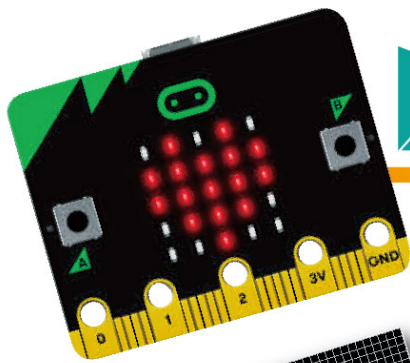


BBC micro:bit with Lumex ezDisplay



LED Module

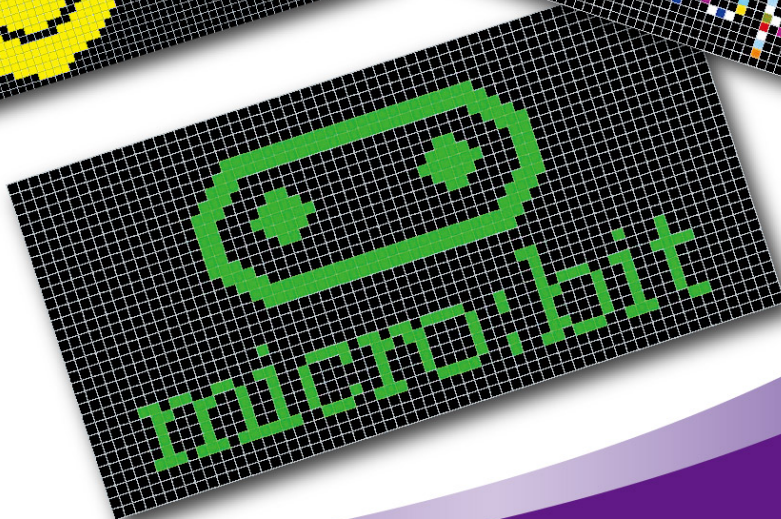
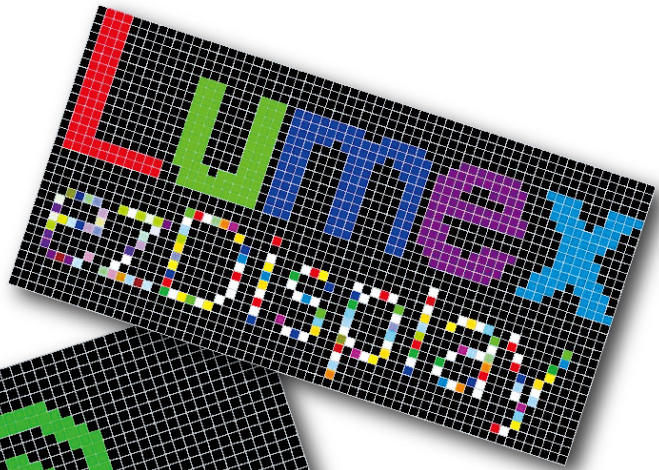
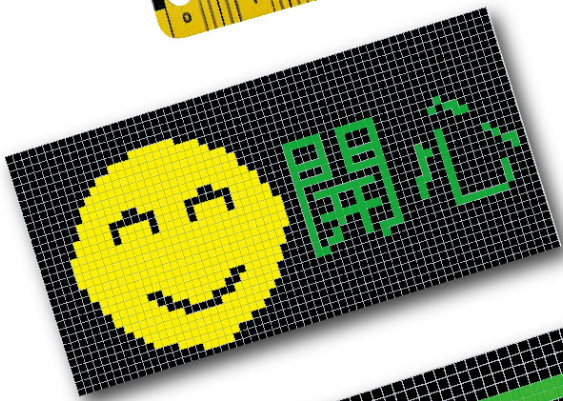


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Chapter 1: Connecting ezLDM to Computer

This chapter demonstrates the steps of making connection between Lumex ezDisplay LED Dot Matrix(ezLDM) to a Windows Computer and tutorial of using Lumex ezDisplay-Advanced to control ezLDM.

1. Before connecting: Install UART bridge driver on Computer

Most computers nowadays do not have UART connector or socket but equipped with USB. Therefore, USB to UART bridge is required to connect Lumex ezLDM to a computer. The UART bridge provided by Lumex is powered by CP210X chip. In order to make this device function as expected, the driver needs to be installed. Please download the driver from this link and choose the OS version.

<https://www.silabs.com/products/development-tools/software/usb-to-uart-bridge-vcp-drivers>

2. Connecting ezLDM and Computer via UART bridge

Once the driver of UART bridge is installed, the next step is simply connecting ezLDM, UART bridge and the computer together. Since there is no additional switch on ezLDM to control the power state. ezLDM will be always on after the connection is proper made and show the first stored picture. If possible, please connecting ezLDM to UART bridge before making the connection between UART bridge and the computer by a Micro-USB cable. This Micro-USB cable is not included and needs to be prepared separately.

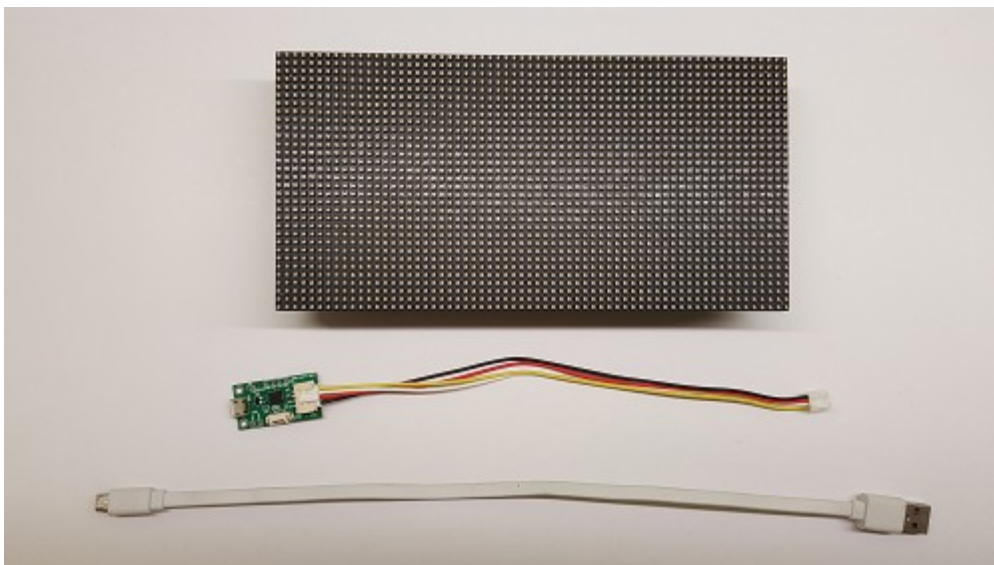


Figure 1-1 Hardware Needed

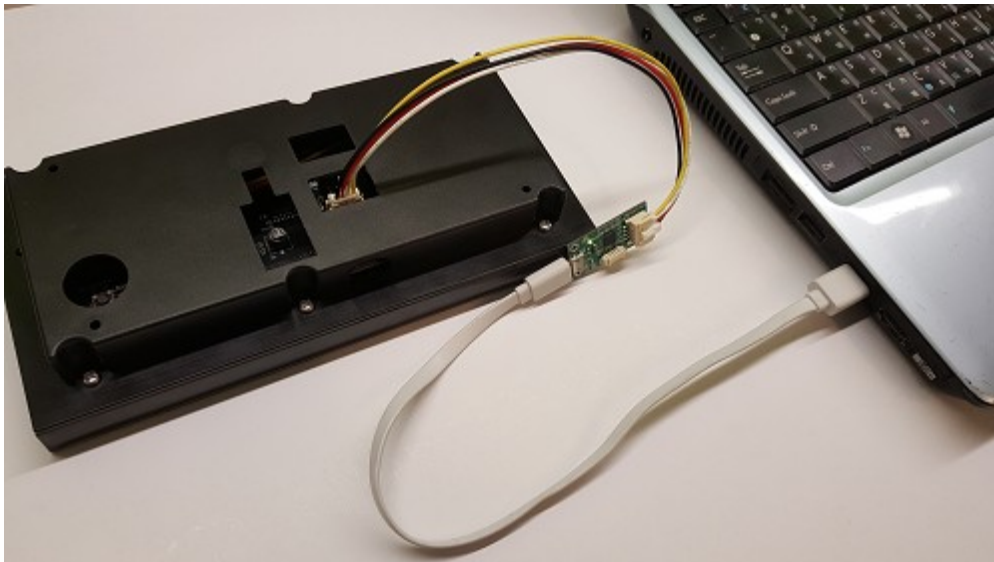


Figure 1-2 Connected ezLDM, UART bridge and Laptop Computer

3. Lumex ezDisplay-Advanced Tutorials

ezDisplay-Advanced is developed to provide a visual interface on Windows computer for users not familiar with programming by text.

a) Software Download and Installation

ezDisplay-Advanced is able to be downloaded in the following web page (Windows only): <https://www.lumex.com/ezDisplay-Dot-Matrix.html>

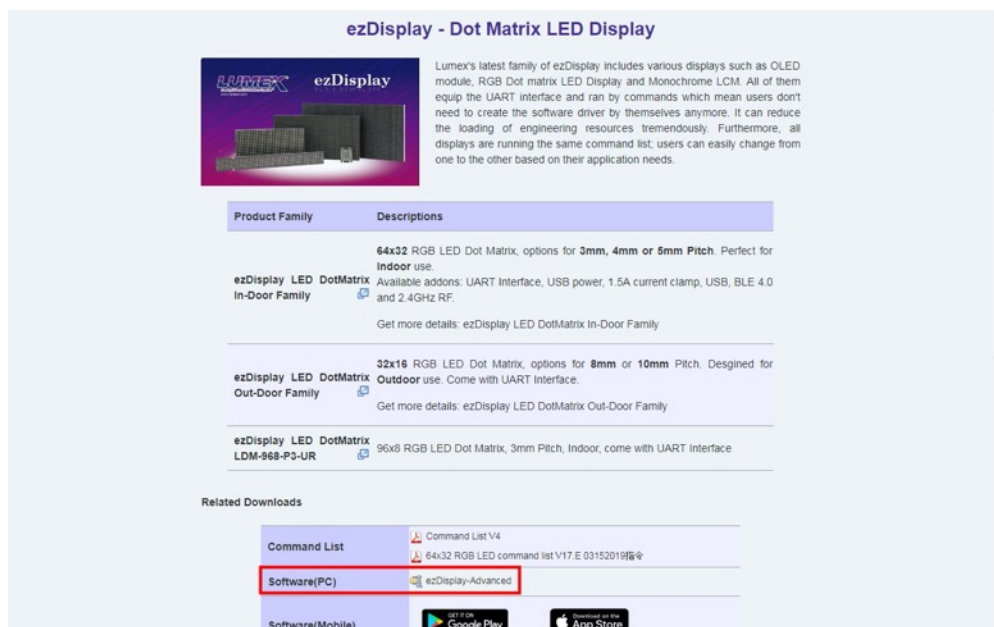


Figure 1-3 Screen shot of ezDisplay LED Dot Matrix Page.

The installation is fairly simple like other software installation. Unzip the downloaded file to ezDisplaySetup.msi and execute this file to start the installation.

b) Communicating ezDisplay LED Dot Matrix by ezDisplay-Advanced Application

i.) Work area overview:

There are three tabs in Lumex ezDisplay-Advanced, they are “**Device Configuration**”, “**AT Command Mode**” and “**Graphic Mode**”.

ii.) Serial port selection:

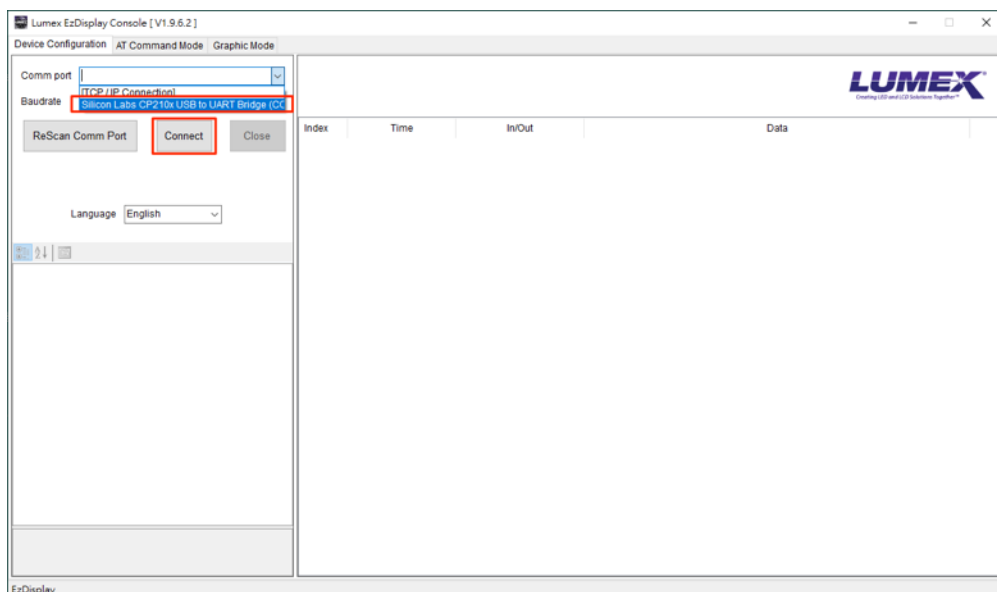
After the installation, ezDisplay-Advanced is dropping a shortcut on the Desktop.



Double click ezDisplay-Advanced icon and start using the software.

The first thing to do is picking the correct serial port in “Device Configuration” and it should be something like “Silicon Labs CP210x USB To UART Bridge(COMx)” in the dropped down menu.(The x of COMx is referring to the serial port number.)

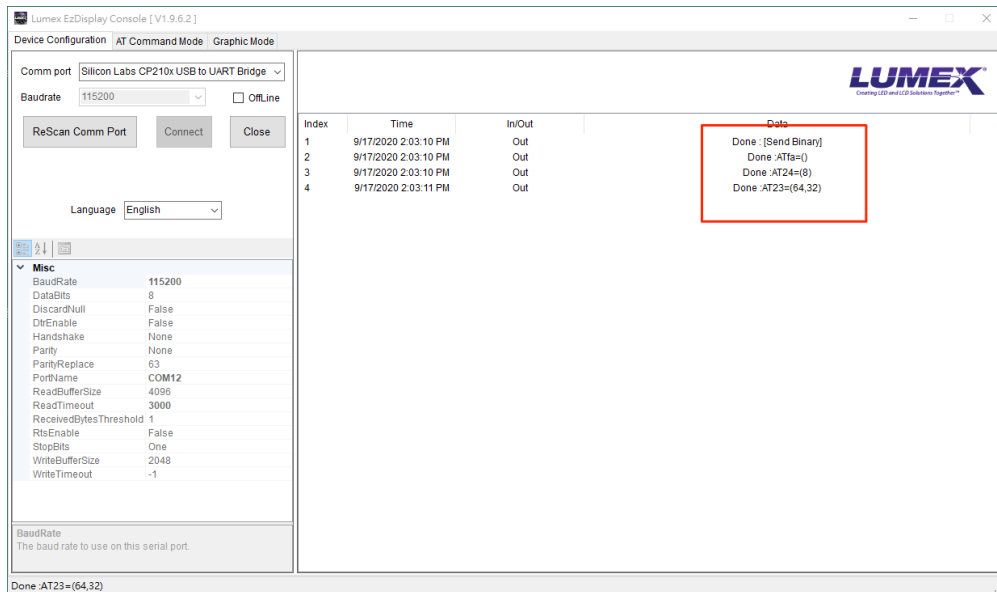
In case of not finding “Silicon Labs CP210x USB To UART Bridge” in the dropped down menu, please check the connection between UART bridge and the computer then click “ReScan Comm Port”. This also needs to be done whenever the UART bridge is disconnected and reconnected.



iii.) Baud rate selection:

Default baud rate of ezDisplay LED Dot Matrix is 115200bps. Another baud rate 9600bps is also available. The default baud rate fits for most case, it is not necessary to change the default baud rate to 9600bps.

After setting the baud rate, click “Connect”. There should be some message on the right, this indicate the communication is established.

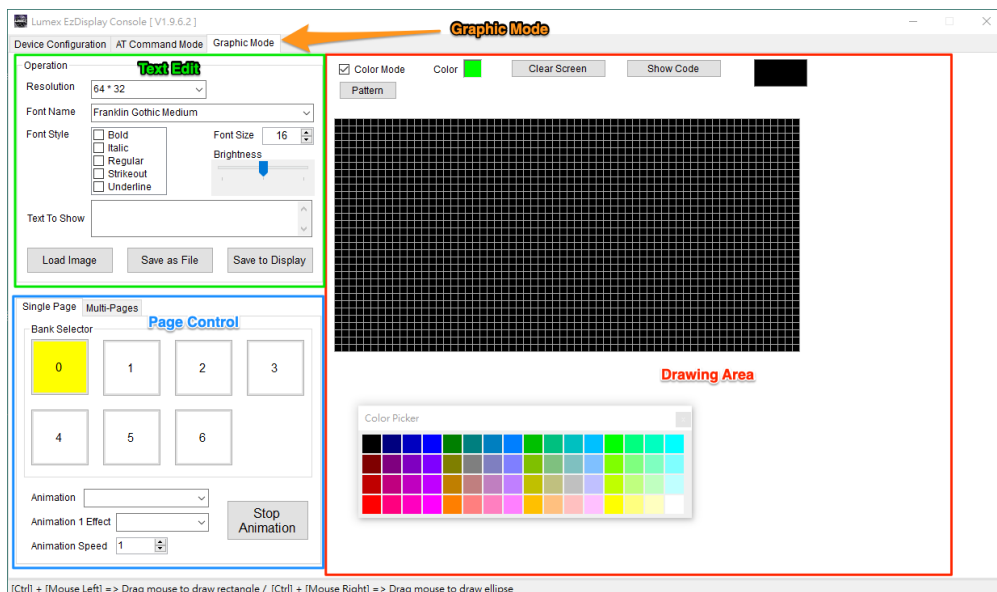


c) Drawing a picture and show on Lumex ezDisplay LED Dot Matrix

iv.) The “Graphic Mode”:

The simplest way to show a picture on ezLDM is using “Graphic Mode”. The following tutorials and examples in this book are using resolution of 64*32. Other resolution such as 32*16 are also applied.

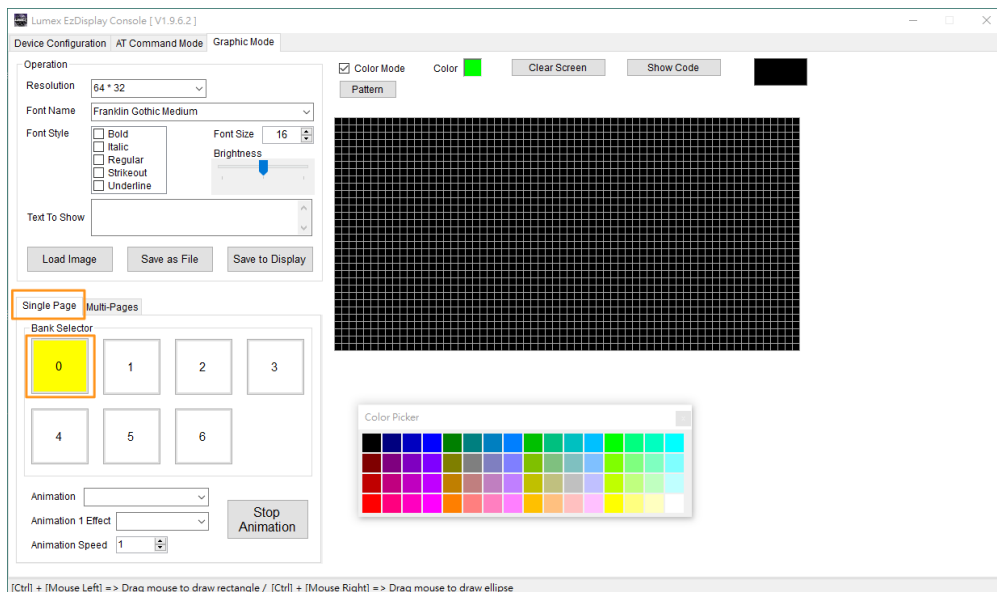
In the tab “Graphic Mode”, the window is split into three parts. On the right-hand side, there is a black rectangle with 64*32 small squares. This is called drawing area; the black rectangle is mapping to ezLDM. There are two areas in the left-hand side. The top area is for text editing and the bottom is page control.



v.) The Graphic Mode - Page Control Area:

There are three tabs in Page Control Area. From left to right, they are “Single Page”, “Multi-Pages” and “Pattern Tool”. With built-in EEPROM, ezDisplay LED Dot Matrix is able to store 7 different pages starting from page 0(the first page) to page 6(the last page). In the “Single Page”, there are 7 squares with number inside. Each square represents a page. Before editing, choose the correct page number, otherwise the editing might be saved into different page and messed up the order in “Multi-Pages” tab. **Always select the page number first.**

“Multi-Pages” tab is basically switching single page with optional animation effect. It always starting from page 0 and cycling repeatedly.



