LCD Module Technical Reference Manual

☐ Preliminary Specification

☐ Final Specification

Project No. 项 目 编 号	**HTM050A1-USART-ST V01**
Product Type 产 品 类 型	TFT LCD Module 800 x 3RGB x 480 Dots 5.0' TFT LCM

Signature by customer:
客 户 确 认 签 章:

☐Trial Production 小批量试产 ☐Mass Production 大批量生产

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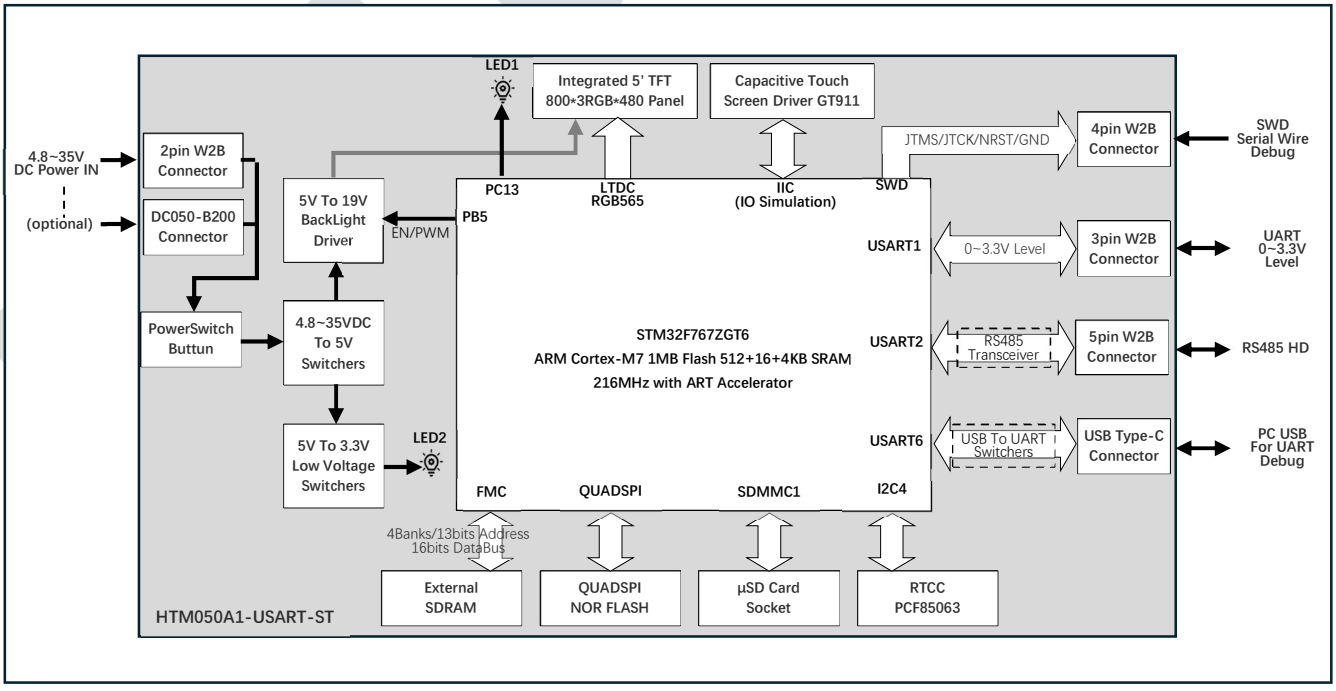
Document Revision	Date	Description	Prepared By	Approved By
V01	20250618	First Release.	y	

