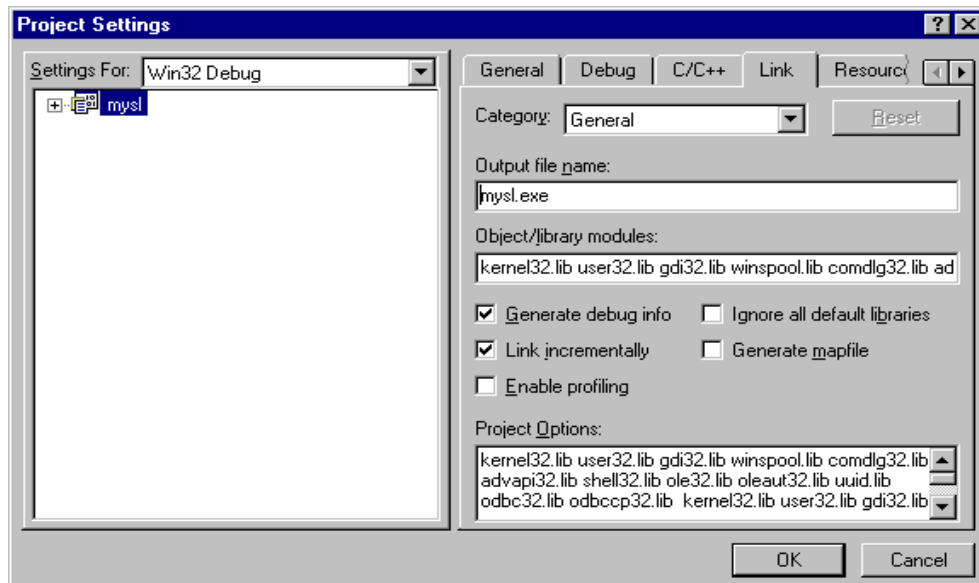


You may want to change the output file path, first go to 6 below. If not, click the “OK” button.

**6) Optionally, set the output file**

It may be useful to change the path of the output file. If you want to use the existing batch file “my32.bat”, set the output file to “..\win32\mysl.exe”. Upon building the project, the output file would overwrite the existing mysl.exe as delivered as part of the example. In these instructions, we keep the new “mysl.exe” in the separate sub-directory, but do change the path in deleting the default “debug\” part of it.

Assuming that the “Project Settings” window is still open, select the “Link” tab. Make sure that “Category” field is set to “General”. Now change the output file field to “mysl.exe”, i.e. delete the “Debug\” part.



## 7) Build the project.

Close the “Project Settings” window by clicking “OK”, if the window was still open.

You can now build the project, e.g. “Project → Build mysl.exe” or “Project → Build All”.

## 8) Create a new batch file to run your new executable.

To run the resulting executable (“mysl.exe” if you named your project “mysl”), it’s perhaps easiest if you create a batch file to run it. Simply copy the existing “my32.bat”. This batch file has 3 lines as follows:

```
%HESL_DIR%\bin\win32\win32sl -I%HESL_DIR%\lib -rl%1 network
rem Change board type if you have HEPC8 instead of HEPC9
win32\mysl hep9a 0 0
```

Change the part that identifies the executable (win32\mysl) to the newly created executable. If you named your project “mysl”, then you would change the above to something like:

```
%HESL_DIR%\bin\win32\win32sl -I%HESL_DIR%\lib -rl%1 network
rem Change board type if you have HEPC8 instead of HEPC9
mysl\mysl hep9a 0 0
```

Open a DOS box, and change directory to the your “mysl” directory. Run the newly created batch file. What you see should be identical to when you run “my32.bat”.

## How to compile the host program for Win32 (with Borland C/C++)

In order to rebuild this example it is necessary to use Borland C/C++ running under Windows 95/98 or NT/W2K. The resulting program can only be run

