Intelligent TFT LCD Module 4.3 User Development Guide

Suitable for Intelligent TFT LCD Module

Beijing STONE Technology Co., Ltd.

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Modification record

Data	Modified content
2015-6-1	First draft.
2015-8-15	Add audio playback function.
2015-10-10	Add video playing function.
2015-11-28	Add the two-dimensional code display function.
2016-4-7	Add text scrolling display function.
2016-8-9	1. Add View Tech OS programming command; 2. Add automatic upload function after the input of RTC; 3. When the name of the folder is "VT _ SET-REPLACE ", update only the files with the same name and not delete other project files. 4. Supports large icons (greater than 255 dot matrix) display
2016-9-5	1. Insert the USB Mini to support the UART receiving command; 2. Add 85 00 command write memory function; 3. The power-on start-up brightness is the screen saver lighting brightness R6, the start-up brightness can be set in the project, and the brightness value in the brightness register is changed to 1 save brightness. 4. Data reverse color display is added to data variable entering and data variable display; 5. Invalid bit zero option is added to data variable; 6. Input length limit is added to variable data entering.
2016-11-4	Examples of command operation. To add register and variable registers.
2016-12-12	Add command to set audio play mode.
2017-01-13	Add Register 0x10-0x1D to configure the register mapping function.
2017-06-20	Update chapter 1 and chapter 2

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1 Intelligent TFT LCD Module 4.3 General

1. 1. Recognize Beijing STONE TECH Intelligent TFT LCD Module

1. 1. 1 System architecture

Intelligent TFT LCD Module software (Graphical User Software) is a configuration and user graphical interface design software of Beijing STONE Technology CO.,LTD., the system architecture of Intelligent TFT LCD Module is shown in Figure 1-1.Intelligent TFT LCD Module 4.3 is the latest version of the configuration software.

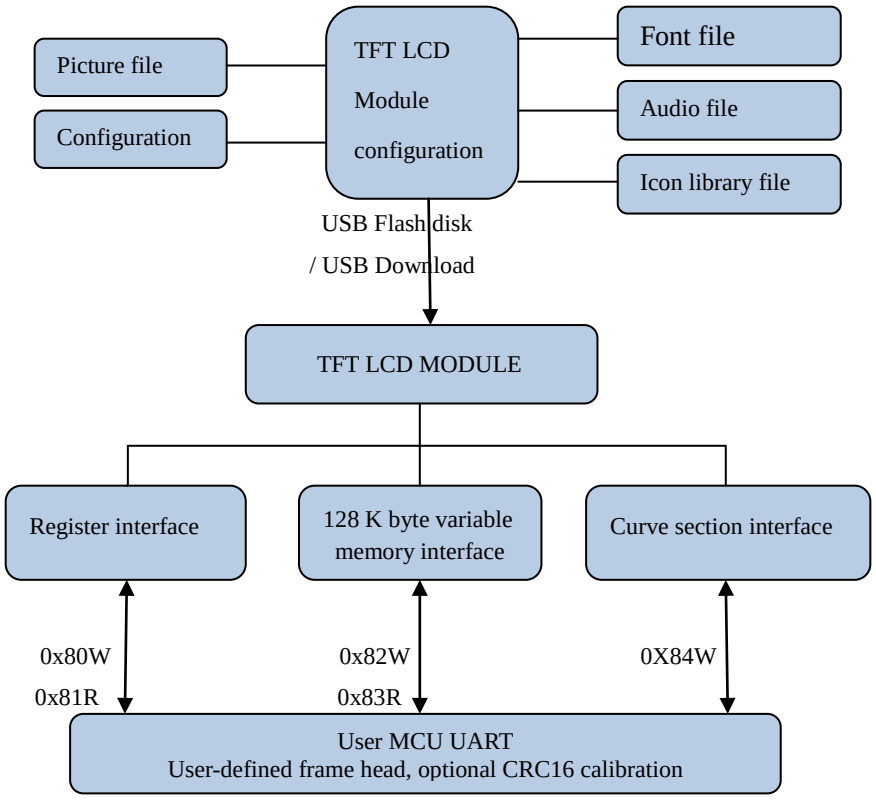

Figure 1-1 System Architecture of Intelligent TFT LCD Module

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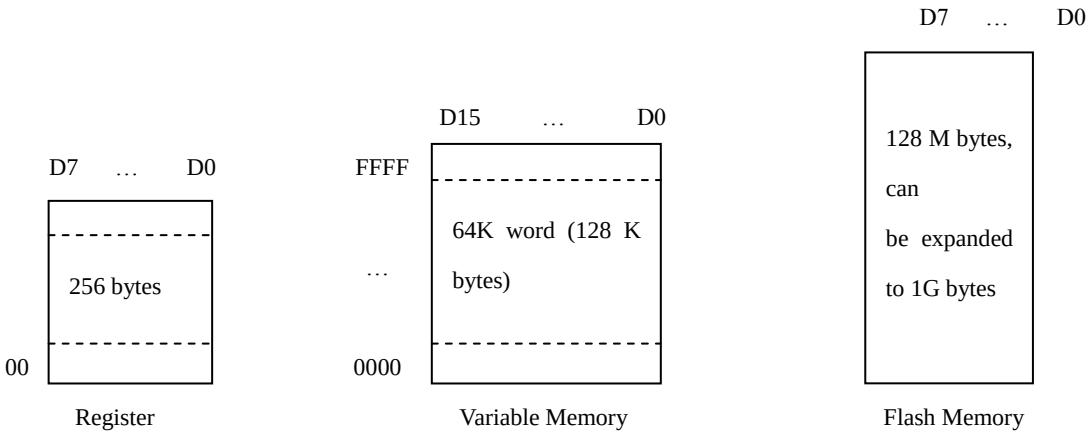

Figure 1-2 Storage space of Intelligent TFT LCD Module

The internal storage space of Intelligent TFT LCD Module is divided into three parts: register area, variable memory area and flash memory.

The register area has 256 units (address 0x00 ~ 0xFF) in total, and each unit corresponds to one byte, which is 256 bytes. It is used for hardware configuration and control operations, the typical functions such as back brightness adjustment, version information read, and UART command control picture display, audio playing control, video playing control, etc. A complete summary of the registers is given in Chapter 3. The user MCU can write and read the register cell contents through the 0x80 and 0x81 commands, respectively.

The variable memory has 64K units (Address 0x0000 to 0xFFFF) in total, and each unit corresponds to two bytes, which has a total of 128K bytes. As its name implies, variable memory is used to store variable values. The user MCU can write and read the register cell contents through the 0x82 and 0x83 commands, respectively.

Flash memory has 128M bytes in total, and can be extended to 1G byte. Flash memory is used to store configuration files (such as variable display formats), picture files, icon files, fonts files, audio files, video files, etc. After the interface design is finished, the above contents are downloaded into the Intelligent TFT LCD Module through USB flash disk and saved permanently. Intelligent TFT LCD Module adopts JPG data compression algorithm and continuous storage mode, which greatly improves the storage efficiency and the number of stored pictures, which is sufficient for general picture applications, such as full-size picture with resolution of 1024 * 768, and can store about a thousand pictures (The actual number stored is related to the color). When customers have more video files need to be stored, it may be necessary to expand storage space.

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1. 1. 2 Product Features

- ✧ 256-byte register space;
- ✧ 128 K byte variable memory space, 8-channel curve trend picture memory, fast (80 ms) variable display response speed;
- ✧ 128 M Flash memory space, expanded to 1G byte;
- ✧ The single page supports 128 display variables at most;
- ✧ Integrated real time clock RTC, touch buzzer sound function;
- ✧ Support the screen rotation of 90 degrees, 180 degrees, 270 degrees by software, adjust to appropriate viewing angle;
- ✧ Support backlight brightness adjustment, automatic standby screen saver function;
- ✧ Support external matrix keyboard;
- ✧ Industry-leading electromagnetic radiation indicators to help you to cope with Class B easily;
- ✧ Support the USB mini interface to download and debug on line, and improve the development efficiency, avoid repeatedly inserting and removing TF cards during debugging
- ✧ Support offline batch download in USB flash disk, effectively improve the download efficiency, reduce the professional requirements of the operator;
- ✧ Support hardware JPG decoding, more efficient storage, faster display
- ✧ Support audio and video playing;
- ✧ Matching a configuration development tools Intelligent TFT LCD Module 4.3 with simple operation;
- ✧ The name rule of the file name is simple, and does not need to correspond to the Flash block number, and does not need for tedious manual allocation of flash block function.

Figure 1-3 7-inch STVI070WT-01 Picture of real products

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1. 1. 3 Recognize Configuration

command set screen	Intelligent TFT LCD Module configuration screen
When the early command set screen displays characters, Chinese characters, icons and other information, the user needs to send the display content and display format as command to the terminal through the UART , so as to realize the display on the current page.	The Intelligent TFT LCD Module is driven by variables, and all displayed characters, icons, etc. are defined as a variable, and the variable storage address is assigned, the display format is defined, then the configuration file is generated and downloaded to the Intelligent TFT LCD Module. When the refresh display is needed, the user only needs to send the variable contents and the variable storage address to the Intelligent TFT LCD Module through the UART, and the Intelligent TFT LCD Module will automatically

Figure 1-4 The difference between the command set screen and the configuration screen

Example: display the floating point variable "25. 3" on interface NO.1

Implement step of command set screen:

- **Step1: The user MCU sends commands directly through the UART to the terminal screen:**

  AA98 0073 00B4 224000 F800 FFFF 32352E33 CC33C33C

  AA 98: Ox 98 character string display command frame header;

  0073 00B4: the coordinates of data 25. 3 displayed on the LCD screen;

  22400 F800 FFFF: defined font ID number + display mode + dot matrix + foreground color + background color (format) ;

  32 35 2E 33: String 25. 3

  CC 33 C3 3C: Frame End;

- **Step2: When refreshing the data, the command of display format and display contents are sent to the terminal through the UART .**
- **Step 3: If the display terminal switches to the interface No. 2, and then back to the interface No. 1, the variable does not display, and it must be displayed again by sending the command to the interface No. 1.**

Implementation steps of configuration screen:

- **Step1 display configuration: first the "data variable" is added on the interface NO.1 through the Intelligent TFT LCD Module configuration software, and setting the basic properties of "data variable display format" (including variable storage addresses, display colors, sizes, displays**

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mode, etc.), as shown in the right. Then the configuration file is generated and downloaded into the screen.

- **Step2 run and refresh the display: when refresh is needed, only the variable content and the variable storage address are needed to be sent to the screen through 82 command.**

  82 command data format: A5 5A 02 82 00 00 00 FD

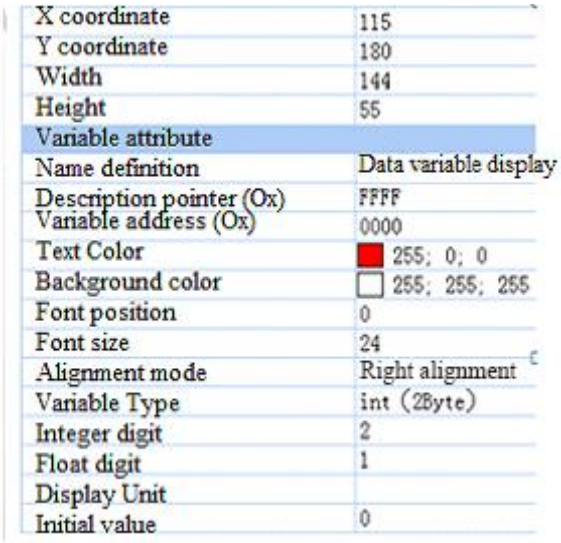
  A5 5A: UART data frame header (user can be self-define frame header content)

  05: Data length

  00 00: User-defined variable storage address for this variable 25.3

  00 FD: Variable 25. 3 (The decimal point is the fixed point display, i. e., hex data of "253").

Note: when switch to interface No. 2 and then return to interface NO.1, the screen will automatically read variable contents from the variable memory and display it.



X coordinate	115
Y coordinate	180
Width	144
Height	55
Variable attribute	
Name definition	Data variable display
Description pointer (Ox)	FFFF
Variable address (Ox)	0000
Text Color	255; 0; 0
Background color	255; 255; 255
Font position	0
Font size	24
Alignment mode	Right alignment
Variable Type	int (2Byte)
Integer digit	2
Float digit	1
Display Unit	
Initial value	0

1. 1. 4 Development Flow

It only needs 3 steps in developing by Intelligent TFT LCD Module to complete complex human-machine interface design.

① Prepare the project materials; Arrange the artwork to design the needed background image and icon for the products, and prepare fonts, audio and video files according to the design needs.

② Interface design; Firstly the Intelligent TFT LCD Module 4. 3 development tool is used to perform Interface layout, screen parameter configuration and control configuration with designed picture, and then perform compile, then preview the effect, finally the generated configuration file is downloaded into the Intelligent TFT LCD Module.

③ User MCU sends UART command to debug interface display. Once the configuration file is downloaded into the screen, and once one button on the screen is pressed, the user MCU will receive the address information of button variables which uploaded from the Intelligent TFT LCD Module. By resolving the variable address, the user can obtain the function attribute of the current button, so that the related peripheral device or interface update display can be controlled. For non-touch products, users only need

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to send related command for page switching and text display.

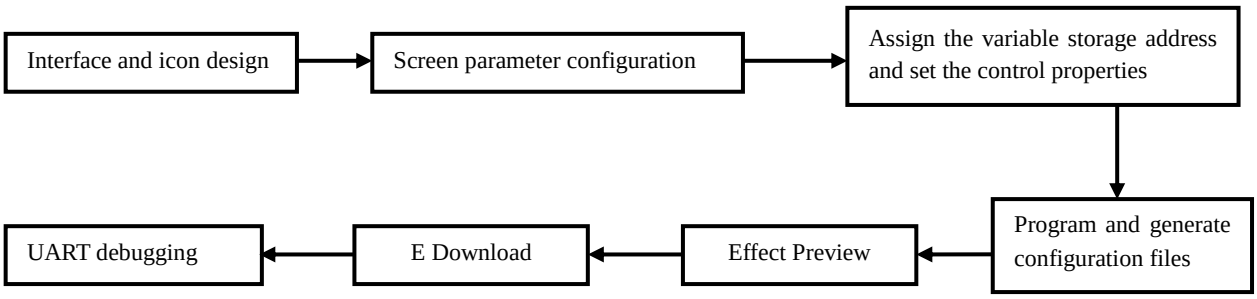

Figure 1-5 Intelligent TFT LCD Module Development Flow

(1) Preparation of project materials

Before using Intelligent TFT LCD Module 4.3 development tool, the used background pictures, icons and the fonts, audio and video files should first be designed.

(II) Interface project design

After the pictures and other materials are prepared, the interface design can be completed in Intelligent TFT LCD Module 4. 3 development tool software.

① Screen parameter configuration

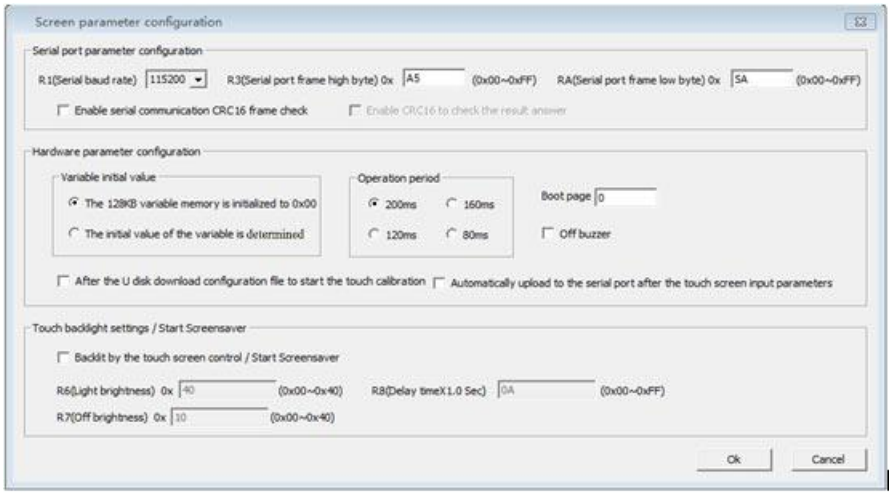

Figure 1-6 Screen Parameters Configuration Interface

The characteristics such as UART baud rate, command frame header, CRC validation and buzzer, touch screen and screen saver are set in the screen parameter configuration, as shown in the following figure.

② Control configuration

Define all the variable storage address and display format, generate the configuration file and download it into the Intelligent TFT LCD Module. The user can send the variable value and the corresponding variable storage address to the Intelligent TFT LCD Module.

For example, add a "data variable" control on interface NO.1, and set the basic property for "data variable" (including variable storage address, display color, size, display mode, etc.), as shown in the figure below. And then the configuration file is generated and downloaded into the terminal. All variable storage

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addresses need to be manually assigned depending on the variable length.

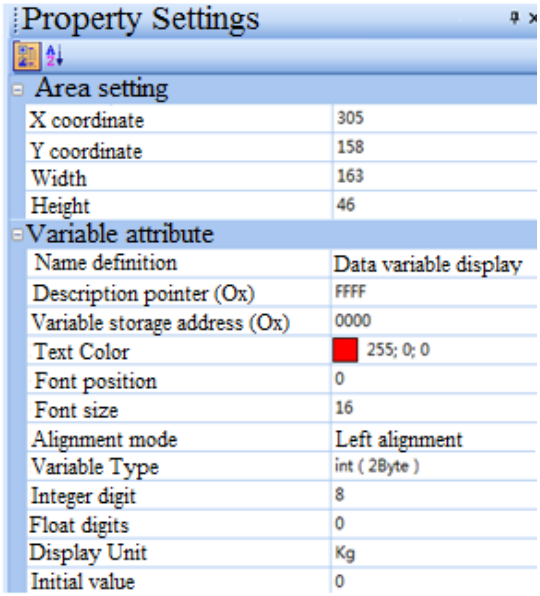

Figure 1-7 Basic Attribute Setting of Data Variable

③ Compile and generate configuration files

After the control configuration in the Intelligent TFT LCD Module software is completed, then the compilation can be done. After the compilation is completed, the configuration folder named "VT _ SET" can be generated under the current project folder, as shown in the following figure.

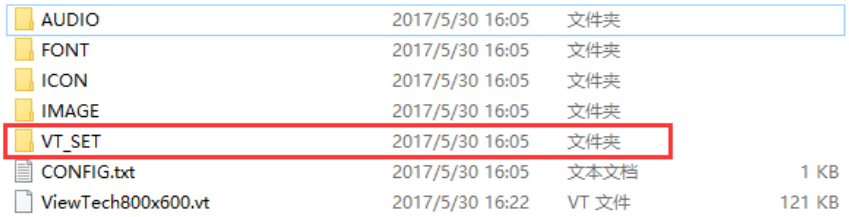

Figure 1-8 Generate configuration folder "VT _ SET"

④ Effect Preview

The compiled project that can be previewed directly in the Intelligent TFT LCD Module software (the actual effects is subjected to the showing on the screen).

(III)Download

Download the "VT _ SET" folder into the Intelligent TFT LCD Module via the USB flash disk or USB mini interface, and the details method is shown in following 1.2 section.

(IV)UART debugging

After the "VT _ SET" folder is downloaded into the terminal, the variable display can be debugged by UART debugging assistant or the third party UART debugging tools of the Intelligent TFT LCD Module software to test the interface function of the Intelligent TFT LCD Module.

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1. 2 Download

After the "VT_SET" folder is compiled and generated, it can be downloaded into the Intelligent TFT LCD Module through the USB mini interface or the USB flash disk. The online download and debugging of the USB mini interface is suitable for use in the development stage, which can effectively improve development efficiency, avoid repeatedly inserting and removing TF cards during debugging; the USB flash disk download is suitable for batch production after the development is finalized, so as to effectively improve download efficiency and reduce requirements for operating personnel.

1. 2. 1 Download online (USB mini interface)

The "configuration files download" button and window are shown in the following figure.

Figure 1-9 Configuration files download button

Open the configuration file download window, connect the USB-mini interface of the Intelligent TFT LCD Module with the computer and power up, and the lower right side on the Intelligent TFT LCD Module software will present "USB connected". At this time, click the "download" button, and the system will automatically downloads the contents in the "VT _ SET" folder into the Intelligent TFT LCD Module.

In the process of development and debugging; it may be necessary to repeatedly download information such as the format of variable, while the pictures, fonts, or icons may not be modified. In this case, the " Undownloaded Picture", " Undownloaded font" and "Undownload icon" and other options in the below figure can be checked. In this way can effectively improve download speed. If the picture, font, or icon are modify, the corresponding option cannot be clicked, and the modified file must be redownloaded.