1. Basic Specifications

No.	Item	Specification	Unit	Remark
1	LCD Size	5.0” (Diagonal)	inch	-
2	Panel Type	a-Si TFT active matrix	-	-
3	Resolution	800x(3RGB)x480	pixel	-
4	Display Mode	Normally Black,Transmissive,IPS	-	-
5	Viewing Direction	All Direction	-	-
6	Color Depth	16.7M	COLOR	
7	Module Size	121.7(W) ×97.0(H) ×20.7(D)	mm	Note 1
8	Controller	STM32F767	-	
9	External SDRAM	32M (16-bit access)	Byte	
10	External Flash Memory	32M	Byte	
11	External SD Card	--	Byte	
12	CTP Driver IC	GT911	-	-
13	Interface	RS485(to USART2),USART1(3.3V TTL),USB(to USART6)	-	-
14	Supply Voltage	5.0~35.0	V	
15	Back Light Source	2x6 White LEDs		
16	Luminance	640	cd/m^2	-
17	Weight	TBD	g	-
18	Operating Temperature	-20~70	℃	-
19	Storage Temperature	-30~80	℃	-

Note 1: Please refer to the mechanical drawing.

2. Function Block Diagram



Note: The use of two DC power ports is mutually exclusive and cannot be used simultaneously.

3. Introduction

The HTM050A1-USART-ST LCD module is an intelligent human-machine interface (HMI) platform,

It has the characteristics of a wide voltage input power supply of 5.0~35VDC and a wide operating temperature, which are designed to improve the conditions for the module to be easily integrated into various smart devices.

The main functions of the module include communication with external devices through RS485, UART(3.3V), Debug UART interfaces. These interfaces are compatible with various protocols, including Modbus(Master/Slave, ASCII/RTU) protocol for bidirectional client/host communication.

Designers only need to connect the UART or RS485 output from the MCU of this module to the device host through the power interface, without the need for complex hardware and software redesign. This solution greatly reduces the development difficulty and shortens the development time for designers while retaining existing functions.

This module provides a ready to use solution for HMI panels, seamlessly integrating with graphic development environments (GDEs) such as ST TouchGFX and LVGL.

The module can be used independently in the system, directly connected to the device control subsystem in the system chassis, or remotely connected to the network through RS485 running Modbus.

Hardware Overview:

Processor and Memory

- The MCU is STM32F767V, with an Arm Cortex-M7 core and a clock frequency of up to 216MHz
- The MCU integrates 1MB FLASH and 512K SRAM
- Onboard 32MB QSPI NOR flash memory
- Onboard 32MB SDRAM display memory
- Onboard RTCC
- µSDCard slot, used for (user provided) storage cards, for functional expansion

Integrated Liquid Crystal Display (LCD)

- 5-inch IPS LCD screen, with software/hardware settings for horizontal/vertical display modes, providing high brightness LCD options.
- Capacitive touch screen, the shape and size of the touch screen cover can be customized according to requirements.

Pilot lamp

- Onboard single blue LED power indicator light
- Single white LED indicator light controlled by MCU onboard

There are numerous communication ports and simple connections

- DC050 connector (5.0~35VDC power supply)
- 2P 2.54mm W2B connector (5.0~35VDC power supply)
- 3P 2.54mm W2B connector (3.3V UART)
- 4P 2.54mm W2B connector (firmware debugging and download)
- 5P 2.54mm W2B connector (RS485 HD)
- USB Type-C connector (Debug UART)

- The above connectors can be customized according to specific needs.

Power supply and working environment

- +5.0 ~ 35V DC power input
- Operating temperature range of -20 ~ 70C° (further limited by LCD options)
- Storage temperature range from -30 ~ 80C°

Support the following embedded software and firmware

- Embedded Operating Systems: FREE-RTOS, ThreadX
- IDE Tools: STM32CubeMX, STM32CubeIDE, MDK
- GUI/GDE: TouchGFX, LVGL, QT
- HAL: STM32CubeMX
- Debug/Download Tools: ST-Link, J-Link

Templates, Drivers, and Libraries

- The module provides libraries, templates, and drivers to facilitate the development of a graphical user interface (GUI) when using TouchGFX.

