T5UIC1 Application Guide　　　　　　　　# Ver2.3

1 Overview

T5UIC1 is a simplified version based on Diwen Technology's T5 CPU, designed for applications that do not require a touch screen, simple UI functions, and demanding cost requirements. Serial command screen.

Its main features include:

(1) 65K color TFT display.

(2) Basic drawing commands, Chinese and ASCII text display, support JPEG icon, JPEG picture, barcode, two-dimensional code display.

(3) 384Kbytes font space.

Stored 6*12-32*64 dot matrix ASCII and 12*12-64*64 dot matrix GB2312 Chinese character library (Chinese characters are scaled based on 16*16 dot matrix).

(4) 512Kbytes image and icon storage space is divided into 16 storage spaces according to 32KB.

It can store up to 16 JPEG full-screen pictures.

Or store 0-16 JPEG icon library files (a single icon library file can exceed 32KB and occupy multiple memory spaces).

(5) 32KBytes SRAM data memory that can be read and written by serial port, the data is lost when power is off, and all initialized to 0x00 when power on.

Mainly used in online pictures, icon library data update, or real-time JPEG icon, picture display.

(6) 16Kbytes Flash data memory that can be read and written by serial port, the data will not be lost when power off, and the write life is 100,000 times.

Mainly used for data storage such as user configuration parameters.

(7) SD/SDHC interface configuration parameters and update fonts and pictures.

(8) An additional full-duplex serial port is extended.

(9) The CPU can be configured to run at 250MHz or 400MHz.

2 Serial port instruction set

2.1 Basic conventions

(1) Color definition

16bit color, 5R6G5B mode

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

(2) Coordinate system

2.2 Serial data frame format

The serial port is fixed in 8N1 mode, and the baud rate is configured with SD card by T5UIC1.CFG file.

The serial port data frame is composed of 4 parts: frame header, command, data, CRC check, and frame end character, which are described in the following table:

Frame header	instruction	data	CRC check (optional)	End of frame
It is fixed to 0xAA 1 byte, see instruction set description. The maximum length is 248 bytes. CRC check of instructions and data.				End has 0xCC 33 C3 3C

2.3 Instruction set

(1) Configuration and interface commands

Features	instruction	data	Description
			For example:
shake hands	0x00	None (issued)/0x4F4B (screen response)	Tx: AA 00 CC 33 C3 3C
			Rx: AA 00 4F 4B CC 33 C3 3C
CRC report	0xFF	0x01	When the serial port CRC check is enabled, if the CRC check fails, it will automatically respond to this command.
			DIM_Set: backlight brightness value, 0x00-0xFF.

