APPLICATION NOTES

4D SYSTEMS
TURNING TECHNOLOGY INTO ART

Serial Arduino Block Image Transfer

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Description

This application note explores the possibilities provided by the Serial environment in Workshop for a 4D display module to work with an Arduino host. In this example, the host is an Arduino Uno board. The host can also be an Arduino Mega 2560 or Due. Ideally, the application described in this document should work with any Arduino board that supports software serial or with at least one UART serial port. See specifications of Aduino boards here.

Before getting started, the following are required:

- Any of the following 4D Picaso display modules:
  gen4-uLCD-24PT
  gen4-uLCD-28PT
  gen4-uLCD-32PT
  uLCD-24PTU
  uLCD-28PTU
  uVGA-III

and other superseded modules which support the ViSi Genie environment

- The target module can also be a Diablo16 display
  gen4-uLCD-24D series
  gen4-uLCD-28D series
  gen4-uLCD-32D series
  gen4-uLCD-35D series
  gen4-uLCD-43D series
  gen4-uLCD-50D series
  gen4-uLCD-70D series
  uLCD-35DT
  uLCD-43D Series
  uLCD-70DT

  Visit www.4dsystems.com.au/products to see the latest display module products that use the Diablo16 processor.

- 4D Programming Cable or µUSB-PA5
- micro-SD (µSD) memory card
- Workshop 4 IDE (installed according to the installation document)
- Any Arduino board with a UART serial port
- microSD Card Shield for Arduino
- 4D Arduino Adaptor Shield (optional) or connecting wires
- Arduino IDE
- When downloading an application note, a list of recommended application notes is shown. It is assumed that the user has read or has a working knowledge of the topics presented in these recommended application notes.

Content

Application Overview

This application note shows how to perform Block Image Transfer (BLIT) using the Arduino Serial library. In this application note, an Arduino Uno board is used as the host, and a uLCD-32PTU is used as the slave display. First, the desired image is converted to an array, which contains all the hexadecimal values for the pixels of the image. A third party application can be used for this process. The array is then saved to a file. The file is loaded to a uSD card, which is then mounted to the uSD card shield attached to the Arduino host. When the Arduino program runs, it will access the file on the uSD card, and will start sending the individual pixel bytes to the 4D display. The display will then show the pixels on the screen.

Setup Procedure

The display must be configured as a slave device first before it can be controlled by a host. For instructions on how to launch Workshop 4, how to connect the display module to the PC, and how to configure the display as a slave device, kindly refer to the section "**Setup Procedure**" of any of the application notes below. Choose according to your display module's processor.

Serial Picaso Getting Started - The SPE Application

Serial Diablo16 Getting Started - The SPE Application

These application notes also introduce the user to the Serial Protocol thru the use of the Serial Commander.

Using the LCD Image Converter

A third party application is used to convert an image to a character array. The application can be downloaded here:

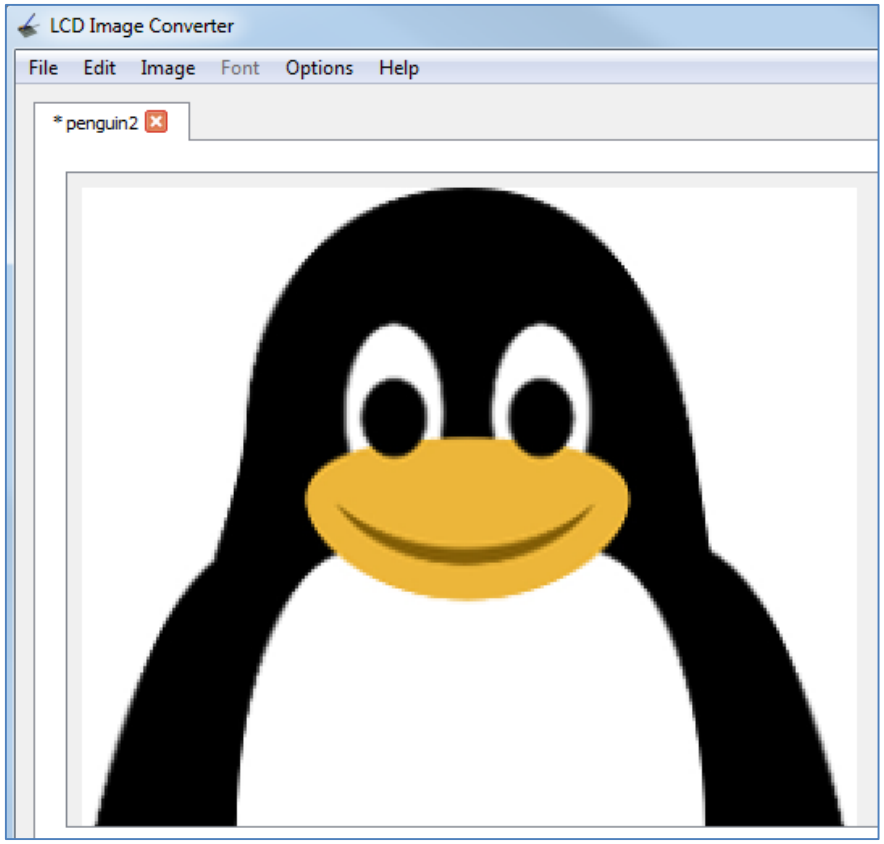
https://code.google.com/p/lcd-image-converter/.