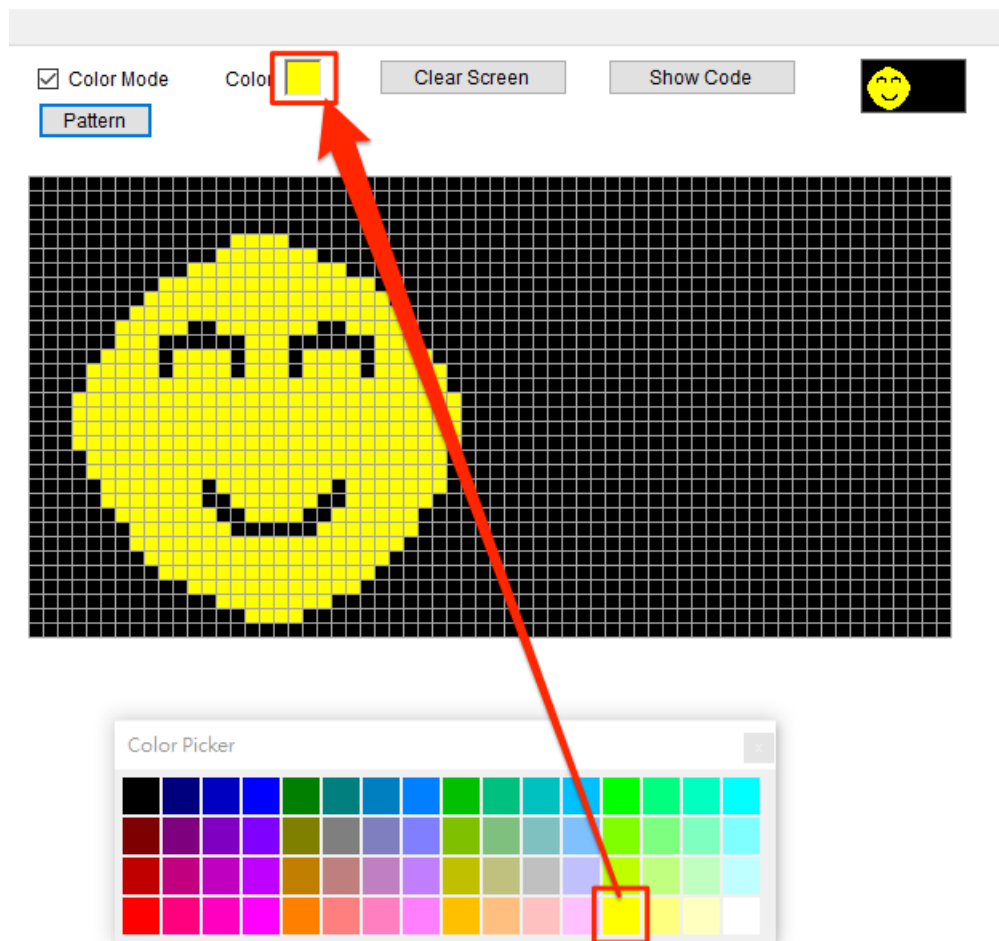
vi.) Starting the First Painting:

Painting in the drawing area on the right-hand side is straight forward. The first thing is clicking the “color” on the top and color panel will popup for color selection. The next thing to do is picking a color by clicking the color and move mouse cursor to start painting.

Tips:

1. Left Click to paint single dot.
2. Left Click Dragging to paint wherever the cursor passed.
3. Right Click to paint in black(erase).
4. Right Click Dragging to paint in black(erase) wherever the cursor passed.
5. Ctrl + Left Click Dragging to paint a solid rectangle(square).
6. Ctrl + Right Click Dragging to paint a solid ellipse(circle).

Click “Clear Screen” to reset the draw area.

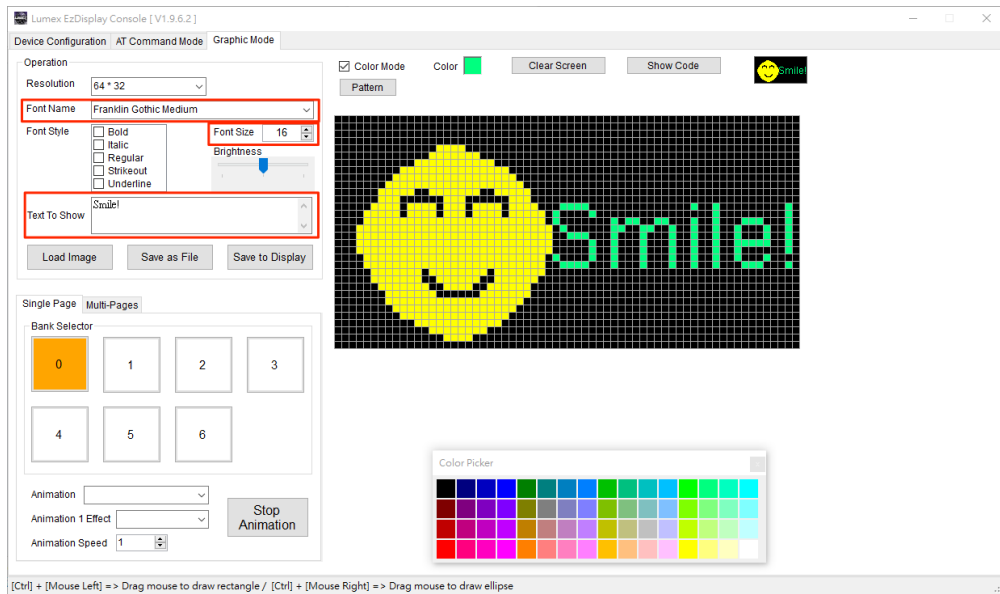


vii.) Writing in Lumex ezDisplay LED Dot Matrix:

To show a string on ezLDM is a simple task. It only needs to take two things to write a string in the draw area. Obviously, the text to be showed on ezLDM is required. The second thing is picking a color. There is no order between those two, in another term, picking a color then typing the text is also working. Once the text is typed and color is selected, it is time to move mouse cursor to drop the text in the preferable place in the draw area.

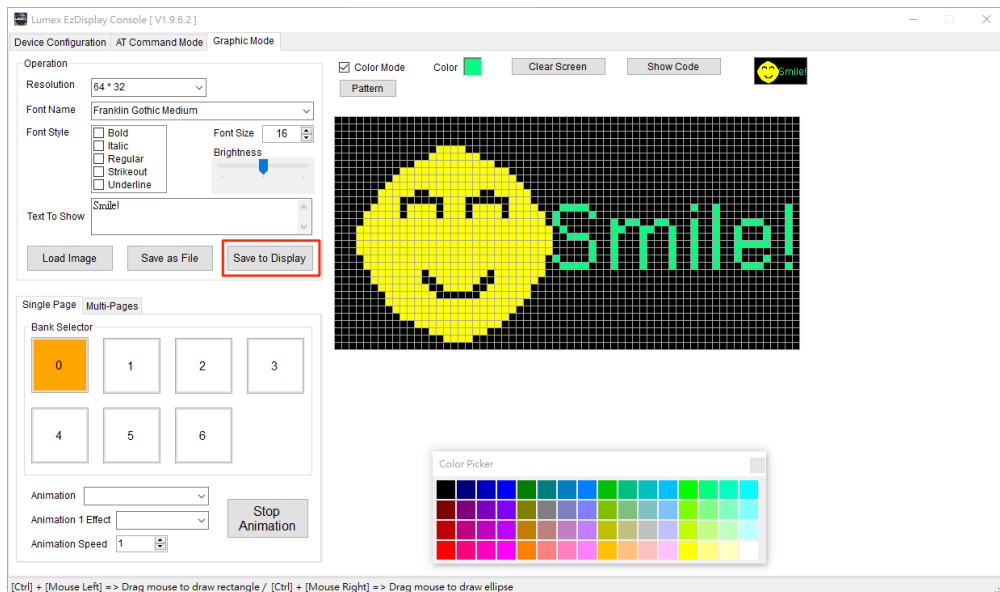
There are also options for font face and font size. By the way, the number of font size does not mean the dots on ezLDM.

Since Lumex ezDisplay-Advanced software is sending the text to ezLDM as graphic, surely Asia characters are also supported as long as the fonts are installed in the Windows Computer.



Do remember to “Save to Display” the painting on the draw area to ezLDM:

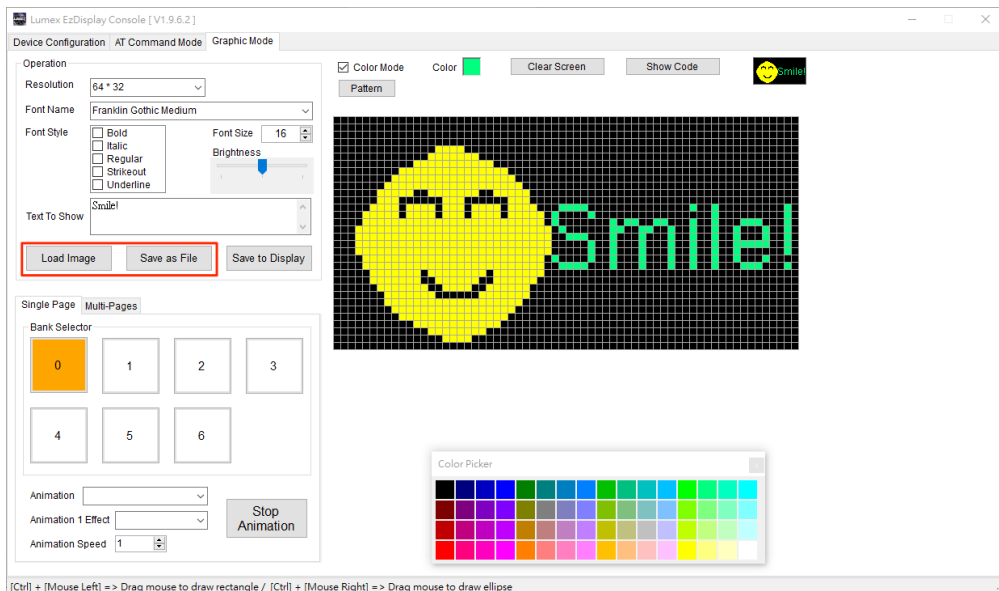
The painting on the draw area is not going to show on ezLDM, unless “Save to Display” is clicked.



Once the “Save to Display” button is clicked, ezLDM will show the content immediately.



Note: In case of reuse the content in the future, please use the button “Save as File” to save the content in draw area into a bmp file. Also, if the page is not selected before painting, please use “Save as File” first and “Load Image” after selecting the correct page number.



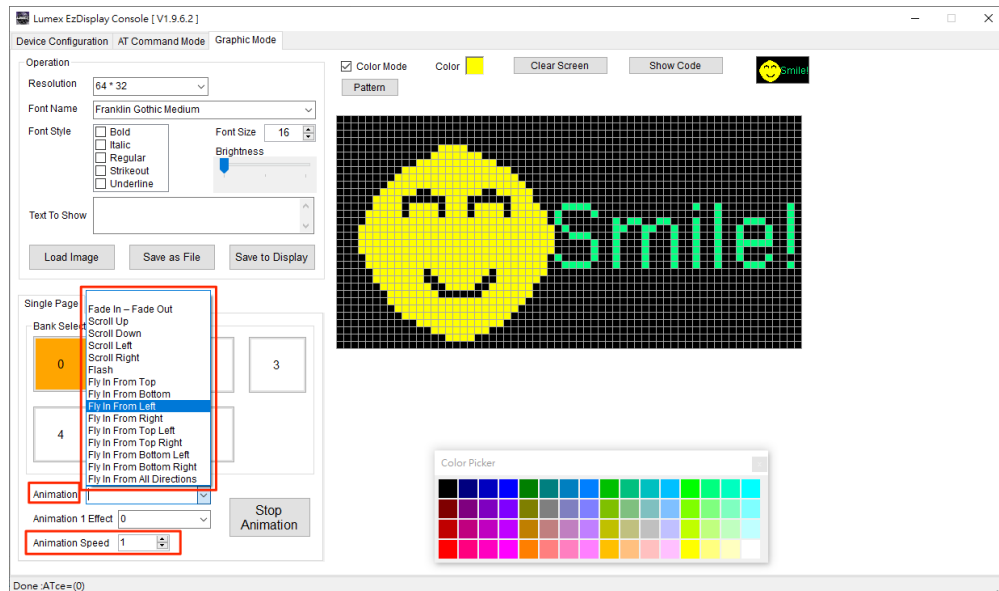
There are page 0 to 6 for you to draw.

viii.) Single Page Animation:

There are some built-in animation or effect in ezLDM. The animation setting in “Single Page” only applied to the page. (Do not forget to click “Save to Display”

button.) The dropped menu of “Animation 1 Effect” is for “Fade in and Fade out” only. The speed of animation is also adjustable by select a number from 1 to 10. The larger number the longer duration of the animation.

The button “Stop Animation” is available to stop the animation at any time, and the current running animation will stop after completed the animation cycle.



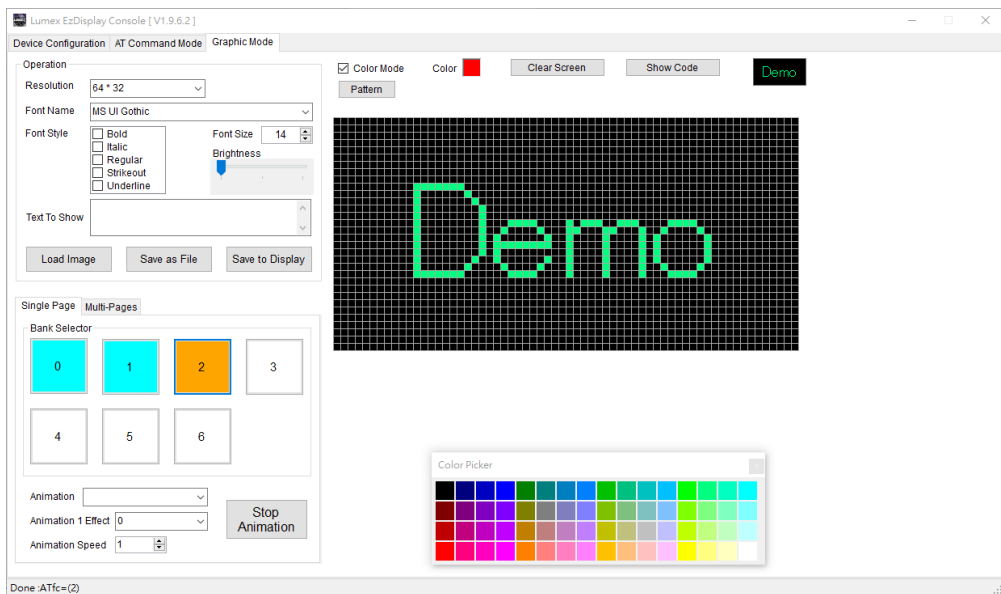
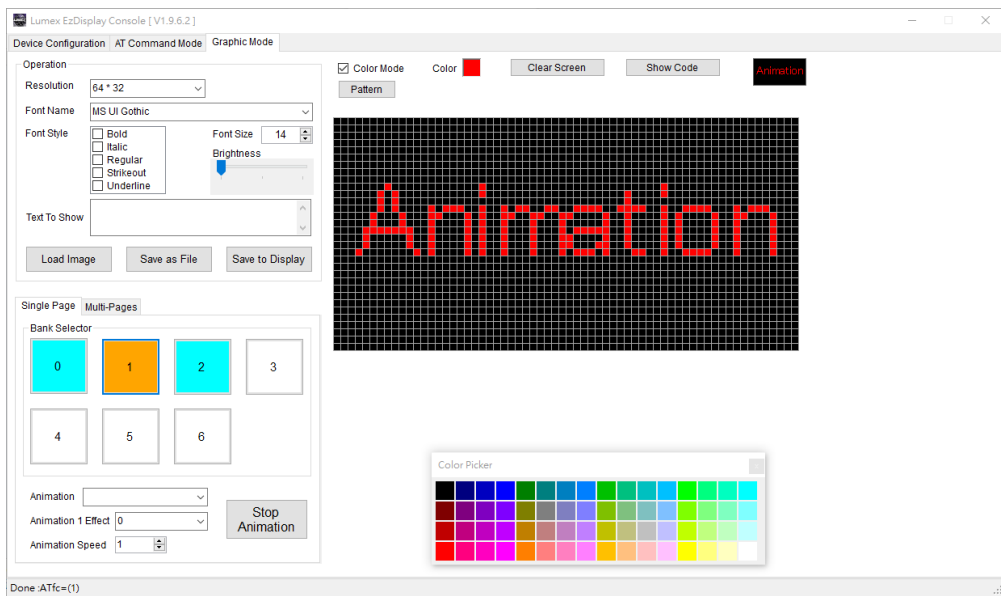
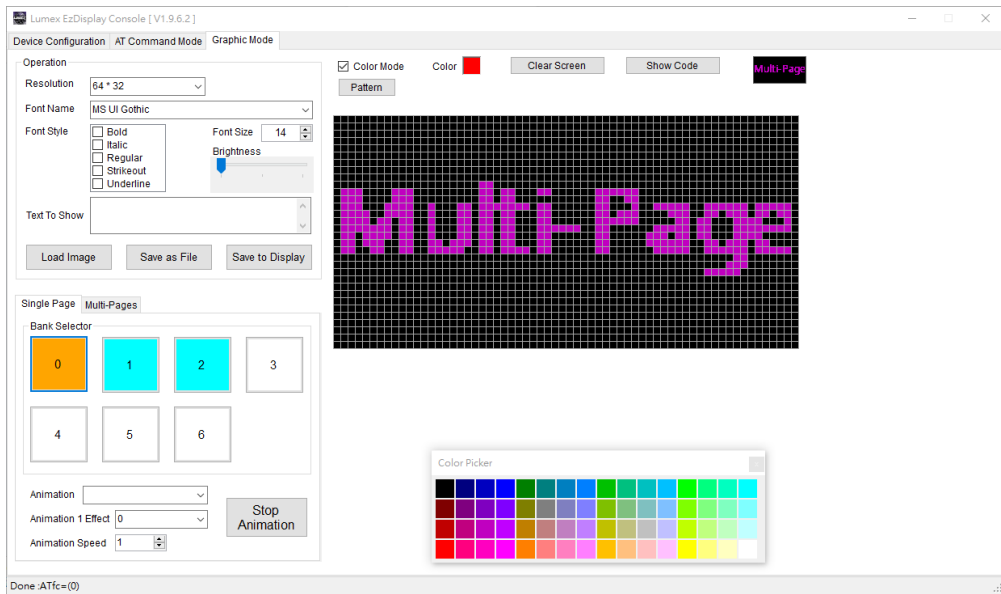
ix.) “Multi-Pages” Animation:

The animation of “Multi-Pages” is more like transition between different pages. The animation of “Multi-Pages” always starts from page 0, for example, “2” pages for animation means from page 0 to page 1; “3” pages for animation means from page 0 to page 2 and so on.

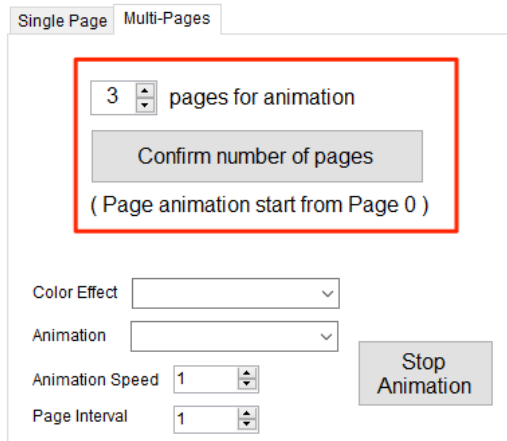
“Color Effect” are not covered in this book. This field is specific for combination of 4 pieces 32x16 ezLDM together.

“Animation Speed” is like “Single Page”, means how fast the animation is. And “Animation Interval” means the waiting time between pages. Again, “Stop Animation” is to stop current animation after it completed.

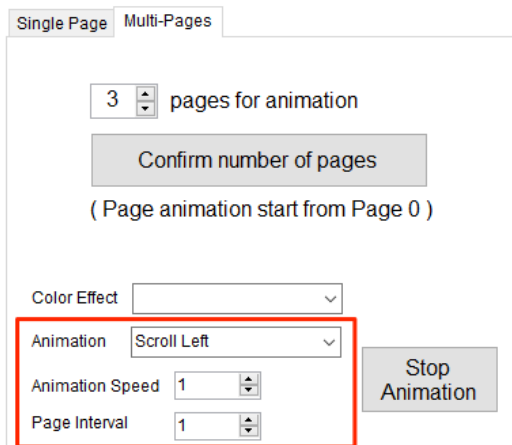
Try it: First of all, starting to write something into Page 0, 1 and 2 in “Single Page”. Don’t forget to click “Save to Display” after drawing each page.



Secondly, click “Multi-Pages” tab and select “3” pages for animation (Page 0, 1 and 2).



The next thing is select “Animation Speed” and “Animation Interval”. Once the speed and interval are decided, it is time to pick the preferred animation. **Note: Once the animation is picked, ezLDM start do the animating effect. Please select the animation after speed and interval.**



x.) Example of Draw TEXT Shadows:

There is no mystery of showing text with shadow on Lumex ezDisplay LED Dot Matrix. Text shadow effect is actually overlapping of two same text with different color and some shift of position.

First, write some text with color of “dark” first and using the same text with “brighter” color.

Tips for making text shadow: using “Bold” text is making the shadow looks better.