Instruction	Data	Description
Backlight brightness adjustment 0x30 DIM_Set		0x00 backlight is off, 0xFF backlight is the brightest, among which 0x01-0x1F setting value backlight It may flicker. The power-on default value is 0xFF. Example: AA 30 80 CC 33 C3 3C adjust the brightness to 50%. Processing time, SRAM can be ignored; Flash takes 1 second at most.
Write data memory 0x31	Issued: Type, Address, Datas Write Flash response: 0xA5 0x4F 0x4B.	Type: Write memory selection, 0x5A=32KB SRAM, 0xA5=16KB Flash. Address: write data memory address, 0x0000-0x7FFF or 0x3FFF. Datas: The data string to be written. Example: AA 31 5A 00 00 31 32 33 34 CC 33 C3 3C write SRAM Processing time, SRAM can be ignored, and Flash delay is about 0.1mS.
Read data memory 0x32	Issued: Type, Address, Length Response: Type, Address, Length, Datas	Type: Read memory selection, 0x5A=32KB SRAM, 0xA5=16KB Flash. Address: write data memory address, 0x0000-0x7FFF or 0x3FFF. Length: The length of the read data byte, 0x01-0xF0. Datas: The read data string. For example: Tx: AA 32 5A 00 00 04 CC 33 C3 3C read SRAM Rx: AA 32 5A 00 00 04 31 32 33 34 CC 33 C3 3C data response The processing time can take up to 2 seconds.
Write picture memory 0x33	Issued: 0x5A, 0xA5, PIC_ID Response: 0xA5 0x4F 0x4B.	Write the contents of the 32KB SRAM data memory into the designated image memory space. PIC_ID: Picture memory space location, 0x00-0x0F, each space is 32Kbytes. For example: Tx: AA 33 5A A5 00 CC 33 C3 3C Rx: AA 33 4F 4B CC 33 C3 3C
Display direction adjustment 0x34	Issued: 0x5A, 0xA5, Dis_CFG Response: 0xA5 0x4F 0x4B	Dis_CFG is defined as follows: 0x00=0 degrees, no rotation. 0x01=90 degree rotation. 0x02=180 degrees, the viewing angle is flipped. 0x03=270 degree rotation. For example: Tx: AA 34 5A A5 02 CC 33 C3 3C Rx: AA 34 4F 4B CC 33 C3 3C
Expansion serial port Configuration 0x38 Bode_Set		Bode_Set: Set the baud rate of the extended serial port, 0x0001-0x03FF. Bode_Set= 15667200/baud rate, the lowest baud rate is 15300. The power-on default value is 0x0088, which corresponds to a baud rate of 115200bps. For example: AA 38 03 30 CC 33 C3 3C Set the baud rate of the extended serial port to 19200bps.
Expansion serial port Data sending 0x39 Datas		Send the Datas packet from the extended serial port. For example: AA 39 31 32 33 34 35 36 37 38 39 CC 33 C3 3C Send the string "123456789" from the extended serial port.
Expansion serial port Data reception 0x3A Len_Data, Datas		The screen actively uploads the data received by the extended serial port. Len_Data: The length of the data uploaded this time. Datas: The data uploaded this time. For example: Assuming that the extended serial port receives a byte of data 0x55, the screen will automatically upload AA 3A 01 55 CC 33 C3 3C.

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(2) Drawing related instructions

instruction	data	Description
0x01 Color		Clear the screen; processing time 1.5mS (corresponding to 400MHz main frequency, the same below). Color: Clear screen color. Example: AA 01 00 1F CC 33 C3 3C
0x02 Color,Nx,Ny,(X0,Y0)……(Xn,Yn)		Set point; processing time=0.4*Nx*Ny*number of set points uS. Color: Set point color. Nx: Actual pixel size in X direction, 0x01-0x0F. Ny: actual pixel size in Y direction, 0x01-0x0F. (Xn, Yn): Set point coordinate sequence. Example: AA 02 F8 00 04 04 00 08 00 08 01 00 01 00 CC 33 C3 3C
0x03 Color,(X0,Y0),……(Xn,Yn)		End connection; processing time=0.5*Max (length of line segment in X direction, length of line segment in Y direction) uS. Color: Connection color, 2Bytes. (Xn, Yn): the coordinates of the end point of the line segment. Example: AA 03 FF FF 00 40 00 40 01 00 01 00 CC 33 C3 3C
0x05 Mode,Color,(Xs,Ys),(Xe,Ye)		Rectangular area display; processing time=0.14*number of pixels uS. Mode: 0x00=Color color displays a rectangular frame. 0x01=Color fills the rectangular area with color. 0x02=Color XOR rectangle area data, mostly used for menu selection/unselection coloring. Color: color.

(Xs,Ys),(Xe,Ye): The coordinates of the upper left and lower right corners of the rectangle.

Example: AA 05 02 07 E0 00 40 00 40 01 00 01 00 CC 33 C3 3C

instruction	data	
0x08 (x,y), Wide, Color1, Color0, data		Two-color bitmap filling; processing time=0.22*number of filled pixels uS.

Two-color bitmap filling; processing time=0.22*number of filled pixels uS.

(X, y): the starting point coordinates of the upper left corner of the bitmap filled area;

Wide: the width of the filled area in the X direction, 0x0001-0x01E0;

Color1: fill color corresponding to bit1;

Color0: fill color corresponding to bit0;

data: Fill the data, note that the data needs to be left-aligned to 1Byte in the width direction.

For example, to fill the width of 6 pixels, it also needs to occupy 1Byte space, and the high 6bit is effective.