After the image is converted, the content of the array will then be copied to a text file. The text file has a format that must be followed:

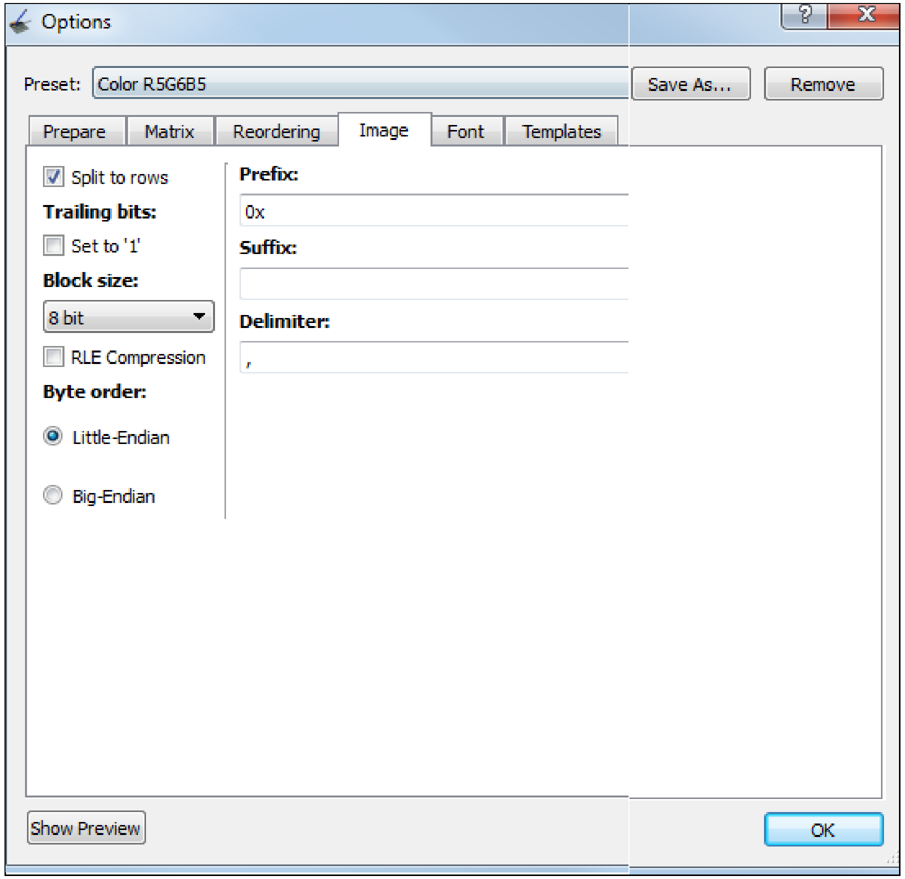
```
[width, height]

Image character array content
```

This text file will be copied to the uSD card, which will be mounted to the uSD card shield of the Arduino.

In the LCD Image Converter application, you can load an existing image by going to File->Open. Here, an image of a penguin is opened.



For this project, these were the conversion settings used under Options-> Conversion:



If the setup is ok, go to File-> Convert or press "Ctrl+P". The converted output can be viewed using a text editor.

```
static const uint8_t image_data_penguin2[153600] = {
    0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
    0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
    0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
    0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
    0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
    0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
    0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
    0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
    0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
    0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
    0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
    0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
```

Only the contents of the array are to be copied to the text file. The final text file should look like the image below:

```
[240,320]

0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
0x5a, 0xcb, 0x42, 0x28, 0x31, 0x86, 0x21, 0x04, 0x18,
0x63, 0x0c, 0x84, 0x30, 0xad, 0x55, 0xce, 0x79, 0xef,
0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
```

The first line contains the width and height of the image and the succeeding lines contain the characters of the array. The Arduino program will parse the text file and expects it to be in this format.

Program the Arduino Host

A thorough understanding of the application note **Serial Connection to an Arduino Host** is required before attempting to proceed further beyond this point. **Serial Connection to an Arduino Host** provides all the basic information that a user needs to be able to get started with Serial Environment and Arduino. The following is a list of the topics discussed in **Serial Connection to an Arduino Host**.

- Understanding the basic Arduino Demo Sketch (without Message Logging)
- How to download and install the Serial-Arduino library
- How to open a serial port for communicating with the display and how to set the baud rate
- The Acknowledgement Byte
- The Error Handling Routine
- How to set the Timeout Limit
- How to set the baud Rate
- How to reset the Arduino Host and the Display
- How to let the Display Start Up
- How to set the Screen Orientation
- How to Clear the Screen
- The uSD Card Mount Routine
- Understanding the Arduino Demo Sketch (with Message Logging)

Discussion of any of these topics is avoided in other Serial-Arduino application notes unless necessary. Users are encouraged to read **Serial Connection to an Arduino Host** first.