4. Module features

4.1 RS485 port

The HTM050A1 module provides an RS485 port, which is output from the USART2 of STM32F767 to the RS485 transceiver and connected to the outside world through a 5-pin W2B connector. The transceiver is in half duplex (2-wire) mode. Hardware flow control data transmission can be selected, which uses additional hardware signals to manage the data flow between the sender and receiver to avoid problems caused by buffer overflow, data loss, or communication errors at the receiving end. The transfer will only start when the drive sends a "send enable" signal on the motherboard. This configuration mode was enabled during UART initialization.

Most RS485 interface modules are used as receiving terminals, which requires placing a 120Ω terminal resistor at the AB (RxD) input terminal. This module is equipped with a 120Ω terminal resistor R16 and a switch SW1. The terminal resistor can be switched as needed by turning the switch SW1 to ON (enable) or 1 (disable).

Note:

1. The onboard RS485 is not an isolated transceiver, and an external isolated transceiver is required to fully isolate network connections.

2. (2-wire) Differential half duplex RS485 must also be connected to a common ground wire. If not grounded, RS485 differential signals may generate common mode offset, which may cause electrical damage to the module.

4.2 UART port

The module provides a USB Type-C (for Debug UART) slave port, which is derived from the STM32F767 USART6 GPIO output to UART USB converter, providing convenience for developers to debug and verify the UART communication protocol of LCD modules using a PC. When using a USB (for Debug UART) port, the module needs to be connected to a 5.0-35VDC power supply, and a USB A-to-C cable is used to connect the PC to the module. There are various serial port debugging software (such as SSCOM) that support this function of the module.

In addition, the module also provides a 3.3V level UART port, which is directly connected to the USART1 GPIO port of the MCU. It is not protected by ESD or voltage/current, so caution must be taken when connecting.

4.3 SWD port

The W2B connector with a spacing of 2.54mm on board 4P is a Series Wire Debug interface used for debugging/downloading firmware for modules. Users can use DuPont wires to connect ST Link and modules for firmware debugging/downloading. ST Link is recommended to use V3 version for faster download speed.

5. Usage

5.1 Hardware preparation

LCD module, download/debugger ST Link V3SET, DuPont line

5.2 Software preparation

The following toolchain needs to be installed on the PC:

a). TouchGFX (V4.21.1)

b). KEIL MDK-ARM (V5.21)