For example:

AA 08 0004 0004 00 08 0000 FFFF 7C C6 C6 C6 7C C6 C6 C6 7C CC 33

C3 3C

The screen area moves; processing time=0.20*the number of pixels in the moving area uS.

Mode: mobile mode

　.7: Movement mode, 0=circular movement. 1=Translation, the vacant area is filled with color.

　.6-.4: Write 0.

　.3-.0: moving direction, 0x00=left. 0x01=to the right. 0x02=Up. 0x03=Down.

0x09 Mode, DIS, Color, (Xs, Ys), (Xe, Ye)

DIS: moving distance, number of pixel dots, 0x0000-horizontal resolution/2, 2Bytes.

Color: Fill color, only valid when DIR.7=1.

(Xs, Ys): The coordinates of the upper left corner of the selected area.

(Xe, Ye): The coordinates of the lower right corner of the selected area.

Example: AA 09 00 00 08 FF FF 00 40 00 40 01 00 01 00 CC 33 C3 3C

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(3) Text related instructions

instruction	data	Description
0x11 Mode, Color, Bcolor, (x, y), Strings		Character string display; the processing time of a 16*16 dot matrix Chinese character is 76uS, and the rest are converted according to the ratio of the dot matrix numb
0x14	Mode, Color, Bcolor, Num_I, Num_F, (X, y), Datas	

Character string display; the processing time of a 16*16 dot matrix Chinese character is 76uS, and the rest are converted according to the ratio of the dot matrix numb

Mode: Display mode.

　.7 Character width adjustment setting 1=adjust 0=no adjustment.

　.6 Background color display setting 1=display 0=not display.

　.5-.4 Write 0.

　.3-.0: font size, 0x00-0x09, the corresponding font size is as follows:

　0x00=6*12 0x01=8*16 0x02=10*20 0x03=12*24 0x04=14*28

　0x05=16*32 0x06=20*40 0x07=24*48 0x08=28*56 0x09=32*64

Color: Character display color.

Bcolor: The color of the character background display.

(X, y): The coordinates of the upper left corner of the string display.

Strings: Strings to be displayed, non-ASCII characters are displayed according to Chinese characters in GB2312 encoding format.

For example:

AA 11 41 FF FF 00 00 00 20 00 80 44 57 49 4E 20 B5 CF CE C4 CC 33 C3 3C

Data variable display; processing time is the same as 0x11 instruction calculation.

Mode: Display mode.

　.7 Background color display setting 1=display 0=not display.

　.6 1=signed number 0=unsigned number.

　.5 1=invalid 0 display 0=invalid 0 not display.

　.4 1=Invalid 0 is displayed as 0 0=Invalid 0 is displayed as a space.

　.3-.0: font size,

　　0x00-0x09, same as 0x11 command;

　　0x0A-0x0F Use font library 0x02:7400-0x02: BBFF special dot matrix size of 18KB font library space

Small characters are arranged in the order of 0-9, ., -, +, SP (space).

　　0x0A=64*120 dot matrix;

　　0x0B=44*80 dot matrix.

Color: Character display color.

Bcolor: The color of the character background display.

Num_I: The number of integer digits displayed, 0x01-0x14.

Num_F: The number of decimal places displayed. 0x00-0x14, the sum of Num_I+Num_F cannot exceed 20.

(X, y): The coordinates of the upper left corner of the variable display.

Datas: Data variables, up to 8 bytes.

Example: AA 14 85 FF FF 00 00 0A 02 00 00 00 00 49 96 02 D2 CC 33 C3 3C

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(4) Instructions related to pictures and icons