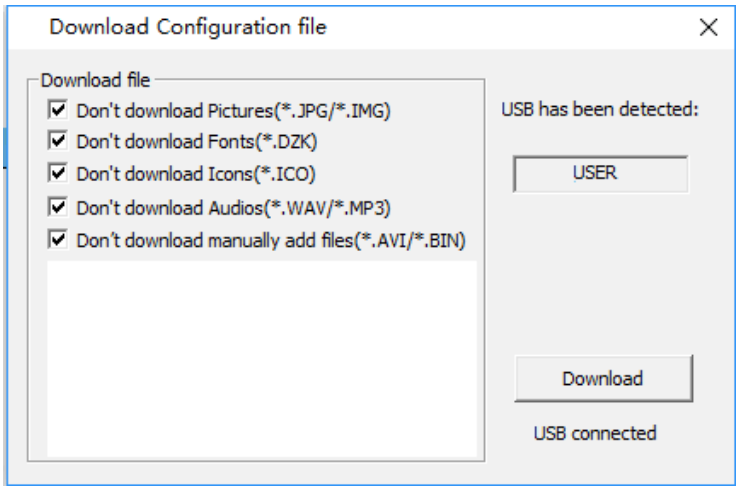

Figure 1-10 Configuration File Download Window

Gentle hint:

When the Intelligent TFT LCD Module is connected with the computer through the USB-mini interface, it is actually a virtual hard drive, and a new disk letter "Intelligent TFT LCD Module _ USER " will appear in

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the computer. If the configuration file, download failed, please reformat Intelligent TFT LCD Module _ USER to FAT 32 format in My Computer.

1. 2. 2 Offline download (USB flash disk)

① The "VT _ SET" folder can be copied into the USB flash disk directly through the' Download to USB flash disk' button in the Intelligent TFT LCD Module software, as shown in figure below. The tedious process of copying and pasting is not required.

Figure 1-11 Download to USB Flash disk Button

② By inserting the USB flash disk into the Intelligent TFT LCD Module, the system will automatically start the data copy, and the data in the USB flash disk can be copied into the Intelligent TFT LCD Module one by one. Upon completion of the copy, the buzzer will prompt the download completion, while the upper left corner on the screen will display "Please plug out the U disk".

③ Pull out USB flash disk.

Description:

② Before the first use of USB flash disk, it is recommended to format USB flash disk into FAT 32 file format.

② The "VT _ SET" folder contains information of all configuration files, fonts, pictures, audio files and drawings, etc. , and the user cannot make any modification to these files in the folder;

③ The video file needs to be manually copied to the "VT _ SET" folder before downloading;

④ When the name of the folder is "VT _ SET _ REPLACE ", only update the files of the same name when downloading, and not delete other project files. This function is suitable for the user to modify the startup interface.

1. 3 File Format and Name Rules

The file formats supported by Intelligent TFT LCD Module 4. 3 are listed in the table below.

Table 1-1 Intelligent TFT LCD Module 4.3 Supported file formats

File Format	Meaning	Numbering limit
*.Jpg	Picture file, recommended	0-65535
*.bmp	Picture file, not recommended	0-65535
*.ico	Icon file	0-255
.dzk/.hzk	User font File	0-255
*.mp3	Audio files, recommended	0-4095
*.wav	Audio file, not recommended	0-4095
*.avi	Video Files	0-65535
*.bin	User data file	0-255

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UserDb.bin	User database file	Fixation

- **File naming rules**

The file names for all types of files in the table must begin with Arabic numerals. For example, when a picture is numbered to 20, the picture file can be named as "20_testing jpg" or "20. jpg", but cannot be named as "testing 20. jpg".

- **Picture file format**

The picture file format supported by Intelligent TFT LCD Module 4.3 is JPG and BMP, if the user imports the picture files in other formats, the system will automatically convert into JPG format. It is strongly recommended that users directly use the JPG format, because the JPG format takes a small space with quick display.

There are many kinds of JPG formats, Intelligent TFT LCD Module 4. 3 only support Baseline mode, 4: 4: 4 or 4: 1: 1 format. When using JPG pictures in other modes, it may cause Display Error!

The resolution of the picture depends on the resolution of the TFT LCD screen. The resolution of the TFT LCD screen can be found in the product specifications. If the download picture is not matched with the screen resolution, the display will be abnormal.

The name of the image file should be numbered from 0, the number 0 picture will be displayed when power on and the user can also self-define the settings in the screen parameter configuration.

Do not use drawings, QQ screenshots and other tools to save JPG format files directly, because JPG format files are damaged compressed, the display effect is poor. It is recommended to save the BMP format file by using tools such as QQ screenshot, etc., and then open the picture with the Photoshop tool, and save as JPG format, the specific steps are as follows:

1. Open the picture with Photoshop;
2. Save as jpg format

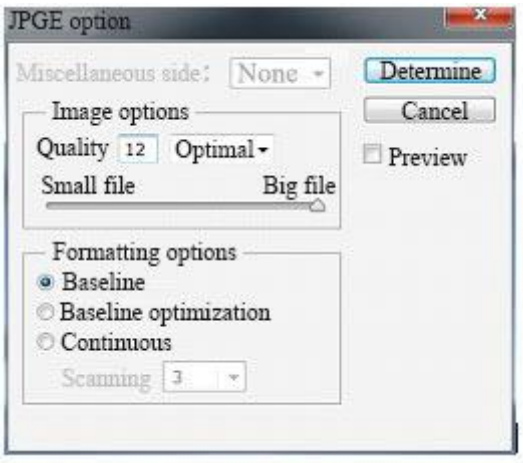

Figure 1-12 the Options of Save Image Quality

3. Select the "Best" option of image effect.

The BMP format is the original bitmap file, which contains the most complete information. If the

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display effect of JPG format file cannot meet the requirements and the user can select the BMP format file. The use of BMP format will takes up more storage space, and the speed of screen refresh becomes slower.

- **Icon file format**

The icon file also supports multiple formats such as BMP and JPG. However, the BMP format should be used in the case of transparent display of icons, because the working principle of icon generating tools extracting transparent icons is to take the color of the pixel point of the source picture (0, 0) as the background filter color. As the JPG file is a damaged compressed file, each pixel in background color may have very small differences (which may not be recognized by the human eye), resulting in an inability to effectively filter the background.

The name of picture in the ICON source file must be began with number, otherwise it cannot be generated, and it is the best begin with consecutive numbers.

The designed icons need to use the ICON generator in the Intelligent TFT LCD Module 4.3 development tool, so the icon files can be generated into ICON format file. Then it can be added to use in project (see the document " Intelligent TFT LCD Module 4. 3 Development Tools Usage command" for the ICON generator).

- **Font file format**

The 0 # font file (0. dzk) is pre-installed for Intelligent TFT LCD Module, which contains all ASCII codewords from 4 * 8 to 64 * 128 dots.

When other types of fonts are needed, they can be obtained through technical support to obtain or generate through TS3 software. The new font needs to be named from 1 and not renamed 0-font.

TS3 software and command for use can be downloaded from. official website .The font code support ASCII code, GB2312 internal code, GBK, BIG5, SJIS and UNI CODE.

- **Audio file format**

Intelligent TFT LCD Module 4. 3 Supports WAV and MP3 audio file formats, as detailed in 3. 3 sections.

- **Video File Format**

Intelligent TFT LCD Module 4. 3 Supports AVI format video files, as detailed in 3. 4 Section.

1. 4 User data encryption

When the Intelligent TFT LCD Module is connected to the computer through the USB-mini interface, it is actually a virtual hard disk, and the internal data of the Intelligent TFT LCD Module can be copied directly through the computer. Therefore, when the user design is finished, the data in the Intelligent TFT LCD Module must be protected against copying.

Firstly, the user creates an encrypted file“password.txt”, the file contains a no more than 128 bytes of any Chinese and English string as a password, the user needs to remember the password, and then the password file “password.txt”will be copied to the root directory of USB flash disk, and when inserting the

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USB flash disk onto the Intelligent TFT LCD Module, the password will be automatically copied into the Intelligent TFT LCD Module to protect the internal data of Intelligent TFT LCD Module.

Once the Intelligent TFT LCD Module is encrypted, the internal data of the Intelligent TFT LCD Module cannot be read out. the USB-mini port can not be connected to the computer, and not support online download debugging.

The decryption process is similar to encryption, firstly, the decrypted file "de _ encrypted. Txt " will be copied to the root directory of USB flash disk (the password must be the same as the encrypted file "password.txt"), when the USB flash disk is inserted into the Intelligent TFT LCD Module, the system will automatically check the decryption password. If it is consistent with the encryption password, the Intelligent TFT LCD Module will automatically decrypt it. After the decryption, the Intelligent TFT LCD Module can be reconnected to the computer through the USB-mini interface to implement the online download debugging.

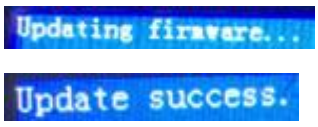
The encrypted file "password. Txt" is the same as the password in the decrypted file "de _ password. Txt", except that the file name is different. The password is an arbitrary Chinese-English character string no more than 128 bytes. It must be saved properly. Once the password is lost, it will not be decrypted again.

1. 5 Firmware update

Make sure the power supply is stable during the firmware update!

During the firmware update process, the display will be automatically restarted multiple times, the power should not be cutted during the process!

1. Copy the firmware program " Intelligent TFT LCD Module -Plus II. bin" file to the root directory of USB flash disk;
2. Insert the USB flash disk into the UART display，and ensure the stable power supplying. The system will automatically start updating the firmware.
3. Please pull out the USB flash disk after the prompt message “Please plug out the USB flash disk” is displayed, and the buzzer also ring.



4. After the information "Update success." is displayed, the firmware update has been completed and after stopped for 3 seconds to restart automatically.

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2 UART Command Set

The Intelligent TFT LCD Module adopts variable drive mode working, the working modes of screen and GUI states can be fully controlled by variables and registers. Correspondingly, the UART command only need to read and write variables and registers, there are five commands in total.

The Intelligent TFT LCD Module adopts asynchronous, full duplex serial port (UART), using 10 bits for each byte data transmission: 1start bit, 8 data bits, 1 stop bit, with no checking bit. The baud rate of UART can be set through "Screen parameter Configuration" in Intelligent TFT LCD Module 4. 3 development tools.

2.1 Format convention

- **Data format**

The Intelligent TFT LCD Module supports data formats such as integer (double bytes), unsigned integers (double bytes), long integers (4 bytes), super long integers (8 bytes), and the numerical ranges are shown in Table 2-1.

Table 2-1 Numerical Range

Data format	Minimum value	Maximum value
Integer (Double Bytes)	-32768（0x8000）	+32767（0x7FFF）
Unsigned integer (double bytes)	0（0x0000）	65535（0xFFFF）
Long integer (4 bytes)	-2147483648（0x80000000）	+2147483647（0x7FFFFFFF）
Super Long integer (8 bytes)	-9223372036854775808	9223372036854775807

The decimal is expressed by a fixed point decimal, and the user can self-define decimal bit, such as 0x4D2 (1234), if it is specified that the decimal bit is 2, then it represents 12. 34.

- **Color definition**

All the color data of the Intelligent TFT LCD Module are 16 bits and 2 bytes. As shown in Table 2-2, the format is Red 5-Green 6-Blue5, that is red account for 5 bits in high, green account for 6 bits in middle, and blue account for 5 bits in low. The colors can be displayed are 2^{16} colors, i. e. 65536 colors.

Table 2-2 Color Definition

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B4	B3	B2	B1	B0
Red					Green						BLUE				

Example: red: 0xF800, green: 0x07E0, blue: 0x001F, white: 0xFFFF, black: 0x0000

- **command frame format**

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All UART commands or data are in a hexadecimal (HEX) format. As for the double-byte data, the method of high byte transfer first is adopted. For example 0x1234, sends 0x12 first, then sending 0x34.

Table 2-3 Command Frame format

command frame header	command length	command	beginning address	[Data Length]	[Data Content]	[CRC checking code]

Each command includes four parts: command frame header, command length, command and start address. [Data length], [data content], [CRC checking code],these three parameters are not included in each command.

The command frame header is a double byte, the user can self-define the content (Register R3, RA)through “Screen Parameter Configuration” in Intelligent TFT LCD Module 4.3 Development Tool. Users can implement multiple Intelligent TFT LCD Modules in parallel by setting different frame heads.

The command length includes command, start address, data content, data length, and CRC checking code.

The commands include two register reading and writing commands (0x80, 0x81), two variable memory reading and writing commands (0x82, 0x83), a write curve buffer command 0x84, and an extension function command 0x85.

2. 2 Register Reading &Writing command 0x80, 0x81

The Intelligent TFT LCD Module has 256 Byte registers, which are used primarily for related hardware control operations and addressing according to bytes.

The beginning address is a single byte for the register reading and writing command (0x80, 0x81), and the address range is 0x00 to 0xff.

The unit of data length (N) is bytes, representing the number of consecutive read-write register units.

Supports sequential read-write multiple registers.

Table 2-4 UART Send 0x80 command Frame Structure (Write Register)

Definition	command frame header	command length	command	beginning address	Data Contents
Length (bytes)	2	1	1(0x80)	1	N

Example: Register 0x03 and Register 0x04 are consecutively written by 0x00, 0x01

Send: 0xA5 0x5A 0x04 0x80 0x03 0x00 0x01

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Table 2-5 UART sends 0x81 command Frame Structure (Read Register Transmission)

Definition	command frame header	command length	command	beginning address	Data length
Length (bytes)	2	1	1(0x81)	1	1(N)

Table 2-6 UART receive 0x81 command frame structure (read register reception, UART transmission)

Definition	command frame header	command length	command	beginning address	Data length	Data Contents
Length (bytes)	2	1	1(0x81)	1	1(N)	N

Example: Continuous Read Register Register 0x03 and 0x04 unit

Send: 0xA5 0x5A 0x03 0x81 0x03 0x02

Return: 0xA5 0x5A 0x05 0x81 0x03 0x02 0x00 0x01

Table 2-7 Register read and write command

Function	**command**	**Data**	**Description**
Access register interface	0x80	send : register address (0x00-0xFF) + write data	Specify address write register data
	0x81	send : Register address (0x00-0xFF) + Read byte length (0x00-0xFF)	The specified address starts reading the register data of the specified byte length
		Response: Register Address (0x00-0xFF) + byte Data Length + Read Register Data	Intelligent TFT LCD Module response of read register
	The Intelligent TFT LCD Module has 256Byte registers, which are used primarily for related hardware control operations, and addressing according to bytes.		

2. 3 Variable Memory Read & Write command 0x82, 0x83

Intelligent TFT LCD Module has 64K word（128K Byte) variable memory, the addressing operation is done based on the word, and the address is 0x0000-0xFFFF. When the user is planning a variable, the variable memory address is manually assigned according to the variable length.

The start address is two bytes for the variable memory read-write command (0x82, 0x83), and the address range is 0x0000-0xFFFF.

The data length (N) use a word (double byte) as unit, representing the number of consecutive read and write variables.

The data content is 2N bytes, because each variable storage unit contains 2 bytes.

Support for reading and writing multiple variable memory units in sequence.

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Table 2-8 UART receive 0x82 command frame structure (write variable memory unit)

Definition	command frame header	command length	command	beginning address	Data Contents
Length (bytes)	2	1	1(0x82)	2	2N

Example: Write 0x00, 0x01 in variable Memory 0x0003 Unit

Send: 0xA5 0x5A 0x05 0x82 0x00 0x03 0x00 0x01

Table 2-9 UART Send 0x83 command Frame Structure (Read Variable Memory Transmit)

Definition	command frame header	command length	command	beginning address	Data length
Length (bytes)	2	1	1(0x83)	2	1(N)

Table 2-10 UART receiving 0x83 command frame structure (read variable memory receiving, UART transmission)

Definition	command frame header	command length	command	beginning address	Data length	Data Contents
Length (bytes)	2	1	1(0x83)	2	1(N)	2N

Example: Continuous read the variable memory 0x0003 and 0x0004 unit

Send: 0xA5 0x5A 0x04 0x83 0x00 0x03 0x02

Return: 0xA5 0x5A 0x08 0x83 0x00 0x03 0x02 0x00 0x01 0xFF 0xFF

Table 2-11 Memory Read Write command

Function	**command**	**Data**	**Description**
Access variable memory interface	0x82	Send: Variable address (0x0000-0xFFFF) + written variable data	Specify variable address to begin writing data (word data) to variable storage area
	0x83	Send : Variable address (0x0000-0xFFFF) + Read variable data word length (0x00-0x7F)	Specify the data for the specified word length from the specified address in the variable storage area
		Response: Variable memory address + variable data length + read variable data	Intelligent TFT LCD Module response of read data memory

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	Intelligent TFT LCD Modules adopts variable drive to separate variable values from variable display formats. The variable display format is downloaded in the terminal through the configuration file in advance. And the variable value is transmitted to the terminal through the UART in real time. The variable memory is used to store the received variable value. **Intelligent TFT LCD Module has 64K word（128K Byte）variable memory, the addressing operation is done according to the word, address is 0x0000-0xFFFF. When the user is planning a variable, the variable memory address is manually assigned according to the variable length.**

2. 4 writing command 0x84 of curve buffer

Table 2-12 Write Curves Buffer command Details

Function	command	Data	Description
Write curve buffer interface	0x84	CH_Mode（Byte）+DATA0（Word）+…+DATAn	Write the curve buffer data. CH _ Mode defines the sequence of channels for subsequent data: Each bit of CH _ Mode corresponds to one channel; CH_Mode. 0 corresponds 0 channel, 7 corresponds to 7 channels; Corresponding position 1 represents the presence of corresponding channel data; Corresponding position 0 represents that the corresponding channel data is not present. Low channel data is placed in the front row For example, CH_Mode = 0x83 (10000011B), indicating that the subsequent data format is: (Channel 0 + Channel 1 + Channel 7) +… + (Channel 0 + Channel 1 + Channel 7).

The Intelligent TFT LCD Module has a buffer area of 8K Word, which can store eight curves buffer, and it is used for simple and fast display of curves. The data in the curve buffer is a 16-bit unsigned number.

2. 5 Extended command 0x85

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Table 2-13 Details of extended command

Function	command	Data	Description
Direct write memory	0x85	00+X(Word)+ Y(Word)+DATA0(Word)+…+DATAn	00 means write memory command; X represents the X coordinate of the beginning position and Y represents the Y coordinate of the beginning position; The data content is the color value that needs to be written of each pixel. When the written data exceeds, the maximum pixel point of one line, the line wrap automatically. When the display content is less than one line, the beginning position and data length of each line need to be calculated.
UART download specified file	0x85	01 5a a5+filesize(4bytes)+filename(ASCII)	01 5a a5 represents UART download file command; File size represents the size of the file bytes; Filename represents the file name of the download file (complete file name, including expended name, if the file name is "1. jpg", and sending ASCII code shall be 31 2e 6a 70 67). After the command is sent correctly, return to "Please Tax file !" information After the saving is finished, screen will return to prompt "One file Saved OK!" Note: when the USB line is connected, downloading files through UART may lead to file error.
Playing audio files in sequence	0x85	03+Mode+NUM0+…+NUMn	03 indicate playing audio file command in sequence; Mode defines the mode for playing audio files: 0 represents circle play, 1 represents sequence play, and others indicate stop playing. NUM represents the audio play setting value (2 bytes, value range 0x0000-0xFFFE), and if setting a non-existent audio file value, the audio file will be skipped directly.
	In order to improve the playing effect, the audio file format in the command must be consistent. And it must be in WAV or MP3 format. It is recommended to select double-channel data for WAV file. The total size of the list file shall not exceed 2M. The total size of MP3 format is not limited.		

2. 6 CRC checking

Whether to enable CRC is depend on the user's choice, and it can be set via "Screen Parameter Configuration" in Intelligent TFT LCD Module 4. 3 Development Tools. When CRC checking is enabled, the tail of all commands will add a double-byte CRC checking code.

The CRC checking does not include the command frame header and command length, adopt ANSI-16

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(X16 + X15 + X2 + 1) format.

Example: Write the CRC checking, the register 0x03 and 0x04 units are written to 0x00, 0x01 continuously

Send: 0xA5 0x5A 0x04 0x80 0x03 0x00 0x01 0x18 0x24

Definition	Frame head	command length	command	beginning address	Data Contents	CRC checking code
Example	0xA5,0x5A	0x06	0x80	0x03	0x00，0x01	0x18,0x24

When the CRC checking and CRC checking result response is enabled simultaneously (through Intelligent TFT LCD Module 4. 3 in the development tool "screen parameter configuration" setting), the Intelligent TFT LCD Module automatically sends out the checking result through the UART after CRC checking. CRC checking result response frame structure is shown in Table 2-2.