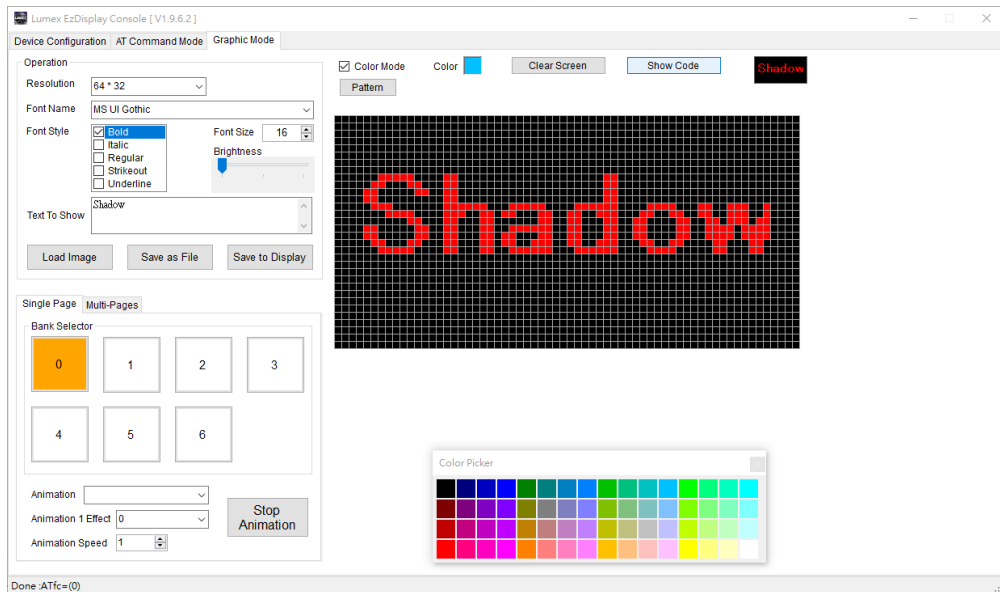


Figure 1-4 Text with "Dark" color first

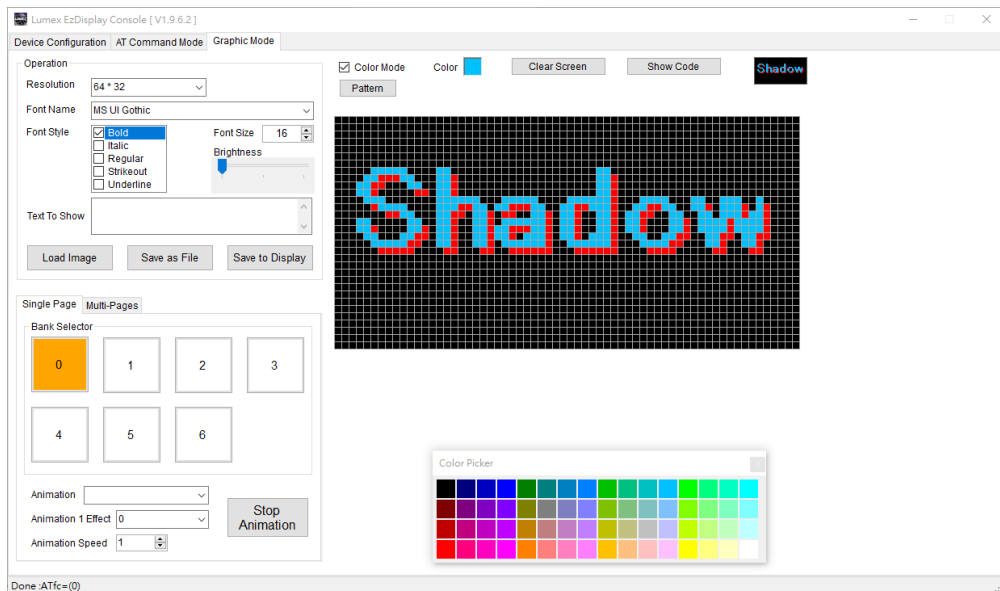


Figure 1-5 Using Brighter Color on top of the previous text

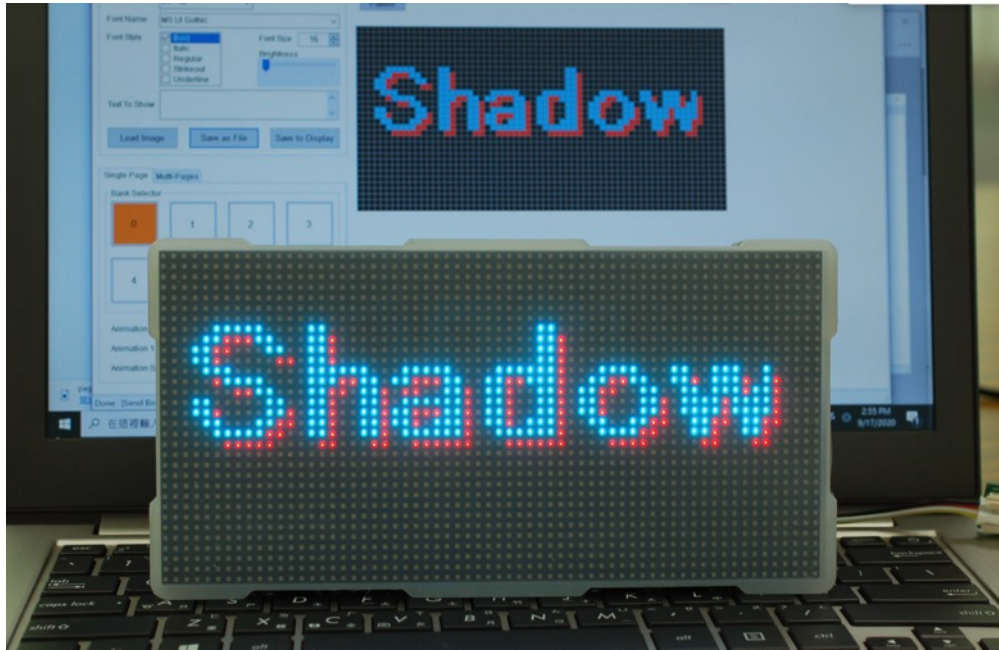


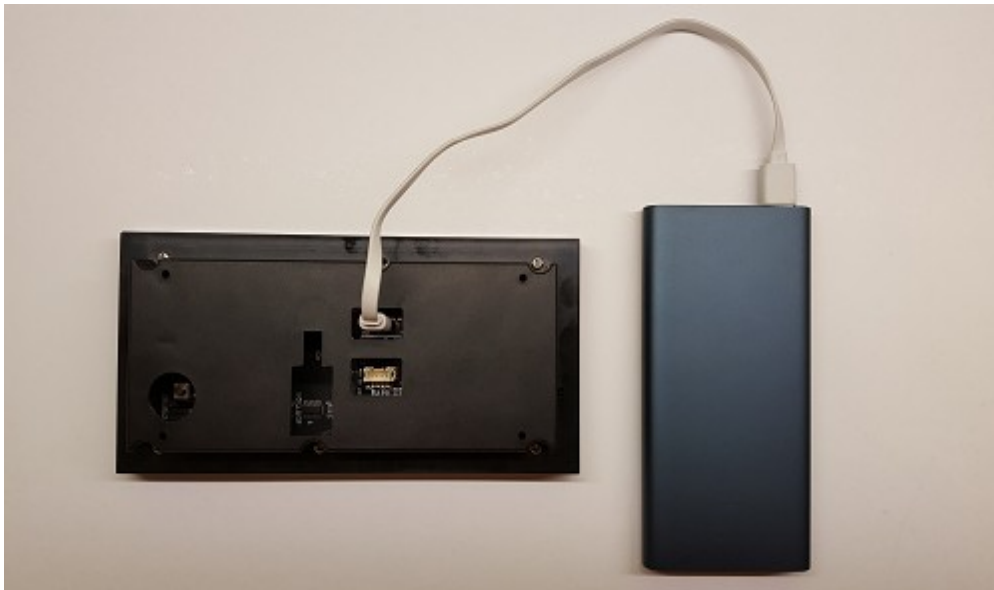
Figure 1-6 Result on Lumex ezDisplay LED Dot Matrix

4. Disconnecting ezLDM from the Computer

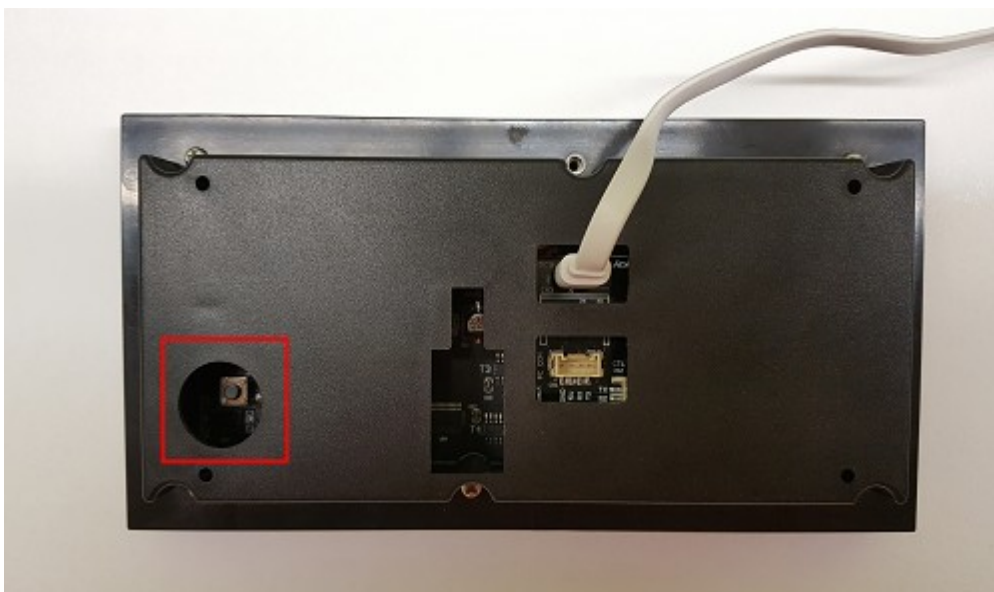
Once the pages are sent to ezLDM, it can be disconnected from the computer. Without the UART bridge, only a Micro-USB cable and a power bank (or a 5V USB wall charger) are required.



Connect ezLDM with Micro-USB cable to power bank, and it will start to work. If any animation effects have been set for single-page or multi-page display before disconnecting from computer, they will be showed on ezLDM according to the presetting.



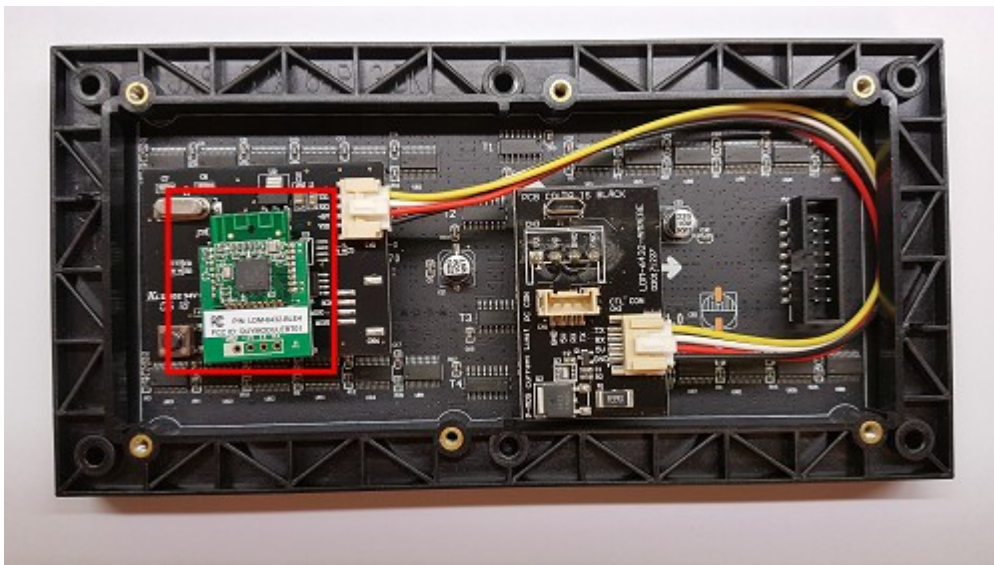
If the animation effects are not set, press the button on the back side of ezLDM to switch the pages. Every press will move to next page, cycling from page 0 to page 6.



Chapter 2: How to Control ezLDM with micro:bit – Basic Operation

1. Remove the Bluetooth Device from ezLDM

If the ezLDM you purchased is the version for Bluetooth connection, it is required to detach the Bluetooth device from ezLDM since the Bluetooth system has conflicting issue with micro:bit. Please remove the back board of ezLDM with screwdriver. Find a small green PCB inside the ezLDM and detach it from ezLDM. Store it in a safe place and lock the back board. Now it enables micro:bit to control ezLDM.



2. Hardware Connection

The connection between ezLDM and micro:bit is through serial ports using the Rx and Tx lines for serial communications. Since ezLDM has high power consumption, micro:bit and ezLDM that shall be connected to the same grounding system but need independent power supply. In this case the connection of these two devices requires three lines: Rx line, Tx line and ground (GND) line. The ezLDM provides the lines for connecting to micro:bit, a white Rx line, a yellow Tx line and a black GND line. **Please note that the red VCC line cannot be connected.** The micro:bit also needs an extension board to expand the pin header interface. The followings are essential items for connection.

1. Two Micro-USB cables (for supplying power to ezLDM and micro:bit separately)
2. micro:bit with expansion board

3. Communication lines connected to serial ports (ezLDM contains four lines, black, red, white and yellow lines)
4. Power bank (for micro:bit to use while disconnecting from the computer, or it can use the computer as power supply)

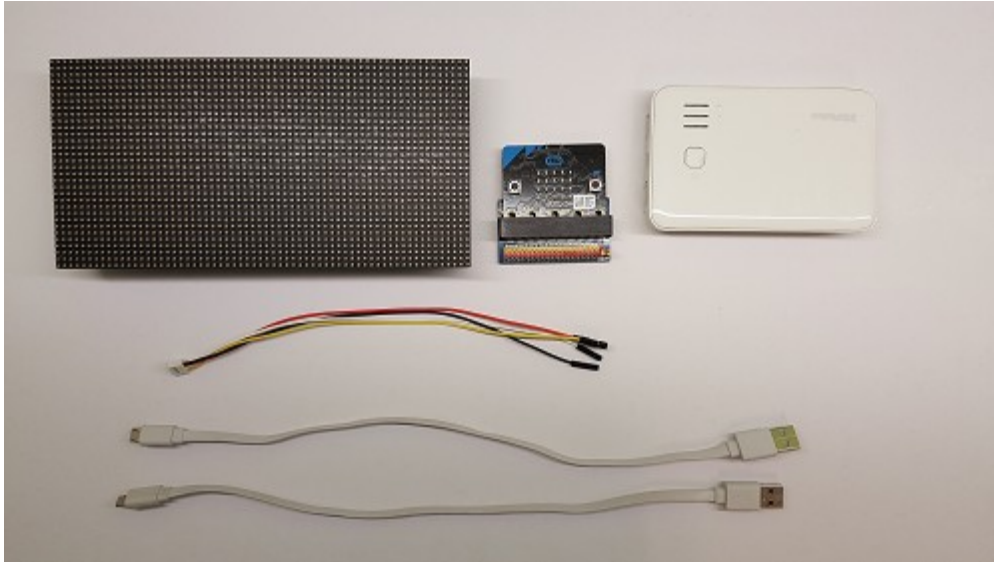


Figure 2-1 Essential items to get ezLDM connected to micro:bit

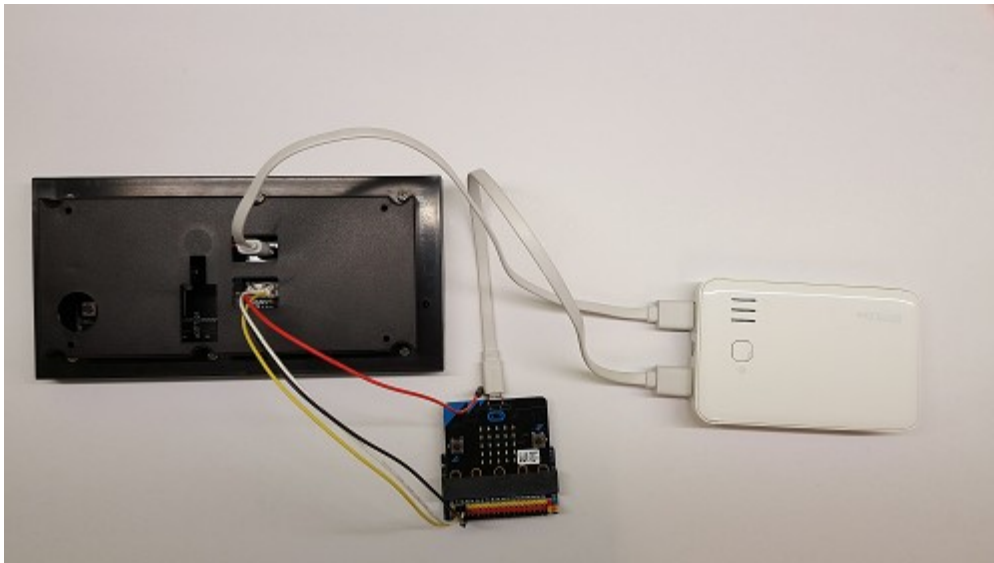
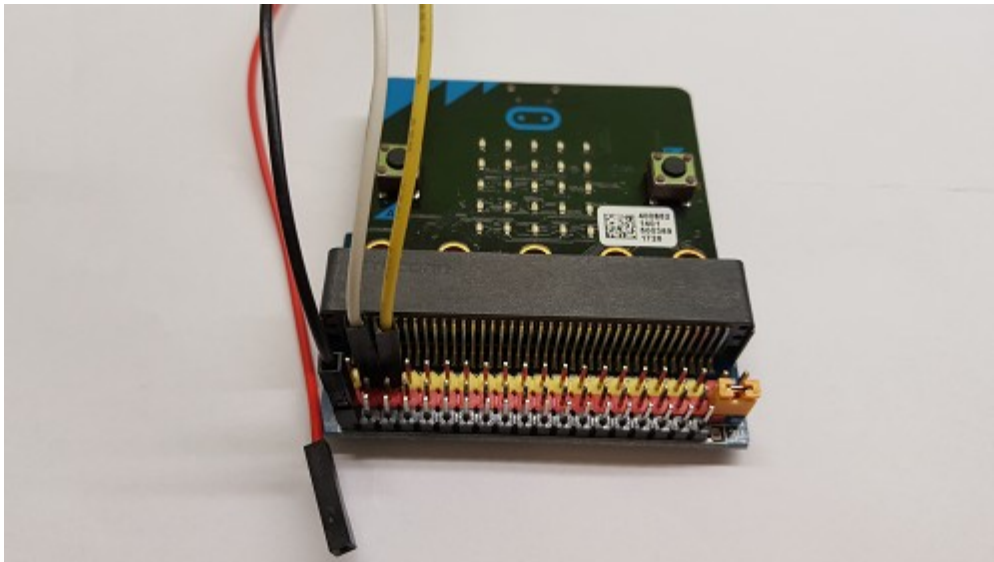


Figure 2-2 Connection all together.

Connection of ezLDM to micro:bit. The ezLDM requires high power consumption, and both micro:bit and ezLDM need power supply.



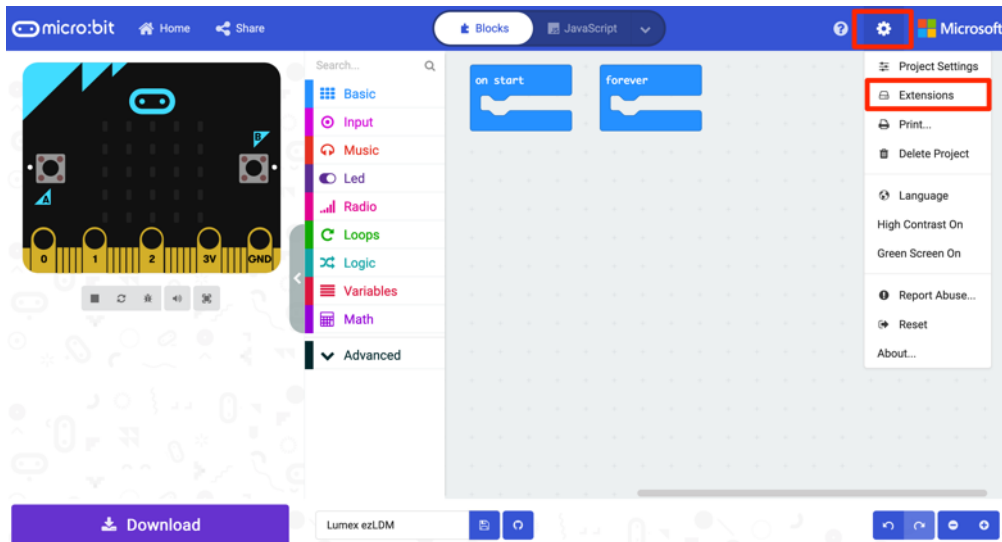
All the examples in this manual are to connect the white line to P1, yellow line to P2, and black GDN line to the black pin on expansion board. **Note: Do not connect the red line!**

3. Installation of Extension Blocks

The communication between ezLDM and micro:bit is mainly established by the AT commands from micro:bit to ezLDM through the serial ports to ask ezLDM to display certain page, show the detected temperature value at a certain position on ezLDM or certain color of the text. There are tons of commands and very difficult to remember all of them or even freely use. For this reason, we have reorganized all these commands and created the blocks that can be used in MakeCode for the users to easily control ezLDM through micro:bit. By dragging and dropping these blocks, you can freely control the operation of ezLDM, even elementary school children can use it without difficulty. The following are the steps to install the extension blocks to MakeCode:

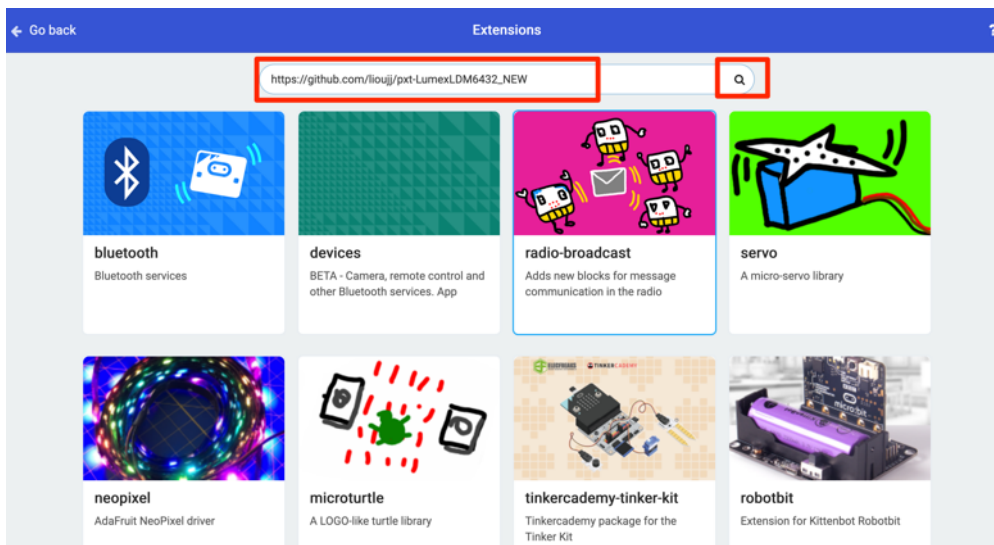
a) MakeCode Extension:

Go to MakeCode website to create a new project. Click the “gear” icon top right corner and then click the “Extension” in the drop menu.



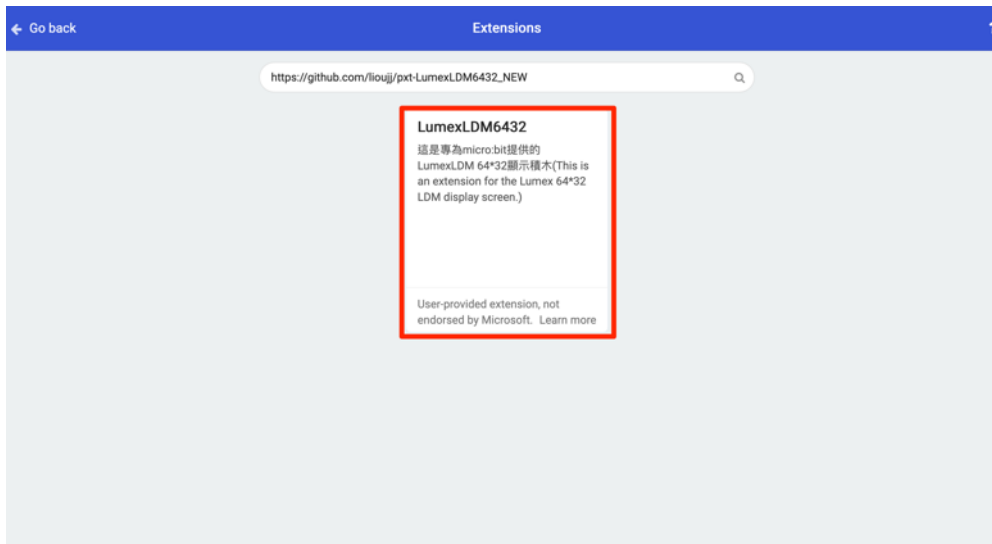
b) Lumex Extension URL:

Go to the page of installation extension and some extension block icons officially approved by micro:bit can be seen. There is an input field above these icons. Enter the URL address https://github.com/lioujj/pxt-LumexLDM6432_NEW here and click the search button with magnifying-glass icon on the right of the input field.