instruction	data	Description
		QR code display; QR_Pixel=4 QR code processing time is 7.5mS.
		(X, y): the coordinate position displayed by the QR code;
		QR_Pixel: The size of pixels occupied by each point of the QR code, 0x01-0x0F;
0x21	(X,Y), QR_Pixel, DATA	DATA: Display data, up to 154 bytes.
		The size of the QR code is (46*QR_Pixel)*(46*QR_Pixle) dot matrix.
		Example: AA 21 00 08 00 08 04 68 74 74 70 3A 2F 2F 77 77 77 2E 64 77 69 6E 2E 63 6F 6D 2E 63 6E CC 33 C3 3C
		JPEG picture display; 480*272 resolution 4:1:1 format compression processing time is 250mS.
		Display JPEG pictures saved in 512Kbytes picture memory.
0x22	0x00, JPEG_ID	The picture is also cached to the 0# virtual display area (0x27 command operation can be used).
		JPEG_ID: 0x00-0x0F, corresponding to the starting ID of the picture stored in JPEG.
		Example: AA 22 00 00 CC 33 C3 3C
		Icon library icon display; 1 28*45 icon, background display mode, processing time 3.2mS.
		(X, y): The starting position of the first icon, corresponding to the upper left corner of the icon.
		Mode: Icon display mode.
		.7 Icon background display settings: 0=Background filtering is not displayed, 1=Background display.
		When setting the background filter to not display, the background must be pure black.
		.6 Background picture restoration settings (only valid when .7=0)
0x23	(X,y), Mode, Icon_IDs	0=Background pictures are not restored, 1=Automatically use 0# virtual display area pictures for background restoration.
		.5 Background filtering intensity selection (only valid when .7=0) 0=normal, 1=enhanced
		.4 Undefined, write 0.
		.3-.0 Icon library storage location, 0x00-0x0F.
		Icon_IDs: Icon IDs that need to be displayed, each ID is represented by 1 Byte, 0x00-0xFF.
		Example: AA 23 00 10 00 10 08 00 01 02 03 CC 33 C3 3C
		SRAM memory icon display; 1 28*45 icon, background display mode, processing time 3.1mS.
		(X, y): The display position of the icon, corresponding to the upper left corner of the icon.
		Mode: Icon display mode.
		.7 Icon background display settings: 0=Background filtering is not displayed, 1=Background display.
		When setting the background filter to not display, the background must be pure black.
0x24	(X,y), Mode, Address	.6 Undefined, write 0.
		.5 Background filtering intensity selection (only valid when .7=0) 0=normal, 1=enhanced
		.4-.0 is not defined, write 0.
		Address: The starting address of SRAM memory to store JPEG icon data, 0x0000-0x7FFF.
		Example: AA 24 00 10 00 10 00 00 00 00 CC 33 C3 3C
		The JPEG picture is decompressed to 1# virtual display area.
		480*272 resolution 4:1:1 format compression processing time is 240mS.
0x25	0x01, JPEG_ID	Decompress the JPEG pictures saved in the 512Kbytes picture memory to the 1# virtual display area, which is convenient
		Copy, paste and other operations of the icon.
		JPEG_ID: 0x00-0x0F, corresponding to the starting ID of the picture stored in JPEG.
		Example: AA 25 01 01 CC 33 C3 3C
		1# Copy and paste the designated area of the virtual display area to the current display interface.
		256*256 pixel area processing time is 12.5mS (0.2uS per pixel).
		(Xs, Ys): 1# The coordinates of the upper left corner of the selected area of the virtual display area icon.

0x26	(Xs,Ys), (Xe,Ye), (x,y)	(Xe, Ye): 1# The coordinates of the lower right corner of the area specified by the icon in the virtual display area. (X, y): When pasting to the current display area, the coordinate position of the upper left corner. Example: AA 26 00 40 00 40 01 00 01 00 00 20 00 20 00 CC 33 C3 3C Copy and paste from the designated area of the virtual display area to the current display interface. 256*256 pixel area processing time is 12.5mS (0.2uS per pixel).

0x27	Mode, (Xs, Ys), (Xe, Ye), (x, y)	Mode: Display mode.
		.7 Background display setting 0=Background filtering is not displayed, 1=Background display.
		    When setting the background filter to not display, the background must be pure black.
		.6 Background picture restoration settings (only valid when .7=0 and .1=1):
		    0=Background pictures are not restored, 1=Automatically use 0# virtual display area pictures for background restoration.
		.5 Background filtering intensity selection (only valid when .7=0) 0=normal, 1=enhanced
		.4-.1 Reserved, write 0.
		.0 Virtual display area selection 0=0#virtual display area, 1=1#virtual display area.
		(Xs, Ys): The coordinates of the upper left corner of the selected area of the icon in the virtual display area.
		(Xe, Ye): The coordinates of the lower right corner of the icon area in the virtual display area.
		(X, y): When pasting to the current display area, the coordinate position of the upper left corner.
		Example: AA 27 01 00 40 00 40 01 00 01 00 00 40 00 40 CC 33 C3 3C

0x28	(X,y), Mode, Icon_Lib, Icon_IDs, Icon_IDe, Delay_Time	The icon animation automatically displays the command settings. (X, y): The starting position of the animation icon, corresponding to the upper left corner of the icon.

