AN0035
Application Note

QR USB HID Keyboard

Introduction

This application note is written to introduce a general approach to implementing QR Decode application on AT32 MCUs, and upload the decoded data to PC through USB HID keyboard.

Note: The corresponding code in this application note is developed on the basis of V2.x.x BSP provided by Artery. For other versions of BSP, please pay attention to the differences in usage.

Applicable products:

Part number	AT32F403A series AT32F407 series

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1 Overview

Nowadays, barcode technology has been widely used in our daily life, such as WeChat QR code, Ali Pay barcode, commodity barcode and supermarket locker barcode. Due to the complexity of two-dimensional code, it is necessary to optimize barcode recognition equipment.
In this application note, the AT32F403A MCU featured with FPU, large-size SRAM and high frequency is used together with Artery_QR code decoding library to scan and recognize two-dimensional code and CODE128\CODE39\I25\EAN13 barcode on AT-START-F403A evaluation board.

2 Introduction to barcode

2.1 One-dimensional barcode

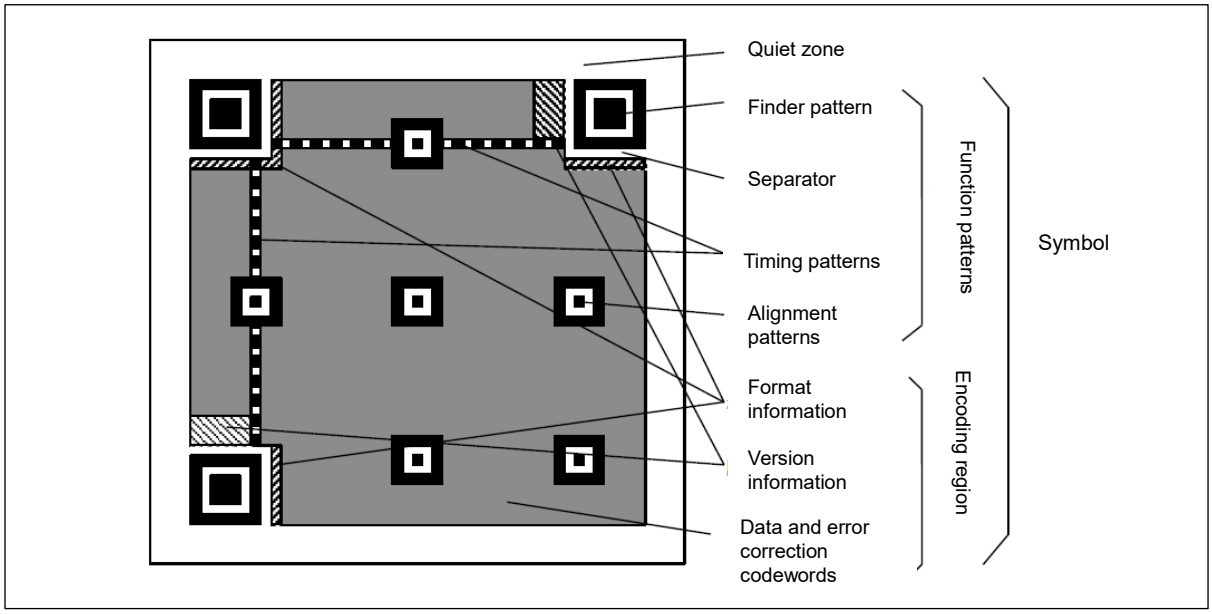
A one-dimensional barcode consists of a set of regularly arranged vertical lines, spacings and characters. The vertical lines have low reflectivity to light, while spacings have relatively high reflectivity to light. The data represented data by lines and spacings convey specific information that can be read and identified by specific devices and converted into computer-compatible binary and decimal information. The one-dimensional barcode can convey information such as the country of origin, manufacturer, product name, date of manufacture, library classification number, mail address, class and date. Therefore, it has been widely used in commodity circulation, library management, postal management, banking system and other fields.
The one-dimensional barcode only expresses information in one direction (generally the horizontal direction) but does not express any information in the vertical direction. Although the efficiency of information entry has been improved and error rate is reduced, the space utilization rate is low and the data capacity is small.