c). STM32CubeMX（V6.12.0）

d). Visual Studio 2022

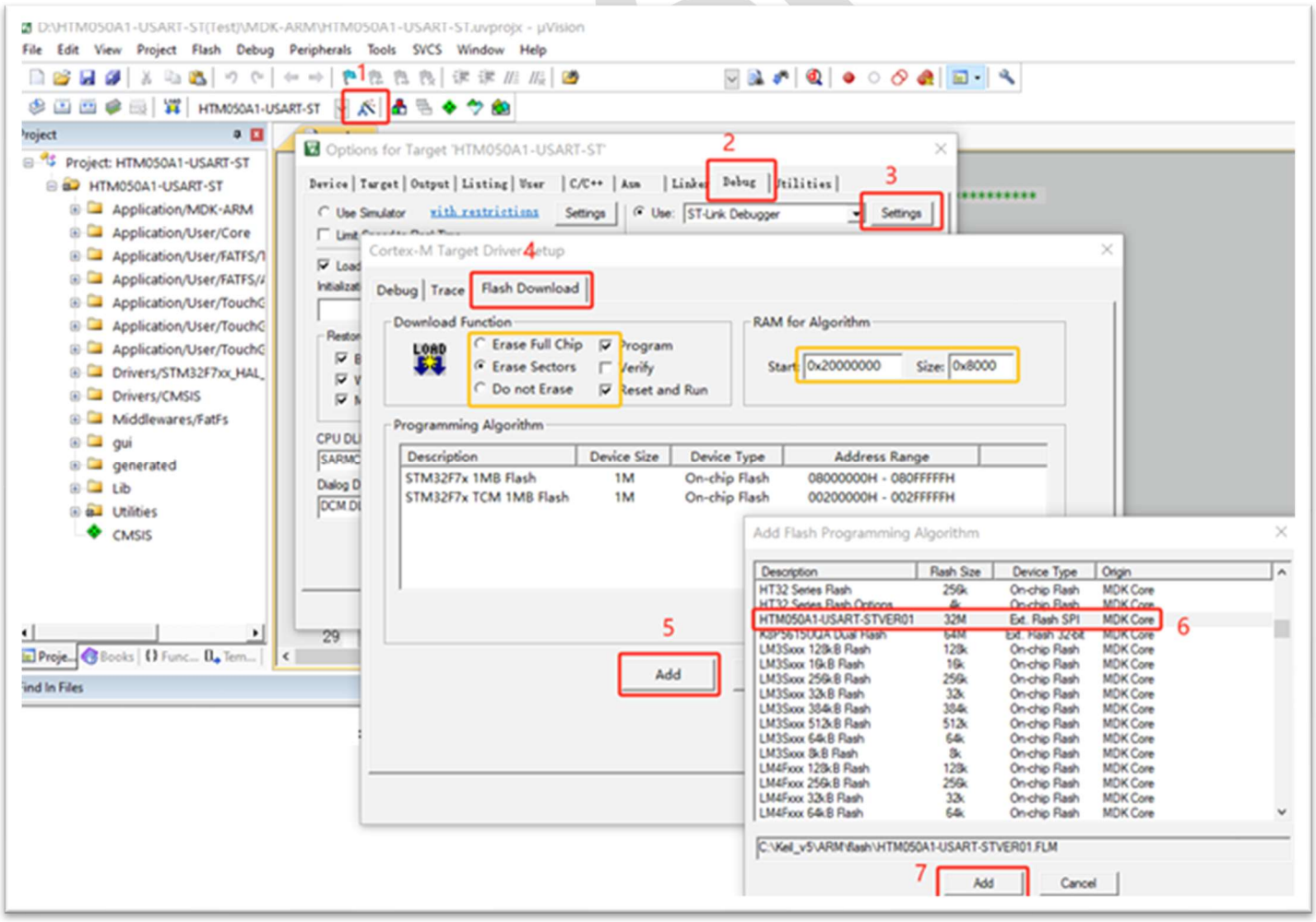
e). DEMO “HTM050A1-USART-ST(Test).zip“ (You can contact HOTDISPLAY sales personnel for assistance)

f). ST-Link driver

5.3 Add programming algorithm files

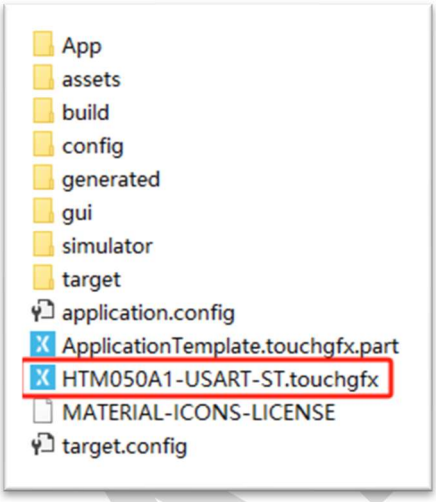
Install the above Toolchain software on the PC, unzip the compressed file of the demonstration program into the folder \HTM050A1-USART-ST(Test), and save it to the root directory of the PC. Copy the HTM050A1-USART-STVER01.FLM file from the folder to C:\KEIL MDK-ARM\ARM\Flash.