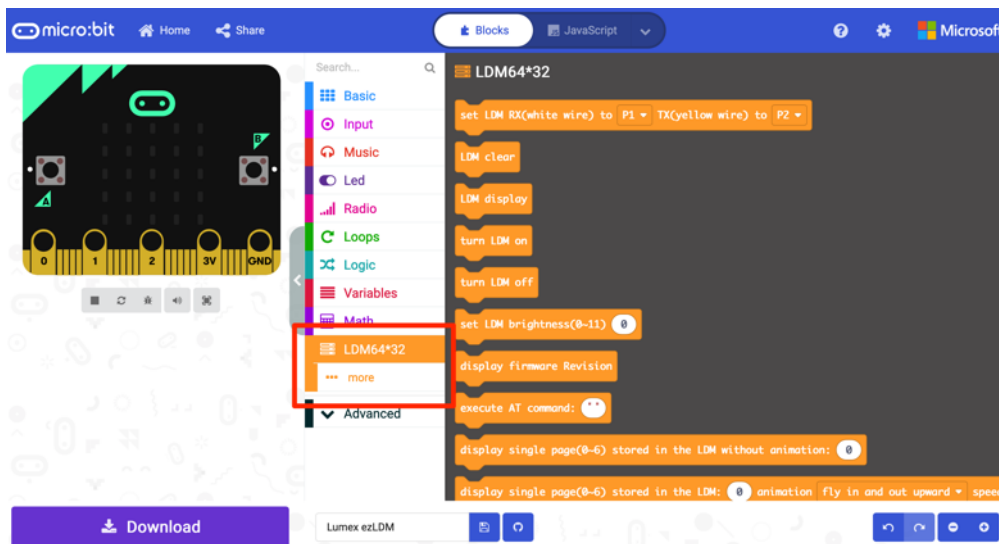
c) Install Lumex LDM6432:

The instructions of extension blocks for Lumex ezLDM will show. Click on it to download and install the extension blocks from MakeCode.



d) Installation complete:

After the installation, you can find the “LDM64*32” block list in MakeCode’s block group.



Here are 12 examples to explain how to use micro:bit to design the ezLDM’s program for having a more impressive output image. In order to make it easier for everyone to use, we provide the original files in hex format for these 12 examples, and the ezLDM pattern files needed in each example. Please download the files from the following URL and unzip them for use.

Original URL: <https://drive.google.com/drive/folders/1rGc5-dzyyNUAeNNGqOP-zVQWaxa-0C5v>

Shortened URL: <https://ppt.cc/f4unqx>

Example 1: Static Page Displayed on ezLDM

Program Presentation:

Press the A button and ezLDM will show page 0; press the B button to show page 1; and press both A and B buttons at the same time to show page 2.

Please refer to the video : <https://www.youtube.com/watch?v=fH5FdEnk3JI>

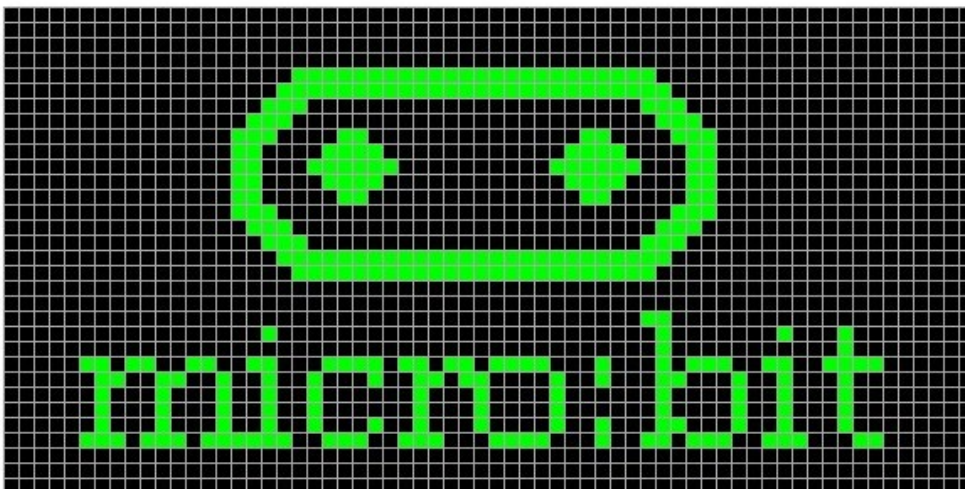
Video QR Code :



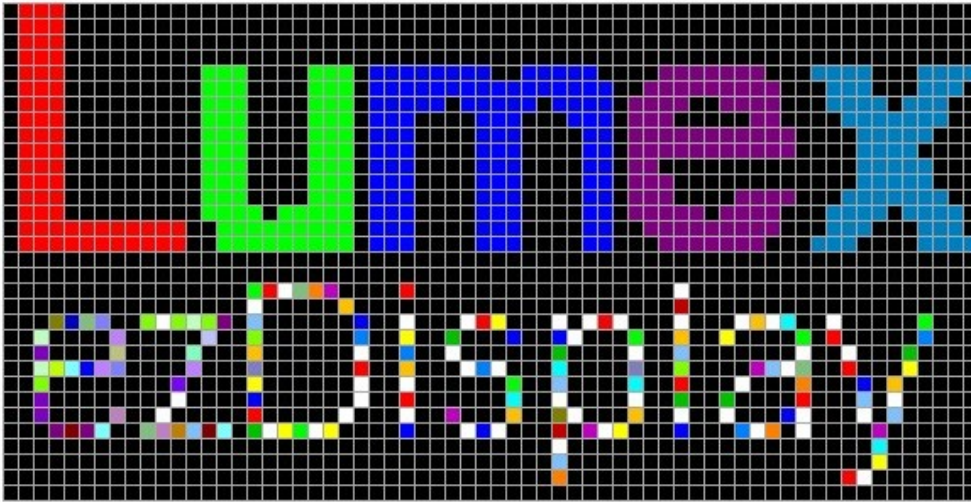
Steps:

1. Save three single-pages created on computer to ezLDM as from page 0 to page 2, or use the pattern files provided in Example 1 to directly send the graphics to ezLDM.

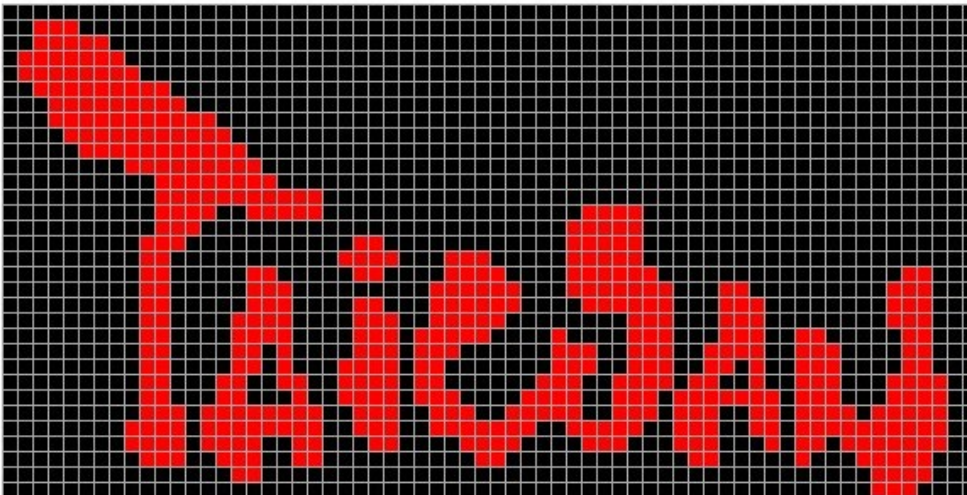
Page0 :



Page1 :



Page2 :



2. Connect ezLDM to micro:bit according to the previous instructions (white Rx line to P1, yellow Tx line to P2 and black line to GND, but **do not connect the red line**).
3. Drag and drop the blocks in MakeCode, as shown below, and download the program to micro:bit.

```
on start
  set LDM RX(white wire) to P1 TX(yellow wire) to P2
  LDM clear

on button A pressed
  display single page(0~6) stored in the LDM without animation: 0

on button B pressed
  display single page(0~6) stored in the LDM without animation: 1

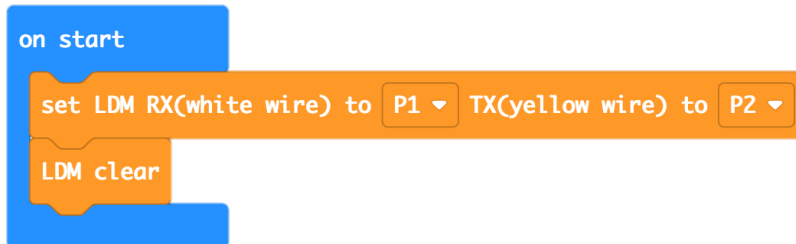
on button A+B pressed
  display single page(0~6) stored in the LDM without animation: 2
```

Program Explanation:

1. The connection between ezLDM and micro:bit is through serial port. It means that when “activating” the program of micro:bit, it is required to set the configuration of Rx and Tx lines. In this example, Rx line (white) is connecting to P1 on micro:bit, and Tx line (yellow) is connecting to P2 on micro:bit. Every program connected to ezLDM must do the setting

of micro:bit, as well as the connected pin location with the lines on ezLDM, by dragging and dropping these blocks.

2. Normally, when ezLDM is powered on, the page 0 will be shown automatically. If you prefer not to show any patterns on ezLDM at the beginning, the “LDM Clear Screen” block can be used to clear the current field on ezLDM.



```
on start
  set LDM RX(white wire) to P1 TX(yellow wire) to P2
  LDM clear
```

3. When pushing the “A” button, the block of “Page X displayed without effects” shall be used by selecting the page number from 0 to 6 if you want the page 0 to be showed without any effects.



```
on button A pressed
  display single page(0~6) stored in the LDM without animation: 0
```

Example 2: Single Page Displayed with Animation Effect

Program Presentation:

Press the A button and ezLDM will show page 0 with animation effect; press the B button to show page 1 with animation effect; press both A and B buttons at the same time to stop animations and erase current field.

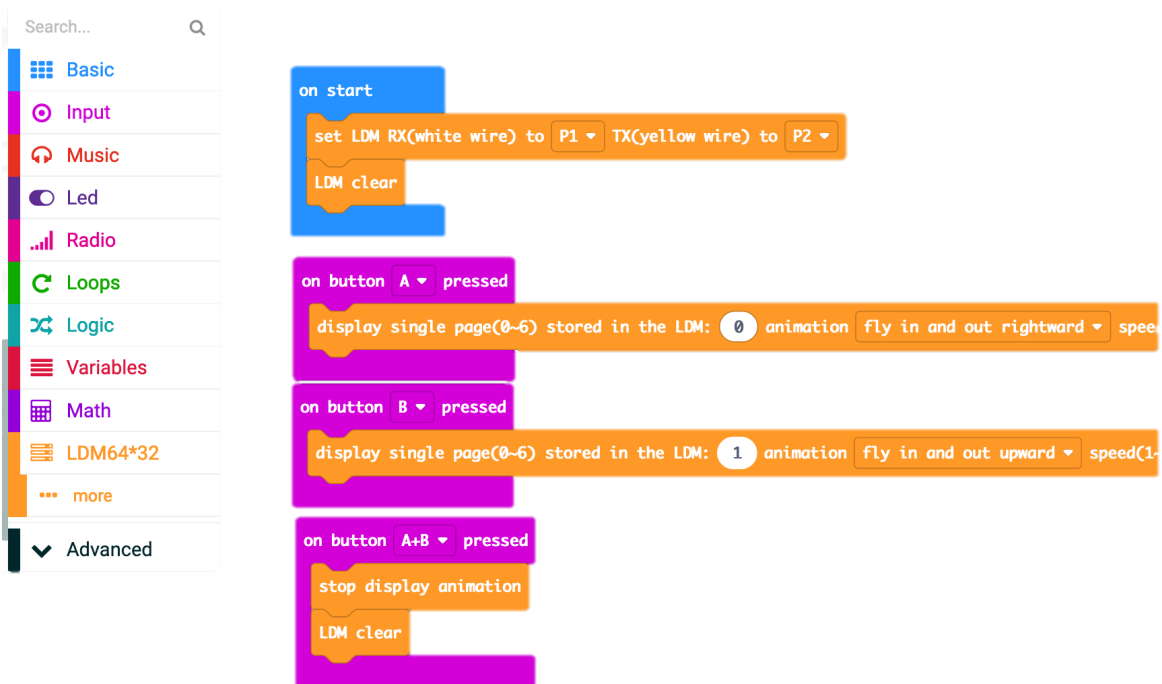
Please refer to the video: <https://www.youtube.com/watch?v=9OhUomTJ6Ko>

Video QR Code:



Steps:

1. Use the single page created in Example 1, but now it shall be shown with animation effect.
2. Connect ezLDM to micro:bit according to the previous instructions (white Rx line to P1, yellow Tx line to P2 and black line to GND, but **do not connect the red line**).
3. Drag and drop the blocks in MakeCode, as shown below, and download the program to micro:bit.

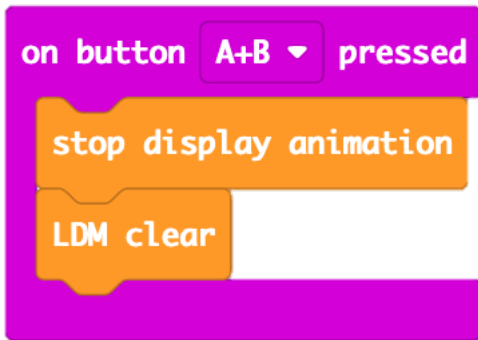


Program Explanation:

1. The following block enables certain page to display with animation effect. There are three options: displayed page number, animation effect and display speed (from 1 to 10. The smaller the number, the faster the display speed)



- Pressing both A and B buttons (A+B) at the same time to stop the animation effect by the use of "Stop all animations" block, and erase the current field with the block of "Clear LDM screen".



Example 3: Multi-page Displayed with Animation Effect

Program Presentation

Press the A button and ezLDM will animatedly display the first three pages by scrolling to the left; press the B button to show the first three pages animatedly by scrolling upward; press both A and B buttons at the same time to stop animation effect and erase the current field.

Please refer to the video: <https://www.youtube.com/watch?v=lcx09oeqgjc>

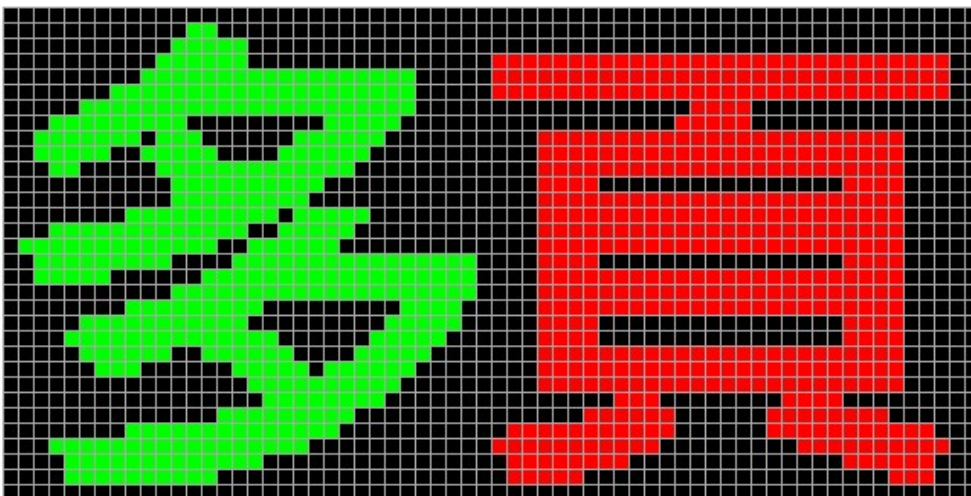
Video QR Code:



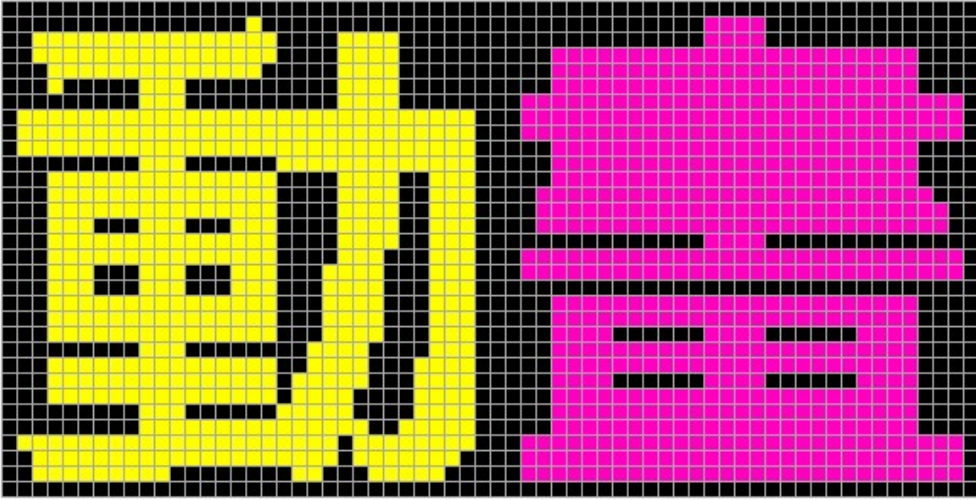
Steps:

1. Save three single-pages created on computer to ezLDM as page 0, 1 and 2, or use the pattern files provided in Example 3 to send the graphics directly to ezLDM. These three pages will be integrated into a rectangular pattern to show on ezLDM.

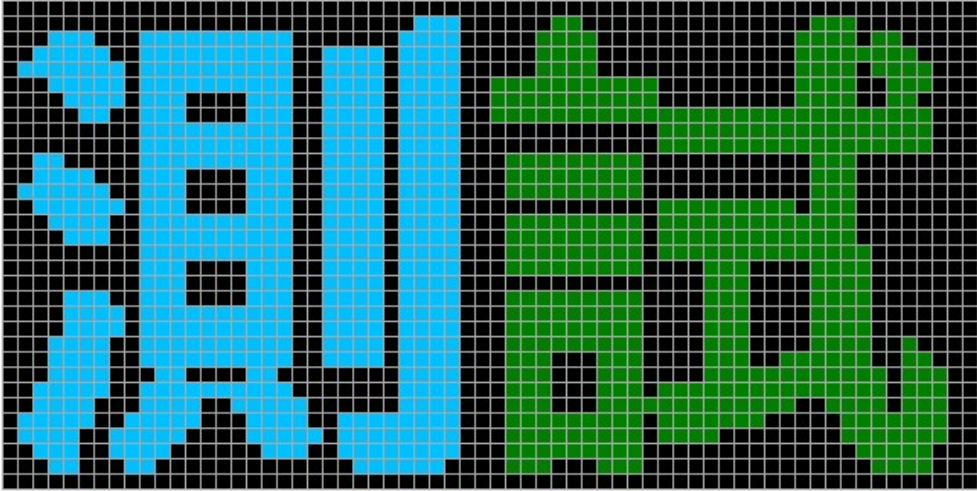
Page0 :



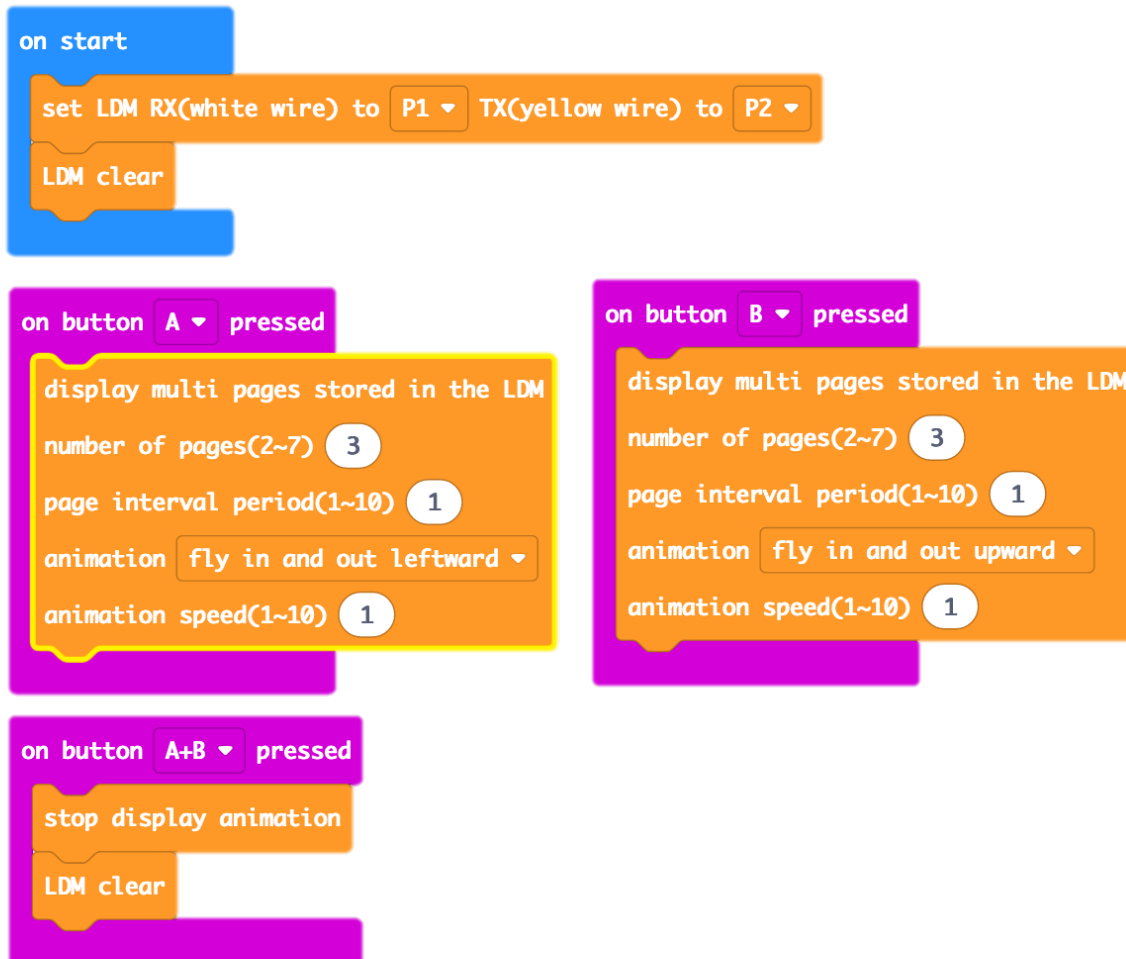
Page1 :



Page2



2. Connect ezLDM to micro:bit according to the previous instructions (white Rx line to P1, yellow Tx line to P2 and black line to GND, **but do not connect the red line**).
3. Drag and drop the blocks in MakeCode, as shown below, and download the program to micro:bit.



