# Introducing a new UNO bootloader

**Background**
Details of PCB 111000, a WinAVR taster pcb, intended for use by novice WinARV/Atmel studio programmers, were posted here in November 2018.  It contained two Atmega devices connected together via a programming interface and I2C bus.  One device was programmed with a mini-operating system and the other with user programs.

The OS device was combined with an 8 digit LCD display which it drove on behalf of the user programs, producing a pattern generator, clock/stop watch or simple calculator.  It was also able to program the user device.  A simplified version of this pcb, PCB 111000_1 has since been produced. It plugs into a UNO pcb which provides the user device, the USB bridge and all power supplies. The combination of the UNO and PCB 111000_1 is referred to as PCB 111000_UNO.

**The purpose of the new bootloader**
A new bootloader has been developed for use with PCB 111000_UNO. It resides on the UNO device and its purpose is to control the operation of both the UNO and PCB 111000_1 so that they function as a single product, rather than two separate ones that have been plugged together.

It programs flash memory of the UNO device, not only with the user programs, but also with text. The idea is that this text will provide a commentary for the sample user programs that will be supplied as part of this project.  The user can read the strings one at a time rather than being confronted with a page of text all in one go.

**Bootloader components**
The bootloader consists of the following components:

1.  <u>A hex text programmer</u>      This resides in address space 0x7000 to 0x7FFF.
Hex files are loaded into addresses starting at location zero.  Text files are loaded at addresses starting at address 0x5BFF.  Hex and text files share the flash between addresses zero and 0x5BFF.

2.  <u>A text verification subroutine</u>      This resides in memory locations between 0x6C00 and 0x6FD2.  It has two modes of operation. One echoes the text as a text files is being composed.  The other displays the text strings one at a time when the program is first launched.

3.  <u>A hex verification subroutine</u>      This resides in memory locations between 0x61B0 and 0x6BF2.  It is used to check that the number of commands programmed to flash equals the number of commands in the original hex file. It can also be used to echo some or all of these commands to the PC screen.

4.  <u>Two default user projects</u>      These reside in flash locations 0x5C10 to 0x5DE0.
They require the presence of PCB111000_1 the plug-in board to work.  One drives the display with a pseudo random sequence.  The other reads strings stored in the EEPROM and sends them to the PC. These applications can be made to run at any time.  Their main purpose is to provide confidence that the PCB111000_UNO assembly is working correctly.

**The bootloader user prompt**
The user prompt consists of the string h/t/r/D repeatedly send to the terminal program.  The user echoes h, t, T, r, or D at the keyboard and the UNO responds as follows:

h        A hex file is requested.  After this has been downloaded and programmed the hex
verification subroutine is automatically called. Verification can be skipped or allowed to run.

t        A text file is requested which is programmed to flash. Once this is complete a hex file is
automatically requested.

T        A text file is requested and the text verification routine is automatically called.

r        The program downloaded at the h response is launched.

D        The program downloaded at the h response is deleted and the default programs are
         automatically launched.

Note:
Following the h, t and T responses the user prompt is re-instated.  It can also be obtained at any time
by pressing the UNO reset button.


**Using the new bootloader without plug in board PCB 111000_1**
Use of the bootloader to program both hex and text files can be checked out in the absence of PCB
111000_1.  Two evaluation projects are included:

1.       Project "FP_arithmetic".  This does some arithmetic using the WinAVR maths library and
sends the results to the terminal program.  A text file "FP_arithmetic_commentary.txt" is included
with this project.

2.       Project  "Text_printer".  This reads strings programmed to flash and sends them to a
terminal program.

Terminal settings are as follows: 57.6kBaud, 8 data bits, 1 stop bit, no parity and no handshaking

**Future developments**

An Arduino program "Project_programmer_UNO"  that can be downloaded to the UNO device
using the Arduino bootloader.  This is used to

         Program PCB111000_1 (also know as PCB_A) with the mini-OS and "PCB_A_Bootloader"
         and automatically calibrate the pcb_a device.
         Program the EEPROM of the PCB_A device with text and numeric data

The PC_A bootloader is used to;
         Read the original Arduino bootloader from the UNO device
         Upload the new bootloader to the UNO device
         Reinstate the Arduino bootloader if required

The USBasp programmer was essential to the development of this project and could be used for an
initial evaluation of it.. However when programming PCB 111000_UNO the Arduino bootloader
will be available and it will not be required.

**Config bytes**          Extended, high, Low and lock
0x5/0xFD,     0xD0,          0xFF,          0x2F/0xEF          The new bootloader
0x5,          0xDE,          0xFF,          0x3F               The Arduino bootloader