1. Autostarting an IsoMax Application

2. The Autostart Search

When the IsoPod is reset, it searches the Program Flash ROM for an **autostart pattern**. This is a special pattern in memory which identifies an autostart routine. It consists of the value $A55A, followed by the address of the routine to be executed.

```
xx00:  $A55A
xx01:  address of routine
```

It must reside on an address within Program ROM which is a multiple of $400, i.e., $0400, $0800, $0C00, ... $7400, $7800, $7C00.

The search proceeds from $0400 to $7C00, and terminates when the *first* autostart pattern is found. This routine is then executed. If the routine exits, the IsoMax interpreter will then be started.

3. Writing an Application to be Autostarted

Any defined word can be installed as an autostart routine. For embedded applications, this routine will probably be an endless loop that never returns.

Here's a simple routine that reads characters from terminal input, and outputs their hex equivalent:

```
: MAIN   HEX BEGIN KEY . AGAIN ;   EEWORD
```

Note the use of `EEWORD` to put this routine into Flash ROM. An autostart routine must reside in Flash ROM, because when the IsoPod is powered off, the contents of RAM will be lost. If you install a routine in Program RAM as the autostart routine, the IsoPod will crash when you power it on. (To recover from such a crash, see "Bypassing the Autostart" below.)

Because this definition of `MAIN` uses a `BEGIN...AGAIN` loop, it will run forever. You can define this word from the keyboard and then type `MAIN` to try it out (but you'll have to reset the IsoPod to get back to the command interpreter). This is how you would write an application that is to run forever when the IsoPod is reset.

You can also write an autostart routine that exits after performing some action. One common example is a routine that starts some IsoMax state machines. For this discussion, we'll use a version of `MAIN` that returns when an escape character is input:

```
HEX
: MAIN2   HEX BEGIN KEY DUP .  1B = UNTIL ;   EEWORD
```

In this example the loop will run continuously until the ESC character is received, then it exits normally. If this is installed as the autostart routine, when it exits, the IsoPod will proceed to start the IsoMax command interpreter.

4. Installing an Autostart Application

One the autostart routine is written, it can be installed into Flash ROM with the command

```
address AUTOSTART routine-name
```

This will build the autostart pattern in ROM. The *address* is the location in Flash ROM to use for the pattern, and must be a multiple of $400. Often the address $7C00 is used. This leaves the largest amount of Flash ROM for the application program, and leaves the option of later programming a new autostart pattern at a lower address. (Remember, the autostart search starts low and works up until the *first* pattern found, so an autostart at $7800 will override an autostart at $7C00.) So, for example, you could use

```
HEX 3C00 AUTOSTART MAIN2 ( IsoMax V0.6 or newer )

HEX 7C00 AUTOSTART MAIN2 ( IsoMax V0.5 or earlier )
```

to cause the word `MAIN2` to be autostarted. (Note the use of the word `HEX` to input a hex number.)

Try this now, and then reset the IsoPod. You'll see that no "IsoMax" prompt is displayed. If you start typing characters at the terminal, you'll see the hex equivalents displayed. This will continue forever until you hit the ESC key, at which point the "IsoMax" prompt is displayed and the IsoPod will accept commands.

5. Saving the RAM data for Autostart

Power the IsoPod off, and back on, and observe that the autostart routine still works. Then press the ESC key to exit to the IsoMax command interpreter. Now try typing `MAIN2`. IsoMax doesn't recognize the word, even though you programmed it into Flash ROM! If you type `WORDS` you won't see `MAIN2` in the listing. Why?

The reason is that some information about the words you have defined is kept in RAM[1]. If you just reset the board from MaxTerm, the RAM contents will be preserved. But if you power the board off and back on, the RAM contents will be lost, and IsoMax will reset RAM to known defaults. If you type `WORDS` after a power cycle, all you will see are the standard IsoMax words: all of your user-defined words are lost.