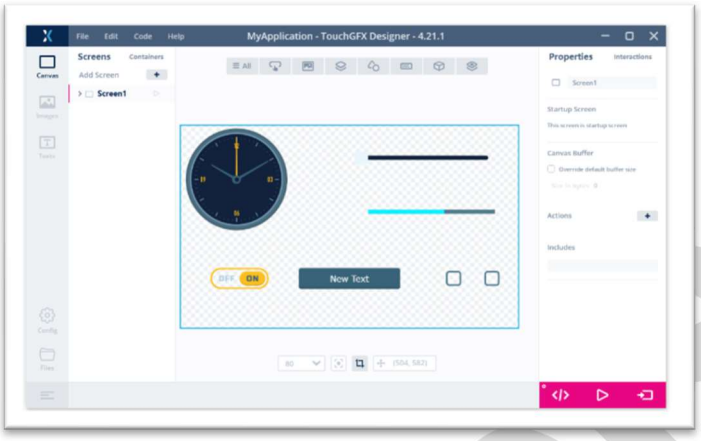
Open the \MDK-ARM\HTM050A1-USART-ST.uvprojx project file in the folder, and add programming algorithm files in uVision in the order of the red box numbers shown in the figure below.



5.4 Design GUI

Click on \HTM050A1-USART-ST(Test)\TouchGFX folder and select HTM050A1-USART-ST.touchgfx (as shown on the right) to launch the TouchGFX Designer application.





It opens a Canvas sample template (left image), in which buttons, sliders, progress bars, analog clocks, and other widgets have been dragged and dropped within Screen1. Users can now create their own well-designed GUI interfaces on this pre configured template.

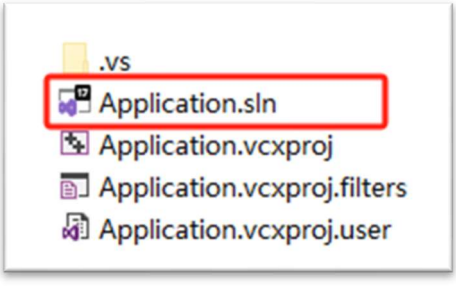
As this project was created using TouchGFX Designer **V4.21.1** version, users need to open it with the corresponding version.

Note: Users can log in https://support.touchgfx.com/docs/category/introduction

Get a detailed user manual for TouchGFX.

After completing the GUI design, save the project and click on "Generate Code" in the bottom right corner (or press F4). If you want to view the overall effect of the GUI without connecting hardware, you can click the play button in the bottom right corner (or press F5) to run the emulator to view it.

Due to the fact that TouchGFX applications are a set of C++files generated by TouchGFX Designer and TouchGFX Generator and written by ST developers, developers can use Visual Studio to develop and debug logic code just like developing other C++ applications, and a project file is provided for maintenance.



Open the msvs solution file Application. sln (as shown in the right image) in the folder \ HTM050A1 USART-ST (Test) \ TouchGFX \ simulator \ msvs. You can open and use Visual Studio to edit and debug code in logical C++type files using all the features of the IDE. After completion, save and run the VS emulator in debug mode to view the display effect of the GUI.

5.2 Firmware Programming

When you're satisfied with the GUI, it's time to make it work on your monitor:

a). Connect the PC USB port and the download/debugger ST Link with a USB cable.

b). Connect ST Link and LCD module correctly according to the SWD programming port pin definition of the LCD module using DuPont wire.

c). Connect the LCD module to the DC12V power supply.

d). Click on  'Build' in  uVision, generate the firmware, and then click  'Download'.

6. HANDLING AND CARE

Please follow the following operation and maintenance guidelines

6.1 ESD prevention measures

The module is highly sensitive to electrostatic discharge (ESD). Even if invisible static electricity dissipates into the circuit board, it will permanently render it inoperable. Ensure that ESD assembly and handling precautions are functioning properly. Like all electronic subsystems and circuits, follow the correct ESD handling procedures.

6.2 Handle

Be very careful when handling the edges of the module, as the flexible cables of the LCD panel are exposed there. If shear force is applied during transportation, it is easy to damage or tear.

Do not attempt to disassemble modules or solder components or wires onto modules; This may cause your circuit board to malfunction and render your warranty invalid.

Like any glass product, it should be handled with reasonable care to avoid shattering and scratching the glass.