2.2 Two-dimensional barcode

A two-dimensional barcode is a black-and-white image that composed of specific geometric patterns distributed on a plane (in two-dimensional direction) under certain rules, and it stores data and symbol information. In coding, the two-dimensional barcode uses the concept of “0” and “1” bit streams that constitute the internal computer logic basis, and it express information (words and values) through several geometric shapes corresponding to binary. It can be read and identified by image input devices or photoelectric scanner to realize automatic information handling.

Due to specific design characteristics, the two-dimensional barcode can contain more information, and the range of encoded information is wider. In addition, the two-dimensional code decoding is more accurate (bit error rate: one in ten million) because it has functions such as verification, automatically identifying the information of different lines, and processing the rotation points of graphics. The QR code structure is shown in Figure 1.

Figure 1. QR code structure

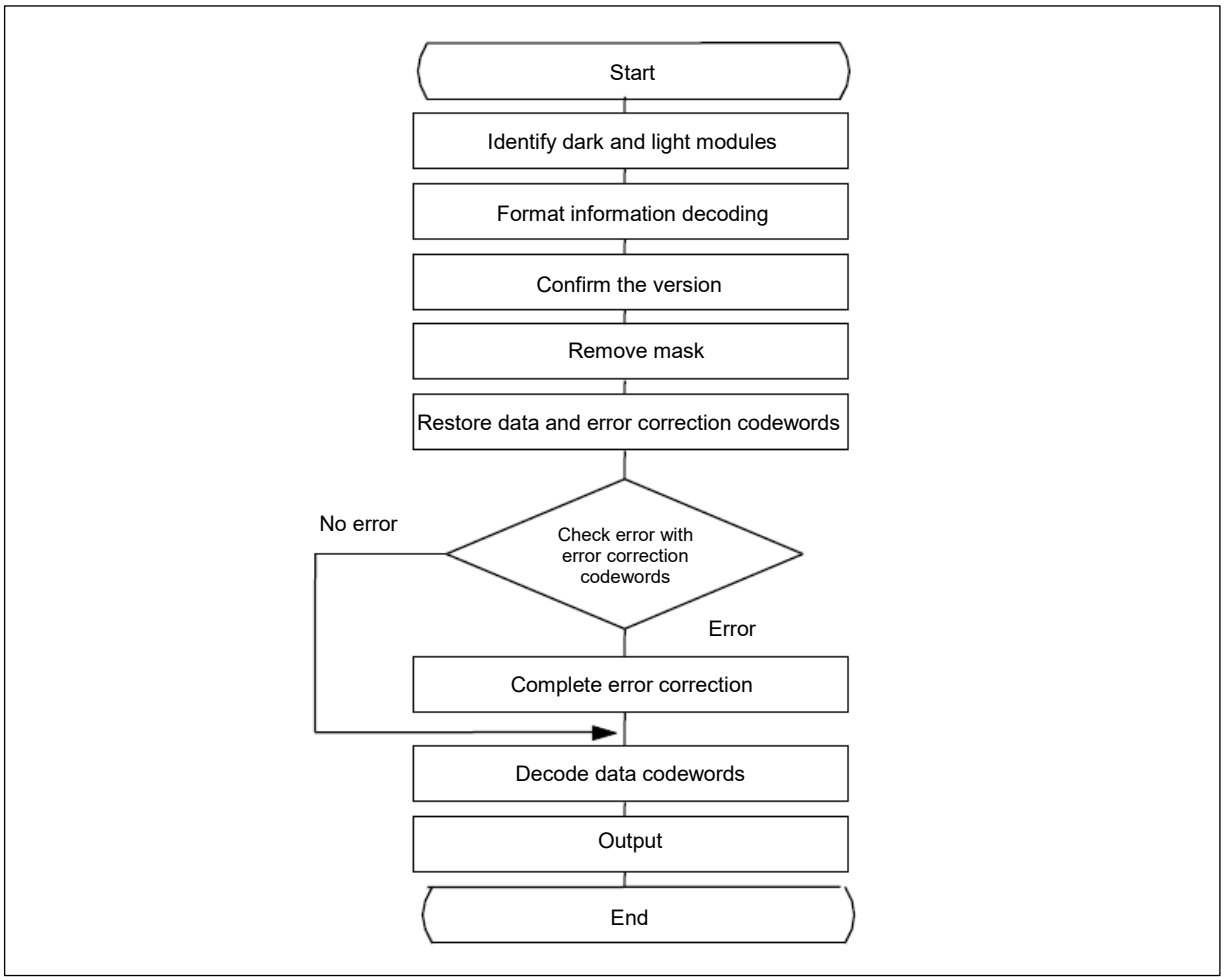


1) Finder pattern and separator: They are used for QR code positioning. For each QR code, its position is fixed, but the size varies. These black-and-white squares are easy to detect for image processing.
2) Timing patterns: These black-and-white grids serve as a coordinate axis that define the grid on QR code.
3) Format information: it indicates the QR code error correction level, including L, M, Q and H;
4) Data zone: Encode content using black-and-white binary grids (8 grids can encode a byte).