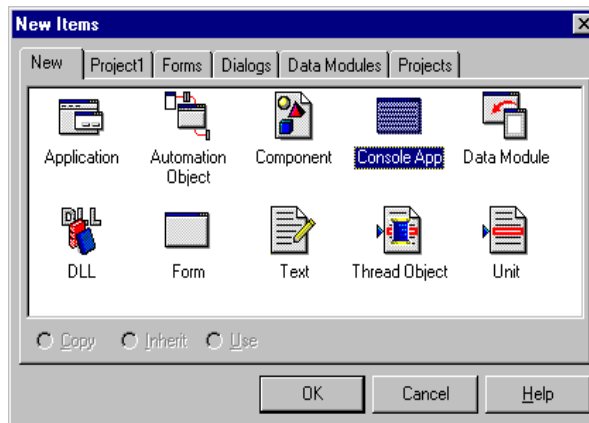
- in a Windows 95/98 DOS Box (Console Window)
- in a Windows NT DOS Box (Console Window)

The following instructions assume that you are familiar with using the Borland compiler and how to manipulate the workspace. The Borland compiler we use is quite old, and it may be that with your version the details of how to do something may differ; but the steps themselves should still be valid.

### **1) Create a new workspace.**

File → New.

Select “Console App”.

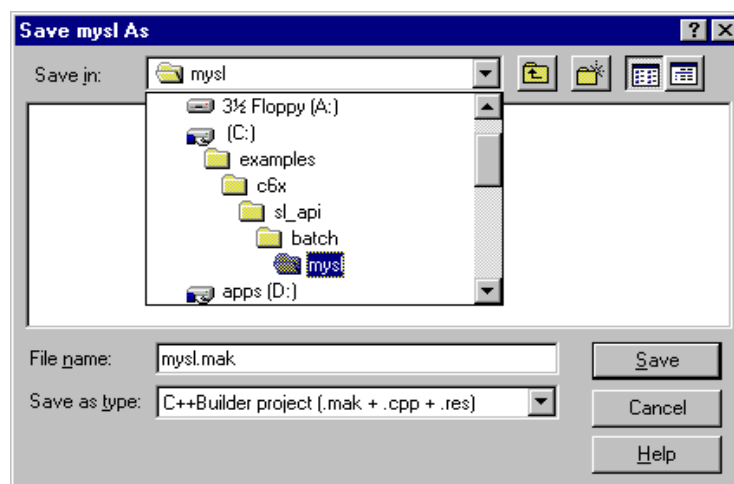


Click “OK”.

### **2) Save the newly created project.**

Create a sub-directory in the “sl\_api\batch” example directory, for example “mysl”. Then save the newly created project (File → Save Project As) in this newly created sub-directory, using the name “mysl”. This will create a make file “mysl.mak” using a C++ file “mysl.cpp”.

The “Save As” window should look similar to:



### **3) Add source files**

There's only one source file to add: “mysl.cpp”. This file is located in the main “sl\_api\batch” example directory, i.e. one directory lower (higher?). The idea is to overwrite the “mysl.cpp” created by Borland with the example “mysl.cpp”. Thus, copy “mysl.cpp” from the main “sl\_api\batch” example directory over the “mysl.cpp” file that was created by Borland C/C++ Builder when saving the project.

#### 4) Add the HUNT ENGINEERING API library.

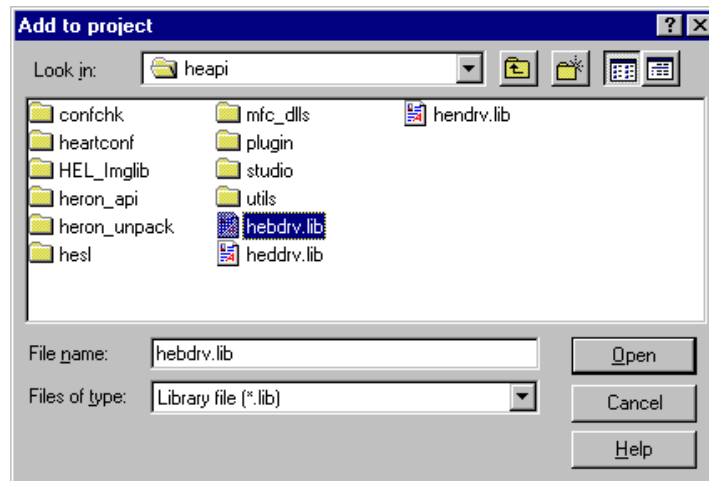
Close the project, then re-open it. The reason for this is to get Borland C/C++ Builder to add extra source lines at a proper location. In my case, I had problems getting Borland to add a source line correctly.

Next, add the HUNT ENGINEERING API library file. The file is called “hebdrv.lib”, and is located in the “\lib\win32” directory of the API installation.