If the LCD glass breaks and the LCD liquid material overflows, please avoid contact with exposed skin. Immediately wash the exposed skin with soap and water, and handle the product according to local material handling procedures.

If the module has a protective cover on the LCD during factory packaging, it is recommended to leave this protective film in place before installing the module in the final component to prevent scratches and fingerprints from damaging the surface of the display screen. Do not expose to high temperature and/or high humidity testing in areas with protective panels. Slowly remove the protective plate to minimize potential static electricity generation.

6.3 Pressure and impact

Do not use sharp objects to activate the touch screen on the module, otherwise the surface material may also be damaged.

Do not apply pressure to the surface of the LCD and ensure that it is not affected by the end user.

Do not apply any bending/twisting force to the PCB or LCD of the module, otherwise the device may be permanently damaged.

6.4 Store

For modules that have been stored for a long time without installation, please follow the following basic precautions:

1. Store modules in their original factory packaging as much as possible. Sealed polyethylene anti-static bags or anti-static trays are designed for long-term storage.

2. Store the module in a place that is not affected by high temperature, sunlight, or high humidity conditions. The recommended storage temperature should be maintained between 0 ℃ and+40 ℃, and the relative humidity should be below 80%.

If the seal is good and the ambient temperature is maintained at room temperature, no desiccant is needed.

6.5 Clean

Clean the surface of the LCD panel with a mixture of 50% ethanol and purified water diluted with a clean soft cloth.

Note: Do not use abrasives, ketone and aromatic solvents that may damage the polarizer or cause separation of adhesives used in the module structure.

No type of liquid or solvent is allowed to flow inside the LCD metal case or near electronic devices.

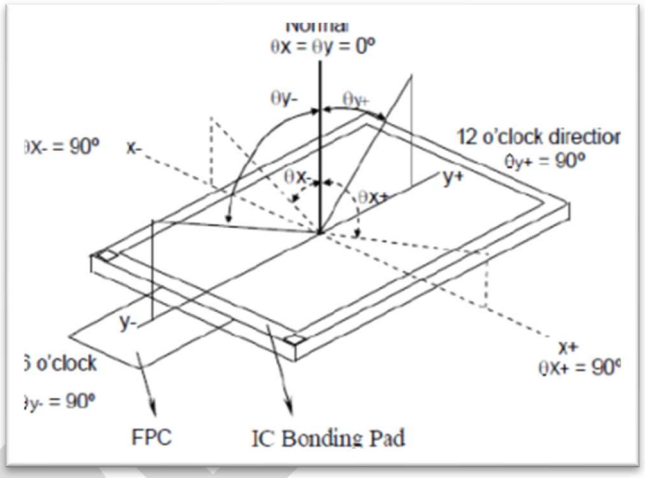
7. OPTICAL CHARACTERISTICS

The LCD viewing angle is specified in degrees, ranging from "direct view display" (0°) to looking flat from the side (90°). Different types of LCDs have different viewing angle characteristics, and system designers should typically choose the cheapest LCD option that supports the required installation direction.

The general categories of LCD technology listed from low to high by viewing angle are as follows:

- TN type:

  A cheap TFT horizontal/vertical display screen, characterized by its cost-effectiveness. It has three "good" viewing angles (usually around 65°) and one "bad" viewing angle (around 45°), and grayscale inversion (GSI) can impair the readability of the screen.



- Multi perspective (MVA):

  MVA technology, whether it is optical technology or underlying LCD technology, typically provides a viewing angle of 75°+ in all directions. Although MVA is often used as a general term, it was initially only possible to achieve it through a specialized LCD technology called multi domain vertical alignment. Nowadays, the most common approach to multi view is to use optical viewing angle (OVA) films to modify inexpensive TN type TFT horizontal/vertical LCDs, in order to overcome "bad" angles and increase the overall viewing angle. MVA screens are not as common as TN TFT horizontal/vertical screens, and are an advanced choice for most screens ≤ 10.1 inches.