Table 2-14CRC checking Result Response Frame Structure

Definition	Frame head	Data length	command	Data	CRC checking code
Length (bytes)	2	1	1	1	2
Description	User Defined	Fixed to 0x02	Received command	0xFF represents correct CRC checking 0x00 represents wrong CRC checking	
Example	0xA5,0x5A	0x02	0x81	0xFF	0x21,0xA0

CRC checking routine

Uint 8 _ t uchCRCHi; CRC high byte

Uint 8 _ t uchCRCLo; CRC low byte

Accuvo8 _ t auchCRCHi [] = { * CRC High level byte Value Table */

0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,

0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,

0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1,0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,

0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1,0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,

0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00,

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0xC1, 0x81, 0x40,

0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1,0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,

0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40,

0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,

0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,

0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,

0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40,

0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1,0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,

0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,0x80, 0x41, 0x00, 0xC1, 0x81, 0x40} ;

Accuvo8 _ t auchCRCLo [] = { * CRC Low level byte Value Table */

0x00, 0xC0, 0xC1, 0x01, 0xC3, 0x03, 0x02, 0xC2, 0xC6, 0x06,0x07, 0xC7, 0x05, 0xC5, 0xC4, 0x04, 0xCC, 0x0C, 0x0D, 0xCD,

0x0F, 0xCF, 0xCE, 0x0E, 0x0A, 0xCA, 0xCB, 0x0B, 0xC9, 0x09,0x08, 0xC8, 0xD8, 0x18, 0x19, 0xD9, 0x1B, 0xDB, 0xDA, 0x1A,

0x1E, 0xDE, 0xDF, 0x1F, 0xDD, 0x1D, 0x1C, 0xDC, 0x14, 0xD4,0xD5, 0x15, 0xD7, 0x17, 0x16, 0xD6, 0xD2, 0x12, 0x13, 0xD3,

0x11, 0xD1, 0xD0, 0x10, 0xF0, 0x30, 0x31, 0xF1, 0x33, 0xF3,0xF2, 0x32, 0x36, 0xF6, 0xF7, 0x37, 0xF5, 0x35, 0x34, 0xF4,

0x3C, 0xFC, 0xFD, 0x3D, 0xFF, 0x3F, 0x3E, 0xFE, 0xFA, 0x3A,0x3B, 0xFB, 0x39, 0xF9, 0xF8, 0x38, 0x28, 0xE8, 0xE9, 0x29,

0xEB, 0x2B, 0x2A, 0xEA, 0xEE, 0x2E, 0x2F, 0xEF, 0x2D, 0xED,0xEC, 0x2C, 0xE4, 0x24, 0x25, 0xE5, 0x27, 0xE7, 0xE6, 0x26,

0x22, 0xE2, 0xE3, 0x23, 0xE1, 0x21, 0x20, 0xE0, 0xA0, 0x60,0x61, 0xA1, 0x63, 0xA3, 0xA2, 0x62, 0x66, 0xA6, 0xA7, 0x67,

0xA5, 0x65, 0x64, 0xA4, 0x6C, 0xAC, 0xAD, 0x6D, 0xAF, 0x6F,0x6E, 0xAE, 0xAA, 0x6A, 0x6B, 0xAB, 0x69, 0xA9, 0xA8, 0x68,

0x78, 0xB8, 0xB9, 0x79, 0xBB, 0x7B, 0x7A, 0xBA, 0xBE, 0x7E,0x7F, 0xBF, 0x7D, 0xBD, 0xBC, 0x7C, 0xB4, 0x74, 0x75, 0xB5,

0x77, 0xB7, 0xB6, 0x76, 0x72, 0xB2, 0xB3, 0x73, 0xB1, 0x71,0x70, 0xB0, 0x50, 0x90, 0x91, 0x51, 0x93,