Program Explanation

1. The following block allows multiple pages to work as a combination and show with animation effect. The combination always starts from page 0 with four options: numbers

of page to combine from page 0, interval of each page, display effect and display speed level (from 1 to 10, the small the number, the faster the speed).

```

on button A pressed
  display multi pages stored in the LDM
  number of pages(2~7) 3
  page interval period(1~10) 1
  animation fly in and out leftward
  animation speed(1~10) 1
  
```

This block will combine the first three pages horizontally and scroll to the left to present the combined big image (192x32) in a limited screen (64x32).



2. The following block for multi-page animation will combine these three pages vertically and scroll upward to present the combined big image (64x96) in a limited screen (64x32).

```

on button B pressed
  display multi pages stored in the LDM
  number of pages(2~7) 3
  page interval period(1~10) 1
  animation fly in and out upward
  animation speed(1~10) 1
  
```



Example 4: Display of Animated Text

The page used to display on ezLDM shall be made on computer prior to sending to ezLDM. Actually, there are some built-in English and number fonts in ezLDM for selecting the font size from 5x7 or 8x16, and the text color. It allows the users to easily apply the blocks to display some data. In this example, we will demonstrate how to use animated text to create a simple countdown from 10 to 0.

Program Presentation

Press the A button and the yellow 5x7 pixel fonts "countdown" will be shown at the specified position on ezLDM, and the yellow 8x16 pixel fonts will start to countdown from 10 to 0; press the B button to erase the current field.

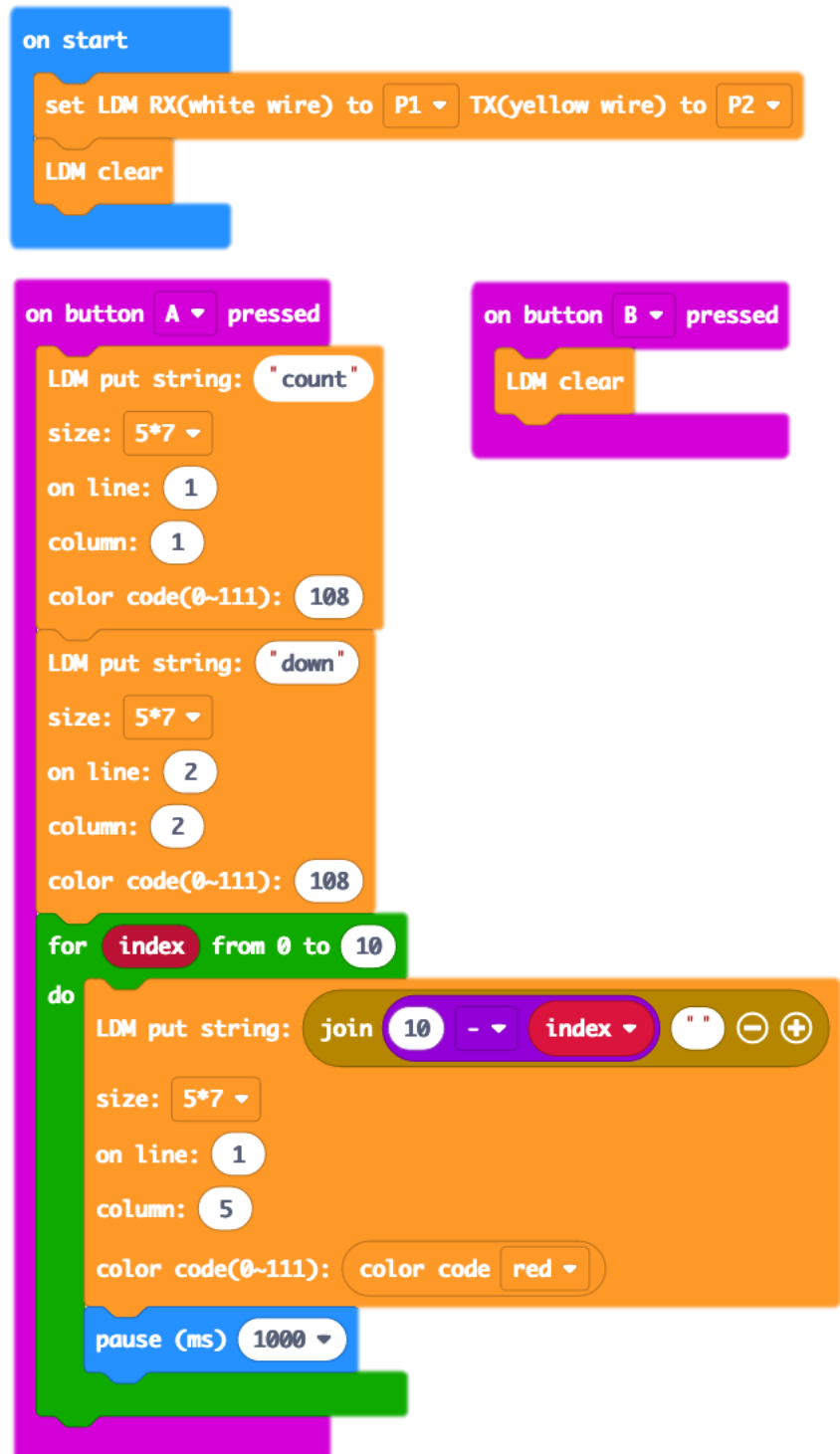
Please refer to the video: <https://www.youtube.com/watch?v=zFI6nFiFASw>

Video QR Code:



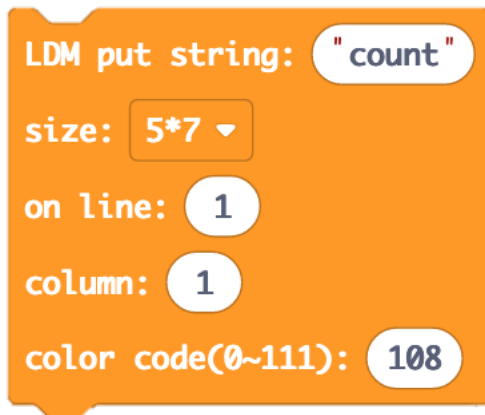
Steps:

1. Connect ezLDM to micro:bit according to the previous instructions (white Rx line to P1, yellow Tx line to P2 and black line to GND, but do not connect the red line).
2. Drag and drop the blocks in MakeCode, as shown below, and download the program to micro:bit.



Program Explanation

1. The following block allows ezLDM to display animated text. In this example, the block will have the 5x7 pixel font, and can be specified the row and column numbers, as well as the color.

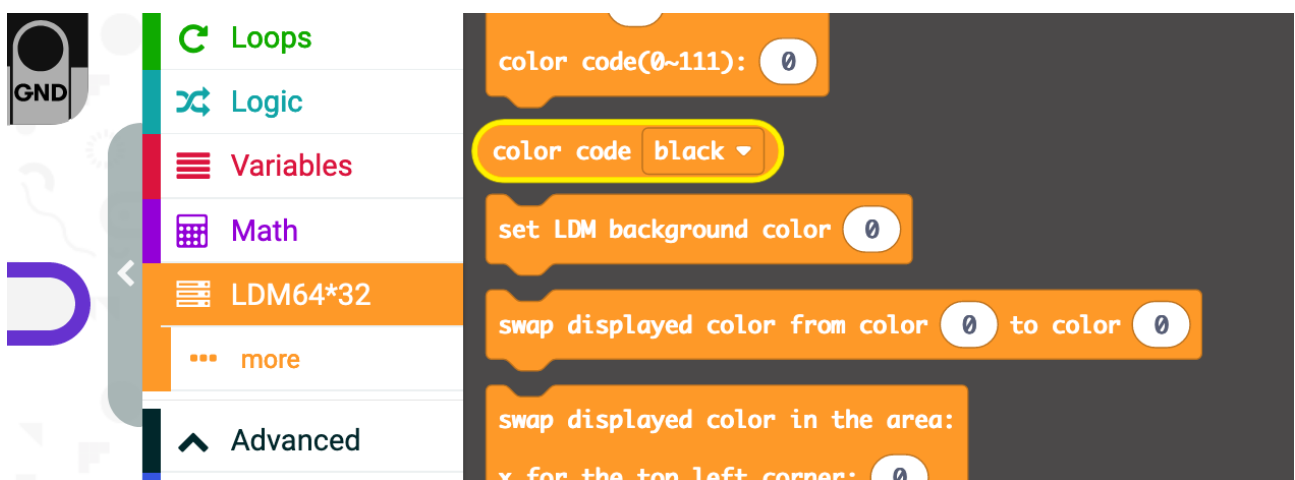


2. Since we are going to present the countdown effect, we should use a loop with an index from 0 to 10 to wrap the number block to be shown. Due to 0-10 are positive numbers, the countdown effect can be created by using the "10-index". As for the reason of adding a half-width space to the string combination block, it is because the number "10" is a 2-digit

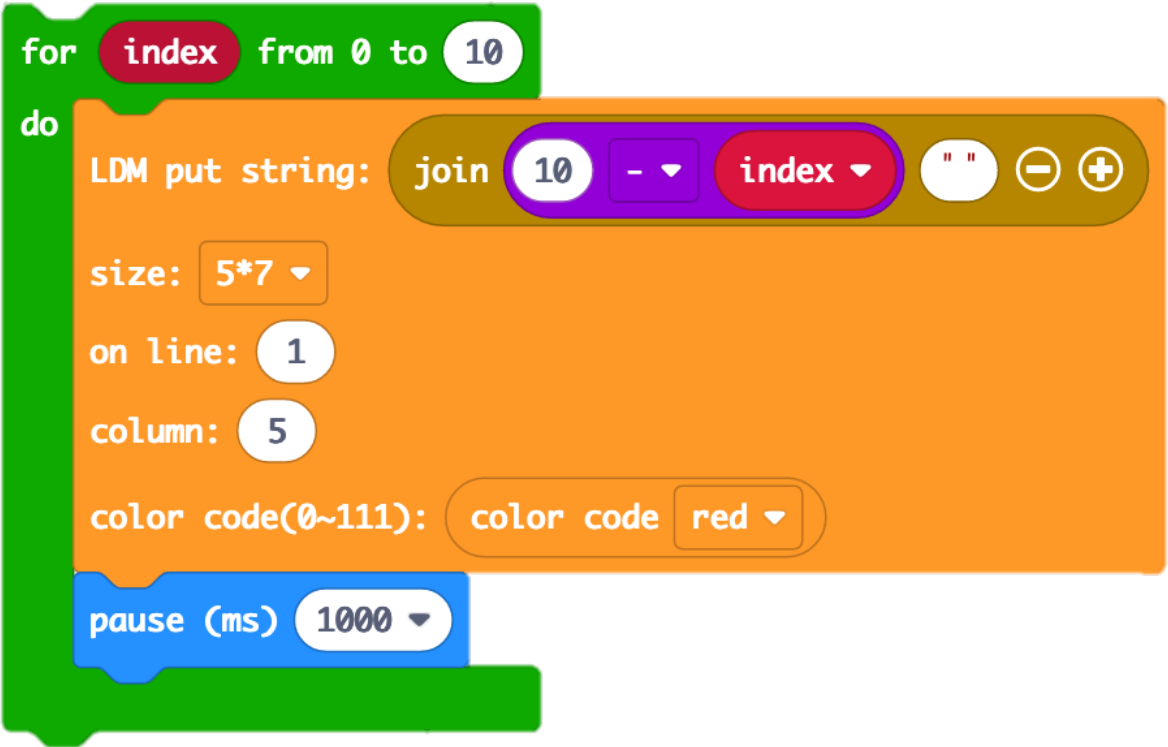


number. When the countdown goes to the "9", it will overwrite the "1" of "10" and the "0" of "10" remain

on the screen to become "90" showing on the screen. Therefore, it is necessary to leave a



blank space in the program to cover the "0". Regarding the red color, we use the color block instead of checking the color code chart in this example.



```
for index from 0 to 10
do
  LDM put string: join 10 - index " "
  size: 5*7
  on line: 1
  column: 5
  color code(0~111): color code red
  pause (ms) 1000
```

Color Coding

The ezLDM can display 64 colors and each color has unique code. If the text "count down" shows in yellow, the yellow code #108 shall be entered according to the color code chart below. Since it is not that convenient to find the corresponding code all the time, you can also drag and drop this color code block



The image shows a software interface for color coding. On the left is a sidebar with categories: Loops, Logic, Variables, Math, LDM64*32, more, and Advanced. The main area contains several blocks: 'color code(0~111): 0', 'color code black', 'set LDM background color 0', 'swap displayed color from color 0 to color 0', and 'swap displayed color in the area:'. The 'color code black' block is highlighted in yellow.

to put it in the place where the color code number shall be entered.

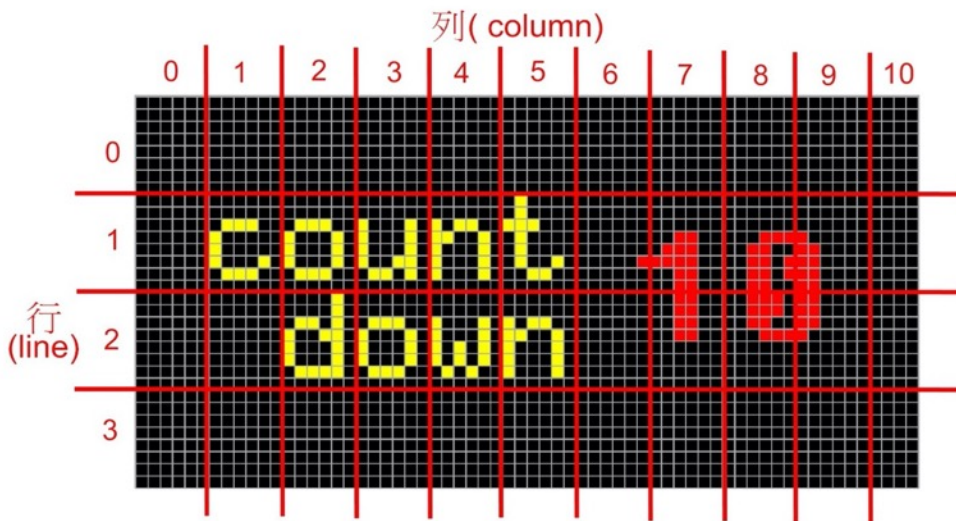


This block contains the commonly used color such as black, white, yellow, red or green into the drop-down list. With this block, it is no longer required to look for the color code chart.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111

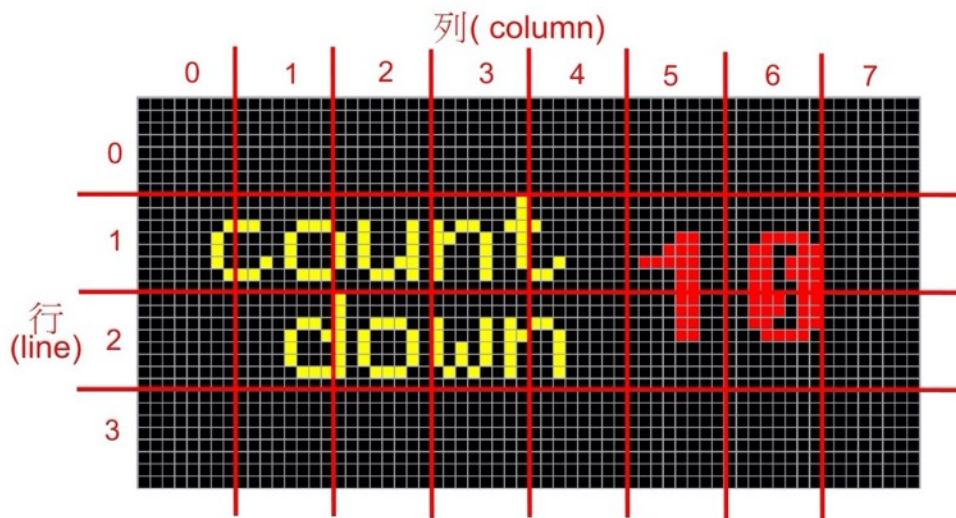
Coordinate System of 5x7 Pixel Fonts

If we use 5x7 pixel font (5 pixels width by 7 pixels tall) on the 64x32 ezLDM, the word "count" starts from the first row with first column, and the word "down" starts from the second row with second column.



Coordinate System of 8x16 Pixel Fonts

The coordinate plan of 8x16 animated text is divided into 4 rows by 8 columns in an 8x8 unit structure. It makes the upper left corner of the number "10" located in the 1st row with 5th column. That means the block shall be set to show the text from the 1st row with 5th column



Example 5: Animated display of detected value

The micro:bit is often used with sensors for environmental monitoring (for example, connecting to the DHT11 for both temperature and humidity sensing). If these data can be displayed animatedly on ezLDM, it will be helpful for people to quickly understand the current conditions. In this example, we will demonstrate how to directly display the detected data by the temperature and light sensor integrated in micro:bit on ezLDM.

Program Presentation:

The program shows page 0 at the beginning, and then automatically and repeatedly detects the temperature and light conditions to display on ezLDM. Press the B button to switch the background to page 1; press the A button and return to page 0.

Please refer to the video: <https://www.youtube.com/watch?v=JQdJTjwoqSY>

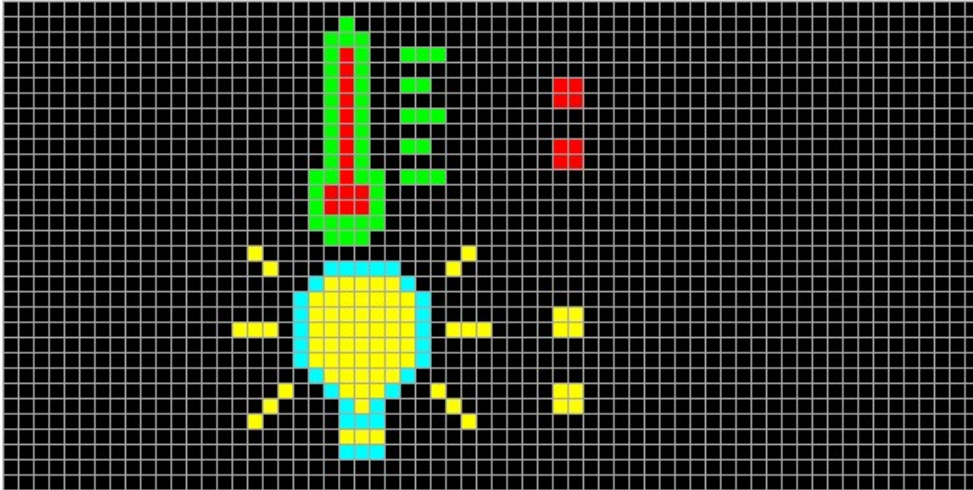
Video QR Code:



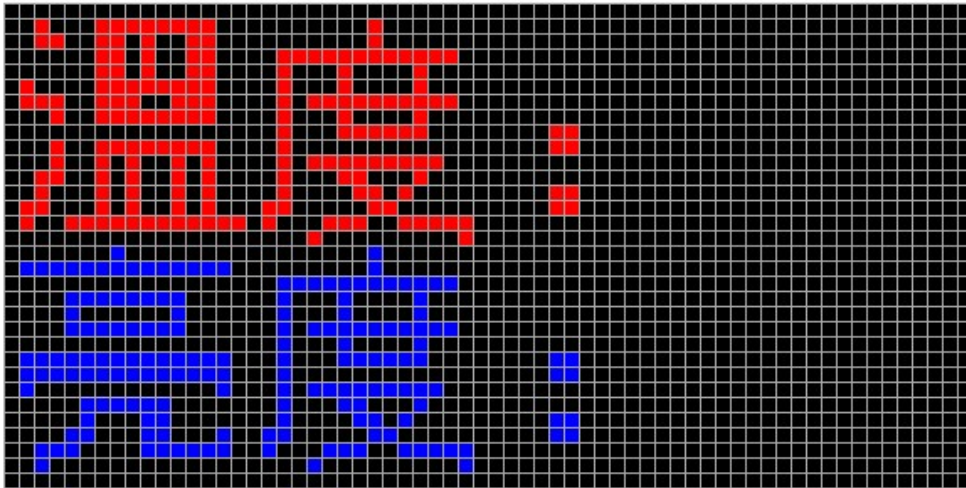
Steps:

1. Save two single-pages (as shown in figure below) created on computer to ezLDM as from page 0 to page 1, or use the pattern files provided in Example 5 to directly send the graphics to ezLDM.

Page0 :



Page1 :



2. Connect ezLDM to micro:bit according to the previous instructions (white Rx line to P1, yellow Tx line to P2 and black line to GND, but do not connect the red line).
3. Drag and drop the blocks in MakeCode, as shown below, and download the program to micro:bit.

```

on start
  set LDM RX(white wire) to P1 TX(yellow wire) to P2
  LDM clear
  display single page(0-6) stored in the LDM without animation: 0

forever
  LDM put string: convert temperature (°C) to text
  size: 8*16
  on line: 0
  column: 5
  color code(0-111): color code yellow
  LDM put string: join light level ☹️ ⚡️ ☺️
  size: 8*16
  on line: 2
  column: 5
  color code(0-111): color code orange
  pause (ms) 1000

on button A pressed
  display single page(0-6) stored in the LDM without animation: 0

on button B pressed
  display single page(0-6) stored in the LDM without animation: 1
  
```

Program Explanation:

1. Clean the screen of ezLDM when activating the program. Display the image of Page 0 on ezLDM.

```

on start
  set LDM RX(white wire) to P1 TX(yellow wire) to P2
  LDM clear
  display single page(0-6) stored in the LDM without animation: 0
  
```

2. Press the A button to switch the background to page 0; press the B button to switch to page 1.



3. Here is the block for displaying the temperature value. Because the value of detected temperature is digital output, it is required to use the block of "Convert XXX to text" to convert the temperature value to text for display. As for the font size, rows, columns and color code, they have been explained in previous example. If there is anything that you don't quite understand, please refer to the previous example.