- Organic LED (OLED):

  This is a completely different underlying technology from TFT-LCD. OLED does not require LED backlight (pixels are self luminous) and has excellent all-round viewing angle. Unfortunately, OLED still faces significant manufacturing, yield, storage, and lifespan issues. The practicality, usability, and cost-effectiveness of large-sized (>3.5 inches) OLEDs in industrial/medical/embedded fields still have a long way to go.

- In plane switching (IPS): This is a TFT technology that has begun to be popularized to all sizes, with a very wide and omnidirectional viewing angle, typically up to 80° or more.

  The best viewing angles are MVA, OLED, and IPS screens, which are suitable for installation in any direction. But the most cost-effective LCD technology is the basic TN type TFT horizontal/vertical mode screen, which has a 'bad' angle. For example, many landscape mode displays have a "6 o'clock" direction as their grayscale reversal (i.e. terrible!) viewing angle. Installing this monitor on systems typically used above eye level can cause viewing angle issues. However, rotating the module 180 ° and installing it "upside down" can solve this problem, and as long as the system does not need to be used below line of sight, it is still the most cost-effective display available. Installing this monitor from the side (vertical) can also be problematic, as it is almost impossible to view the screen from one side.

  Note: We offer many LCD options for the module, including affordable TN mode, as well as MVA and IPS options to meet more challenging viewing angle requirements. Not all sizes support all viewing angle technologies: please refer to the LCD code and product order code.

8. ABSOLUTE MAXIMUM RATINGS

Items	Symbol	MIN.	MAX.	Unit	NOTE
Supply Voltage	VDD_IN	-0.3	+40	V	①
Digital I/O Signals Voltage	VIO	-0.5	3.3	V	①
Operating Temperature	TOP	-20	+70	℃	-
Storage Temperature	Tst	-30	+80	℃	-
Storage Humidity (@25±5°C)	HST	10	-	%RH	-
Operating Ambient Humidity (@25±5°C)	HOP	10	-	%RH	-

Note: ① Exceeding the maximum value may cause abnormal operation or permanent damage to the equipment.

9. ELECTRICAL CHARACTERISTICS

Items	Symbol	Values			Unit	Condition
		MIN.	TYP.	MAX.		
Supply Voltage	VDD_IN	5.0	12	35	V	-
Digital I/O Signals High Level Voltage	VIH	2.0	-	3.3	V	UART1(RX/TX) SWD(JTMS/JTCK/NRST)
Digital I/O Signals Low Level Voltage	VIL	0	-	0.8	V	
Operation Current @5V	IOP	-	436	-	mA	-
Operation Current @8V		-	287	-		
Operation Current @12V		-	189	-		
Operation Current @24V		-	96	-		
Operation Current @32V		-	71	-		

Note:

1 . The LCD module should be powered by a 5.0 to 35VDC power supply, and it is recommended to use a 12V/1A (24V/1A) DC power supply.

2. The power supply should not exceed a continuous or instantaneous voltage greater than 35VDC.

3. Although the module will not be damaged when working with a power supply below 5V, it cannot be guaranteed that the module will operate normally below this voltage.。

10. LED BACKLIGHT ELECTRICAL CHARACTERISTICS

Items	Symbol	Values			Unit	Condition
		MIN.	TYP.	MAX.		
Forward Voltage	VF	18	19	20	V	If=3.1V/20mA/1-chip
Forward Current	IF	-	100	-	mA	
Luminance(With LCD)	Lv	-	700	-	cd/m²	Without TP

		-	640	-		With TP
LED Life Time	Hr	20000	30000	-	Hours	Ta=25±3℃

Note:

1. LED life time (Hr) can be defined as the time in which it continues to operate under the condition:Ta=25±3 ℃, typical IL value indicated in the above table until the brightness becomes less than 50%.

2. The above results are estimated and judged by the MTBF calculation method of the LED failure time. The actual test LED is lit for 5000H at Ta=25±3 ℃, and the brightness decays by 8%

11. LCD DIMENSIONS