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```
0x53, 0x52, 0x92,
0x96, 0x56, 0x57, 0x97, 0x55, 0x95, 0x94, 0x54, 0x9C, 0x5C,0x5D, 0x9D, 0x5F, 0x9F, 0x9E, 0x5E, 0x5A,
0x9A, 0x9B, 0x5B,
0x99, 0x59, 0x58, 0x98, 0x88, 0x48, 0x49, 0x89, 0x4B, 0x8B,0x8A, 0x4A, 0x4E, 0x8E, 0x8F, 0x4F, 0x8D,
0x4D, 0x4C, 0x8C,
0x44, 0x84, 0x85, 0x45, 0x87, 0x47, 0x46, 0x86, 0x82, 0x42,0x43, 0x83, 0x41, 0x81, 0x80, 0x40} ;
uint16_t CRC16 (uint8_t * pMsg, uint16_t Len)
{     uint8_t i;
      uchCRCHi = 0xFF;
      uchCRCLo = 0xFF;
      while (Len--)
      {i = uchCRCHi ^ (*pMsg++);
            uchCRCHi = uchCRCLo ^ auchCRCHi[i];
            uchCRCLo = auchCRCLo[i];
}
      return (uchCRCHi << 8 | uchCRCLo);
}
```


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3 Register

The Intelligent TFT LCD Module is internally designed with 256-byte registers for hardware related operations such as backlight adjustment, clock read-write, and speech play.

3. 1 Register Schedule

Table 3-1 Register Schedule

Register Address	Definition	R/W	Byte length	Description
0x00	Version	R	1	Intelligent TFT LCD Module version number, BCD code representation, 0x40 represents V4. 0
0x01	LED_NOW	R/W	1	LED brightness control register, 0x00-0x40 When the maximum bit is set to 1, it indicates that the brightness is saved after power off.
0x02	BZ_TIME	W	1	Buzzer tweeter control register, unit 10ms
0x03-0x04	PIC_ID	R/W	2	Read: Current User Interface ID; write: switch to the specified user interface
0x05	TP_Flag	R/W	1	0x5A represents updating coordinates of touch screen; others indicate that touch screen coordinates are not updated
0x06	TP_Status	R	1	0x01 represents first pressing; 0x03 represents keep pressing; 0x02 represents releasing; other representations are invalid
0x07-0x0A	TP_Position	R	4	The pressing coordinate position on touch screen: X _ H: L Y _ H: L
0x0B	TPC_Enable	R/W	1	0x00 represents that touch control is not enabled; other represents touch control enable (default 0xFF as power-up)
0x0C-0x0F	RUN_TIME	R	4	Run time after power-up, BCD code mean hour minute second, in which hour is represented by two bytes, maximum 9999: 59: 59

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0x10-0x1C	R0-RC	R/W	13	Screen parameter configuration register mapping, when configurating 1D register, 11-1C register can rewrite the data of R1-RC register	
0x1D	CONFIG_EN	W	1	Write 0x5A, R1-RC reset and save; write 0xA5, reset only, do not save	
0x1F-0x26	RTC_COM_ADJ	W	1	0x5A represents that the user UART applied to rewrite the RTC data, after the Intelligent TFT LCD Module is modified, the RTC will be cleared	
	RTC_NOW	R/W	7	YY: MM: DD: WW: HH: MM: SS, year: month: day: week: hours: minutes: seconds, format is BCDcode	
0x27-0X3F	Reservation		16	Undefined	
0x40-0x49	En_Lib_OP	R/W	1	0x5A represents to apply to load user date into the variable space, and the register is cleared after operation. Each Intelligent TFT LCD Module cycle perform a read operation.	
	Lib_OP_Mode	W	1	Fixed to 0xA0	
	Lib_ID	W	1	Specify user data file name 0x00-0xff	
	Lib_Address	W	3	Specify data operation head (word) address, 0x00: 00: 00-0x01: FF: FF	
	VP	W	2	Specify data operation (head) Address for variable space 0x0000-0xFFFF	
	OP_Length	W	2	Data length of operation, 0x0001-0xFFFF	
0x4A-0x4B	Timer0	R/W	2	16bit software timer, unit 4ms, self-reducing to zero and stop	There is +-4ms error between the set value and the actual operation value, such as setting bit as 2, the actual operation value is between 4 and 12 ms
0x4C	Timer1	R/W	1	8bit software timer, unit 4ms, self-reducing to zero and stop	
0x4D	Timer2	R/W	1	8bit software timer, unit 4ms, self-reducing to zero and stop	
0x4E	Timer3	R/W	1	8bit software timer, unit 4ms, self-reducing to zero and stop	

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0x4F	Key_code	W	1	User key code is used to trigger configuration files, 0x01-0xFF, 0x00 represents invalid After the key code is processed by Intelligent TFT LCD Module , the key code register is automatically cleared.
0x50-0x52	Music_Set	W	1	0x5b: Play Voice 0x5c: Stop playing
	Music_Num	W	2	Audio play setting (0-4095)
0x53-0x54	Vol_Adj_En	W	1	0x5A represents to apply for the volume adjustment of playback music
	Vol	W	1	Volume value, range 0x00-0x40, default value of power-up is 0x40
0x55	Vol_Status	R	1	Audio play status 0x00: stop playing ; 0x01: Play
0x56-0x5F	En_DBL_OP	R/W	1	0x5A represents user apply for database operation, and register is cleared after completion of operation. Each Intelligent TFT LCD Module cycle performs a database read or write operation
	OP_Mode	W	1	0x50 represents writing the variable memory data into database space 0xA0 represents reading the data of the database space into the variable storage space.
	DBL_Address	W	4	Database head (word) address (both database and user's "VT _ SET" folder is stored under " Intelligent TFT LCD Module _ USER " drive letter)
	VP	W	2	The head (word) address of variable space, 0x0000-0xFFFF
	OP_Length	W	2	Database operation (word) length, 0x0001-0xFFFF
0x60-0x67	Play_Avi_Set	R/W	1	0x5a: Apply to play avi video, and register is cleared after completion of operation.

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	Avi_Type	W	1	0x00: play one video in Intelligent TFT LCD Module (Default mode) 0x01: play one video in USB flash memory 0x02: Sequential play the video in Intelligent TFT LCD Module 0x03: play one video in USB flash memory Note: The extension name of video file must be *. avi; The file name must be an Arabic numeral for single play, such as "123. avi "; The file name in sequential play may be a letter + number, such as "Wuhan 123. avi".
	Play_Position	W	4	The coordinate position video window's supper left corner (X _ H, X _ L, Y _ H, Y _ L) Note: (0, 0) represents the center display.
	Play_Avi_Num	W	2	Select and play video tracks by video file name, up to 65536 videos; Only used for single play, invalid in sequential play.
0x68-0x69	Vol_Adj_En	W	1	0x5A representing adjusting and playing video volume
	Vol	W	1	The volume value of played video, the range is 0x00-0x3F, and the default value as power-on is 0x3F.
0x6a	Play_Control	W	1	0x5A: Play/ Pause
0x6b	Play_Stop	W	1	0x5A: Stop
0x6c	Play_Next	W	1	0x5a: Play the next one (cleared after Intelligent TFT LCD Module processing , end when single play)
0x6d	Play_Status	R	1	0x00 = idle 0x01 = play 0x02 = Pause
0x6e-0xE8	Reservation		137	Undefined
0xE9	Scan_Status	R/W	1	Read: 0x00 represents that the touch screen is not in the entering state, 0x01 represents the touch screen is in entering state; Write: If the touch screen is written 0x00 in the enterin state, it will be forced to exit the entering state.

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0xEA	TPCal_Triger	W	1	Write 0x5A to starts a touch screen calibration and is cleared by Intelligent TFT LCD Module after calibration.
0xEB	Trendline _Clear	W	1	0x55 represents clearing all 8 curve buffer data; 0x56-0x5D represents that the curve buffer data of the CH0-CH7 channel is cleared respecively. When the curve buffer data is cleared, this register will be cleared by Intelligent TFT LCD Module .
0xEC-0xED	Reservation		2	Reservation
0xEE-0xEF	Reset_Triger	W	2	Write 0x5AA5 will lead to the reset of Intelligent TFT LCD Module software once
0xF0-0xFF	Reservation		16	Reservation

3. 1. 1 Read version number

Register Address	Definition	R/W	Byte length	Description
0x00	Version	R	1	Intelligent TFT LCD Module version number, BCD code representation, 0x40 represents V4. 0

Read version information, UART send command A5 5A 03 81 00 01

Return A5 5A 04 81 00 01 43

Description: A5 5A: Frame head

04: byte length of command, 81 00 01 43 total 4 bytes (excluding frame header)

81: Read register command

00: register address

01: the byte length of the return data, 43 is 1 byte

43: return data information

3. 1. 2 Modify the back light brightness

Register address	Definition	R/W	Byte length	Description
0x01	LED_NOW	R/W	1	LED brightness control register, 0x00-0x40 as high level is set 1, the brightness is saved as power-off

For example, turn off the backlight

A5 5A 03 80 01 00

Suggestion: 1. When the device requires a higher power consumption, the back light brightness of the display can be modified to reduce the power consumption.

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2. If it needs to achieve the screensaver effect by MCU control, the command can be used to control the back light brightness to achieve the screensaver effect.

3. 1. 3 Control buzzer

Register Address	Definition	R/W	Byte Length	Description
0x02	BZ_TIME	W	1	Buzzer chirping control register, unit 10ms

For example, control the buzzer chirping for 2s, send the command

A5 5A 03 80 02 C8

3. 1. 4 Switching interface

Register address	Definition	R/W	Byte length	Description
0x03-0x04	PIC_ID	R/W	2	Read: The current user interface ID is displayed; write: switch to the specified user interface

For example, the command for switching to interface 2

A5 5A 04 80 03 00 02

3.2 Clock (RTC) read-write

Table 3-2 Clock Read Write Register

Register Address	Definition	R/W	Byte Length	Description
0x1F-0x26	RTC_COM _ADJ	W	1	0x5A represents that the user's UART has requested to rewrite the RTC data and it will be cleared after the Intelligent TFT LCD Module modify the RTC
	RTC_NOW	R/W	7	YY: MM: DD: WW: HH: MM: SS, year: month: day: week: hours: minutes: seconds, format is BCD code

UART Read Clock RTC

The 0x20 register save the current RTC value, then reads it by the 0x81 command.

Read Calendar (YY: MM: DD: WW: HH: MM: SS): A5 5A 03 81 20 07

Read time (HH: MM: SS): A5 5A 03 81 24 03

UART modify (write/set) clock RTC

The 0x80 command is used to rewrite 0x1F register to 0x5A, and write the time need to be revised for the register begining with 0x20, that is rewrite the RTC.

For example, set the RTC to 2015-06-01 Monday at 18: 56: 00, the UART sends the following

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commands:

A5 5A 0A 80 1F 5A 15 06 01 00 18 56 00 the Intelligent TFT LCD Module can convert the week automatically. When rewrite the time, any value for week can be written.

3. 3 Voice playing

3. 3. 1 Audio file format

Intelligent TFT LCD Module 4. 3 Supports WAV and MP3 audio file formats with extensions *. wav or *. mp3.

WAV format occupies large space, the voice output is free of delay, and suitable for played with short waiting time. Two-channel data is recommended for WAV format file.

MP3 format occupies small space, so the voice output will be slightly delayed (0. 5 seconds). It is suitable for playing with long waiting time.

The user adds the voice file to the project through the Intelligent TFT LCD Module configuration software, and then through the 0x80 command to write the relevant register to control voice playing and adjust volume.

Table 3-3 voice playing register

Register Address	Definition	R/W	Byte Length	Description
0x50-0x52	Music_Set	W	1	0x5b: Playing Voice 0x5c: Stop playing
	Music_Num	W	2	Music playing setting (0-4095)
0x53-0x54	Vol_Adj_En	W	1	0x5A represents the volume of the applied adjustment playing music
	Vol	W	1	Volume value, range 0x00-0x40, default value as power-up is 0x40
0x55	Vol_Status	R	1	Audio playing status 0x00: Stop playing; 0x01: Playing

For example, a piece of voice is saved as 6. wav, play with 100 % volume, UART send :

A5 5A 07 80 50 5b 00 06 5A 40

To stop audio playing, UART send :

A5 5A 05 80 50 5c 00 06

In addition, that extension command 0x85 provide sequential playing audio functions, refer to chapter 2 for details.

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3. 4 Video playing

The design of the Intelligent TFT LCD Module video play without increasing the hardware cost, satisfying the video function needs for various occasions such as power-on animation, advertisement video, entertainment video, equipment maintenance video, and so on.

1. Power-on animation: it is a powerful way to show the equipment level and image of the enterprise. At present, the animation of peer products is achieved through displaying images continuously. On the one hand, it is limited by the number of stored pictures and the playing time is very limited, also it is impossible to realize synchronous playing of sound.

2. Advertising video: such as retail equipment, vending equipment, the advertising videos can be played during the free time of the equipment.

3. Entertainment video: such as fitness equipment, beauty equipment, medical devices, etc., the entertainment videos can be played during working time of the equipment.

4. Equipment maintenance video: such as daily maintenance and troubleshooting of equipment, the video can be embedded into the equipment, which can effectively improve the daily service efficiency and reduce the after-sale service cost.

3. 4. 1 Video File Format

The video file has an extension of * .avi, allows up to 65536 video files. Before usage, it should according to the requirements of avi file format, the format of video files should be set by "format factory" software, as shown in below figure. Resolution can be less than or equal to the screen resolution, the video encoding MJPEG format, audio encoding mp3 (sampling frequency 16kHz) format.

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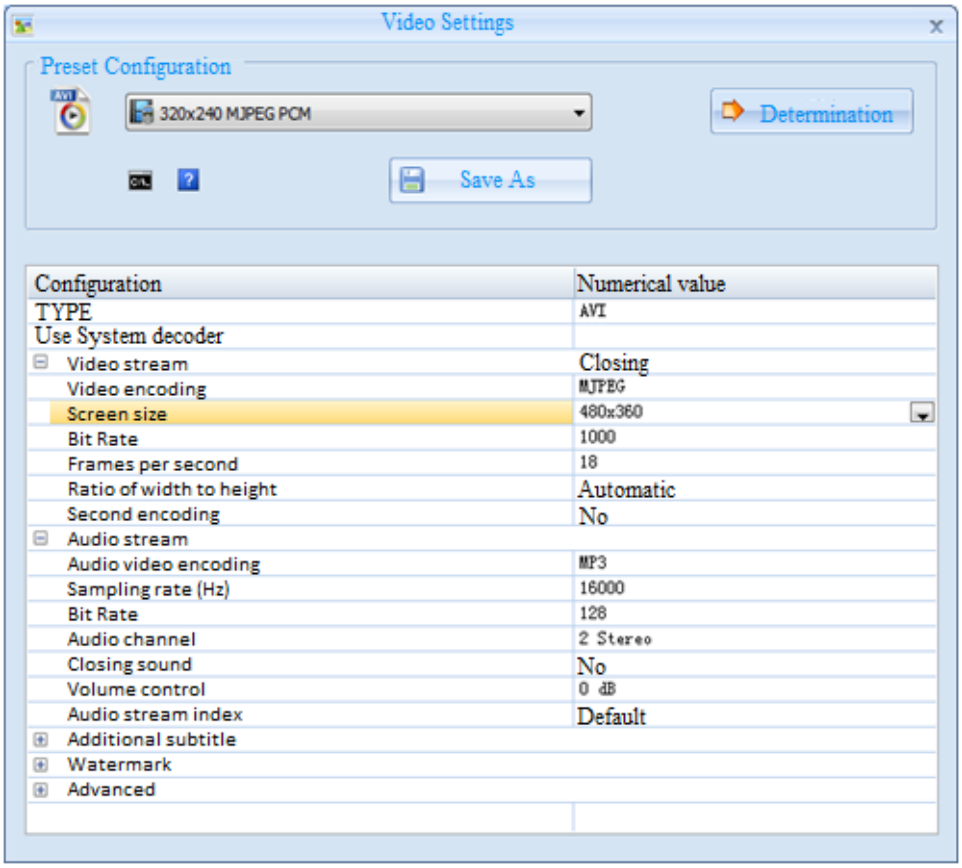

Figure 3-1 Audio and Video File Format Editing Software "Format Factory"

If the video file is saved into the Intelligent TFT LCD Module, the video file should be manually copied into the "VT_SET" file, and the video file will be downloaded into the Intelligent TFT LCD Module along with the "VT_SET" folder.

If the video file in the USB flash disk is played directly, the video file needs to be saved directly under the root directory of the USB flash disk. In addition, when playing the video file in the USB flash disk directly, it is required that the bit rate of the video file should not be more than 4096KB, otherwise, the video cannot be played fluently as the restriction by USB transmission speed.

3. 4. 2 Video file playing

Table 3-4 video playing registers

Register address	Definition	R/W	Byte length	Description
0x60-0x67	Play_Avi_Set	R/W	1	0x5A: Request to set player parameter
	Avi_Type	W	1	0x00: play one video in Intelligent TFT LCD Module (Default mode) 0x01: circle play one video in Intelligent TFT LCD Module 0x02: sequential play the video in VGA screen

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				0x03: play one video in USB flash memory 0x04: circle play one video in USB flash memory 0x05: Sequential play the video in USB flash memory Note: Video file extension must be *. avi; The file name must be an Arabic numeral for a single play, such as "123. avi "; The file name in sequential playing may be a letter + number.
	Play_Position	W	4	The coordinate position of top left corner in video window (XH, XL, YH, YL) Note: (0, 0, 0, 0) represents the center display.
	Play_Avi_Num	W	2	Select and play video tracks by video file name, up to 65536 videos; Used for single play only, invalid in sequential playing.
0x68-0x69	Vol_Adj_En	W	1	0x5A: Request for adjustment of volume for played video
	Vol	W	1	The volume value of played video, range 0x00-0x3F, and the default value of power-on is 0x3F.
0x6A	Play_Control	W	1	0x5A: Play/Pause For single playing mode, after the current video is played, the system will automatically jumps back to the current picture interface.
0x6B	Play_Stop	W	1	0x5A: Stop After the video is stopped, the system automatically jumps back to the current picture interface, and it also can jump according to the button.
0x6C	Play_Next	W	1	0x5A: Play next
0x6D	Play-Prev	W	1	0x5A: Play the previous one
0x6E	Play_Status	R	1	0x00 = Idle; 0x01 = Play; 0x02 = Pause.

Tips: User registers 0x61-0x6e map to user variable memory 0xff01-0xff0e, that is the operating user variable memory 0xff01-0xff0e performs the same function (avi video is played through touch control, no need user MCU command intervention).

video playing can be controlled through user command control and touch control.

Mode 1: User command control mode.

The user MCU writes the register 0x60-0x6d through 0x80 command, and realizes the function of play, pause, continuation and stop of avi video.

Mode 2: Touch control mode.

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On the player interface, the user creates play/pause, stop, next one, volume adjustment buttons, and the variable memory 0xff01-0xff0e is modified through "button key value return". The avi video can be played without the intervention of user MCU.

Tip: implement power-on default play-on animation. By Intelligent TFT LCD Module4. 3 Configuration software sets the initial value of 0xff0a unit to 0x5a and sets the file name video file name to 0. avi: After the Intelligent TFT LCD Module is powered on, the power-on animation 0.avi will be played automatically.

The specific method is to set a data variable, the address is set to 0xff0a, and the initial value is set to 90.

For example, single play the 01 video in the USB flash disk in display screen (10, 10) position:

First modify the play parameter A5 5A 0A 0A 80 60 5A 03 00 0A 00 0A 00 0A 00 01, and then send the command for playing the video A5 5A 03 80 6A 5A.

When the video is played, the variable on the display screen is no longer refreshed and the voice playing in the previous section is not available

3. 5 User data files loaded into variable space

Table 3-5 Load the User Data Files into Variable Space register

Register address	Definition	R/W	Byte length	Description
0x40-0x49	En_Lib_OP	R/W	1	0x5A represents that the application user data file is loaded into the variable space, and the register is cleared after operation. One read operation is performed per Intelligent TFT LCD Module cycle
	Lib_OP_Mode	W	1	Fixed to 0xA0
	Lib_ID	W	1	Specify the user data file name 0x00-0xff.
	Lib_Address	W	3	Specify data operation head(word) address, 0x00: 00: 00-0x01: FF: FF
	VP	W	2	Specify data operation(head) address for variable space 0x0000-0xFFFF
	OP_Length	W	2	Data length of operation(word), 0x0001-0xFFFF

The user data file extension is * bin, numbered 0x00-0xff. The user data file can be loaded into the variable memory via the UART command (if the user system needs to be used, it can be read from the variable memory using the 0x82 command). User data files must be manually copied to the "VT _ SET" folder.

For example, start reading the 4KW (0x1000) data from 0x 00 00 00 adress of “80.bin” user data file to the beginning position of variable memory 0x1000, the UART send the command :

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A5 5A 0C 80 40 5A A0 50 00 00 00 10 00 10 00

3. 6 Database read-write

The file name of the user database is "User Db. bin", which can be read and written at random, and has the function of power-down storage user data. The“UserDb.bin”and" VT _ SET "folders are stored under" Intelligent TFT LCD Module _ USER ", the size of the database file is related to the user project file, and the free space of "Intelligent TFT LCD Module _ USER " can be viewed to determine the size of the available database files.

Table 3-6 Database Read and Write Register

Register address	Definition	R/W	Byte length	Description
0x56-0x5F	En_DBL_OP	R/W	1	0x5A represents user application for database operation, and register is cleared after completion of operation. Each Intelligent TFT LCD Module cycle performs a database read or write operation once
	OP_Mode	W	1	0x50 represents writing variable memory data into database space 0xA0 represents reading the data of the database space into the variable storage space.
	DBL_Address	W	4	Database head (word) address (both database and user's "VT _ SET" folder is stored under " Intelligent TFT LCD Module _ USER ")
	VP	W	2	First address (word) of variable space, 0x0000-0xFFFF
	OP_Length	W	2	Length (word) of database operation, 0x0001-0xFFFF

For example, write the data of the variable address 0000-0100 to the database address 0000 0000-0000 0100, the data length is 256W (0x0100), and the UART sends the command:

A5 5A 0C 80 56 5A 50 00 00 00 00 00 00 01 00

Write the data of the database address 0000 0000-0000 0100 to the variable address 0000-0100, the data length is 256W (0x0100), and the UART sends the command:

A5 5A 0C 80 56 5A A0 00 00 00 00 00 00 01 00

□ □ **Database space data export**

The data stored in the database can be exported through from the UART or USB port.

□ □ **Export data using USB flash disks**

Insert a USB flash disk (Fat32 format) under the working status of Intelligent TFT LCD Module, the Intelligent TFT LCD Module will automatically copy database file "UserDb. bin" to the root directory of the

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USB flash disk.

Export Data Using UART

The data is first read into the variable memory space through Register 0x56-0x5F and then read from the variable memory by using the 0x83 command.

3. 7 Touch screen calibration

All Intelligent TFT LCD Modules are calibrated prior to shipment, and users do not need to calibrate again before using. The Intelligent TFT LCD Module provides two start-up touch screen calibration methods for different applications.

Method 1 _ Product Integration

The user MCU writes 0x5A to the Intelligent TFT LCD Module 0xEA register through the UART to start the touch screen calibration. By this method, the touch screen calibration function can be provided as an option function of the final device to the operator of the device. The method is suitable for user MCU to send UART command.

Table 3-7 Touch Screen Calibration Register

Register address	Definition	R/W	Byte length	Description
0xEA	TPCal_Triger	W	1	Start touch screen calibration by writing 0x5A. After calibration, it will be cleared by Intelligent TFT LCD Module .

Touch screen calibration send command A5 5A 03 80 EA 5A

Method 2 _ Mass Production

In "Screen Parameter Configuration" of Intelligent TFT LCD Module4.3 development Tools, click "USB flash disk Download Configuration File to Start Touch Calibration". After configuration file download is finished each time, the Intelligent TFT LCD Module will automatically start the touch screen calibration. If the customer wants to calibrate each display once again at the production stage, the method can be use, which is suitable for use in the batch production stage. All Intelligent TFT LCD Modules have been calibrated and we don’t recommend customer to do it again.

Regardless of which method is used, once the touch screen calibration is started, it is required to follow the command for operation, click the touch point of the cross point "top left corner", "lower left corner", "lower right corner", "upper right corner" and "center point" on the screen in turn; When the calibration is finished, the terminal will automatically enter into the touch test state. Click the touch screen to observe the touch position accuracy.

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3. 8 Screen parameter configuration read

For simple applications, users do not need to learn about this section.

Screen parameter configuration is implemented via Intelligent TFT LCD Module 4.3 development tool as shown in Figure 1-6. UART baud rate, command frame header, CRC checking, buzzer, touch screen and screen saver are set in the screen parameter configuration. The user can read the relevant setting values through the 0x10-0x1C register by the UART.

Table 3-8 Screen Parameter Configuration register

Register address	Definition	R/W	Byte Length	Description
0x10-0x1C	R0-RC	R	13	The mapping register of "screen parameter configuration" of Intelligent TFT LCD Module development tool, UART can be read through register address.

3. 8. 1 UART baud rate setting (R1/0x10)

When R1 takes a value at 00-10, R5 and R9 are invalid, and one of the fixed baud rates of 17th gear can be selected as follows (baud rate is bps):

Table 3-9 UART Baud Rate Setting Register

R1(0x)	00	01	02	03	04	05	06	07	
Baud Rate (bps)	1200	2400	4800	9600	19200	38400	57600	115200	
R1(0x)	08	09	0a	0b	0c	0d	0e	0f	10
Baud Rate (bps)	28800	76800	62500	125000	250000	230400	345600	691200	921600

When R1 takes a value of 11, the baud rate is determined by R5 and R9, and is calculated by the following formula:

R5: R9 = 6250000 baud rate R5: R9 represents a double byte parameter, R5 is high byte, and R9 is low byte.

For example, set 10000 bps baud rate, R5: R9 = 6250000/10000 = 625 = 0x0271R5 = 02 R9 = 71

The default baud rate of the Intelligent TFT LCD Module is 115200 bps.

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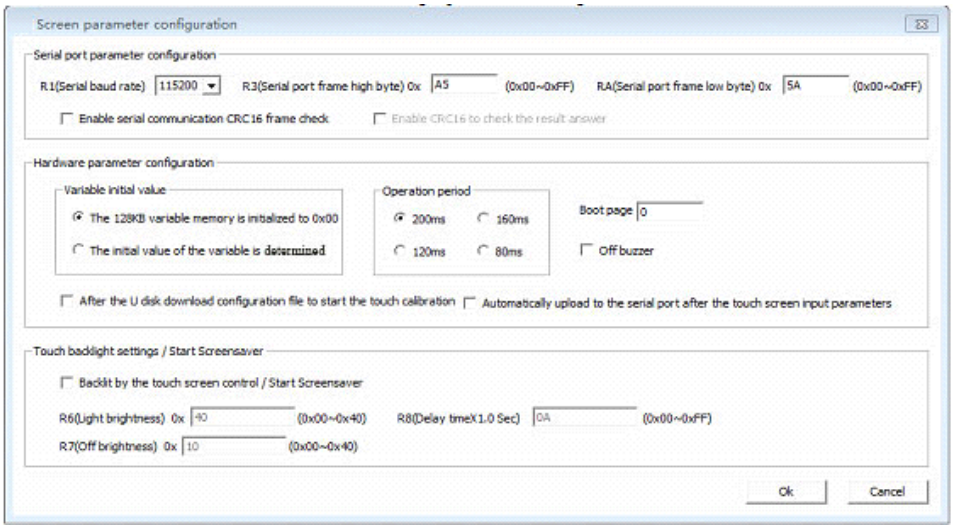


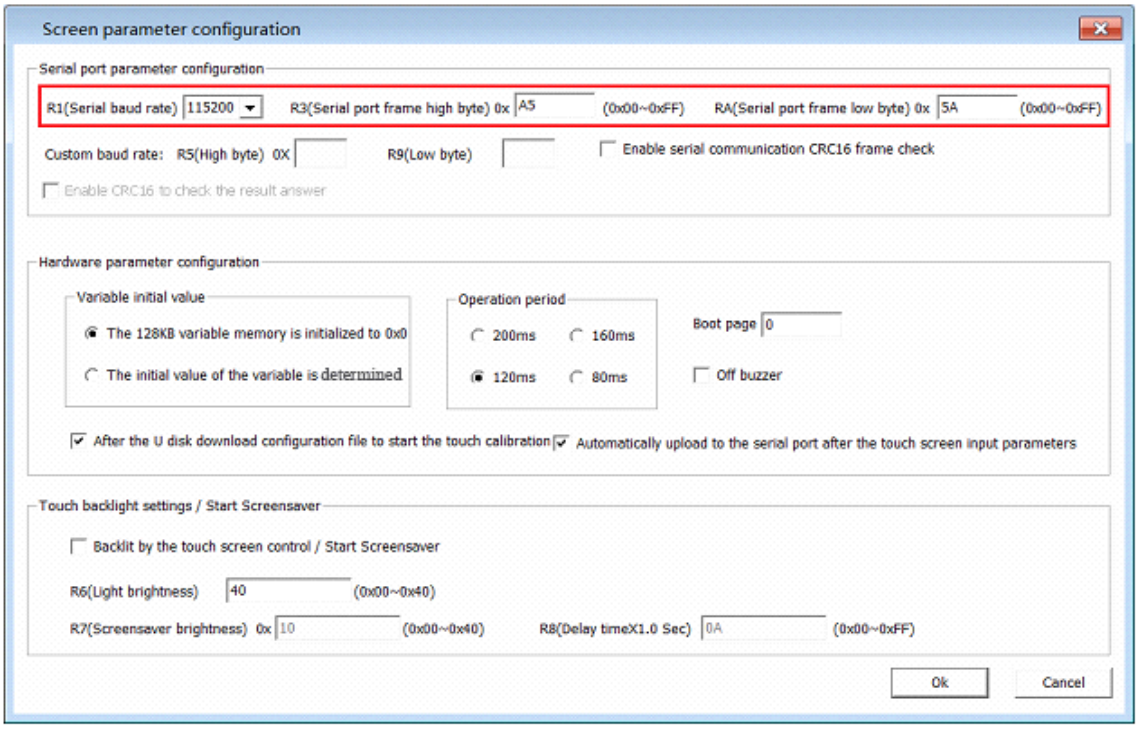
3. 8. 2 UART command Frame Head Setting (R3 0x13, RA 0x1A)

Refer to Table 2-1 for detailed information on the command frame header. The setting of command frame header mainly achieves the following two purposes:

(1) Identification and synchronization of UART command frames;

(2) When multiple Intelligent TFT LCD Modules are operated in parallel, the frame head is distinguished as the equipment address.

The default frame header of the Intelligent TFT LCD Module is A5 5A.



3. 8. 3 Working mode configuration register 1 (R2 0x12)

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The R2 register is defined by bit for configuring the Intelligent TFT LCD Module software operating mode, as shown in the following table (shaded areas indicate factory setting values).

Table 3-10 Register R2 Bit Function Definition

<table>
<tr><th>Bit</th><th>Weight</th><th>Definition</th><th>Description</th></tr>
<tr><td>.7</td><td>0x80</td><td>VDS</td><td>Undefined</td></tr>
<tr><td>.6</td><td>0x40</td><td>HDS</td><td>Undefined</td></tr>
<tr><td>.5</td><td>0x20</td><td>TP_LED</td><td>0 = disable screen saver function, backlight is not controlled by touch screen status
1 = enable screen saver function, backlight is controlled by touch screen state, control parameters are set by the R6, R7, R8 registers
R6 is the display brightness at the start-up time, and the user can set the start-up brightness in the work</td></tr>
<tr><td>.4</td><td>0x10</td><td>FCRC</td><td>0 = CRC16 frame checking is disabled for serial communication
1 = CRC16 frame checking is enabled for serial communication</td></tr>
<tr><td>.3</td><td>0x08</td><td>TPSAUTO</td><td>0 = touch screen input parameter is not automatically uploaded (user query)
1 = whether the input parameters of touch screen are automatically uploaded to the UART is determined by the configuration of corresponding touch variables</td></tr>
<tr><td>.2</td><td>0x04</td><td>Initial value of variable</td><td>0 = 128 KB variable memory power-up initialization is 0x00
1 = power-up initial value of 128 KB variable memory determined by configuration file</td></tr>
<tr><td>.1</td><td>0x02</td><td>FRS1</td><td rowspan="2">Set the Intelligent TFT LCD Module period, the smaller the Intelligent TFT LCD Module period, the more sensitive the variable response, but the lower the ability of the variable process.
<table><tr><td>Intelligent TFT LCD Module period</td><td>80ms</td><td>120ms</td><td>160ms</td><td>200ms</td></tr><tr><td>FRS1</td><td>1</td><td>1</td><td>0</td><td>0</td></tr><tr><td>FRS0</td><td>1</td><td>0</td><td>1</td><td>0</td></tr></table>For 1024 * 768 resolution, it is recommended that the Intelligent TFT LCD Module cycle be set to more than 120 ms.
The Intelligent TFT LCD Module circle period can affect the animation speed of the animated icon display.</td></tr>
<tr><td>.0</td><td>0x01</td><td>FRS0</td></tr>
</table>

3. 8. 4 Working Mode Configuration Register 2 (RC 0x1C)

The RC register (AUX _ CFG configuration word) is defined by bit (bit) for configuring the Intelligent TFT LCD Module software operating mode, as shown in the following table (shaded areas represent factory set values).

Table 3-11 Register RC Bit Designations

Bit	Weight	Definition	Description
.7	0x80	System reservation	Must write 0
.6	0x40	Undefined	Write 0

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.5	0x20	TP_BUZZ_EN	0 = Click the active area of touch screen, there is buzzer tone 1 = No warning tone of the buzzer appears when clicking on the active area of the touch screen, but the buzzer can be controlled by writing the data control buzzer to the 0x02 register
.4	0x10	PAGE128_EN	0 = Display variables number per page is 64 1 = Undefined
.3	0x08	CRC_ACK_EN	0 = No response to frame checking result after CRC frame checking is started 1 = Response to frame checking result after CRC frame checking is started
.2	0x04	TP_CAL_MOD	Undefined
.1	0x02	Undefined	Write 0
.0	0x00	Undefined	Write 0

3. 8. 5 Screen saver/touch screen control backlight (R2. 5, R6, R7, R8)

Set R2. 5 = 1, the backlight brightness will be controlled by the touch screen state (the first click on the touch screen will not trigger action after the backlight standby).

Table 3-12 Screen saver Function Register

R#	Range of value	Description
R6	0x00-0x40	Starting the touch screen control backlight function, the brightness of the back light turn on after clicking the touch screen. (screen saver working brightness)
R7	0x00-0x40	Starting the touch screen control backlight, and does not click on the touch screen for a while. The brightness of the backlight is closed. (screen saver brightness)
R8	0x01-0xFF	Starting the touch screen control backlight, the touch screen backlight brightness time is 1 seconds. (Screen delay time)

For example, set R2. 5 = 1, R6 = 0x40, R7 = 0x10, R8 = 0x1E, do not click on the touch screen for 30 seconds (0x1E) , the backlight brightness will automatically be reduced to 0x10 (25% brightness); click on the touch screen, the backlight will automatically adjusted to 0x40 (100% brightness).

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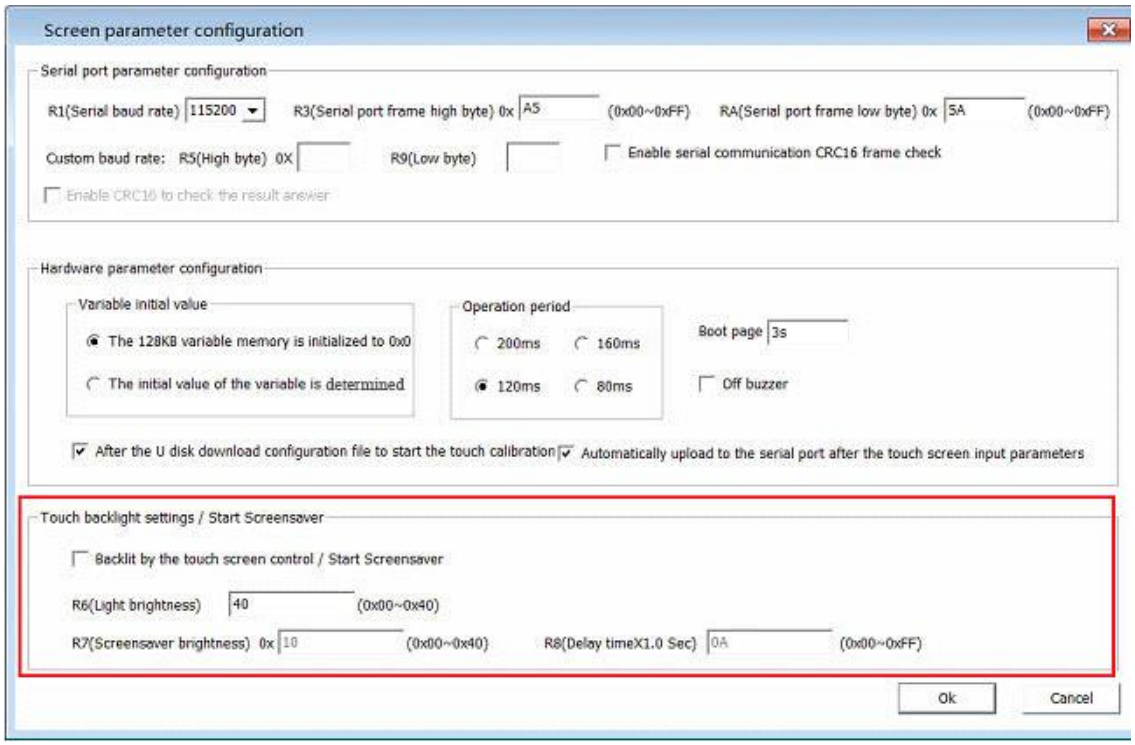

4 Input Control

Table 4-1 Schedule of Input Controls

No.	Function	Description
00	Variable data entering	Enter integer, fixed point decimal and other data to the specified variable storage space.
01	Pop-up menu selection	Click to trigger a pop-up menu to return the key value of the menu item.
02	Incremental adjustment	Click the button to perform +-operation on the specified variable. The step length and the upper &lower limit can be set. Setting 0-1 range loop adjustment enables Column checking box function
03	Drag control	Dragging slider to achieve variable data entering and set the scale range.
04	RTC Settings	Setting the RTC assembly by touching the keyboard of the Intelligent TFT LCD Module, and the complete calendar year, month, day, hour, minute and seconds need to be entered
05	Button key return	Click the button to return the key value directly to the variable, to support the return of the bit variables.
06	Text entry	Various characters are input in text mode, the input process supports cursor movement and editing. Directly support the input of ASCII characters, GBK Chinese and traditional Chinese characters. the modified font and the 0 font can support 8-bit encoded text entering of all similar ASCII characters;
07	Hardware parameter configuration	Provides a way to rewrite the register space by the touch screen, to indirectly control the hardware. For example, the contents of the backlight register read to the variable, the

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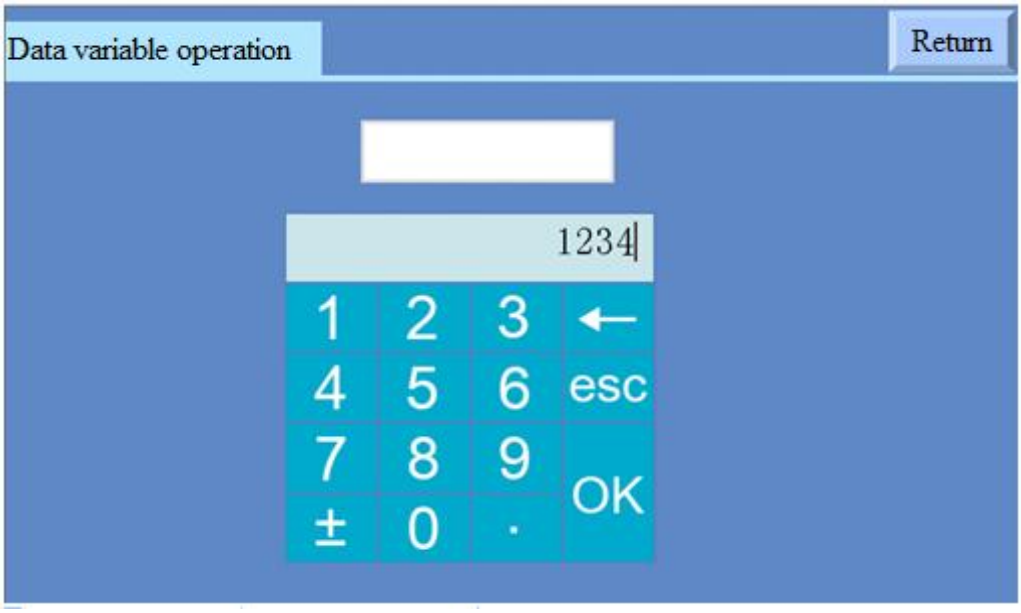
		backlight brightness is adjusted after adjusting the variable
		Click the touch screen to send the data of specified VP area to the user UART (COM1).
08	Press data synchronous return	Click the touch screen to return to the variable or UART as specified.
09	Rotary adjustment	Rotate the button to input variable data, and set the scale range.

4. 1 Variable data entering

Range setting	
X coordinates	310
Y coordinates	96
Width	62
Height	59
Key code	null
Button property	
Name definition	Data entry
After the data automation	☑
Button effect	null
Page switch	null
Audio file	null
Variable anti-color display	☐
Variable attributes	
Variable storage address	0000
Variable type	0x00==Integer (word)
Integer digit	8
Decimal digit	0
Display the location	0,0
Text color	255; 0; 0
Font location	0
The font size	16
Cursor color	Black
Input display mode	Marked by(*)
Enabled range limits	☐
keyboard properties	
keyboard in the curren	☑



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For example: Setting the number of input data bits is 4 bit, click "Data entering" button to input "1234 ", click "OK", and the UART returns to the command:

A5 5A 06 83 00 20 01 04 D2

Description: A55A: Frame head

06: command byte length, 83 00 20 01 04 D2 total 6 bytes (without frame header)

83: Read variable register command

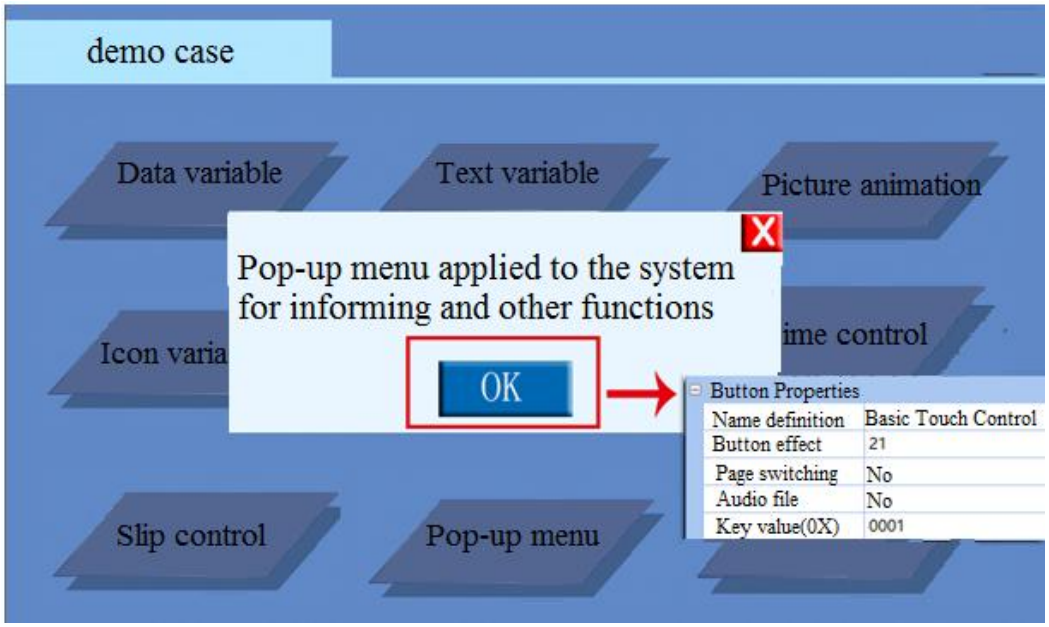
00 20: Variable address, set in control properties

01: Data word length, 04 D2 total 1 word length

04 D2: Data content, 1234 hexadecimal data

4. 2 Pop-up menu selection

Button Properties	
Name definition	Pop-up menu
Automatic data upload	☑
Button effect	1
Audio file	No
Variable attribute	
Variable storage address(Ox)	0200
Variable mode	Word-adjusted
Menu Properties	
Popup menu settings	Click to set
Page	20
⊞ Menu Area	(196,157) (622,326)
⊞ Display position	170,160



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For example: the variable address of "pop-up menu" button is set as 0200, and the key value of "OK" button on the pop-up menu page is set to be 0001. Click the "pop-up menu" button to pop-up the set menu. Click "OK" on the menu to return the button value 0001 to address 0200. The UART returns the command:

A5 5A 06 83 02 00 01 00 01

Description: A55A: Frame head

06: command byte length, 83 02 00 01 00 01 total 6 bytes (without frame header)

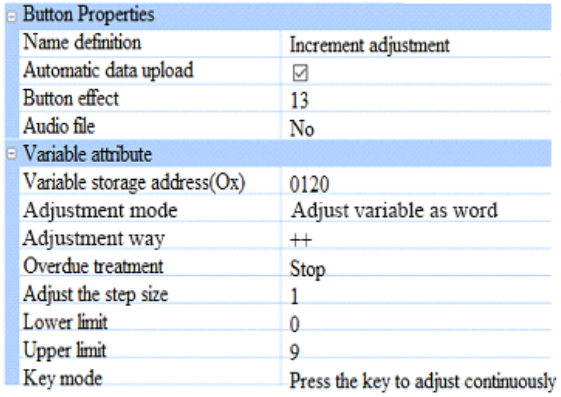
83: Read variable register command

02 00: Variable address, set in the pop-up menu control property

01: Data word length, 0001 total 1 word length

00 01: Data content, set button key value 00 01

4. 3 increment adjustment



For example: set the lower limit to 0 and the upper limit to 9. Click the "increment Adjustment" button continuously. The UART returns the command:

A5 5A 06 83 01 20 01 00 01

A5 5A 06 83 01 20 01 00 02

……

A5 5A 06 83 01 20 01 00 08