Do a Project → Add to Project.

Browse to the API installation directory.

Change “Files of Type” to “Library files (\*.lib)”.



Select “hebdrv.lib”. Then click “Open”.

#### 5) Make sure the libraries are imported correctly.

Borland adds some lines to the source file (“mysl.cpp”) that import the libraries. But sometimes these lines get inserted at the wrong place. Review your “mysl.cpp” file and make sure the library lines are inserted at a proper point; if not, change the position, e.g., what would work nicely is the following:

```
...
#include "heapi.h"

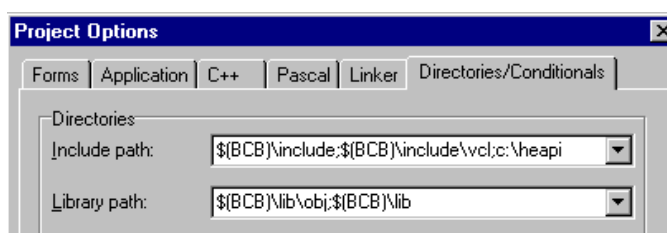
//-----
USELIB( "\\heapi\\hebdrv.lib" );
//-----
...
```

#### 6) Add API include directories.

Select Options → Project.

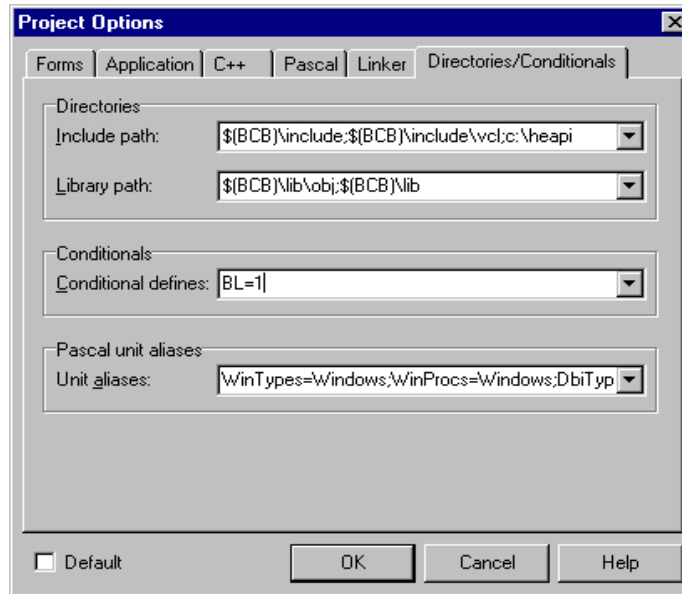
Select the “Directories/Conditionals” tab.

In the “Include path” edit box, add the HUNT ENGINEERING API include directory. In my case, the Borland compiler didn’t allow environmental variables. So I had to add the absolute path. With an API installation in “c:\heapi”, you would add “;c:\heapi” to the “Include path” edit box. If your compiler version allows environmental variables, you may want to add “;\$(HEAPI\_DIR)” instead.



## 7) Add preprocessor definition “BL”.

In the same window, add a preprocessor definition to the “Conditional defines” edit box. This is “BL=1”. This pre-processor definition, “BL=1”, is necessary, because it selects the Borland specific code in the example code (“mysl.cpp”).



## 8) Build the project.

Project → Build All, or Project → Make.

## 9) Create a new batch file to run your new executable.

To run the resulting executable (“mysl.exe” if you named your project “mysl”), it’s perhaps easiest if you create a batch file to run it. Simply copy the existing “bl32.bat”. This batch file has 1 line as follows:

```
%HESL_DIR%\bin\win32\win32sl -I%HESL_DIR%\lib -rl%1 network
rem Change board type if you have HEPC8 instead of HEPC9
win32\b1s1 hep9a 0 0
```

Change the part that identifies the executable (win32\b1s1) to the newly created executable. If you named your project “mysl”, then you would change the above to something like:

```
%HESL_DIR%\bin\win32\win32sl -I%HESL_DIR%\lib -rl%1 network
rem Change board type if you have HEPC8 instead of HEPC9
mysl\mysl hep9a 0 0
```

Open a DOS box, and change directory to the your “sl\_api\batch” directory. Run the newly created batch file. What you see should be identical to when you run “bl32.bat”.