4. This block is for the display of temperature and light sensing values. Why does the light sensing value use the block of "string combination" instead of the block of "convert XXX to text font" as temperature sensing? The reason is, the unit of temperature used in Taiwan is Celsius scale. It is mostly double-digit, and rarely lower than 10 degree Celsius. As the light sensing value, the maximum and minimum readings limit to 0 and 255, that is, the value may be 1, 2 or 3 digits. If the light sensing value "8" is sensed after the value "234", the position of "2" will be overwritten by "8" and the figure "34" will remain. Therefore,

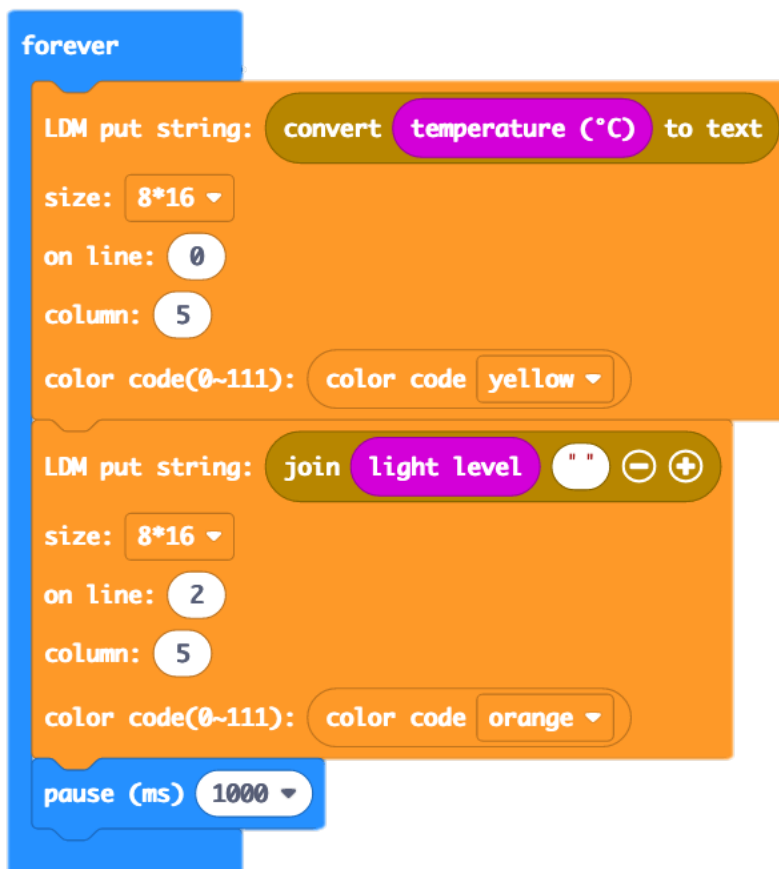
adding two half-width empty spaces after the light sensing value



is able to overwrite the figure "34".



5. Once placing the temperature and light sensing blocks in an infinite repetition, they will keep sensing these two environmental factors to show on ezLDM. In fact, the temperature and light values do not change too much in a very short time, a block of "Pause 1000 ms" can be added at the end of "infinite repetition" allowing user to adjust the pause duration as needed.



Example 6: Animated Geometric Shapes

In this example, we will learn how to make some geometric shapes, such as rectangles and circles. By showing these geometric shapes randomly on different positions of ezLDM, we are going to create an aesthetic feeling.

Program Presentation:

The program will clear the screen at the beginning. Press the A button can make the frame around the edges of ezLDM; pressing both A and B buttons (A+B) at the same time allows the program to draw circles of different sizes and colors in the black area (in the middle of ezLDM). During the process of drawing circles, press the A button again will remake the frame in different color and erase all the circles; pressing the B button will only erase all the circles that have been made.

Please refer to the video: <https://www.youtube.com/watch?v=2yYZOwXR4RA>

Video QR Code:



Steps:

1. Connect ezLDM to micro:bit according to the previous instructions (white Rx line to P1, yellow Tx line to P2 and black line to GND, but do not connect the red line).
2. Drag and drop the blocks in MakeCode, as shown below, and download the program to micro:bit.

```
on start
  set LDM RX(white wire) to P1 TX(yellow wire) to P2
  LDM clear

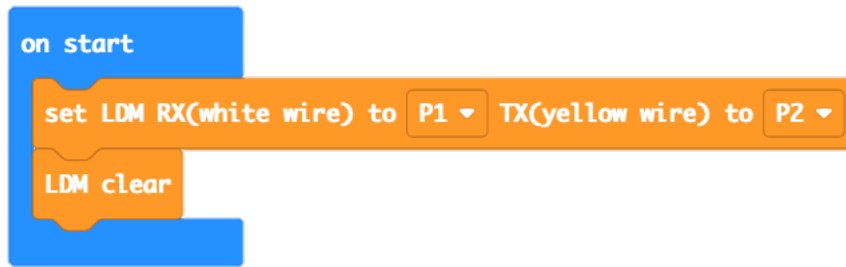
on button A pressed
  draw a rectangle
  filled yes
  up left corner X 0
  up left corner Y 0
  bottom right corner X 63
  bottom right corner Y 31
  color code(0~111) pick random 1 to 111
  draw a rectangle
  filled yes
  up left corner X 3
  up left corner Y 3
  bottom right corner X 60
  bottom right corner Y 28
  color code(0~111) color code black

on button B pressed
  draw a rectangle
  filled yes
  up left corner X 3
  up left corner Y 3
  bottom right corner X 60
  bottom right corner Y 28
  color code(0~111) color code black

on button A+B pressed
  while true
  do
    draw a circle
    filled yes
    center X pick random 8 to 55
    center Y pick random 8 to 23
    radius pick random 1 to 5
    color code(0~111) pick random 1 to 111
  pause (ms) 200
```

Program Explanation

1. When activating the program, clear the screen.

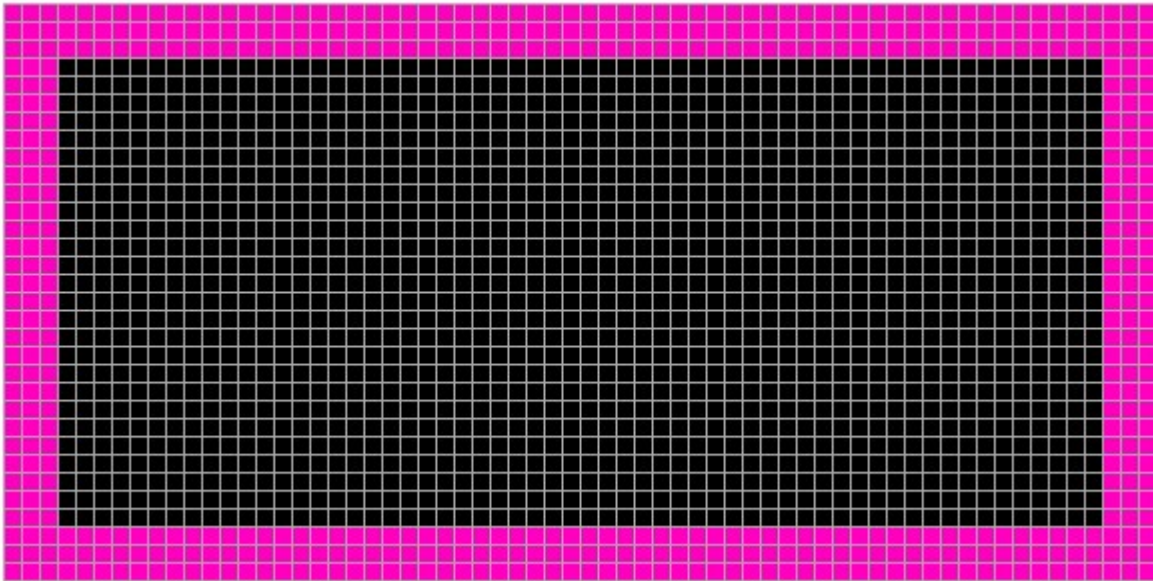


2. A frame with width of 3 pixels will be made around the edges of ezLDM in a random color by pressing the A button. For making a colored frame, it is required to draw a rectangle filled the entire screen. Since ezLDM has 64x32 pixel resolution, that is, to draw from the coordinate (0,0) at top-left corner to the coordinate (63,31) at bottom-right corner. As for the color of this rectangle, we randomly pick a number from 1 to 111 according to the color code chart mentioned in previous example. Then make a black rectangle in the middle to

form a colored frame. This black rectangle is made from the coordinate (3,3) at top-left corner to the (60,28) at bottom-right corner.

```
on button A pressed
  draw a rectangle
  filled yes
  up left corner X 0
  up left corner Y 0
  bottom right corner X 63
  bottom right corner Y 31
  color code(0-111) pick random 1 to 111
  draw a rectangle
  filled yes
  up left corner X 3
  up left corner Y 3
  bottom right corner X 60
  bottom right corner Y 28
  color code(0-111) color code black
```

By pressing the A button it will make a frame like this one on ezLDM. Every time to press the A button, the frame will be remade in different color.



- When pressing both A and B buttons (A+B) at the same time, it will continue to make a circle with an infinite loop in the black area (in the middle of ezLDM). To draw circles using the block, it is required to specify the X and Y coordinates of the center, radius and color of the circle. In this example, we always use random coordinates to draw the circle, and a pause command (duration of 200 milliseconds) after each circle is drawn. Since an infinite loop is activated, it is not going to stop the circle drawing action.

```
on button A+B pressed
  while true
    do
      draw a circle
      filled yes
      center X pick random 8 to 55
      center Y pick random 8 to 23
      radius pick random 1 to 5
      color code(0-111) pick random 1 to 111
      pause (ms) 200
```

- Press the B button to clear all the circles that have been made. Draw a black rectangle from the coordinate (3,3) at top-left corner to the (60,28) at bottom-right corner. Since the action

of drawing circles has not been stopped, the program will keep drawing the circles after erasing the field.

```
on button B pressed
  draw a rectangle
  filled yes
  up left corner X 3
  up left corner Y 3
  bottom right corner X 60
  bottom right corner Y 70
  color code(0-111) color code black
```

Example 7: Moving Geometric Shapes

In this example, we are going to learn how to make a red circle at a certain position with command block, and then make another black circle at the same place to overwrite the original one. By using this technique to make circles at different positions, it can create the effect of a moving circle. By pressing the A button the red circle will move one cell to the left; and by pressing the B button the red circle will move one cell to the right.

Program Presentation

When activating the program, the screen will be cleared at the beginning, and then a red circle with a radius of 4 will be made on the coordinates (31,15). By pressing the A button the circle moves one cell to the left and will not stop moving until touching the edge of the screen; by pressing the B button the circle moves one cell to the right and will not stop moving until touching the edge of the screen.

Please refer to the video: https://www.youtube.com/watch?v=eXha_DtLTI

Video QR Code:



Steps:

1. Connect ezLDM to micro:bit according to the previous instructions (white Rx line to P1, yellow Tx line to P2 and black line to GND, but do not connect the red line).
2. Drag and drop the blocks in MakeCode, as shown below, and download the program to micro:bit.

```
on start
  set LDM RX(white wire) to P1 TX(yellow wire) to P2
  LDM clear
  set X to 31
  set Y to 15
  set radius to 4
  draw a circle
  filled yes
  center X X
  center Y Y
  radius radius
  color code(0-111) color code red

on button A pressed
  if X > radius > 0 then
    draw a circle
    filled yes
    center X X
    center Y Y
    radius radius
    color code(0-111) color code black
    change radius by -1
  draw a circle
  filled yes
  center X X
  center Y Y
  radius radius
  color code(0-111) color code red

on button B pressed
  if X < -radius < 0 then
    draw a circle
    filled yes
    center X X
    center Y Y
    radius radius
    color code(0-111) color code black
    change radius by 1
  draw a circle
  filled yes
  center X X
  center Y Y
  radius radius
  color code(0-111) color code red
```

Program Explanation:

1. When activating the program, make a red circle by setting it with a radius of "4" on the coordinates (31,15). For the convenience of subsequent calculations, the variables will be used for X-Y coordinates and the radius of the circle.

```
on start
  set LDM RX(white wire) to P1 TX(yellow wire) to P2
  LDM clear
  set X to 31
  set Y to 15
  set radius to 4
  draw a circle
  filled yes
  center X X
  center Y Y
  radius radius
  color code(0~111) color code red
```

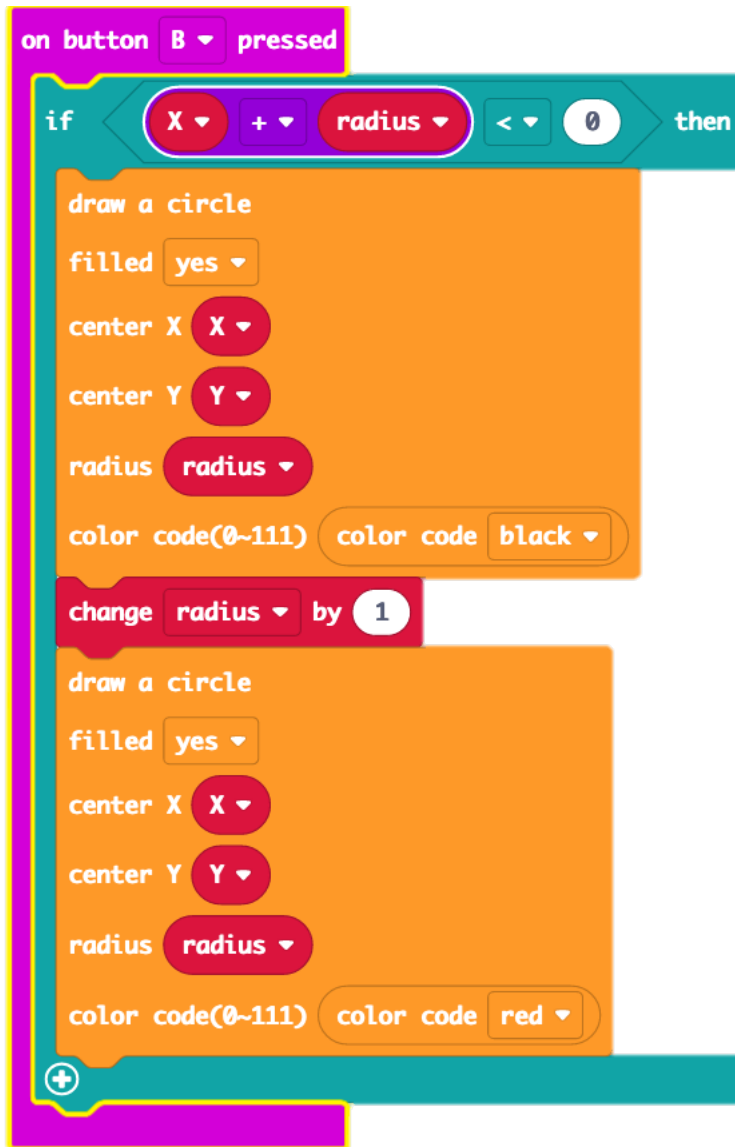
2. When the A button is pressed, the red circle shall move one cell to the left. However, it is necessary to make sure the circle has not reached the left edge of ezLDM before next movement. The red circle is able to move one cell to the left before reaching the edge of the screen. Therefore, we can add an "if" block to determine the position. If subtracting the X-coordinate from the radius is greater than 0, it means that the circle has not reached the edge of the screen. Now a black circle can be made to overwrite the original red one, and then subtract 1 from the X-coordinate. Next, make a red circle with a radius of 4 on the new

X-Y coordinate grid to create the effects by visually believing the red circle moving one cell to the left.

```
on button A pressed
  if X - radius > 0 then
    draw a circle
    filled yes
    center X X
    center Y Y
    radius radius
    color code(0~111) color code black
  change radius by -1
  draw a circle
  filled yes
  center X X
  center Y Y
  radius radius
  color code(0~111) color code red
```

3. When the B button is pressed, the red circle shall move one cell to the right. However, it is necessary to make sure the circle has not reached the right edge of ezLDM before next movement. The red circle is able to move one cell to the right before reaching the edge of the screen. Therefore, we can add an “if” block to determine the position. If adding the X-coordinate and the radius is less than 63, it means that the circle has not reached the edge of the screen. Now a black circle can be made to overwrite the original red one, and then add 1 to the X-coordinate. Next, make a red circle with a radius of 4 on the new X-Y

coordinate grid to create the effects by visually believing the red circle moving one cell to the right.



```
on button B pressed
  if X + radius < 0 then
    draw a circle
      filled yes
      center X X
      center Y Y
      radius radius
      color code(0-111) color code black
    change radius by 1
    draw a circle
      filled yes
      center X X
      center Y Y
      radius radius
      color code(0-111) color code red
```

The image shows a Scratch code block starting with 'on button B pressed'. It contains an 'if' statement with the condition 'X + radius < 0'. Inside the 'if' block, there are two 'draw a circle' blocks. The first block has 'filled' set to 'yes', 'center X' set to 'X', 'center Y' set to 'Y', 'radius' set to 'radius', and 'color code(0-111)' set to 'black'. Below the first 'draw a circle' block is a 'change radius by 1' block. The second 'draw a circle' block has 'filled' set to 'yes', 'center X' set to 'X', 'center Y' set to 'Y', 'radius' set to 'radius', and 'color code(0-111)' set to 'red'. A plus sign icon is visible at the bottom left of the code block.

Example 8: Color Change in Visual Effects

Although there are only 7 pages can be saved in ezLDM, we are able to make some changes to one single page. In this example, we are going to learn how to “change colors”. By changing of the colors, we can change one color to another on ezLDM to create visual effects. Here, pressing the A or B button will continuously replace the red color (code #96) with others to have special visual effects.

Program Presentation

The program will clean the screen at the beginning. Press the A button to show the page 0 and execute the command to change color 20 times; press the B button to show the page 1 and execute the command to change color 20 times.

Please refer to the video: <https://www.youtube.com/watch?v=ONW3bjtRh5U>

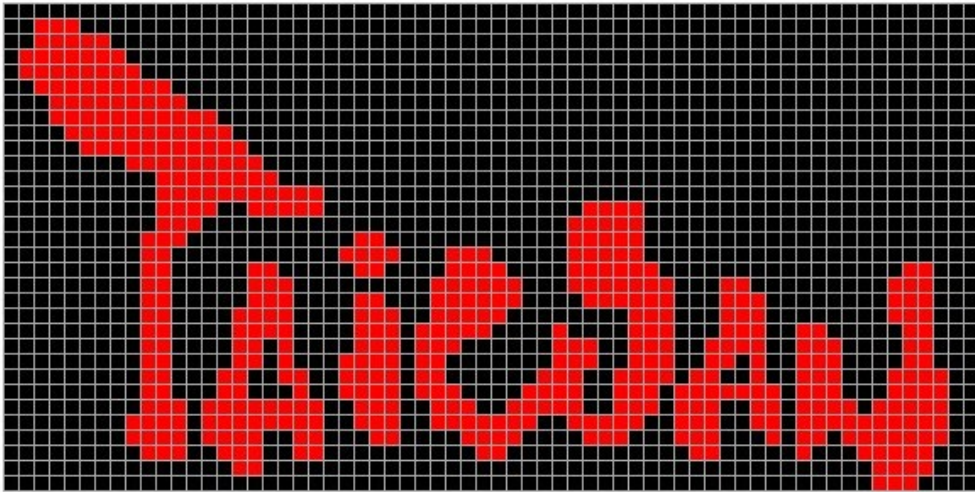
Video QR Code:



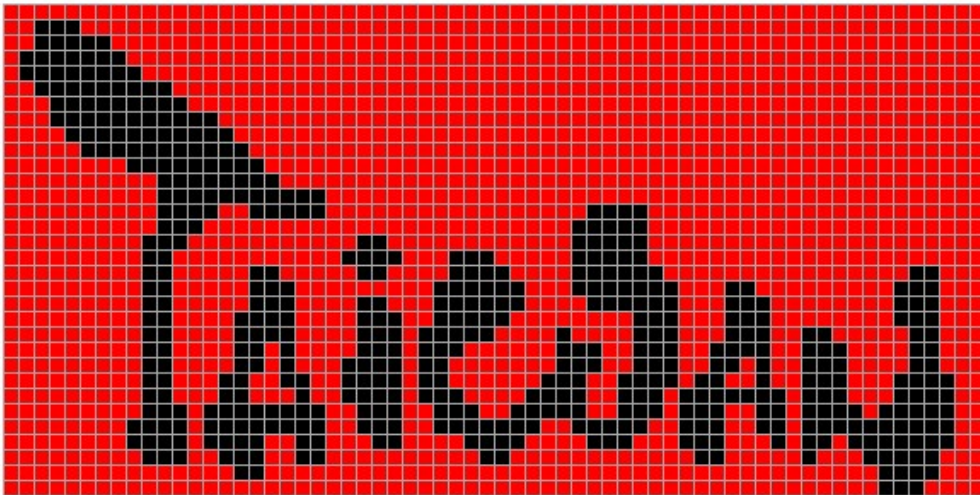
Steps:

1. Send the pattern file provided in Example 8 to ezLDM by computer as page 0 and page 1. These two pages have the same graphics. The difference is that one has red font on a black background and another has black font on a red background. The red color we use here is code #96.

Page0 :



Page1 :



2. Connect ezLDM to micro:bit according to the previous instructions (white Rx line to P1, yellow Tx line to P2 and black line to GND, but do not connect the red line).
3. Drag and drop the blocks in MakeCode, as shown below, and download the program to micro:bit. Since pressing the A or B button is able to change the red color code #96, a general function of "changeColor" will be made for both A and B buttons to use.

```
on start
  set LDM RX(white wire) to P1 TX(yellow wire) to P2
  LDM clear

on button A pressed
  display single page(0-6) stored in the LDM without animation: 0
  call changeColor

on button B pressed
  display single page(0-6) stored in the LDM without animation: 1
  call changeColor

function changeColor
  pause (ms) 200
  set color to 96
  repeat 20 times
    do
      set temp to pick random 1 to 111
      swap displayed color from color color to color temp
      set color to temp
  pause (ms) 200
```

Program Explanation:

1. When activating the program, the screen will be cleared. Press the A button to show the page 0 and run the “changeColor” function; press the B button to show the page 1 and run the same “changeColor” function.

```
on start
  set LDM RX(white wire) to P1 TX(yellow wire) to P2
  LDM clear

on button A pressed
  display single page(0~6) stored in the LDM without animation: 0
  call changeColor

on button B pressed
  display single page(0~6) stored in the LDM without animation: 1
  call changeColor
```

2. The function of “changeColor” is mainly for replacing the color code #96 (red). First, set the color variable to be “96”. Then, set the color change repeating 20 times by randomly selecting a number (1-111) from the color code chart for the temp. This block

```
swap displayed color from color color to color temp
```

will change the the variable color code on ezLDM to be replaced by the temp (randomly selected) to produce the effect of changing color. Next, using the block of “set color variable to temp” to let the color variable remember the new color, allowing the loop to know the next color to be

replaced. Each change of the color will pause for 200 milliseconds for the eyes to notice the effects of the color change. The pause duration can be adjusted as needed.

```
function changeColor  
  pause (ms) 200  
  set color to 96  
  repeat 20 times  
  do  
    set temp to pick random 1 to 111  
    swap displayed color from color color to color temp  
    set color to temp  
  pause (ms) 200
```

The image shows a Scratch code block for a function named 'changeColor'. The function starts with a 'pause (ms) 200' block, followed by a 'set color to 96' block. A 'repeat 20 times' loop contains a 'do' block with four steps: 'set temp to pick random 1 to 111', 'swap displayed color from color color to color temp', 'set color to temp', and 'pause (ms) 200'.