A5 5A 06 83 01 20 01 00 09

Description: A5 5A: Frame head

06: command byte length, 83 01 20 01 00 01 in total 6 bytes (without frame header)

83: Read variable register command

01 20: Variable address, set in control properties

01: Data word length, 0001 for 1 word length

00 01: Data contents, from setting lower limit to upper limit, i. e. continuously from 00 01 to 00 09

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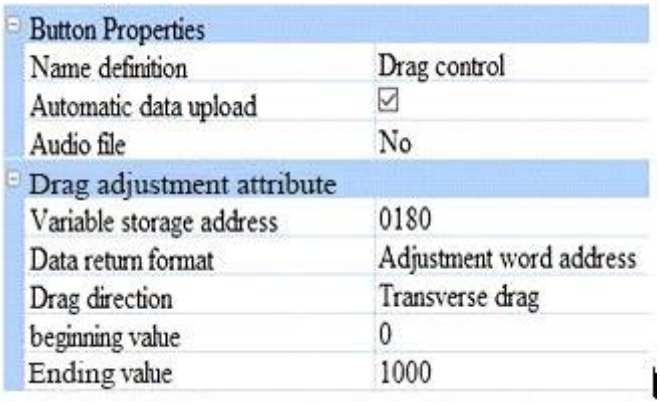
4. 4 Drag adjustment



Button Properties	
Name definition	Drag control
Automatic data upload	☑
Audio file	No
Drag adjustment attribute	
Variable storage address	0180
Data return format	Adjustment word address
Drag direction	Transverse drag
beginning value	0
Ending value	1000

For example: set the beginning value to 0, the ending value to 1000, drag the "dragging adjustment" button, and the UART returns the command:

A5 5A 06 83 01 80 01 00 00

……

A5 5A 06 83 01 80 01 03 E8

Description: A5 5A: Frame head

06: command byte length, 83 01 80 01 00 00 in total 6 bytes (without frame header)

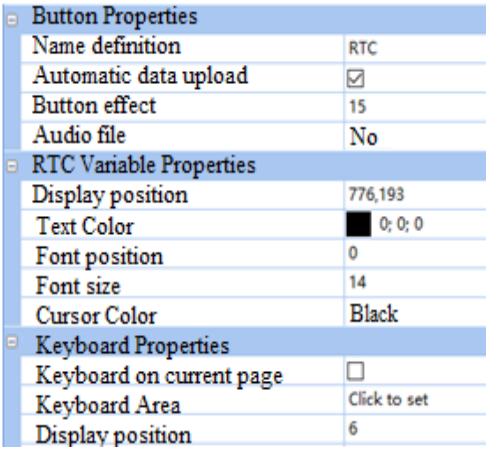
83: Read variable register command

01 80: Variable address, set in control properties

01: Data word length, 00 00 total 1 word length

00 01: The data content, changes from the setting beginning value to the ending value, i. e. changing continuously from 00 00 to 03 E8.

4. 5 RTC Settings



Button Properties	
Name definition	RTC
Automatic data upload	☑
Button effect	15
Audio file	No
RTC Variable Properties	
Display position	776,193
Text Color	0; 0; 0
Font position	0
Font size	14
Cursor Color	Black
Keyboard Properties	
Keyboard on current page	☐
Keyboard Area	Click to set
Display position	6

For example: Click "RTC setup" button to input time 16-10-26 16: 09: 00, and the UART returns the

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command:

A5 5A 0A 81 20 07 16 10 26 03 16 09 00

Description: A5 5A: Frame head

0A: command byte length, 81 20 07 16 10 26 03 16 09 00 is 10 bytes (without frame header)

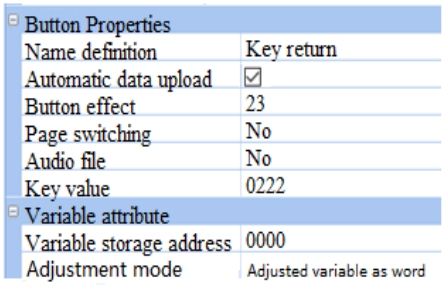
81: Read register command

20: Control register address of RTC

07： Data byte length, 16 10 26 03 16 09 00 total 7 bytes length

16 10 26 03 16 09 00: BCD code of time variable

4. 6 Button key return



For example: Click the "button key value return" button, and the UART return the command:

A5 5A 06 83 00 00 01 02 22

Description: A55A: Frame head

06: command byte length, 83 00 00 01 02 22 total 6 bytes (without frame header)

83: Read variable register command

00 00: Variable register address

01: Data word length, 02 22 total 1 word length

02 22: Data content, setting key value

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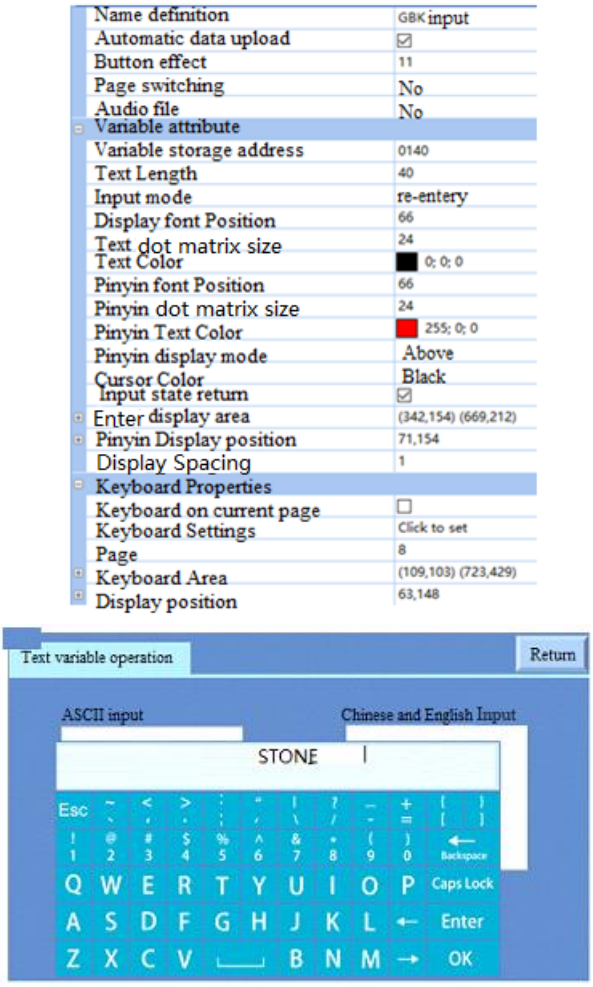
4. 7 Text entering



For example: Click the "GBK Entering" button to input "STONE", and click the "Enter " button. The UART returns the command:

A5 5A 0E 83 01 40 05 CE E4 BA BA D6 D0 CF D4 FF FF

Description: A5 5A: Frame head

0E: command byte length, 83 01 40 06 CE E4 BA D6 D0 CF D4 FF FF total 14 bytes (without frame header)

83: Read variable register command

01 40: Variable address, setting in control properties

05: Data word length, CE E4 BA BA D6 D0 CF D4 FF FF is 5 words length

CE E4 BA D6 D0 CF D4 FF FF: Data Contents, Chinese internal code of "STONE" CE E4 BA D6 D0 CF D4, the last 2 bytes FF FF are the flag bit of the end of entering ending, and the text entering and ASCII entering have an ending flag bit.

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5 Display control

Table 5-1 List of description pointer controls

No.	Function	Description
00	Variable icon display	The change range of a data variable is linearly related to a group of icons; when the variable changes, the icon automatically switches accordingly. It is used for detailed dashboard and progressing bar display.
01	Animation icon display	A fixed value data variable corresponds to three different icon indication states: no display, display fixed icon, and display animation icon. It is used for variables alarm prompt.
02	Slider scale display	The change range of a data variable is corresponds to a change in the display position of an icon (slider). It is used for liquid level, dial, and schedule command.
03	Artistic word variable display	Use ICON instead of font to display variable data.
04	Picture animation display	Play a group of full-screen images at a specified playing speed. it is used for boot screen or screen saver.
05	Icon rotation display	The change range of a data variable is linearly related to the angle data, and then an icon is displayed according to the corresponding angle data after being rotated. It is used for the pointer dashboard display.
06	Bit variable icon display	The 0/1 state of each bit data variable corresponds to two of the 8 different display schemes, and the icon (or icon animation) is used to display. Used for switching status display, such as fan operation (animation), stop (still icon).
10	Data variable display	Displays a data variable in the specified format (integer, decimal, whether with the unit) display with the specified font and the size of the Arabic numerals
11	Text display	The string is displayed in the specified text box display area in the specified format (as determined by the selection font).
12_00	Text format RTC display	Display the Gregorian RTC in the user-edited format
12_01	Dial format RTC display	Rotate the icon and display the Gregorian RTC with the pointer dial.
13	HEX Data Display	Display the variable data in bytes HEX way interval through user specified ASCII characters.
14	Text scrolling display	Scroll text from right to left
20	Real-time curves (trend chart)	Write curve buffer data with 0x84 UART to automatically match display real-time curve (trend chart). The display area, center axis coordinate, display scale (enlargement reduction) can be specified.
21_01	Drawing setting point	Set point （x,y,color）.
21_02	Drawing _ Endpoint Line	Endpoint connections (color, (x0, y0), (xn, yn).
21-03	Drawing _ rectangle	Display rectangle, color and position, size controllable.
21_04	Drawing _ rectangle fill	Fill specified rectangular area, fill color and position, size controllable.
21_05	Drawing _ Circle	Display circle arcs, colors and positions, size controllable .
21_06	Drawing picture cut& paste	Cut an area from the specified image to paste onto the current User Interface.
21_07	Drawing _ icon display	Icon display, icon library can be chosen.
21_08	Drawing _ Closed	Closed area filling, seed point coordinates, and filling color controllable.

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	Area Fill	
21_09	Drawing _ spectrum display	Display spectrum (vertical lines) based on variable data, line color and position controllable.
21_0A	Drawing _ Segment Display	Connecting segment with variable data, endpoint and color controllable.
21_0B	Drawing _ Arc Display	Display circle arc, radius and color and start-stop angle controllable.
21_0C	Drawing _ Character Display	Individual character display based on variable data.
21_0D	Draw _ Rectangular area XOR	The specified rectangular field bitmap data is XOR operated with a specified color, which is used for highlight display.
21_0E	Drawing _ Bicolor Bitmap Display	The variable memory data is regarded as TWO-color bitmap data, and the corresponding color of 0 /1 can be specified for more custom cursor.
21_0F	Drawing _ Bitmap Display	Variable memory data bit 65K color bitmap data for real-time icon (photo) downloading display.
21_10	Drawing _ area magnification pasting	Enlarge the designated area by a factor of 1 and paste it into the specified position. It is used to cooperate with the 0F command to realize the real-time picture display.
22	List display	The data defined by the two-dimensional array is shown in the table column.
23	Two-dimensional code display	The specified two-dimensional pattern information is displayed on the screen based on the specified contents.

5. 1 icon variable

5. 1. 1 Variable icon display (0x00)

Address Offset (Double Bytes)	Definition	Data length(byte)	Description
0x00	*VP	2	The variable pointer, the variable is an integer format.
0x01	X,Y	4	The variable display position is the coordinate position at the top left corner of the icon.
0x03	V_Min	2	The lower limit of the variable, is not displayed for beyond the range.
0x04	V_Max	2	Variable upper limit, is not displayed for beyond the range.
0x05	Icon_Min	2	The icon ID corresponding to V _ Min.
0x06	Icon_Max	1	The icon ID corresponding to V _ Max.
0x07:H	Icon_Lib	1	Icon library storage position.
0x07:L	Mode	1	ICON display mode. 0x00 = transparent (background not shown), others = display icon background.

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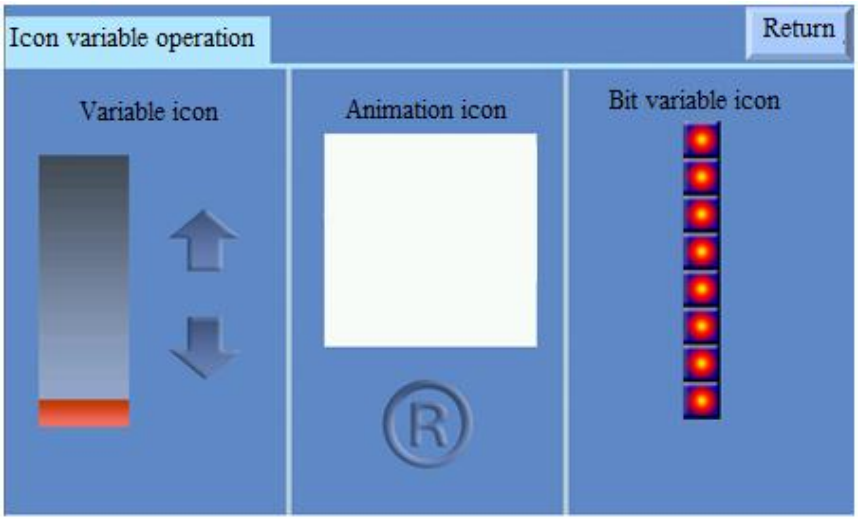
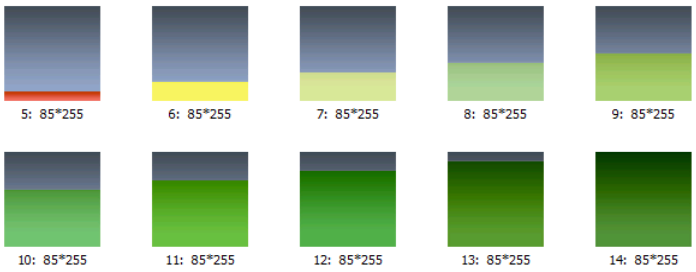


For example: Let the left side of the figure shows the following 10 different states, the UART send command



Variable attribute	
Name definition	Variable icon
Description pointer	FFFF
Variable storage address	0120
Icon file	24.ICO
Lower Limit variable	0
Icon corresponding to upper limit	5
Variable upper limit	9
Icon corresponding to upper limit	14
ICON display mode	Display Background
Initial value	0

A5 5A 05 82 01 20 00 00

A5 5A 05 82 01 20 00 01

……..

A5 5A 05 82 01 20 00 08

A5 5A 05 82 01 20 00 09

Description: A5 5A: Frame head

05: command byte length, 82 01 20 00 01 total 5 bytes

82: write variable register command

01 20: set the variable address, as shown in the figure above

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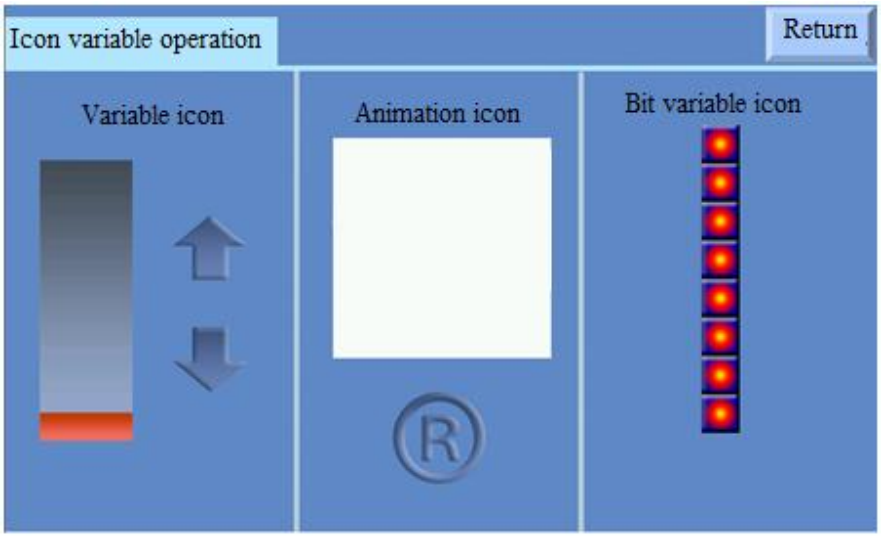
00 00: set the value of the variable, the upper and lower bounds of the variable 0-9 corresponds to the icon of the numbered 5-14 one by one, that is, the sending 00 00 display the icon number 5, 00 01 display the icon number 6, and so on.

Please refer to the Intelligent TFT LCD Module development software operating instruction for details on the generation of the ICON file.

5. 1. 2 Animation icon display(0x01)

Address Offset (Double Bytes)	Definition	Data length (bytes)	Description
0x00	*VP	2	Initial icon variable pointer, variable is double word, low word reserved, high word unsigned
0x01	x,y	4	The variable display position is the coordinate position at the top left corner of the icon.
0x03	0x0000	2	Fixed
0x04	V_Stop	2	The value is fixed when the variable is the specific value.
0x05	V_Start	2	The animated icon is automatically displayed when the variable is the specific value.
0x06	Icon_Stop	2	Fixed displayed icon when variable is V _ Stop.
0x07	Icon_Start	2	When variable is V_Start value, then icons is showed utomatically from Icon_Start to Icon _End, and become animation.
0x08	Icon_End	2	
0x09:H	Icon_Lib	1	Icon library storage position.
0x09:L	Mode	1	ICON display mode. 0x00 = transparent

When the variable is not equal to V _ Stop or V _ Start, icon or animation can not be displayed.



For example, let the middle animation icon in the above figure show the following animation effects:

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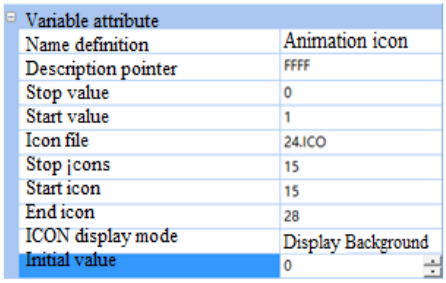

Start animation command A5 5A 05 82 01 21 00 01

Stop animation command A5 5A 05 82 01 21 00 00

Description: A5 5A: Frame head

05: command byte length, 82 01 21 00 01 total 5 bytes

82: write variable register command

01 21: set the variable address, as shown in the figure above

00 00: set variable start value, after sending the start value, it will loop to play start icon to end icon, and display stop icon after sending stop value

Please refer to the Intelligent TFT LCD Module development software operating command for details on the generation of the ICON file

5. 1. 3 Slide scale indication (0x02)

Address offset (Double Bytes)	Definition	Data length (bytes)	Description
0x00	*VP	2	The variable pointer, the format of varible is decided by VP _ DATA _ Mode.
0x01	V_begin	2	Corresponding to beginning variable scale value.
0x02	V_end	2	Corresponding to ending variable scale values.
0x03	X_ begin	2	Beginning scale coordinates (vertical direction is Y coordinates).
0x04	X_ end	2	Ending scale coordinates of terminate scale (vertical direction is Y coordinates).
0x05	Icon_ ID	2	The icon ID of the slide scale block.
0x06	Y	2	The Y-coordinate value of the scale indicates icon display.
0x07:H	X_adj	1	The forward offset of the X coordinate of the scale indicates icon display.
0x07:L	Mode	1	Scale mode. 0x00 = horizontal scale bar, other = vertical scale bar.
0x08:H	Icon_Lib	1	Icon library storage position.
0x08:L	Icon_mode	1	ICON display mode. 0x00 = transparent (not shown), others = display icon background.
0x09:H	VP_DATA _Mode	1	0x00 = * VP points to one integer variable; 0x01 = * VP points to one integer variable high byte data; 0x02 = * VP points to one integer variable low byte data.

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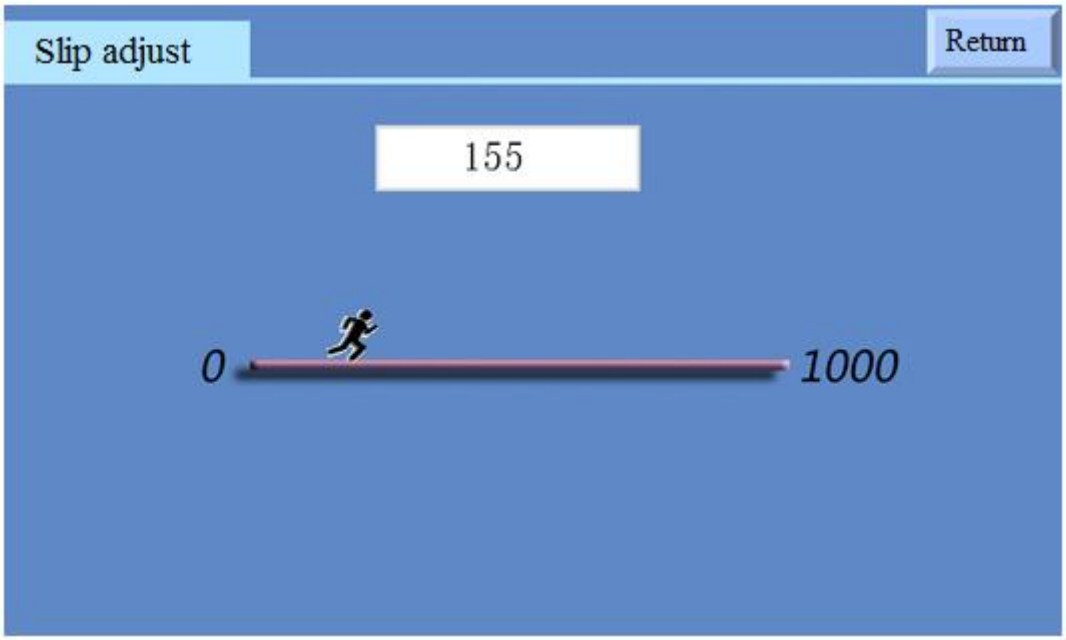
Variable attribute	
Name definition	Slider scale indication
Description pointer	FFFF
Variable storage address	0180
Beginning scale value	0
Ending scale value	1000
Scale mode	Horizontal scale bar
Icon file	24.ICO
Slide icon	0
ICON display mode	Transparent
Y coordinate forward offset	230
X coordinate forward offset	0
Variable mode	Point to one integer variable
Initial value	0



For example: display the sliding scale in the above figure at any position on the progress bar, and send the command:

A5 5A 05 82 01 80 00 00

A5 5A 05 82 01 80 00 01

……..

A5 5A 05 82 01 80 03 E7

A5 5A 05 82 01 80 03 E8

Description: A5 5A: Frame head

05: command byte length, 82 01 80 00 01 total 5 bytes

82: write variable register command

01 80: setting variable address, as shown in above figure

00 00: Setting the variable scale value, i. e., change from 00 00 to 03 E8

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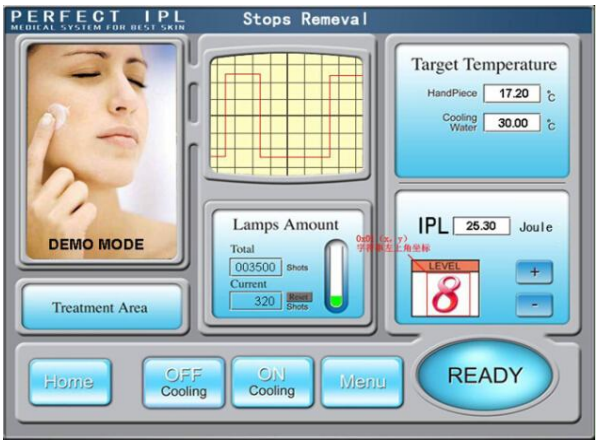
5. 1. 4 Art word variable display (0x03)

Address offset (Double Bytes)	Definition	Data length (bytes)	Description
0x00	*VP	2	Variable pointer
0x01	X,Y	4	Beginning display position Left alignment mode, coordinates are the upper left corner of the display string Right alignment mode, coordinates are the upper right coordinates of the display string
0x03	Icon0	2	0 corresponding to ICON _ ID, the arrangement order is 01234 56789-.
0x04:H	Icon_Lib	1	Icon library storage position.
0x04:L	Icon_Mode	1	ICON display mode: 0x00 = transparent (no background display) Other = display icon background
0x05:H	Integer digit	1	Display integer number
0x05:L	Decimal digit	1	Display decimal number
0x06:H	Data variable type	1	0x00 = integer (2 bytes),-32768 to 32767 0x01 = long integer (4 bytes)-214 7483648 to 214 7483647 0x02 = * VP high byte, unsigned number 0 to 255 0x03 = * VP low byte, unsigned number 0 to 255 0x04 = Extra-long integer (8 bytes)-92233720 36854775808 to 9223372036854775807 0x05 = unsigned integer (2 bytes) 0 to 65535 0x06 = Unsigned long integer (4 bytes) 0 to 4294967295
0x06:L	Alignment mode	1	0x00 = left alignment, 0x01 = right alignment



Can be understood as icon display of word-art, display method and icon display is basically the same.

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5. 1. 5 Picture animation display (0x04)

Address offset (Double Bytes)	Definition	Data length (bytes)	Description
0x00	0x0000	2	Fixed
0x01	Pic_begin	2	Beginning icon position
0x02	Pic_end	2	Ending Icon position
0x03:H	Frame_Time	1	The time for displaying one picture, 8ms

If the "picture animation" control is also set on the Pic _ End page, the replaying can be achieved. UART sends command to switch pictures or touch buttons to switch pictures to end replay

5. 1. 6 Icon rotation (0x05)

Address offset (Double Bytes)	Definition	Data length (bytes)	Description
0x00	*VP	2	Variable pointer, variable format is determined by Mode.
0x01	Icon_ID	2	Specifies the icon ID.
0x02	Icon_Xc	2	The X coordinate of specified rotational center on the icon.
0x03	Icon_Yc	2	The Y coordinate of specified rotational center on the icon.
0x04	Xc	2	The X coordinate of the rotation center position of icon display on the current screen
0x05	Yc	2	The Y coordinate of the rotation center position of icon display on the current screen.
0x06	V_Begin	2	Corresponding to the variable value of starting rotation angle, integer data is not displayed beyond limit.
0x07	V_End	2	Corresponding to the variable value of ending rotation angle, integer data is not displayed beyond limit.
0x08	AL_Begin	2	Beginning rotation angle 0-720 (0x0000-0x02D0), in 0. 5 degrees.
0x09	AL_End	2	Rotation angle = (Ending angle-initial angle) (Ending value-initial value) * input value; Ending rotation angle 0-720 (0x0000-0x02D0) in 0. 5 degrees.
0x0A：H	VP_Mode	1	0x00 = * VP points to an integer variable; 0x01 = * VP points to one integer variable high byte data; 0x02 = * VP points to one integer variable low byte data.

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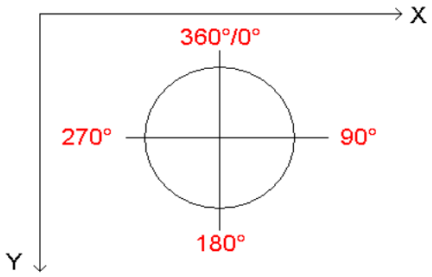
0x0A：L	Lib_ID	1	Icon library storage position.
0x0B	Mode	1	ICON display mode. 0x00 = transparent (background not shown), others = display icon background.