To prevent this from happening, you must save the RAM data to be restored on reset. This is done with the word `SAVE-RAM`:

```
SAVE-RAM
```

[1] To be specific, what is lost is the LATEST pointer, which always points to the last-defined word in the dictionary linked list. The power-up default for this is the last-defined word in the IsoMax kernel.

This can be done either just before, or just after, you use `AUTOSTART`. `SAVE-RAM` takes a "snapshot" of the RAM contents, and stores it in Data Flash ROM. Then, the next time you power-cycle the board, those preserved contents will be reloaded into RAM. This includes *both* the IsoMax system variables, and any variables or data structures you have defined.

Note: a simple reset will not reload the RAM. When the IsoPod is reset, it first checks to see if it has lost its RAM data. Only if the RAM has been corrupted -- as it is by a power loss -- will the IsoPod attempt to load the `SAVE-RAM` snapshot. (And only if there is no `SAVE-RAM` snapshot will it restore the factory defaults.) If you use MaxTerm to reset the IsoPod, the RAM contents will be preserved.

6. Removing an Autostart Application

Don't try to reprogram `MAIN2` just yet. Even though the RAM has been reset to factory defaults, `MAIN2` is still programmed into Flash ROM, and IsoMax doesn't know about it. In fact, if you try to redefine `MAIN2` at this point, you might crash the IsoPod, as it attempts to re-use Flash ROM which hasn't been erased. (To recover from this, see "Bypassing the Autostart," below.)

To completely remove all traces of your previous work, use the word `SCRUB`:

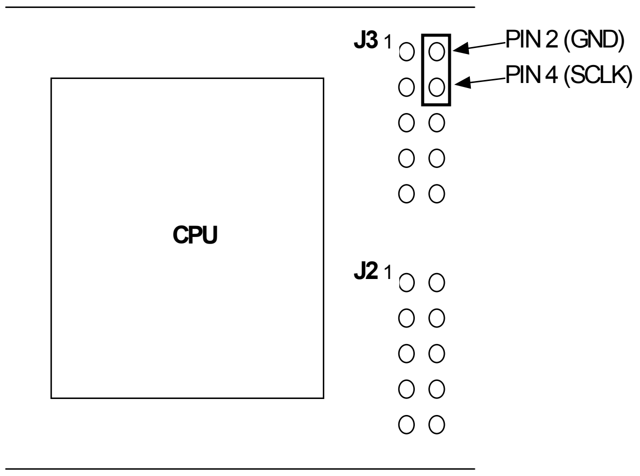
```
        SCRUB
```

This will erase all of your definitions from Program Flash ROM -- including any `AUTOSTART` patterns which have been stored -- and will also erase any `SAVE-RAM` snapshot from Data Flash ROM. Basically, the word `SCRUB` restores the IsoPod to its factory-fresh state.

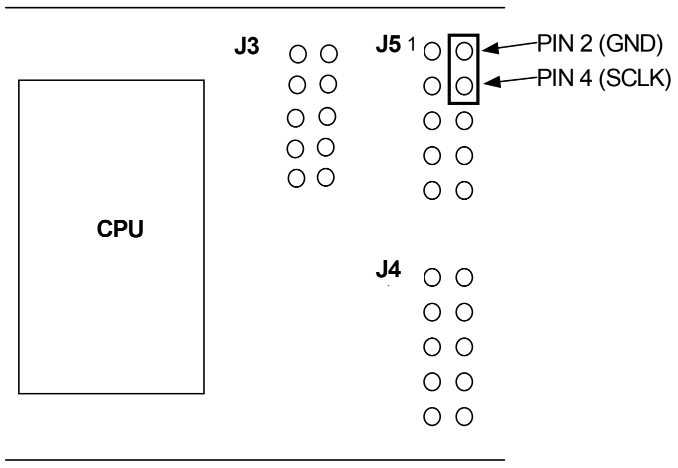
7. Bypassing the Autostart

What if your autostart routine locks up? If you can't get access to the IsoMax command interpreter, how do you `SCRUB` the application and restore the IsoPod to usability?