Example 9: Making Custom Patterns

*Pattern Tool is available after version 1.9.7.2

In addition to keep seven pages of size 64x32, ezLDM also enables you to make four sizes (5x5, 8x8, 12x12 and 16x16) of small patterns. By saving these small patterns in ezLDM, it can be easier for users to make more interesting pages with animation effects using these small patterns, or even to design the games. For the quantity of each size of small patterns to be saved in ezLDM, please refer the table below.

Pattern size	5x5	8x8	12x12	16x16
Quantity to be saved	50	50	25	24
Pattern number	From 0 to 49	From 0 to 49	From 0 to 24	From 0 to 23

Take the patter of size 5x5 as an example: the ezLDM can save 50 patterns of this size, from number 0 to 49. For selecting the pattern to be used, just access the number of such pattern. Note: If these custom patterns are saved in the ezLDM, they will occupy the memory where is originally for saving page 1 to page 6. In this case, it means that only page 0 will be available to use. The following example will demonstrate how to save and create the patterns of size 5x5.

Program Presentation:

The program will clear the screen at the beginning. Press the A button to fill the screen, from left to right and from top to bottom, with these twelve custom patterns saved in ezLDM; press the B button to erase the field.

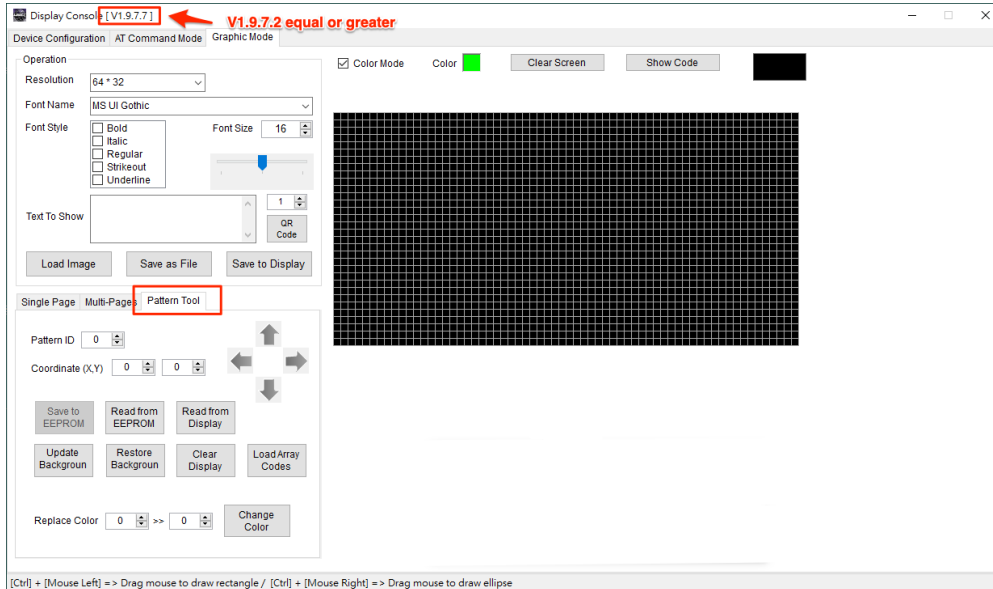
Please refer to the video: <https://www.youtube.com/watch?v=-uzc98-izbU>

Video QR Code:

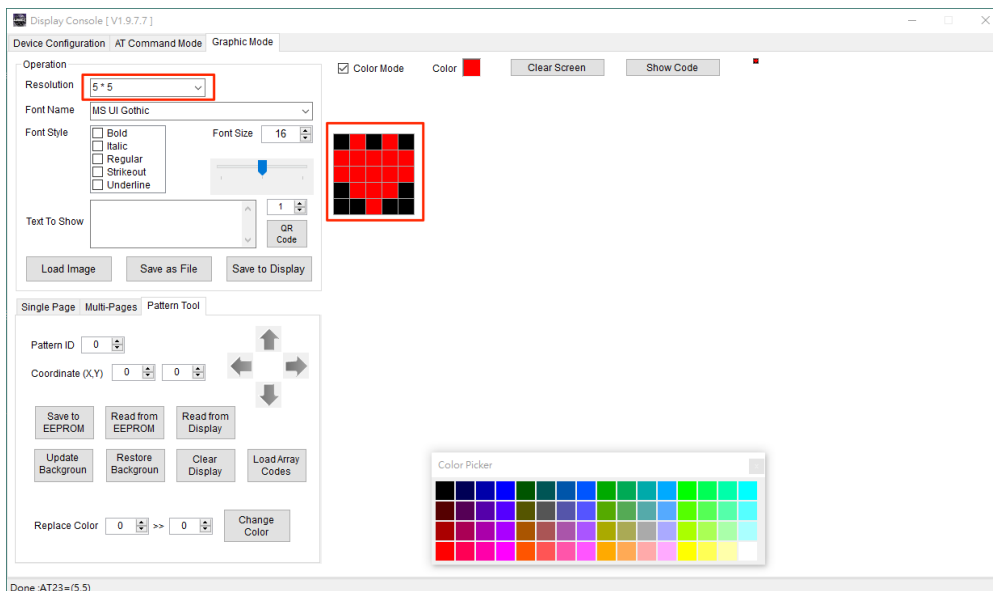


Steps:

1. Connect the computer and ezLDM with UART bridge. Launch the ezDisplay program, select the "Graphic Mode" tab after setting the link and then click on the tab of "Pattern Tool".

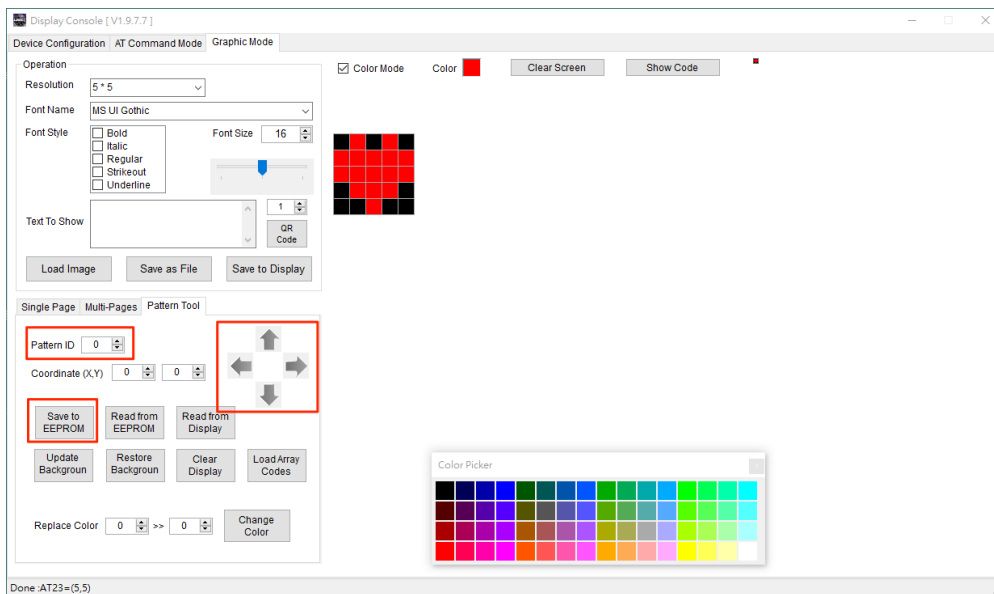


2. Drop down the list of "Resolution" and select the pattern size to be "5x5". There will be 5x5 black squares showing in the drawing area. Please make a small heart shape with red color (code number #96 at the bottom-left corner of color palette).

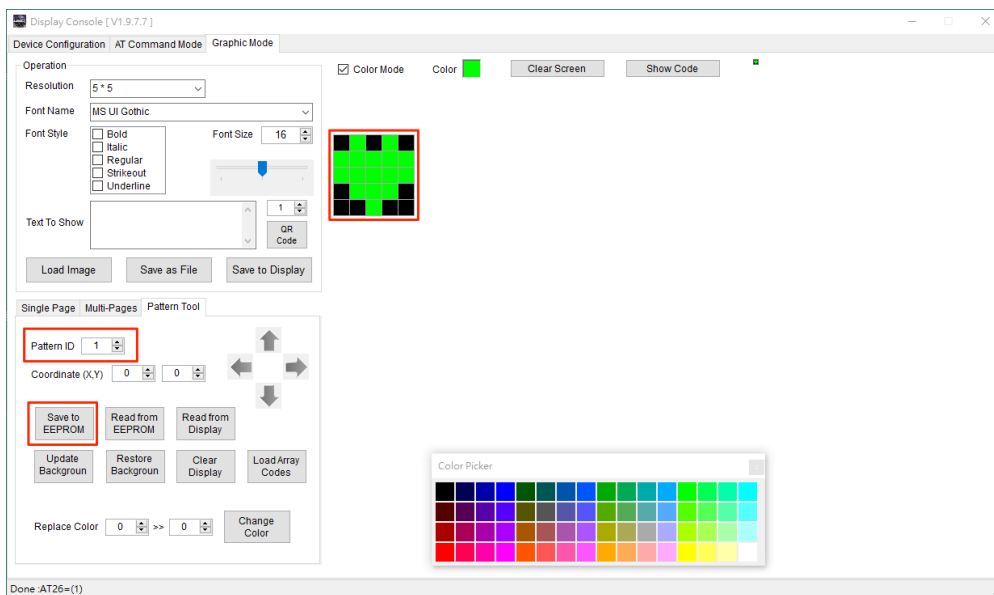


3. There are 50 patterns of size 5x5 that can be saved in ezLDM, starting from the number 0. Please enter the number "0" in the "Pattern number" box, which means that this is going to be save as 5x5 pattern No.0. Then press the button of "save to EEPROM" to save such

pattern in ezLDM and to show it on ezLDM. By pressing the arrow buttons (up, down, left and right) on the software, the heart can move on the ezLDM.

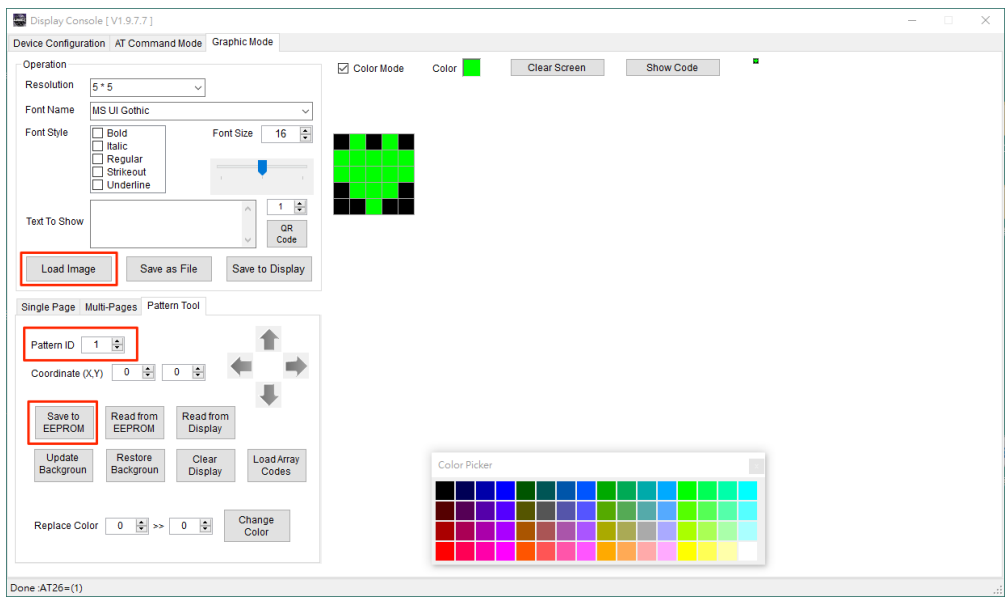


- Next, make another heart of size 5x5 in different color in the drawing area. After selecting "1" for "pattern number" and clicking on "save to EEPROM", this heart will be saved to the location of No.1 in ezLDM.



- Follow the previous steps to make twelve custom heart patterns in different colors, saving as pattern numbers from 0 to 11. Or you can load the twelve 5x5 patterns provided in this Example, choose the corresponding pattern numbers and click on the "save to EEPROM" prior to sending to ezLDM. Once again, the saved patterns will take up the spaces that were

for storing pages 1-6. If now you choose page 1 to 6 under single-page operation, some strange images may appear and that is normal condition.

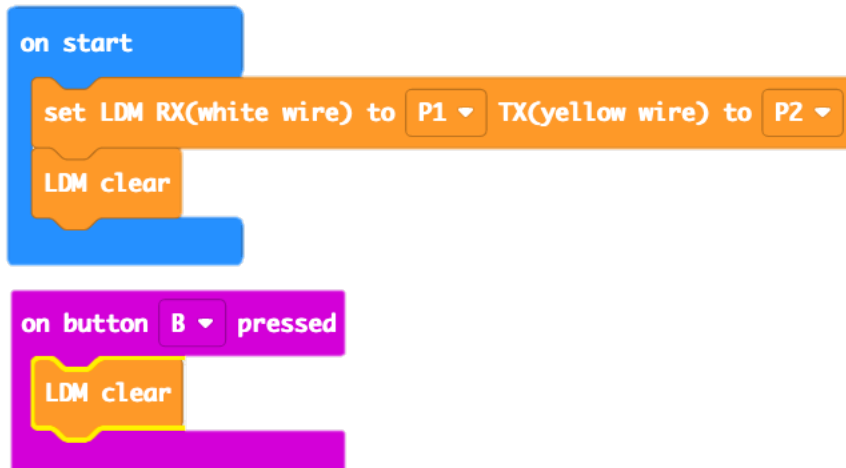


6. Connect ezLDM to micro:bit according to the previous instructions (white Rx line to P1, yellow Tx line to P2 and black line to GND, but do not connect the red line).
7. Drag and drop the blocks in MakeCode, as shown below, and download the program to micro:bit.

The image shows a MakeCode script for a micro:bit. It starts with an 'on start' block containing two orange blocks: 'set LDM RX(white wire) to P1 TX(yellow wire) to P2' and 'LDM clear'. Below this is a purple 'on button A pressed' block containing a green 'for Y from 0 to 5' loop. Inside this loop is another green 'do for X from 0 to 11' loop. Inside the X loop is an orange 'load user pattern from EEPROM' block with settings: 'pattern type: 5*5', 'Pattern ID: X', 'to X: X x 5', 'to Y: Y x 5', 'display now: yes', and a blue 'pause (ms) 100' block. To the right is a purple 'on button B pressed' block containing a yellow 'LDM clear' block.

Program Explanation

1. When activating the program, the screen will be cleared. Or press the B button to clear the screen.



2. When the A button is pressed, two loops will be used to fill the entire screen with twelve custom patterns saved in the ezLDM. Since the size of ezLDM is 64x32 and the size of the pattern is 5x5, the screen can display twelve patterns (from No.0 to 11) in horizontal direction or six patterns (from No.0 to 5) in vertical direction. These custom patterns can be accessed by using the block of "Read custom patterns from EEPROM" and display on ezLDM. For this reason, the patterns to be accessed need to set the size and number in the beginning for ezLDM to read the exact file, as well as the X and Y coordinates of each one

for indicating the display position. As for the option of “display immediately?”, we will discuss it in the following example. Now please select it to be “Yes”.

```
on button A pressed
  for Y from 0 to 5
  do
    for X from 0 to 11
    do
      Load user pattern from EEPROM
      pattern type: 5*5
      Pattern ID: X
      to
      X: X x 5
      Y: Y x 5
      display now yes
      pause (ms) 100
```

Example 10: Custom Pattern with Regionally Changing Color

*Pattern Tool is available after version 1.9.7.2

The function of custom patterns allows us to easily create some small patterns on ezLDM with animation effects. If it runs with the function of regionally changing color, it can produce the effect of numerous patterns with single graphic. In this example, we will use a single 5x5 pattern to create the effect similar to the Example 9.

Program Presentation:

The program will clean the screen at the beginning. Press the A button to erase the original field and fill the screen with the custom pattern No.0 saved in ezLDM. The heart pattern will be reproduced in different color and filled up the screen from left to right, from top to bottom; press the B button will erase the current field and then fill the screen with heart patterns, but display them all together after filling up the screen.

Please refer to the video: <https://www.youtube.com/watch?v=4ystp8s5iZE>

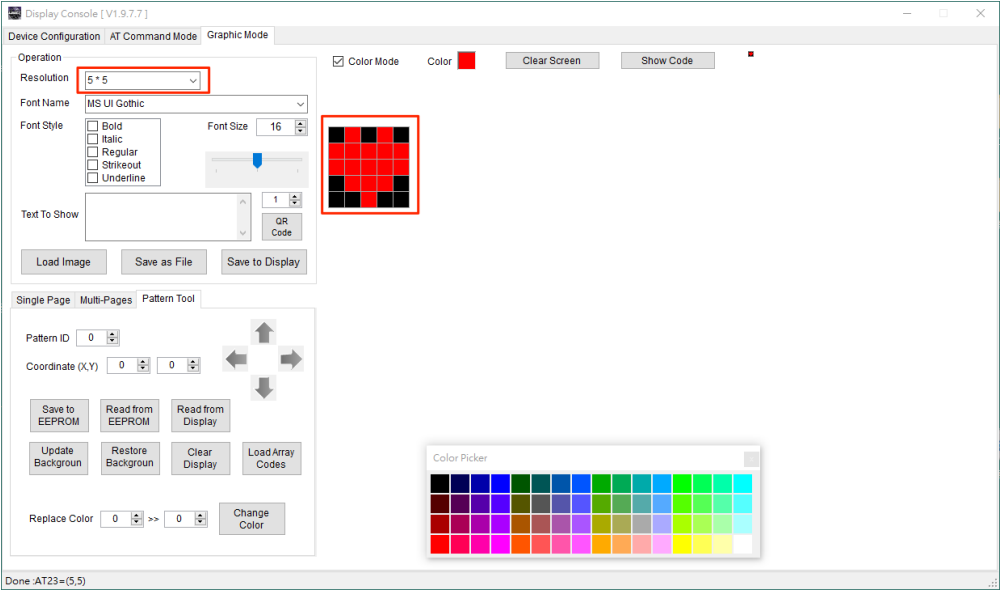
Video QR Code:



Steps:

1. Connect the computer and ezLDM with UART bridge and launch the ezDisplay program to make a heart pattern of size 5x5 with red color (code number 96) on ezLDM before saving it as pattern No. 0 to EEPROM. Or load the pattern file included in this example for sending

to ezLDM. If you are not familiar with the procedure, please refer to the description in the previous example.



2. Connect ezLDM to micro:bit according to the previous instructions (white Rx line to P1, yellow Tx line to P2 and black line to GND, but do not connect the red line).
3. Drag and drop the blocks in MakeCode, as shown below, and download the program to micro:bit.

```

on start
  set LDM RX(white wire) to P1 TX(yellow wire) to P2
  LDM clear

on button A pressed
  LDM clear
  for Y from 0 to 5
  do for X from 0 to 11
  do load user pattern from EEPROM
    pattern type: 5*5
    Pattern ID: 0
    to
    X: X x 5
    Y: Y x 5
    display now yes
    swap displayed color in the area:
    x for the top left corner: X x 5
    y for the top left corner: Y x 5
    width: 5
    height: 5
    from color 96
    to color pick random 1 to 111
  pause (ms) 100

on button B pressed
  LDM clear
  for Y from 0 to 5
  do for X from 0 to 11
  do load user pattern from EEPROM
    pattern type: 5*5
    Pattern ID: 0
    to
    X: X x 5
    Y: Y x 5
    display now yes
    swap displayed color in the area:
    x for the top left corner: X x 5
    y for the top left corner: Y x 5
    width: 5
    height: 5
    from color 96
    to color pick random 1 to 111
  load and show the whole display contents from RAM
  
```

Program Explanation:

1. When activating the program, it will clear the screen.

```
on start
  set LDM RX(white wire) to P1 TX(yellow wire) to P2
  LDM clear
```

2. The operation is similar to example 9. Pressing the A button to clear the screen, and then use two loops to fill the entire screen with the custom pattern No.0 saved in ezLDM. Run the pattern No.0 (color code #96) with the block of "Read custom pattern from EEPROM" to place it on the designated X and Y coordinates. Using the block of "Change color in specified area" to replace the red heart pattern (color code #96) displayed on ezLDM with a random color. This procedure can produce numerous heart patterns of different color from a single one.

```
on button A pressed
  LDM clear
  for Y from 0 to 5
  do for X from 0 to 11
  do load user pattern from EEPROM
    pattern type: 5*5
    Pattern ID: 0
    to
    X: 5
    Y: 5
    display now yes
    swap displayed color in the area:
    x for the top left corner: 5
    y for the top left corner: 5
    width: 5
    height: 5
    from color 96
    to color pick random 1 to 111
  do pause (ms) 100
```

3. The functions of pressing the B or A button is similar to the Example 9. The difference is that when the B button is pressed, the custom pattern No.0 is accessed, but not showed on ezLDM right away. Now it is time to select the option of “display immediately?” to be “No”.

Use the block  until the entire screen is filled with heart patterns to display the processed patterns.



```
on button B pressed
  LDM clear
  for Y from 0 to 5
  do
    for X from 0 to 11
    do
      load user pattern from EEPROM
      pattern type: 5*5
      Pattern ID: 0
      to
      X: X x 5
      Y: Y x 5
      display now yes
      swap displayed color in the area:
      x for the top left corner: X x 5
      y for the top left corner: Y x 5
      width: 5
      height: 5
      from color 96
      to color pick random 1 to 111
    do
  load and show the whole display contents from RAM
```


Example 11: Moving the Pac-man Character

*Pattern Tool is available after version 1.9.7.2

Using the function of custom pattern of ezLDM enables us to create the game easily. In this example, we are going to simulate the Pac-man game. Here we will need two micro:bits. One is connected to the ezLDM to control the display of Pac-man, and another is used as remote control for sending signals to the micro:bit connected to the ezLDM in order to control the moving direction of Pac-man character.

Program Presentation:

Tilting the remote-control micro:bit to different directions allows the Pac-man on ezLDM to move in different directions.