This command is mainly used for indication of the instrument dial.
Rotation is always assumed to be "clockwise" rotation, i. e., AL _ End must be greater than AL _ Begin (if AL _ End is less than AL _ Begin, the system will automatically add 360 °).



5. 1. 7 Bit variable icon display (0x06)

Address Offset (Double Bytes)	Definition	Data length (bytes)	Description
0x00	*VP	2	Bit variable pointer, word variable
0x01	*VP_AUX		Auxiliary variable pointer, double word, user disabled
0x02	Act_Bit_Set	2	A bit value of 1 indicates that the corresponding position of the*VP needs to be displayed
0x03：H	Display_Mode	1	Display mode definition:

Display_Mode	Bit value	
	0	1
0x00	ICON0S	ICON1S
0x01	ICON0S	Not shown
0x02	ICON0S	ICON1S-ICON1E animation
0x03	Not shown	ICON1S
0x04	Not shown	ICON1S-ICON1E animation
0x05	ICON0S-ICONFIG animation	ICON1S
0x06	ICON0S-ICONFIG animation	Not shown

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			0x07 | ICON0S-ICONFIG animation | ICON1S-ICON1E animation
0x03：L	Move_mode	1	Bitmap icon arrangement: 0x00=X++, Act_ Bit_ Set, point to not dispose bit, not reserve position 0x01=Y++, Act_ Bit_ Set, point to not dispose bit, not reserve position 0x02 = X ++, Act_ Bit_ Set, point to not dispose bit, reserve Dis_ Move position 0x03=Y++, Act_ Bit_ Set, point to not dispose bit, reserve Dis_MOV position
0x04:H	Icon_Mode	1	ICON display mode: 0x00 = transparent (no background display) Other = display icon background
0x04:L	Icon_Lib	1	Icon storage position
0x05	ICON0S	2	No animation mode, bit 0 icon ID Show animation mode, bit 0 icon animation starting ID position
0x06	ICON0E	2	Show animation mode, bit 0 icon animation ending ID position
0x07	ICON1S	2	No animation mode, bit 1 icon ID Show animation mode, bit 1 icon animation starting ID position
0x08	ICON1E	2	Show animation mode, bit 1 icon animation ending ID position
0x09	(x,y)	4	Starting variable display position, coordinate of top left corner of icon
0x0B	Dis_MOV	2	The interval of next icon coordinate move

5. 2 Text Variables

5. 2. 1 Data variable display (0x10)

Address Offset (Double Bytes)	Definition	Data length (bytes)	Description
0x00	*VP	2	Variable pointer
0x01	X,Y	4	Starting display position, display coordinates of upper left corner of character string
0x03	Color	2	Display Color
0x04:H	Lib_ID	1	ASCII font Position
0x04:L	Font size	1	The dot matrix number in the character X direction
0x05:H	Alignment	1	0x00 = left alignment, 0x01 = right alignment, 0x02 = centered

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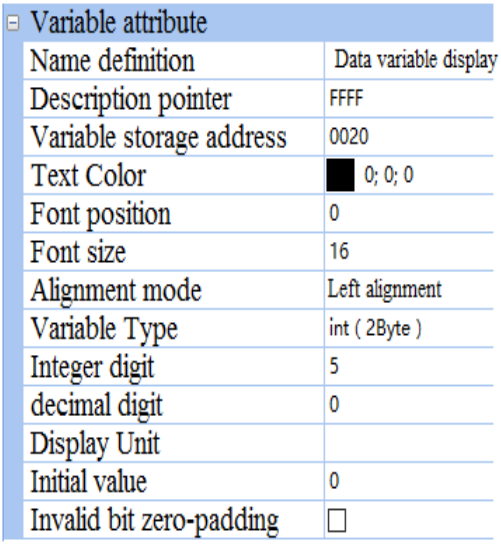
	mode		
0x05:L	Integer digit	1	Display the number of integer digits(the sum of the integer and decimal digits cannot exceed 20).
0x06:H	Decimal digit	1	Display the number of decimal digits(the sum of the integer and decimal digits cannot exceed 20)
0x06:L	Variable data TYPE	1	0x00 = integer (two bytes) : -32768 to 32767 0x01 = long integer (4 bytes) : -214 7483648 to 214 7483647 0x02 = VP * high byte: 0 to 255 0x03 = VP * low byte: 0 to 255 0x04 =Extra-long integer (8 bytes) : -9223372036854775808 to 9223372036854775807 -9223372036854775808 to 9223372036854775807 0x05 = unsigned integer (2 bytes) : 0 to 65536 0x06 = Unsigned long integer (4 bytes) : 0 to 4294967295
0x07:H	Len_unit	1	Variable unit display length, 0x00 represents the unit is not displayed
0x07:L	String_unit	9	Unit string, ASCII code
0x0C	Bclr	2	Background color



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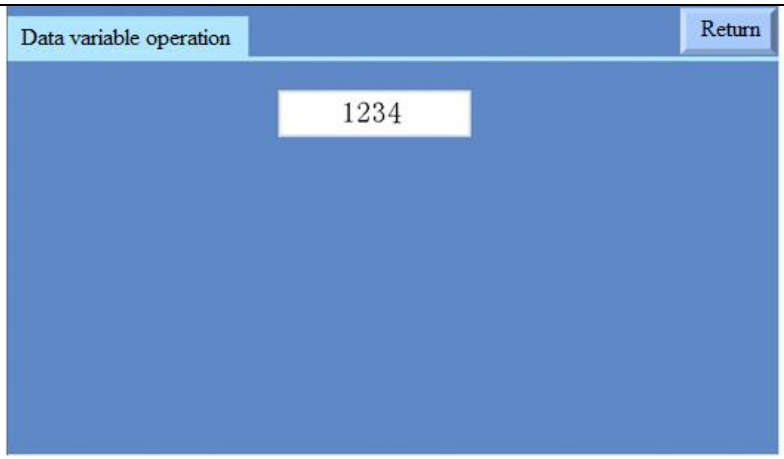

For example: Show integer "1234 ", the UART returns the command:

A5 5A 05 82 00 20 04 D2

Description: A5 5A: Frame head

05: command byte length, 83 00 20 04 D2 total 5 bytes (without frame header)

83: write variable register command

00 20: Variable address, setting in control properties

04 D2: Data content, 1234 hexadecimal data

5. 2. 2 Text display (0x11)

Address Offset (Double Bytes)	Definition	Data length (bytes)	Description
0x00	*VP	2	Text pointer
0x01	X,Y	4	Beginning display position, display coordinates of upper left corner of character string
0x03	Color	2	Show Text Color
0x04	Xs,Ys,Xe,Ye	8	Text box
0x08	Text_Length	2	Number of bytes displayed, 0xFFFF, do not display when 0xFFFF data is encountered or displayed to the end of the text box
0x09:H	Font0_ID	1	ASCII font location when the encoding mode is 0x01-0x04
0x09:L	Font1_ID	1	The position of the fonts used for non-ASCII characters of the coding mode for 0x00,0x05, and 0x01-0x04
0x0A:H	Font_X_Dots	1	The dot matrix number in font X-direction, the ASCII character X is

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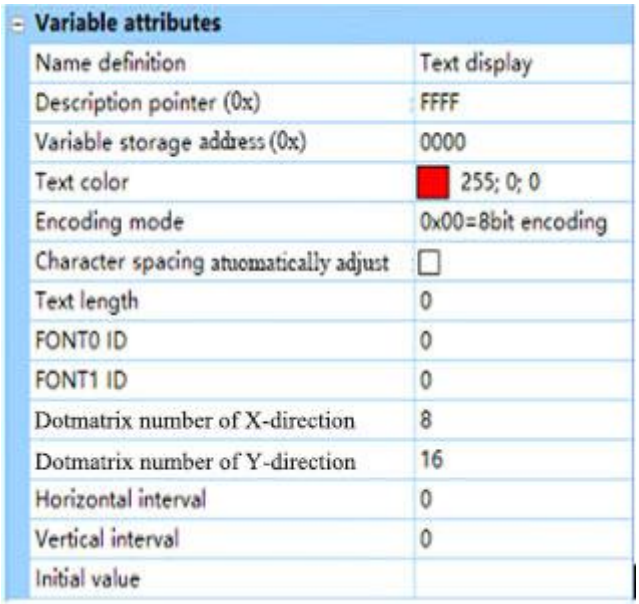
			calculated according to Y /2 as 0x01-ox04 mode
0x0A:L	Font_Y_Dots	1	The dot matrix number in font Y-direction, must be even.
0x0B:H	Encode_Mode	1	. 7 defines whether text display character spacing is automatically adjusted: . 7 = 0 The character spacing is automatically adjusted. . 7 = 1 The character spacing is not automatically adjusted, the character width is the fixed setting dot matrix number. . 6-. 0 defines text encoding: 0x00 = 8bit code, 0x01 = GB2312 internal code, 0x02 = GBK, 0x03 = BIG5, 0x04 = SJIS, 0x05 = UNI CODE
0x0B:L	HOR_Dis	1	Horizontal spacing of character
0x0C:H	VER_Dis	1	vertical space of the character
0x0C:L	Undefined	1	Write 0x00

Note: when the text is displayed, the number of dot matrix in the Y-direction in the font must be even.

The 0 # font pre-install-ed in Intelligent TFT LCD Module, contains all the ASCII characters of 4 * 8-64 * 128 dot matrix



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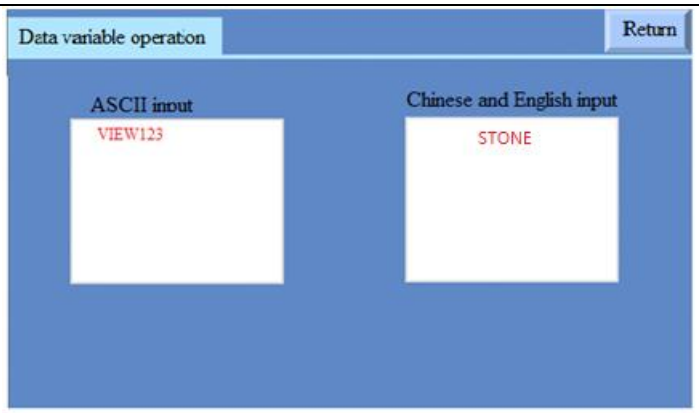

For example: display the English and number "VIEW 123", the UART sends command:

A5 5A 0A 82 01 40 56 49 45 57 31 32 33

Description: A5 5A: Frame head

0A: command byte length, 82 01 40 56 49 45 57 31 32 33 is 10 bytes (without frame header)

82: write variable register command

01 40: Variable address, set in control properties

56 49 45 57 31 32 33: Data content, ASCII code for "VIEW 123"

5. 2. 3 RTC display (0x12)

Text RTC display

Address Offset (Double Bytes)	Definition	Data length (bytes)	Description
0x00	0x0000	2	
0x01	X,Y	4	Beginning display position, display coordinates of upper left corner of character string
0x03	Color	2	Font Color
0x04:H	Lib_ID	1	Font position
0x04:L	Font size	1	The dot matrix number of X direction
0x05	String_Code	Max14	Coded string, composed by RTC coding table and ASCII character Assume current time 2014-05-0112: 00: 00: 00 Wednesday Y_M_D H: Q: S0x00 will be displayed as 2014-05-01 12: 00: 00 M_D W H: Q0x00 will be displayed as 05-01 WEN12: 00

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RTC coding table

Description	Code	Display format
Gregorian calendar_ year	Y	2000-2099
Gregorian calendar_month	M	01-12
Gregorian calendar_dau	D	01-31
Gregorian calendar hour	H	00-23
Gregorian calendar_minute	Q	00-59
Gregorian calendar_second	S	00-59
Gregorian calendar_week	W	SUN MON TUE WED THU FRI SAT
End of coding	0x00	

Dial clock display

Address Offset (Double Bytes)	Definition	Data length (bytes)	Description
0x00	0x0001	2	
0x01	X,Y	4	Pointer center of clock dial
0x03	Icon_Hour	2	The ID of the hour hand ICON and 0xFFFF indicate that the hour hand is not shown.
0x04	Icon_Hour_central	4	Rotation center position of the hour hand ICON.
0x06	Icon_Minute	2	ID of minute ICON, and 0xFFFF represents that the minute hand is not shown
0x07	Icon_Minute_ central	4	Rotation center position of minute ICON.
0x09	Icon_Second	2	The ID of the second hand ICON, 0xFFFF indicates that the second pointer is not shown

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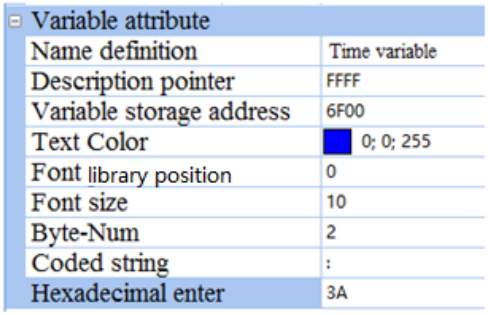
0x0A	Icon_Second _ central	4	Rotation center position of second hand ICON.
0x0C:H	ICON_Lib	1	ICON Library File ID of Pointer icon
	Undefined	1	Write 0x00

5. 2. 4HEX time variable display (0x13)

Address Offset (Double Bytes)	Definition	Data length (bytes)	Description
0x00	*VP	2	The intial address for variable pointer data string, variable is BCD code
0x01	X,Y	4	Intial display position, display coordinates of upper left corner of character string
0x03	Color	2	Font Color
0x04:H	Byte_Num	1	Number of VP pointer high byte start display, 0x01-0x0F
0x04:L	Lib_ID	1	The font library position must be a half angle font. If the Lib _ ID is not 0, it must be encoded with 8 bit.
0x05:H	Font_X	1	Dot matrix number of X-direction
0x05:L	String_Code	Max13	The coded string, combined with the time variable to form the display format required by the client. Each time a BCD code is displayed, an ASCII character is taken in order from the encoding string for interval display The special coding definition of coded string : 0x00: Invalid, no character displayed, two BCD codes connected together. 0x0D: Line feed display. That is X = Xs, Y = Y + Font _ X * 2



For example: display the time variable "08: 30", and UART send the command:

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A5 5A 05 82 6F 00 08 30

Description: A55A: Frame head

05: command byte length, 82 6F 00 08 30 total 5 bytes (excluding frame header)

82: write variable register command

6F 00: Variable address, set in control properties

08 30: data content, BCD code of 08 30

5. 2. 5 Text scroll display (0x14)

Address Offset (Double Bytes)	Definition	Data length (bytes)	Description
0x00	*VP	2	Text pointer The first 3 words of a text pointer must be reserved, the user display text content must be stored from (VP + 3) and text must end with 0xFF or 0x00
0x01:H	Rolling_Mode	1	Scroll mode: 0x00 represents scroll from right to left
0x01:L	Rolling_Dis	1	Scroll distance, pixels number of each Intelligent TFT LCD Module periodic text scrolling
0x02:H	Adjust_Mode	1	Alignment: 0x00 = left alignment, 0x01 = right alignment, 0x02 = centered The scrolling stops when the text display content is insufficient for the text box, and the display alignment mode is valid.
0x02:L	Undefined	1	Write 0x00
0x03	Color	2	Show Text Color
0x04	Xs Ys Xe Ye	8	Text box
0x08:H	Font0_ID	1	When coding mode is 0x01-0x04, the font library position displayed by ASCII characters When coding mode is 0x00, 0x05, do not set this parameter, and write 0x00.
0x08:L	Font1_ID	1	When coding mode is 0x01-0x04, the font library position displayed by non-ASCII character When coding mode is 0x00, 0x05: display the font library position used by character
0x09:H	Font_X_Dots	1	The dot matrix number of font X direction (0x01-0x04 mode, ASCII character X will be automatically calculated according to

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			Y/2)
0x09:L	Font_Y_Dots	1	The dot matrix number of font Y-direction
0x0A:H	Encode_Mode	1	. 7 defines whether displayed character spacing is automatically adjusted: . 7 = 0 character spacing is automatically adjusted; . 7 = 1 character spacing does not automatically adjusted, and the character width is fixed to the set dot matrix number. . 6-. 0 defines text coding: 0 = 8 bit code, 1 = GB2312 internal code, 2 = GBK, 3 = BIG5, 4 = SJIS, 5 = UNI CODE
0x0A:L	Text_Dis	1	Character space distance

Note that when the text is displayed, the dot matrix number of Y-direction in the font must be even.

The 0 font pre-loaded in Intelligent TFT LCD Module contains all ASCII characters of 4 * 8-64 * 128 dot matrix.

Send command reference text display.

5. 3 Graphic Variables

5. 3. 1 Real-time curve (trend chart) display (0x20)

Address Offset (Double Bytes)	Definition	Data length (bytes)	Description
0x00	0x0000	2	No definition
0x01	Xs:Ys:Xe:Ye	8	Curve window: coordinates of upper left corner (Xs, Ys), coordinates of lower right corner (Xe, Ye)
0x05	Y_Central	2	Curve center position
0x06	VD_Central	2	Curve data value corresponding to center curve
0x07	Color	2	Curve Color
0x08	NUL_Y	2	Curve magnification in 1/256, 0x0000-0xFFFF
0x09:H	CHANEL	1	Data Source Channel: 0x01-0x07
0x09:L	Dis_HOR	1	Horizontal axis space distance

The curve data is sent with 0x84 command, refer to 2. 2 command set description

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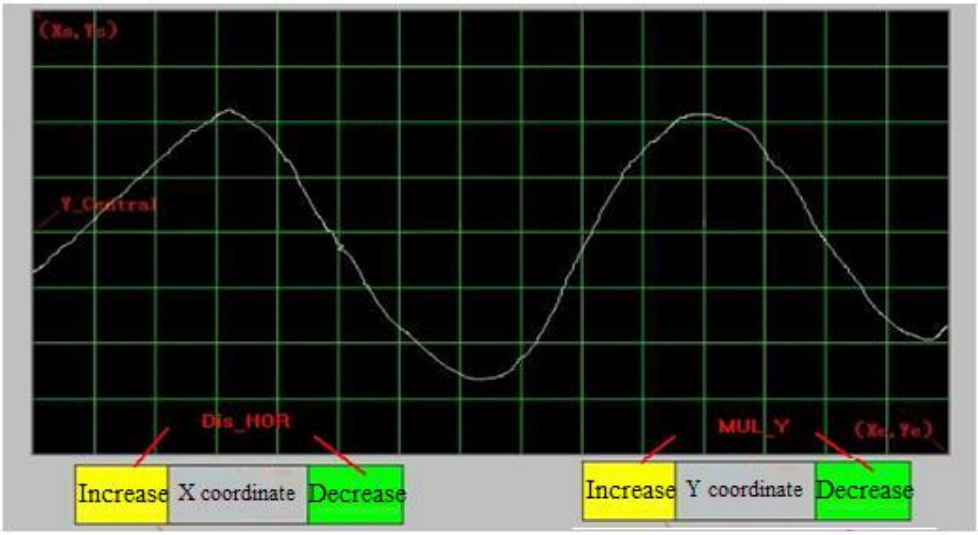

If the variable description content is stored in the data storage space (* SP specifies the storage position), then:

□ □ The automatic contraction and expansion of the curve can be achieved without the user's code intervention when combined with the 0x02 incremental touch command

□ □ The up and down movement of the curve can be achieved without the user's code intervention when combined with 0x03 dragging the touch command to modify the value of Y _ Central.

Vertical axis magnification calculation of full-scale curve:

MUL _ Y = (Ye-Ys) * 256 (Vmax-Vmin) Ye, Ys are Y coordinates of the curve window, and Vmax and Vmin are the maximum and minimum values of the curve data.

For example, a 12bit A D acquisition data (Vmax = 4095Vmin = 0) should correspond to a full-scale display of the screen region of Ys = 50, Ye = 430:

MUL _ Y = (430-50) * 256 (4095-0) = 23. 7 round down to 23..

5. 3. 2Basic graphic display (0x21)

Address Offset (Double Bytes)	Definition	Data length (bytes)	Description
0x00	*VP	2	Variable data pointer
0x01	Area	8	Drawing display area definition: the coordinates of the upper left corner and lower right corner of the specified area Beyond limit drawing will not be shown, and only valid for 0x0001-0x0005, 0x0009, 0x000A, 0x000B
0x05:H	Dashed_Line_Ent	1	0x5A: Line drawing command (0x02, 0x03, 0x09, 0x0A command) will be used Dotted line or dot dash line displayed line segment Other: display the line segment use the drawing command of line segment

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0x05:L	Dash_Set	4	The 4 bytes are sequentially formatted with dotted lines (dot-dash lines) : The number of solid lines dot matrix in first section, The number of dotted lines dot matrix in first section, The number of solid lines dot matrix in second section, The number of dotted lines dot matrix in second section For example, set 0x100x040x100x04 to display dotted lines, and set 0x100x040x020 x04 to display dotted dash lines
		13	Reserved, write 0x00

The basic graphic display first defines a "drawing board" function in the configuration file, and the specific drawing operation is determined by the variable memory content pointed to by * VP. The user can change the variable memory function to achieve different drawing functions.

(Variable storage space)Variable data format Description

Address	Definition	Description
VP	CMD	Drawing command
VP+1	Data_Pack_Num_Max	Maximum number of packets: connection command (0x0002) is defined as the number of lines, that is, vertices -1
VP+2	DATA_Pack	Data

Drawing command data packet description

command (CMD)	Operation	Drawing packet format description (relative address and length units are word)			
		Relative address	Length	Definition	Description
0x0001	Set point	0x00	2	(x,y)	Set point coordinate position, x coordinate high byte is the judgment condition
		0x02	1	color	Set point color
0x0002	End-point connection	0x00	1	color	Line Color
		0x01	2	(x,y) 0	Connection vertex 0 coordinate, X coordinate high byte is the judgment condition
		0x03	2	(x,y) 1	Connection vertex 1 coordinate, X coordinate high byte is the judgment condition
		0x01+2*n	2	(x,y) n	Connection vertex n coordinate, X coordinate high byte is the judgment condition
0x0003	Rectangle	0x00	2	(x,y) s	The upper left corner coordinate of the rectangle and the x coordinate high byte as the judgment condition

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		0x02	2	(x,y) e	Lower right corner coordinate of rectangular
		0x04	1	color	Rectangular color
0x0004	Rectangle filling	0x00	2	(x,y) s	Upper left corner coordinate of rectangular domain, X coordinate high byte is the judgment condition
		0x02	2	(x,y) e	Lower right corner coordinate of rectangular domain
		0x04	1	color	Rectangular Filling Color
0x0005	Integral arc display	0x00	2	(x,y)	Circle center coordinate, X coordinate high byte is the judgment condition
		0x02	1	Rad	Radius
		0x03	1	color	Circular color
0x0006	Picture area cut and paste	0x00	2	Pic_ID	Page ID of cut image area, high byte is the judgment condition
		0x02	2	(x,y) s	Upper left corner of the cut picture area
		0x04	2	(x,y) e	Lower Right Corner of the cut Picture Area
		0x06	2	(x,y)	The cut picture area is pasted to the coordinate position of the current page, the upper left corner coordinate
0x**07	Icon display	0x00	2	(x,y)	Display coordinate position, x coordinate high byte is the judgment condition
		0x02	1	ICON_ID	Icon ID, icon library position is specify by the high byte of command 0x ** 07 The icon is fixed without displaying the background.
0x008	Area filling	0x00	2	(x,y)	Seed-point coordinate, x-coordinate high byte is the judgment condition
		0x02	1	color	Filling Color
0x0009	Spectrum Display (Vertical)	0x00	1	Color0	connect (X0,Y0s)(X0,Y0e)with Color 0, X0 high byte is the judging condition
		0x01	3	X0,Y0s,Y0e	
0x000A	Segment display	0x00	1	Color	Connect (Xs, Ys) (Xe, Ys) with Color, Xs high byte is the judging condition
		0x01	2	(Xs,Ys)	
		0x03	2	(Xe,Ye)	