5) Version information: It is the version of a QR code. QR code image has 40 versions (generally in black-and-white), and the size begins from 21x21 modules (version 1) and up to 177x177 module (version 40), increasing in steps of 4 modules per side.
6) Error correction codewords: They are used to correct errors caused by QR code damage.

3 How to decode a QR code

The aforementioned section introduces the QR code structure. This section describes how to decode a QR code, as shown in Figure 2.

Figure 2. QR code decoding process



1) Locate and get the symbol image. The dark and light modules are recognized as an array of “0” and “1”.
2) Read the format information (if necessary, remove the mask pattern and complete error correction of the formation information, and identify error correction level and mask pattern reference).
3) Read the version information and confirm the symbol version.
4) With reference to the mask pattern, get the bitmap of encoding region from the format information, and then perform XOR processing to remove the mask.
5) According to the module arrangement rules, read the symbol and characters, and restore the data and error correction codewords.
6) Check errors with the error correction codewords corresponding to the error correction level, and correct the error immediately if an error is found.
7) Divide the data codewords into parts according to the mode indicator and character count indicator.
8) Finally, decode and get the data characters according to the mode used, and then output the result.

The decoding process of a QR code is complex, involving the standard rules and corresponding algorithms of QR codes. For details, you can search the information on Internet.