Please refer to the video: <https://www.youtube.com/watch?v=z8z-y3coVkk>

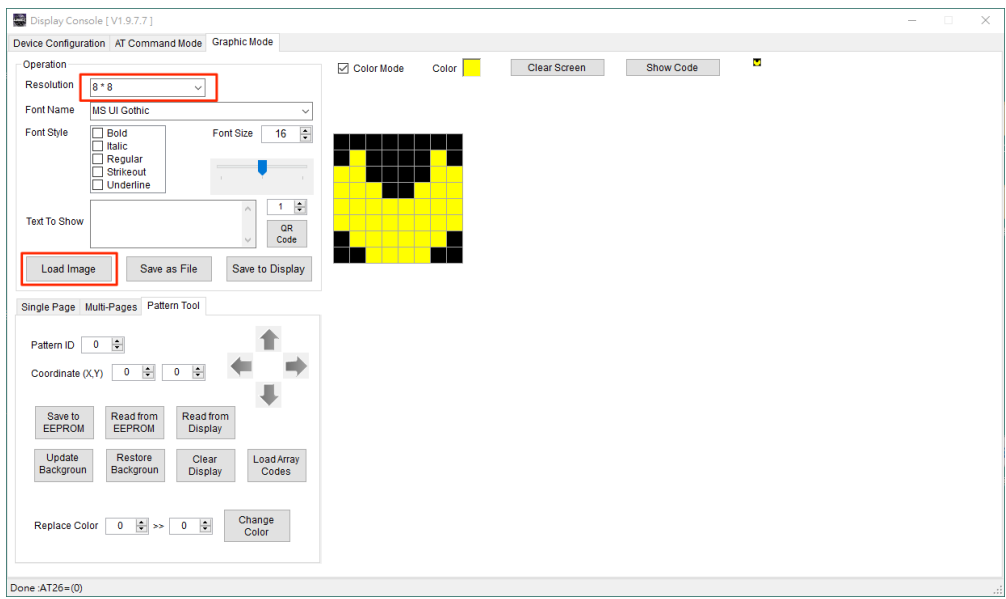
Video QR Code:



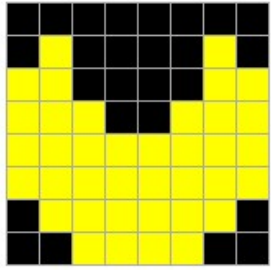
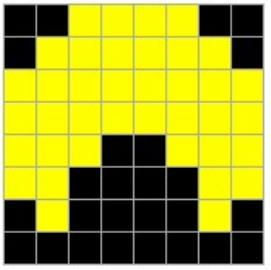
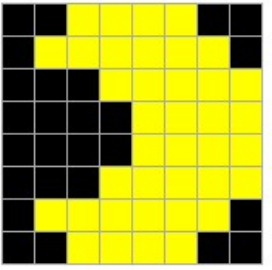
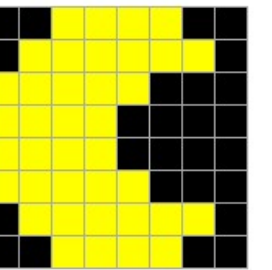
Steps:

1. Connect the computer and ezLDM with UART bridge. Launch the ezDisplay program and select the "Graphic Mode" tab. Drop down the list of "Resolution" and select the pattern size to be "8x8". Load the file "8x8 pattern number 0.bmp" provided in this example to save

it as No.0 to EEPROM. For the operation of making custom pattern, please refer the previous two examples.

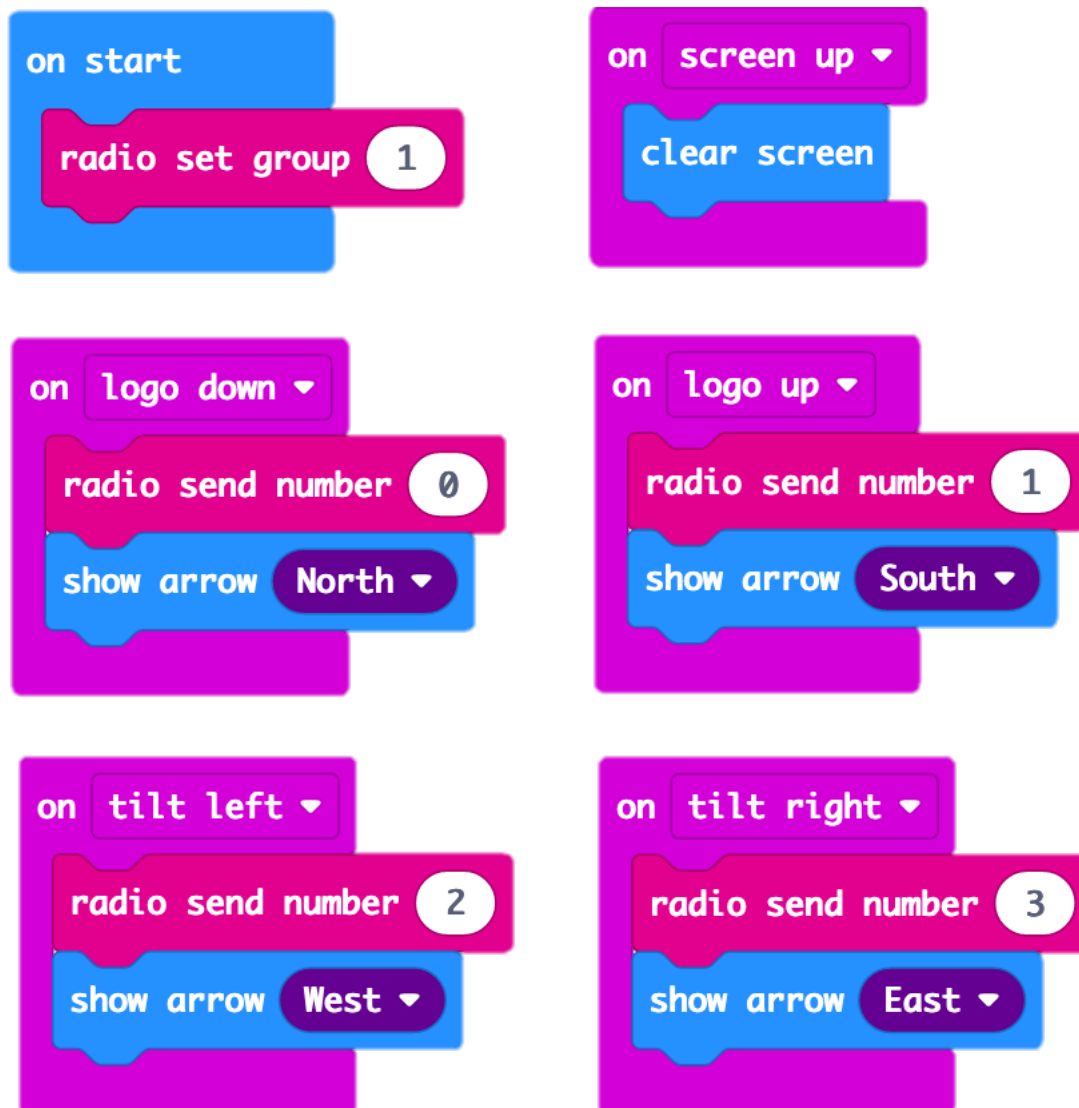


2. Send the custom patterns “8x8 pattern number 1.bmp”, “8x8 pattern number 2.bmp” and “8x8 pattern number 3.bmp” to the positions No.1, 2 and 3 of EEPROM. These are the graphics of Pac-man facing to different directions.

			
No.0: Pac-man facing upwards	No.1 Pac-man facing downward	No.2 Pac-man facing left	No.3 Pac-man facing right

3. Remote-control program: Drag and drop the blocks in MakeCode, as shown below, and download the program to the remote-control micro:bit. This program allows the Pac-man

to make movement by tilting the remote-control micro:bit according to the facing direction defined in previous step to send signals to the micro:bit connected to the ezLDM.



4. ezLDM program: Drag and drop the blocks in MakeCode, as shown below, and download the program to micro:bit connected to ezLDM. This program will receive the digit from the remote-control micro:bit. If the digit received is 0, the Pac-man will move upwards; if it is 1,

the Pac-man will move downwards, if it is 2, the Pac-man will move to the left; and if it is 3, the Pac-man will move to the right.

```

on start
  radio set group 1
  set LDM RX(white wire) to P1 TX(yellow wire) to P2
  LDM clear
  set pattern overlay on background: no
  save the whole display contents to RAM
  set X to 0
  set Y to 0
  load user pattern from EEPROM
  pattern type: 8*8
  Pattern ID: 3
  to
  X: X
  Y: Y
  display now yes

on radio received receivedNumber
  if receivedNumber = 0 then
    change Y by -1
  else if receivedNumber = 1 then
    change Y by 1
  else if receivedNumber = 2 then
    change X by -1
  else if receivedNumber = 3 then
    change X by 1
  +
  if X < 0 then
    set X to 0
  else if X > 55 then
    set X to 55
  +
  if Y < 0 then
    set Y to 0
  else if Y > 23 then
    set Y to 23
  +
  load and show the whole display contents from RAM
  load user pattern from EEPROM
  pattern type: 8*8
  Pattern ID: receivedNumber
  to
  X: X
  Y: Y
  display now yes
  
```

Program Explanation:

1. When activating the program, the screen will be cleared and the Pac-man No.3 (facing right) will be placed at the top-left corner of ezLDM. The use of "Set the pattern to be overwritten? No" block is because the black area where the 8x8 Pac-man should be defined to be transparent to see through the background (even though there is no background in this example). As for the block of "temporarily save the entire field to the memory", it is used

for memorizing the background before the custom pattern showing on ezLDM, in order to quickly display it in the future.

```
on start
  radio set group 1
  set LDM RX(white wire) to P1 TX(yellow wire) to P2
  LDM clear
  set pattern overlay on background: no
  save the whole display contents to RAM
  set X to 0
  set Y to 0
  Load user pattern from EEPROM
  pattern type: 8*8
  Pattern ID: 3
  to
  X: X
  Y: Y
  display now yes
```

- 2. In the program of "receivedNumber", the following program is mainly to decide the X and Y coordinates where the Pac-man should show according to the digit received, as well as

determine if such coordinates are beyond the display area to prevent the Pac-man from running out of the screen.

```
if receivedNumber = 0 then
  change Y by -1
else if receivedNumber = 1 then
  change Y by 1
else if receivedNumber = 2 then
  change X by -1
else if receivedNumber = 3 then
  change X by 1
+
if X < 0 then
  set X to 0
else if X > 55 then
  set X to 55
+
if Y < 0 then
  set Y to 0
else if Y > 23 then
  set Y to 23
+
```

3. The block of "Display the temporary field on the screen" will show the field saved before the Pac-man appears in order to erase the Pac-man character showing on the screen. And

then access the pattern number according to the digit received to show the corresponding Pac-man on the predefined coordinates.

The image shows a Scratch code block with an orange background. The text inside the block is as follows:

- load and show the whole display contents from RAM
- load user pattern from EEPROM
- pattern type: 8*8 ▼
- Pattern ID: receivedNumber
- to
- X: X ▼
- Y: Y ▼
- display now yes ▼

Example 12: Moving Smiley Face

*Pattern Tool is available after version 1.9.7.2

In previous example, we used the way by making the custom pattern located on certain coordinates suddenly disappear and then change its coordinates before quickly appearing to create movement effect. In this example, we will apply simpler and easier command blocks to achieve this effect. Same as in the previous example, another micro:bit is needed to be used as a remote control to control the movement of smiley face.

Program Presentation:

Tilting the remote-control micro:bit to different directions allows the smiley face on ezLDM to move in different directions.

Please refer to the video: <https://www.youtube.com/watch?v=kvcpXJ-zW5E>

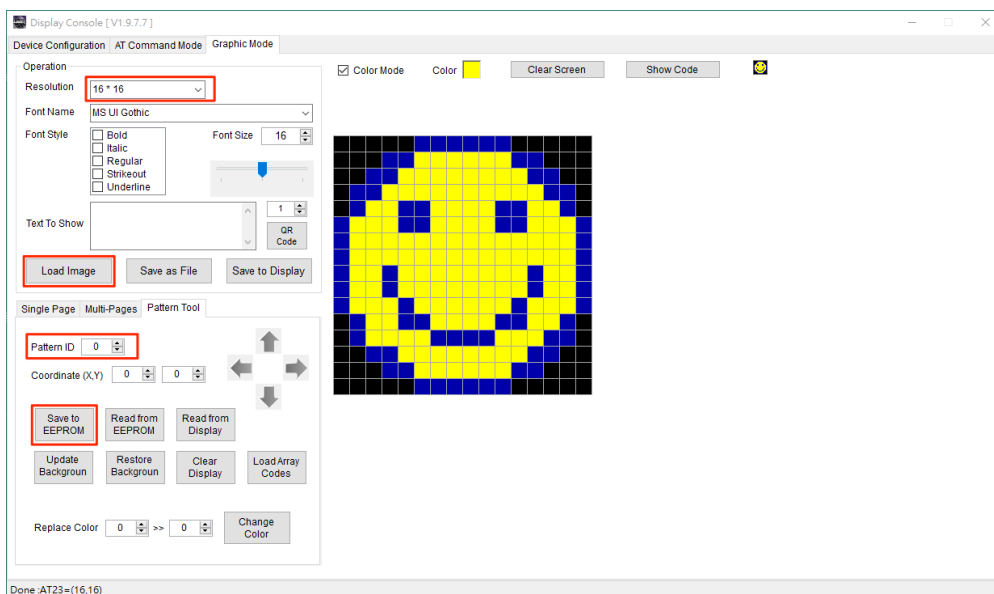
Video QR Code:



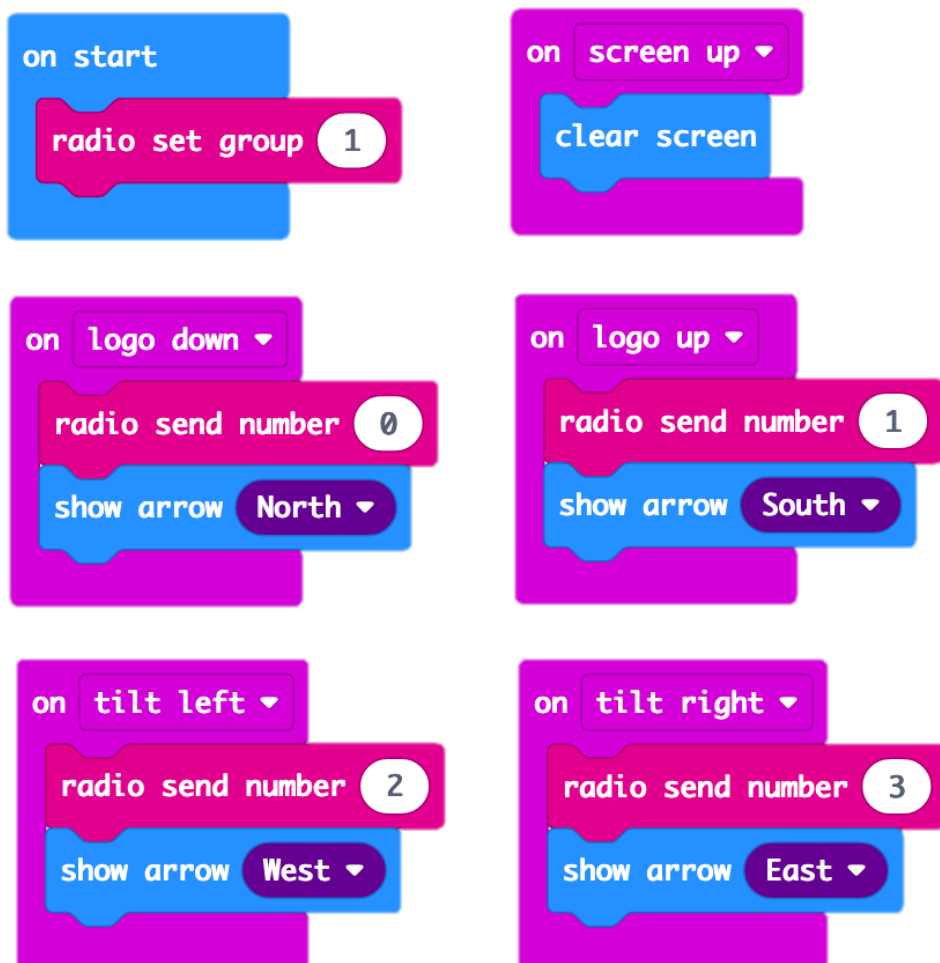
Steps:

1. Connect the computer and ezLDM with UART bridge, and launch the ezDisplay program. After entering the "Graphic Mode" tab, select the pattern size to be "16x16" from the list of "Resolution" and load the file "16x16 pattern number 0.bmp" provided in this example to

save it as No.0 to EEPROM. For the operation of making custom pattern, please refer to the Example 9.



2. Remote-control program: The program using here is same as in example 11.



- ezLDM program: Drag and drop the blocks in MakeCode, as shown below, and download the program to micro:bit connected to ezLDM. This program will receive the digit from the remote-control micro:bit. If the digit received is 0, the smiley face will move upwards; if it is 1, the smiley face will move downwards; if it is 2, the smiley face will move to the left; and if it is 3, the smiley face will move to the right.

```

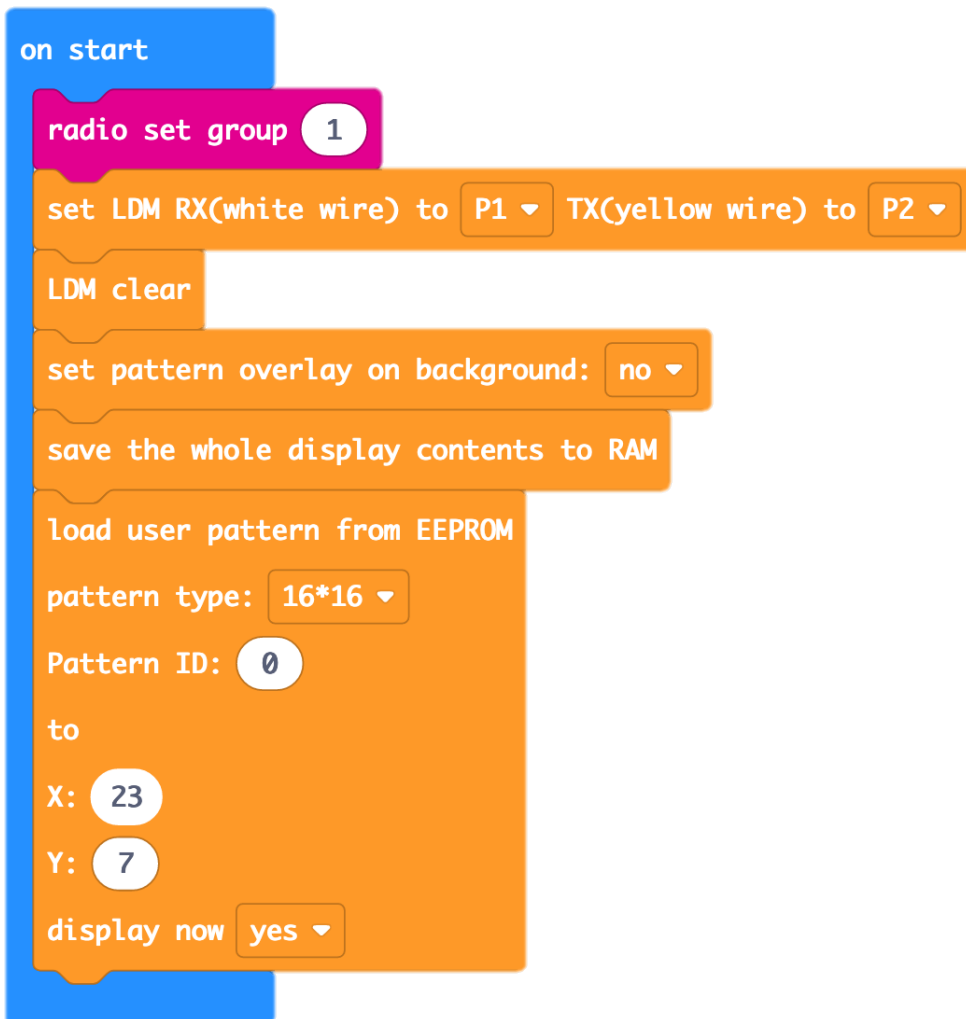
on start
  radio set group 1
  set LDM RX(white wire) to P1 TX(yellow wire) to P2
  LDM clear
  set pattern overlay on background: no
  save the whole display contents to RAM
  load user pattern from EEPROM
  pattern type: 16*16
  Pattern ID: 0
  to
  X: 23
  Y: 7
  display now yes

on radio received receivedNumber
  if receivedNumber = 0 then
    move user pattern 1 pixel upward pattern type: 16*16 Pattern ID: 0
  else if receivedNumber = 1 then
    move user pattern 1 pixel downward pattern type: 16*16 Pattern ID: 0
  else if receivedNumber = 2 then
    move user pattern 1 pixel leftward pattern type: 16*16 Pattern ID: 0
  else if receivedNumber = 3 then
    move user pattern 1 pixel rightward pattern type: 16*16 Pattern ID: 0
  
```

Program Explanation:

- When activating the program, the screen will be cleared. Set the X-coordinate of smiley face No.0 to be 23, and the Y-coordinate to be 7. The use of “Set the pattern to be overwritten? No” block is because the black area where the 16x16 smiley face should be defined to be transparent to see through the background (even though there is no background in this example”. As for the block of “temporarily save the entire field to the memory”, it is used

for memorizing the background before the custom pattern showing on ezLDM, in order to quickly display it in the future.



```
on start
  radio set group 1
  set LDM RX(white wire) to P1 TX(yellow wire) to P2
  LDM clear
  set pattern overlay on background: no
  save the whole display contents to RAM
  load user pattern from EEPROM
  pattern type: 16*16
  Pattern ID: 0
  to
  X: 23
  Y: 7
  display now yes
```

2. In the program of "receivedNumber", the difference is that in previous example, it was required to control the X and Y coordinates where the Pac-man showed. However, if using the block of "Move custom pattern by 1 pixel to *, pattern size 16x16, pattern number 0",

it is no longer needed to worry about its X and Y coordinates and is able to control the movement of such pattern.

```
on radio received receivedNumber
  if receivedNumber = 0 then
    move user pattern 1 pixel upward pattern type: 16*16 Pattern ID: 0
  else if receivedNumber = 1 then
    move user pattern 1 pixel downward pattern type: 16*16 Pattern ID: 0
  else if receivedNumber = 2 then
    move user pattern 1 pixel leftward pattern type: 16*16 Pattern ID: 0
  else if receivedNumber = 3 then
    move user pattern 1 pixel rightward pattern type: 16*16 Pattern ID: 0
```