You can bypass the autostart search, and go directly to the IsoMax interpreter, by jumpering together pins 2 and 4 on connector J3 and J5 of IsoPod V1 and IsoPod V2 respectively, and then resetting the IsoPod. You can do this with a common jumper block:



IsoPod V1



IsoPod V2

This connects the SCLK/PE4 pin to ground. When the IsoPod detects this condition on reset, it does not perform the autostart search.

Note that this does *not* erase your autostart application or your `SAVE-RAM` snapshot from Flash ROM. These are still available for your inspection[2]. If you remove the jumper block and reset the IsoPod, it will again try to run your autostart application. (This can be a useful field diagnostic tool.)

To remove your application and start over, you'll need to use the `SCRUB` command. The steps are as follows:

1. Connect a terminal (or MaxTerm) to the RS-232 port.

[2] The IsoPod RAM will be reset to factory defaults instead of to the saved values, but you can still examine the `SAVE-RAM` snapshot in Flash ROM.

2. Jumper pins 2 and 4 on J5 of IsoPod V2,(or Jumper pins 2 and 4 on J3 of IsoPod V1).

3. Reset the IsoPod. You will see the "IsoMax" prompt.

4. Type the command `SCRUB` .

5. You can now remove the jumper from J3.

8. Summary

Use `EEWORD` to ensure that all of your application routines are in Flash ROM.

When your application is completely loaded, use `SAVE-RAM` to preserve your RAM data in Flash ROM.

Use `address AUTOSTART routine-name` to install your routine for autostarting. "address" must be a multiple of $0400 in empty Flash ROM; `HEX 7C00 is` commonly used on IsoMax V0.5 or earlier version, and HEX 3C00 is commonly used on IsoMax V0.6 or newer version.

To clear your application and remove the autostart, use `SCRUB`. This restores the IsoPod to its factory-new state.

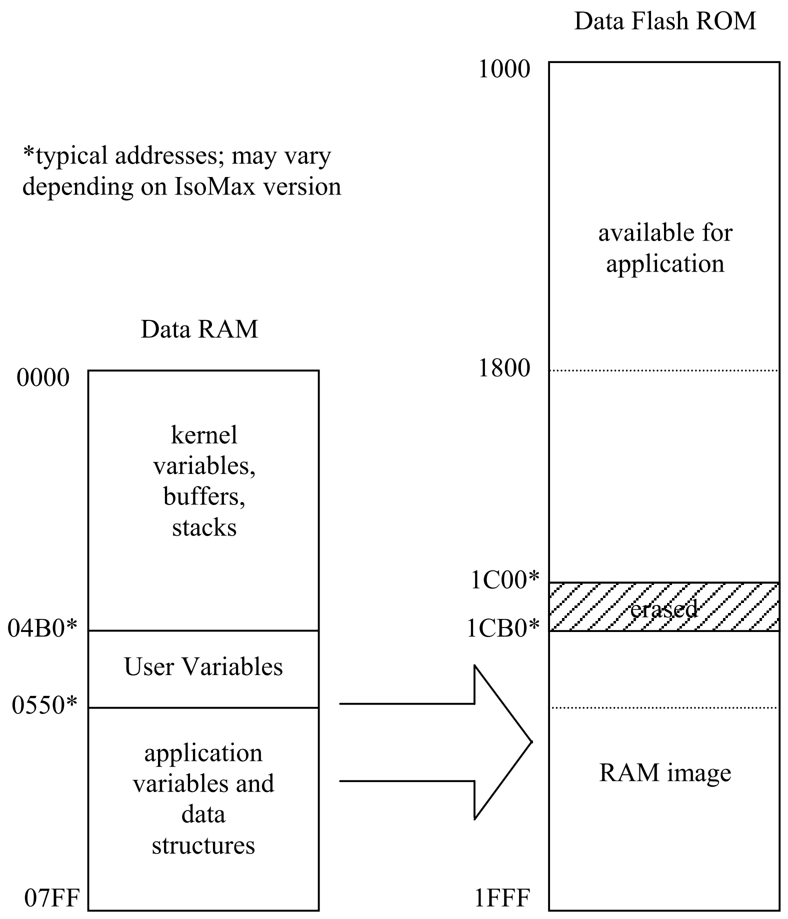
If the autostart application locks up, jumper together SCLK & GND pins, and reset the IsoPod. This will give you access to the IsoMax command interpreter.