0x000B	Circular arc display	0x00	1	Color0	Circular arc display Center (X, Y) coordinate, X coordinate high byte is the judgment condition
		0x01	2	(X,Y) 0	
		0x03	1	RAD0	Radius
		0x04	1	DEG_S0	Starting angle, Unit 0. 5 °, 0-720
		0x05	1	DEG_E0	Ending angle, unit 0. 5 °, 0-720
0x000C	Character display	0x00	1	Color0	Character display color
		0x01	2	(X,Y) 0	Character display position, upper left corner coordinate of character and X coordinate high byte is the judgment condition

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		0x03H	0.5	Lib_ID	Font library position	
		0x03L	0.5	En_Mode	Character coding mode: 0 = 8bit 1 = GB23122 = GBK3 = BIG54 = SJ IS5 = UNI CODE	
		0x04H	0.5	X_Dots	The dot matrix number of character X-direction	
		0x04L	0.5	Y_Dots	The dot matrix number of character Y-direction	
		0x05	1	Text0	Character data, 8 bit coding, valid only for high byte When the coding mode is 01-04, if the character data is ASCII characters, it is displayed automatically using 0 # pre-installed fonts.	
0x000D	Rectangular area XOR	0x00	2	(x，y)s	The upper left corner of coordinates rectangle area and the x coordinate high byte as the judgment condition	
		0x02	2	(x,y)e	The lower right corner coordinates of rectangular area	
		0x04	1	Color	Color of rectangular area XOR, 0xFFFF will perform anti-color operation	
0x000E	Two-color bitmap display	0x00	2	(x,y)s	Bitmap shows the upper left corner coordinates of the rectangular area. The x coordinate high byte is the judgment condition.	
		0x02	1	X_Dots	The dot matrix number of Bitmap X direction	
		0x03	1	Y_Dots	The dot matrix number of Bitmap X direction	
		0x04	1	Color1	Display color corresponding to "1" bit	
		0x05	1	Color0	Display color corresponds to "0" bit: if color 0 and color 1 are the same, representing that the "0" bit does not need to be displayed and directly skips.	
		0x06	N	Data_Pack	Display data, MSB mode; for the convenience of users to read and write data, each line of data must be aligned to a word, that is the next line of data is always begin with a new data word (word)	
0x000F	Bitmap display	0x00	2	(x,y)s	Bitmap shows the upper left corner coordinates of the rectangular area. The x coordinate high byte is the judgment condition.	
		0x02	1	X_Dots	The dot matrix number of Bitmap X direction	Limited by variable space size , maximum display bitmap is 196 * 146 (4: 3) or 226 * 126 (16: 9)
		0x03	1	Y_Dots	The dot matrix number of Bitmap Y direction	
		0x04	N	Data_Pack	Display data, one word per pixel (MSB, 565RGB data format)	

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0x0010	Sticking display of area magnification	0x00	2	(x,y)	After magnified once, the image is pasted on the upper left corner of the screen, and the X high byte is the judgment condition.	When the area to be enlarged is located in the enlarged image area, it must be aligned in the lower right corner. Nested amplification can produce greater magnification
		0x02	2	(x,y)s	Top left corner coordinates of rectangular area to be enlarged	
		0x04	2	(x,y)e	Right corner coordinates of rectangular area to be enlarged	

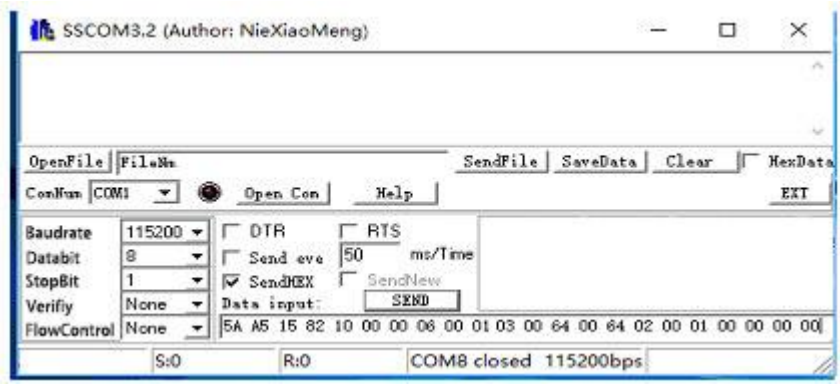
Judgment condition: 0xFF drawing operation ends, 0xFE is skipped (omitted).

Example of basic graphic display (take the example of cut and past command in picture 0x0006)

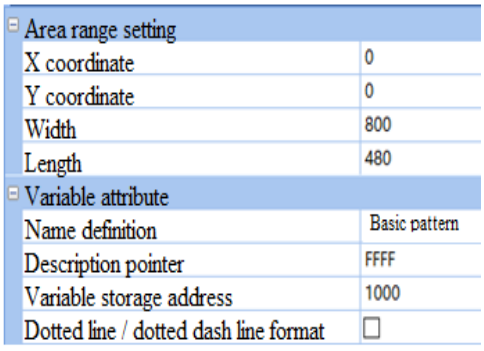
Step1 defines a basic graphic display on the interface, and the variable * VP points to Address 0x1000;

Step2 using USB to download the configuration file to Intelligent TFT LCD Module;

Step3 UART writes 0x0006 command related contents to 0x1000 address (* VP), and (cut (100, 100) (512, 256) area of the third page and paste into the (0, 0) position of the current interface.).



As long as the VP content is unchanged, the Intelligent TFT LCD Module will execute command on the page where the drawing board command is located, showing the cut and paste contents



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Connect the end point of coordinate (340, 237) and coordinate (585, 237)

A5 5A 11 82 10 00 00 02 00 01 00 00 01 54 00 ED 02 49 00 ED

Set point on coordinates (340, 237)

A5 5A 11 82 10 00 00 01 00 01 01 54 00 ED 00 00

The rectangle of the lower right corner coordinates(585, 340), and the upper left corner coordinates (340, 237) rectangle

A5 5A 11 82 10 00 00 03 00 01 01 54 00 ED 02 49 01 54 00 00

The circle of circle center coordinates (470, 325), and the radius is 50

A5 5A 0F 82 10 00 00 05 00 01 01 D6 01 45 00 32 00 00

The coordinates of upper left corner(265, 64) and coordinates of lower right corner （785，256）are cut and pasted into the current interface coordinates (265, 64).

A5 5A 15 82 10 00 00 06 00 01 00 01 01 09 00 40 03 11 01 00 01 09 00 40

Endpoint coordinates (80, 80) (128, 128) segment display

A5 5A 11 82 10 00 00 0A 00 01 00 00 00 50 00 50 00 80 00 80

Description: 0001 in above command refers to the number of maximum data packets, that is, the times of implementing drawing command, such as drawing a line, a rectangular box, a circle, is set to 00 01, draw two lines, two rectangular box, two circles, is set to 00 02.

5. 3. 3List display (0x22)

Address Offset (Double Bytes)	Definition	Data length (bytes)	Description
0x00	*VP	2	Table Content Pointer, that is the First Address of TAB _ X _ Num and TAB _ Y _ Num Array
0x01:H	TAB_X_Num	1	Number of columns, 0x01-0xFF
0x01:L	TAB_Y_Num	1	Number of lines, 0x01-0xFF
0x02:H	TAB_X_Start	1	column position of Table start display , 0x00-0xFF
0x02:L	TAB_Y_ Start	1	Line position of Table Start Display, 0x00-0xFF
0x03:H	Unit_Data_Num	1	0x01-0xFF All cell stores have the same data length. 0x00 defines the length of data for different column cells by the * VP variable address pointer to the variable memory space. (Word, word length) When Unit _ Data _ Num = 0x00, the table data content storage position is extended (TAB _ X _ Num 2), and round up to entire word address For example, * VP = 0x1000, TAB _ X _ Num = 0x07, then: 0x1000-0x1003 sequentially stores the table data length of column

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			0-6, where 1003 low byte is unused. 0x1004 Address starts to store table content
0x03:L	Encode_Mode	1	. 7 defines whether text display character spacing is automatically adjusted: . 7 = 0 character spacing automatically adjusted . 7 = 1 no automatic adjustment of characters spacing, and the width of characters is fixed set dot matrix number . 6 defines Form content format: . 6 = 0 Table content is text format . 6 = 1. undefined . 5 Define whether the border line shows: 5 = 0 display border. 5 = 1 does not display border . 4 Not defined, write 0. . 3-. 0 defined coding mode of text: 0x00 = 8bit code, 0x01 = GB2312 internal code, 0x02 = GBK, 0x03 = BIG5, 0x04 = SJIS, 0x05 = UNI CODE
0x04	Xs,Ys,Xe,Ye	8	Form display area definition, upper left corner coordinate, lower right corner coordinate, and no display for beyond limit
0x08	Color_line	2	Table Border Color
0x09	Color_text	2	Table Text Color
0x0A:H	Font0_ID	1	ASCII font library Position when coding is 0x01-0x04
0x0A:L	Font1_ID	1	The fonts library position used for non-ASCII characters in the coding modes 0x00, 0x05, and 0x01-0x04
0x0B:H	Font_X_Dots	1	The dot matrix number in the X-direction of the font, under 0x01-0x04 mode, the ASCII character X is calculated according to X /2
0x0B:L	Font_Y_Dots	1	The dot matrix number in the Y direction of the font, and the dot matrix number in the Y direction of the font must be even.
0x0C:H	TAB_X_Adj_Mod	1	Table head display control is performed when TAB_X_Start is not 0, 0x00 = First column not displayed, 0x01 = First column displayed
0x0C:L	TAB_Y_Adj_Mod	1	When setting TAB_Y_Start is not 0, head display control is performed, 0x00 = first line not displayed, 0x01 = first line displayed

Note: When Encode _ mode. When 6 = 1, the first two words of each cell data content define the table data format, which is explained as follows:
First word high byte: Mode Select data type

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0x00 = integer (2 bytes),-32768 to 32767
0x01 = long integer (4 bytes)-214 7483648 to 214 7483647
0x02 = * VP high byte, unsigned number 0 to 255
0x03 = * VP low byte, unsigned number 0 to 255
0x04 = Super Long integer (8 bytes)-92233720 36854775808 to 92233720 36854775807
0x05 = unsigned integer (2 bytes) 0 to 65535
0x06 = Unsigned long integer (4 bytes) 0 to 4294967295
0x10 = time format 1, 12: 34: 56BCD code string
0x11 = time format 2, 12-34-56BCD code string
0x12 = time format 3, YYYY-MM-DD HH: MM: SS BCD code string
0xFF = Text format

First word low byte:

Mode = 0x00-0x06 defines the fixed point display format of the variable data, the high 4bit represents the integer number of bits, and the low 4bit represents the decimal number.

Mode =Length of byte of 0x10-0X11 time BCD code string

Mode = Other undefined

2nd word: Define cell text color

If that actual content of the table is short than the length specified by Unit_Data_Num, use 0xFFFF as the text ending character of the cell

For particularly large tables, the positioning and dragging of the table can be easily achieved through the modification of TAB_X_Start、TAB_Y_Start value.

5. 3. 4 Two-dimensional QR Code Graphics Display (0x25)

Address Offset (Double Bytes)	Definition	Data length (bytes)	Description
0x00	*VP	2	The two-dimensional code displays the content pointer. The two-dimensional code is 458 Bytes, and 0x0000 or 0xffff is an ending character.
0x01	（x，y）	4	The coordinate position of the two-dimensional code. (x, y) is the coordinate position of the upper left corner of the two-dimensional code in the screen. Two-dimensional code graphics have 45 * 45 unit pixels (data less than 155 bytes) and 73 * 73 unit pixels (data less than 459 bytes).
0x03	Unit Pixels	2	The physical pixel dot matrix size of each two-dimensional code unit pixel, 0x01-0x07. Setting Unit _ Pix els = 4, then each unit pixel will show in 4 * 4 dot matrix size.

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Variable attribute	
Name definition	Two-dimensional code display
Description pointer (0X))	FFFF
Variable storage address	0000
Unit-Pixels	4

For example: display the two-dimensional code generated in website www.stone-hmi.com ,and the UART sends command:

A5 5A 20 82 00 00 77 77 77 2E 73 74 6F 6E 65 2D 68 6D 69 2E 63 6F 6D

Description: A5 5A: Frame head

20: command byte length, 82 00 00 77 77 77 2E 73 74 6F 6E 65 2D 68 6D 69 2E 63 6F 6D tota lly 2 0 bytes (without frame header)

82: write variable register command

00 00: Variable address, set in control properties

77 77 77 2E 73 74 6F 6E 65 2D 68 6D 69 2E 63 6F 6D : Data content , ASCII code of www.stone-hmi.com

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6 Description pointer

For simple applications, users do not require knowledge of this chapter.

6. 1 Description of pointer introduction

The Intelligent TFT LCD Module is driven by variables, and all displayed characters, icons, etc. are defined as a variable, and the variable storage address is assigned, the display format is defined, and then the configuration file is generated and downloaded to the display terminal. When refreshing the display, the user only needs to send the variable contents and the variable storage address to the display terminal through the UART , and the display terminal will automatically display it according to the defined display format.

For each variable, its display format is fixed, defined by the profile downloaded to the Intelligent TFT LCD Module. When the user needs to temporarily modify the variable display format, it can be implemented by the description pointer described in this chapter.

The user needs to set whether to enable the description pointer when defining each variable, as shown in Figure 6-1.

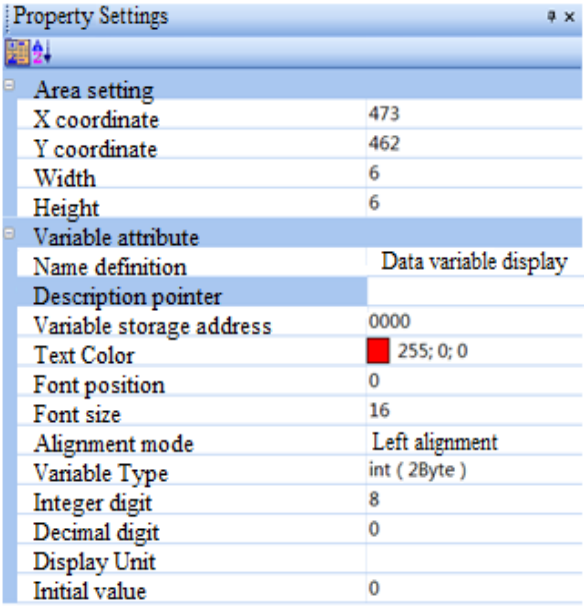

Figure 6-1 Setting Data Variable Display Properties

As shown in the graph description pointer column, FFFF represents that the current variable is prohibited to describe the pointer function. If it is filled with other data (any one of the 0000-FFFE) that represents that the current variable is enabled to describe the pointer, and the filled data is used to specify the variable memory address as the begining unit, open continuously in the variable memory A space (different variable types, block lengths, and data formats are also different, each variable has a detailed table that defines the corresponding data format) for storing the display format of the variable. The user can use the variable memory address to dynamically modify the variable display format using the 0x82 command.

Each attribute of a display variable can be read and written by describing pointer. The pointer address

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range, 0x0000-0xFFFE, is also stored in the user variable data store area, so the user-defined variable address can not overlap with the address describing the pointer.

6. 2 Description of pointer application

This section describes the simple application of the description pointer by changing the display color of a data variable as an example.

1. After adding a picture to the new project, add a data variable display control on the interface. The setting description pointer is 4000 and the variable storage address is 0000. As shown in Figure 6-2-1;

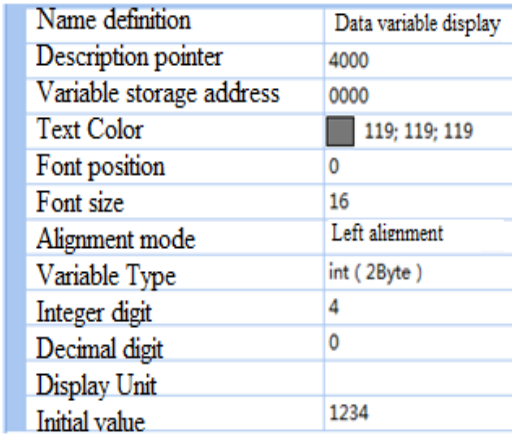

Figure 6-2-1 Adding Data Variables

2. See Section 5.2 for the description of the data variables, as shown in Figure 6-2-2

Address Offset (Double Bytes)	**Definition**	**Data length (bytes)**	**Description**
0x00	*VP	2	Variable pointer
0x01	X,Y	4	Beginning display position, display character string upper left corner coordinates
0x03	Color	2	Display Color
0x04:H	Lib_ID	1	ASCII character Position
0x04:L	Font size	1	The dot matrix number in the character X direction
0x05:H	Alignment mode	1	0x00 = left alignment, 0x01 = right alignment, 0x02 = align centered
0x05:L	Integer digit	1	Number of integer bit displayed (the sum of the integer and decimal bit cannot exceed 20).
0x06:H	Decimal digit	1	Number of decimal bit displayed (the sum of the integer and decimal bit cannot exceed 20)

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0x06:L	Variable data type	1	0x00 = integer (two bytes) :-32768 to 32767 0x01 = long integer (4 bytes) :-214 7483648 to 214 7483647 0x02 = VP * high byte: 0 to 255 0x03 = VP * low byte: 0 to 255 0x04 = Extra-long integer (8 bytes) : -92233720 36854775808 to 92233720 36854775807 0x05 = unsigned integer (2 bytes) : 0 to 65536 0x06 = Unsigned long integer (4 bytes) : 0 to 4294967295
0x07:H	Len_unit	1	Variable unit display length, 0x00 does not display unit
0x07:L	String_unit	9	Unit string, ASCII code
0x0C	Bclr	2	Background color

Figure 6-2-2 Data variable description pointer data format

It can be seen from the figure that the offset corresponding to the color is 03, and the variable memory address corresponding to the color attribute is 0x4000 + 03 = 0x40 03. The display color of the data variable is changed by adjusting the data in the 0x40 03 cell through 0x82 command.

For example, UART sends: A5 5A 05 82 40 03 F8 00

Then setting data variable displayed by red (0xF800 red).

In this example, the button key value is used to return the control. When the button is pressed, the key value is written directly as the corresponding color value into the variable memory 0x40 03 unit. The key return control property setting is shown in Figure 6-2-3.

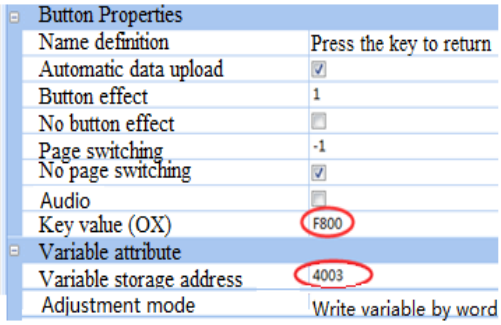

Figure 6-2-3 Return Control Attribute Setting of the keyboard

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Attachment 1 External Keyboard adapter plate KAP02

Many models of Intelligent TFT LCD Module are provided with a keyboard interface, as shown in Figure 1-2, the interface can connect 8 rows and 8 columns keyboard at most through the adapter plate KAP02.

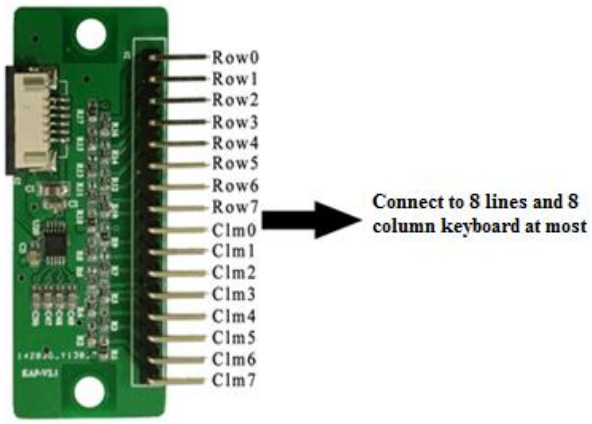

Figure 2-1KAP02 Picture of real products

As shown in the above figure, the adapter plate KAP02 provides two sockets, one is 6 PIN 1.0 pitch FPC socket, used for connection to the Intelligent TFT LCD Module, the other is 16PIN 2.54 pitch single-row bent needle, used to connect 8 rows and 8 columns keyboard at most.

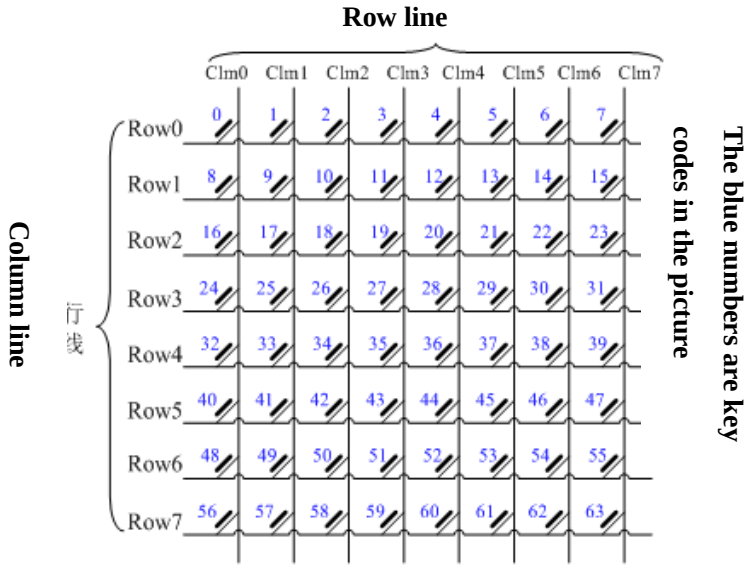

Figure 2-2 Keyboard line connection and key code distribution

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The keyboard line connection relationship and key codes are as shown in the figure above. The intersection position of each line and column is a key, there are 64 buttons at most, and the corresponding key code is 0-63.

When users design the button through Intelligent TFT LCD Module 4.3 configuration software, the specified button and external keyboard can be linked by specified key code.

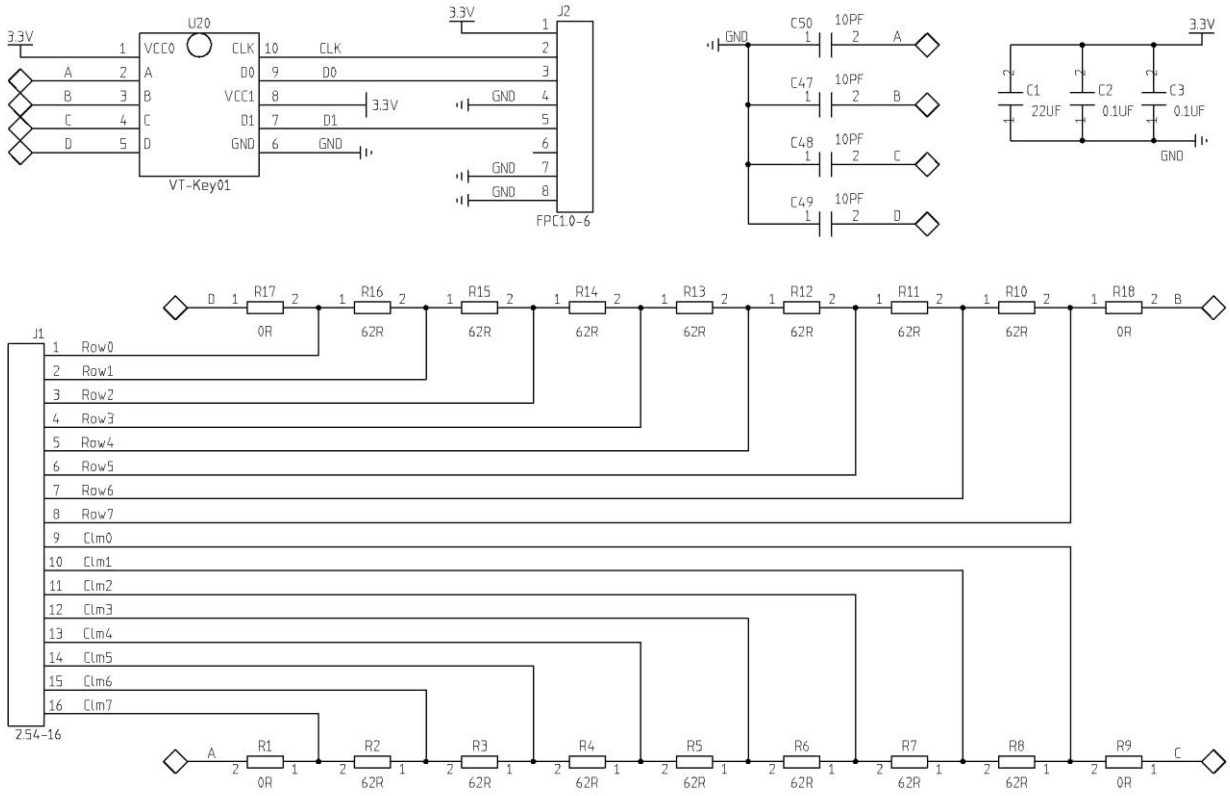

Figure 2-3 KAP02 Circuit Diagram

When the user needs external keyboard, contact the relevant personnel to select the KAP02 adapter plate or make add coring to the circuit principle diagram of Fig. 2-3.

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