Initialize SD shield

```
if (!SD.begin(10)) {
  Serial.println("initialization failed!");
  return;
}
Serial.println("initialization done.");
```

This code initializes the uSD card. The function **begin(cspin)** of the SD library requires one parameter. The **cspin** parameter is the pin connected to the chip select line of the SD card. This defaults to the hardware SS line of the SPI bus.

Get Width and Height

```
myFile = SD.open("BLIT.txt");
if (myFile)
{
  myChar = myFile.read();
  if(myChar == '[')
  {
    while(myChar != ',')
    {
      myChar = myFile.read();
      if(myChar != ',')
      {
      w[counter] = myChar;
      }
      counter++;
    }
    counter = 0;
    if(myChar == ',')
    {
      while(myChar != ']')
      {
        myChar = myFile.read();
        if(myChar != ']')
        {
        h[counter] = myChar;
        }
        counter++;
      }
      counter = 0;
    }
  }
```

This code parses the width and height data contained in the string “[width, height]” of the text file and stores them in variables.

The width and height can be used to determine the screen mode or the orientation of the image. If the width is greater than the height then the image is landscape. If the height is greater than the width then the image is portrait.

```
if(width>height)
{
  Display.gfx_ScreenMode(LANDSCAPE);
}
else
{
  Display.gfx_ScreenMode(PORTRAIT);
}
```

Perform BLIT (Block Image Transfer)

Use **blitFlash()** to perform block image transfer.

```
blitFlash(0,0,width,height,myFile);
myFile.close();
```

The first two parameters are the pixel coordinates of the top-left corner of the image. The **width** and **height** parameters are the values parsed from the text file. The **myFile** variable is the filename of the text file that contains the equivalent array of the image.

```
void blitFlash(word  X, word  Y, word  Width, word  Height,File filename)
{
  DisplaySerial.print((char)(F_blitComtoDisplay >> 8)) ;
  DisplaySerial.print((char)(F_blitComtoDisplay)) ;
  DisplaySerial.print((char)(X >> 8)) ;
  DisplaySerial.print((char)(X)) ;
  DisplaySerial.print((char)(Y >> 8)) ;
  DisplaySerial.print((char)(Y)) ;
  DisplaySerial.print((char)(Width >> 8)) ;
  DisplaySerial.print((char)(Width)) ;
  DisplaySerial.print((char)(Height >> 8)) ;
  DisplaySerial.print((char)(Height)) ;
  blitFromFlash(filename, Width*Height*2) ;
  Display.GetAck() ;
}
```

Inside the routine **blitFlash()**, the function **blitFromFlash()** is called. Below is the definition of this function.

```
void blitFromFlash(File Source, long int Size)
{
        int wk ;
        long int i ;
        File myFile;
        myFile = Source;

    while (myFile.available()) {
        myChar = myFile.read();
        if(myChar == '0')
        {
          myChar = myFile.read();
          if(myChar =='x')
          {
            test[0] = myFile.read();
            test[1] = myFile.read();
            test[2] = 0;

          }
          result = asciihexTohex(test);
          if(result != -1)
            wk = result;
            DisplaySerial.write(wk) ;
        }
    }
}
```

The function **blitFromFlash()** is derived from **blitComtoDisplay()**, which is a function defined in the Arduino-Picaso-Serial and Arduino-Diablo16-Serial libraries. The prototype for **blitComtoDisplay()** is:

```
void blitComtoDisplay(word  X, word  Y,
word  Width, word  Height, t4DByteArray  Pixels)
```

The function **blitComtoDisplay()** will BLIT (Block Image Transfer) pixel data to the screen thru the serial port. This function requires five parameters. The **x** and **y** parameters specify the horizontal and vertical position of the top-left corner of the image. The **width** parameter is the width of the image to be displayed. The **height** parameter is the height of the image to be displayed. The parameter "**Pixels**" is the starting address of an array containing the pixel data to be plotted on the display. For larger images, the equivalent array that contains the pixel data can become very large, such that it exceeds the available program memory space of an Arduino Uno or a Mega2560. To solve this issue, the array containing the pixel data of the image to be displayed is instead stored in a file saved on a uSD card. The Arduino program will then just have to open the file and start the process of "blitting" the contained data. To easily access the uSD card, the functions **blitFlash()** and **blitFromFlash()** were created.

Connect the 4D Display Module to the Arduino Host

Refer to the section "**Connect the Display Module to the Arduino Host"** of the application note **Serial Connection to an Arduino Host** for the following topics:

- Using the New 4D Arduino Adaptor Shield (Rev 2.00)
  - Definition of Jumpers and Headers
  - Default Jumper Settings
  - Change the Arduino Host Serial Port
  - Power the Arduino Host and the Display Separately
- Using the Old 4D Arduino Adaptor Shield (Rev 1)
- Connection Using Jumper Wires

Proprietary Information

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