9. SAVE-RAM

The IsoPod contains 4K words of nonvolatile “Flash” data storage. This can be used to save system variables and your application variables so that they are automatically initialized when the IsoPod is powered up. This is done with the word `SAVE-RAM`.

10. Data Memory Map

The internal RAM of the IsoPod is divided into three regions: kernel buffers, User Variables, and application variables.


Data Flash ROM
1000
*typical addresses; may vary depending on IsoMax version
available for application
Data RAM
0000
1800
kernel variables, buffers, stacks
1C00*
erased
04B0*
1CB0*
User Variables
0550*
application variables and data structures
RAM image
07FF
1FFF

Kernel buffers include the stacks, working “registers,” and other scratch data that are used by the IsoMax interpreter. These are considered “volatile” and are always cleared when the IsoPod is powered up. These are also private to IsoMax and not available to you.

“User Variables” are IsoMax working variables which you may need to examine or change. These include such values as the current number base (`BASE`), the current ROM and RAM allocation pointers, and the Terminal Input Buffer. This region also includes RAM for the IsoMax state machine and the predefined IsoPod I/O objects.

Application data is whatever variables, objects, and buffers you define in your application program. This can extend up to the end of RAM (address 07FF hex in the IsoPod).

11. Saving the RAM image

The word `SAVE-RAM` copies the User Variables and application data to the *end* of Data Flash ROM. All of internal RAM, starting at the first User Variable (currently `C/L`) and continuing to the end of RAM, is copied to corresponding addresses in the Flash ROM.

Note that this will copy all `VARIABLE`s and the RAM contents of all objects, but it will *not* copy the stacks.

Normally you will use `SAVE-RAM` to take a "snapshot"of your RAM data when all your variables are initialized and your application is ready to run.

12. Flash erasure

Because the `SAVE-RAM` uses Flash memory, it must erase the Flash ROM before it can copy to it. This is automatically done by `SAVE-RAM`, and you need not perform any explicit erase function. However, you should be aware that `SAVE-RAM` will erase more Flash ROM than is needed for the RAM image.

Flash ROM is erased in "pages" of 256 words each. To ensure that all of the RAM image is erased, `SAVE-RAM` must erase starting at the next lower page boundary. A page boundary address is always of the form $XX00 (the low eight bits are zero). So, in the illustrated example, Flash ROM is erased starting at address $1C00.

If you use Data Flash ROM directly in your application, you can be sure that your data will be safe if you restrict your usage to addresses $1000-$17FF. Some of the space above $1800 is currently unused, but this is not guaranteed for future IsoMax releases.

13. Restoring the RAM image

The IsoPod will automatically copy the saved RAM image from Flash ROM back to RAM when it is first powered up. This will occur before your application program is started. So, you can use `SAVE-RAM` to create an "initial RAM state" for your application.

If the IsoPod is reset and the RAM contents appear to be valid, the saved RAM image will *not* be used. This may happen if the IsoPod receives a hardware reset signal while power is maintained. Usually this is the desired behavior.

14. Restoring the RAM image manually

You can force RAM to be copied from the saved image by using `RESTORE-RAM`. This does exactly the reverse of `SAVE-RAM`: it copies the contents of Data Flash ROM to Data RAM. The address range copied is the same as used by `SAVE-RAM`.

So, if your application needs RAM to be initialized on every hardware reset (and not just on a power failure), you can put `RESTORE-RAM` at the beginning of your autostart routine.

Note: do not use `RESTORE-RAM` *if* `SAVE-RAM` *has not been performed.* This will cause invalid data to be written to the User Variables (and to your application variables as well), which will almost certainly crash the IsoPod. For most applications it is sufficient, and safer, to use the default RAM restore which is built into the IsoPod kernel.