4 How to use QR decode quickly

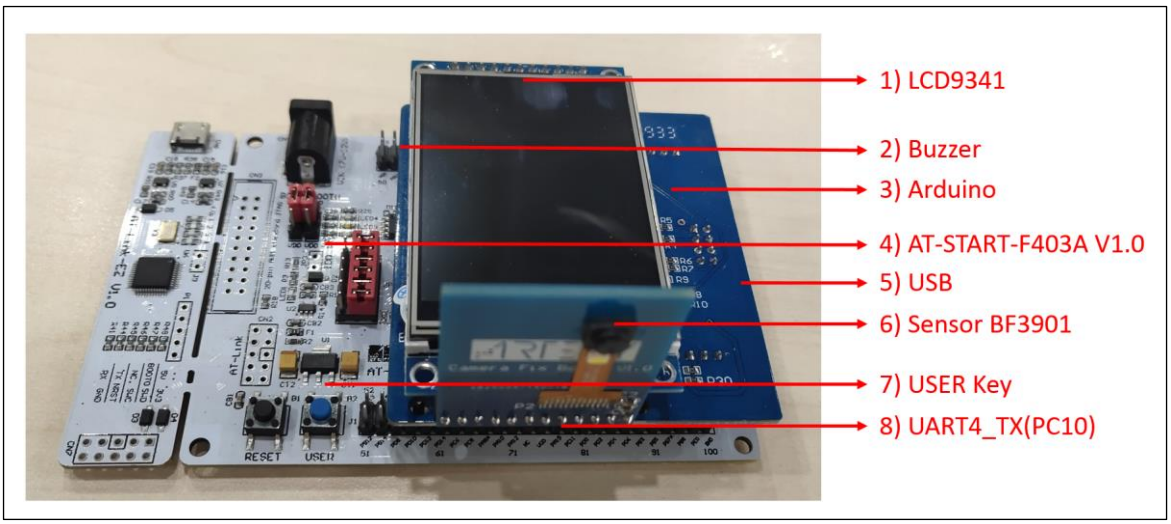
4.1 Hardware resources

Artery provide two kinds of hardware resources, i.e., sensor board V1.0 and sensor board V2.0.

Sensor board V1.0:

1) LCD 9341
2) Externally connected Buzzer (PE15)
3) Arduio
4) AT-START-F403A V1.0 demo board
5) USB
6) Sensor BF3901
7) USER key

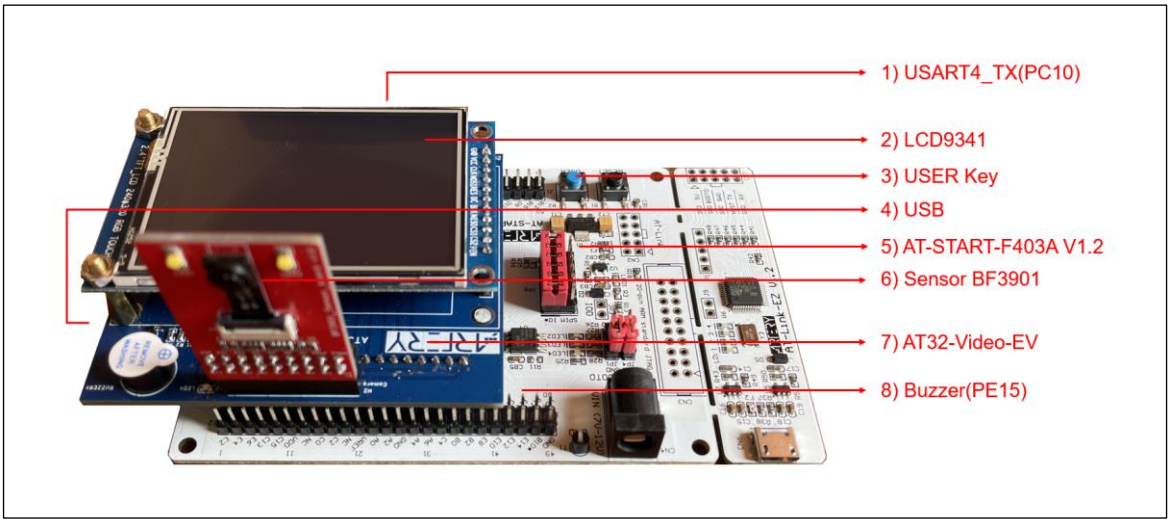
Figure 3. Sensor board V1.0



Sensor board V2.0:

1) UART4_TX(PC10)
2) LCD 9341
3) USER key
4) USB
5) AT-START-F403A V1.2 demo board
6) Sensor BF3901
7) AT32-Video-EV
8) Externally connected Buzzer (PE15)

Figure 4. Sensor board V2.0



Note:

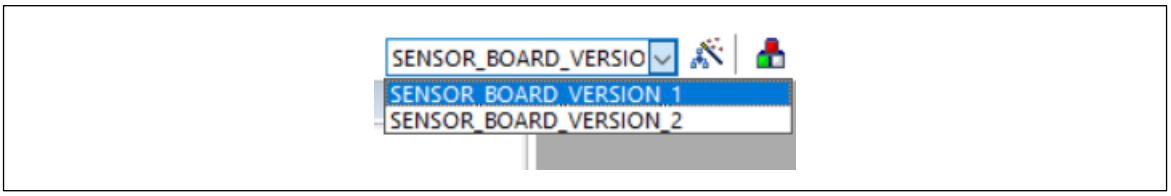
1. This demo is based on the hardware condition of AT32F403A. If users want to use this demo on other AT32 parts, please modify configurations accordingly.

2. Supply: use power supply or USB cable power supply (do not use Link power supply alone).

4.2 How to use QR USB HID keyboard Demo

As mentioned before, Artery provides two kinds of hardware resources, together with two sets of software codes for testing. User can click on ***project target*** to switch the project. The SENSOR_BOARD_VERSION_1 corresponds to sensor board V1.0, and SENSOR_BOARD_VERSION_2 corresponds to sensor board V2.0, as shown below:

Figure 5. Project target selection



It is recommended to use QR USB HID keyboard Demo as follows:

1) Open QR decode project source program; compile and then download to the demo board;

2) The demo occupies 169 K SRAM during running; therefore, the extended SRAM function (extended to 224 KB) should be enabled before using the demo. For the convenience of users, this function is enabled in demo startup file.

```
EXPORT  Reset_Handler
IMPORT  __main
IMPORT  SystemInit
IMPORT  extend_SRAM

MOV32   R0, #0x20001000
MOV     SP, R0
LDR     R0, =extend_SRAM
BLX     R0
MOV32   R0, #0x08000000
LDR     SP, [R0]

LDR     R0, =SystemInit
BLX     R0
LDR     R0, =__main
BX      R0
ENDP
```

3) Connect USB line to PC, and the HID Keyboard Device (Standard keyboard input mode, no driver required) can be recognized by the host.

4) According to the information displayed on LCD, check whether the initialization of BF3901 is successful; then, press USER key to enable QR code decoding detection.

5) Point the camera BF3901 at the QR code, and the LCD will display the current captured image. At this point, the chip is operating QR code decoding.

6) If the chip has not parsed the two-dimensional barcode or one-dimensional barcode data, it will continue running until the data is parsed, as shown in Figure 6 and Figure 7. Once the data is parsed, the buzzer will sound once, and the parsed data will be transmitted to the PC through USB, as shown in Figure 8.

   Ps. QR decoder only detects two-dimensional barcode by default. To detect all image codes, please enable the macro definition “Detect_all”.

Figure 6. Sensor board V1.0 displays parsed data

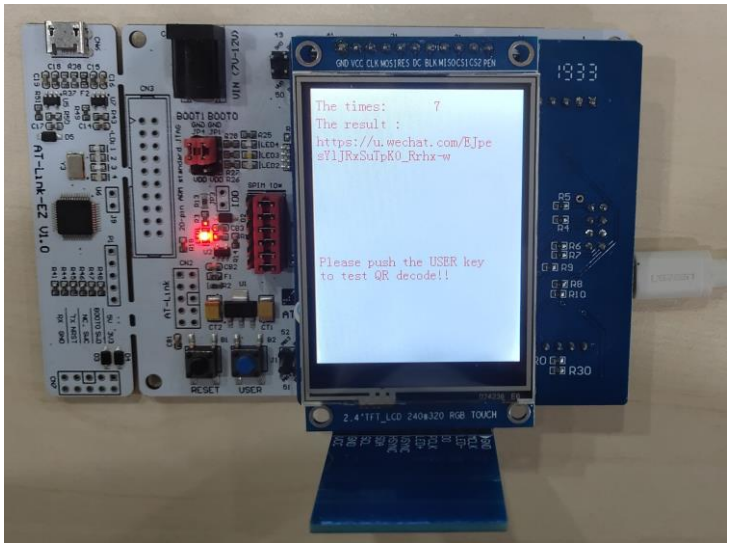


Figure 7. Sensor board V2.0 displays parsed data

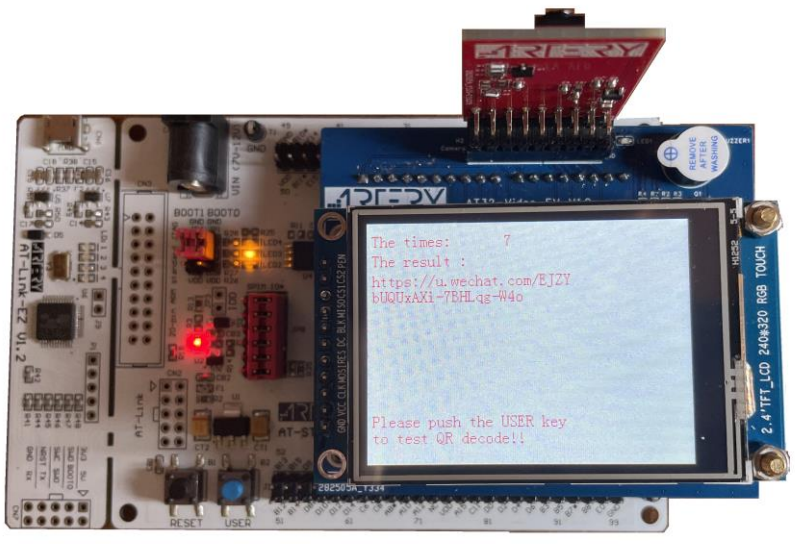
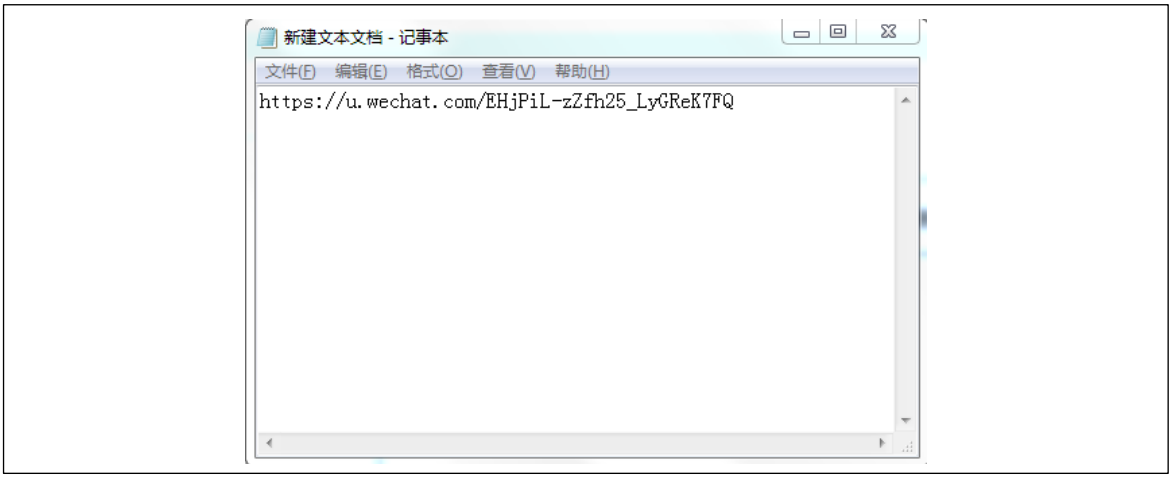


Figure 8. Transmit data to PC through USB



5 Revision history

Table 1. Document revision history

Date	Version	Revision note
2021.12.13	2.0.0	Initial release
2022.09.05	2.0.1	Added sensor board V2.0 hardware resources

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