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Mode: Animation icon display mode.
.7 Switch control 1=This group of animation is on 0=This group of animation is off; it can be controlled by 0x29 command.
.6 Start mode 1=start from the start icon 0=start from the last stop position.
.5-.4 Undefined, write 0.
.3-.0 The command position of this group of animation icons, 0x00-0x0F, there are a total of 16 groups of animation commands.
Icon_lib: icon library storage location, 0x00-0x0F.
Icon_IDs: the starting icon position of the animation, 0x00-0xFF.
Icon_IDe: the position of the animation termination icon, 0x00-0xFF.
Delay_time: The display time interval of the animation icon, 0x00-0xFF, the unit is 10mS.
Example: AA 28 00 10 00 10 80 09 00 09 0A CC 33 C3 3C Set the 0th group animation

0x29	Cartoon_Set	Icon animation automatically displays command control. Cartoon_Set: ICON animation command switch control; Each bit corresponds to a set of instructions, 1=on, 0=off; .15 corresponds to the 15th group of animation commands, and .0 corresponds to the 0th group of animation commands. Example: AA 29 00 05 CC 33 C3 3C Turn on group 0 and group 2 animation commands.
0x2A	(X,Y), DATA	EAN-13 bar code display, the processing time is about 0.5mS. (X, y): The coordinate position displayed by the barcode must be an even number. DATA: 12Bytes barcode data, the data is HEX encoding mode (0x00-0x09). The width of the barcode bit module is fixed to 2 pixels, and the size of the entire barcode area is 222*94 dot matrix. For example: AA 2A 00 08 00 08 09 07 08 07 05 03 09 09 08 03 02 04 CC 33 C3 3C

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3 SD/SDHC interface

The downloaded file must be placed in the DWIN_SET folder in the root directory of the SD card , and must be a 4KB sector, FAT32 format SD or SDHC card.

The file naming instructions are as follows:

file type	Naming rules	Description
Program upgrade file	T5UIC1_*.BIN	
Hardware profile	T5UIC1.CFG	
Font file	0T5UIC1.HZK	T5UIC1 font library special extraction software generation.
JPEG file	Image storage ID + (optional) file name.JPG (For example, 0 boot interface.JPG)	The image or icon library stores ID 0-15. The JPEG file must be the same as the physical resolution of the screen,
JPEG icon file	ICON storage ID + (optional) file name.ICO (For example, 8 icon library.ICO)	Baseline mode, 4:4:4 or 4:1:1 format. The file size of a single JPEG image cannot exceed 32Kbytes.

T5UIC1.CFG hardware configuration file adopts binary data format, and write 0x00 to save unused data, which can be edited by software such as UltraEdit. Edit, the description is as follows:

category	Address	length	definition	Description
Configuration recognition	0x00	4		0x54 0x35 0x43 0x31 Fixed content.

System Configuration	0x04	1	System Configuration	.7 CPU frequency selection 0=250MHz 1=400MHz
				.6 Power-on display settings 0=display the 0th# picture 1=black clear screen, backlight off
				.5 Serial port CRC check switch 0=off 1=on
				.4-.2 Undefined, write 0
				.1-.0 Display direction setting
				      0x00 (00) = 0 degrees, no rotation.
				      0x01(01)=90 degree rotation.
				      0x02(10)=180 degrees, the viewing angle is reversed.
				      0x03(11)=270 degree rotation.

Screen selection	0x05	1	Display selection	0x00=480*272 DMT48270C043_04WN 0x01=240*320 DMT32240C028_04WN (old model LCD screen) 0x02=320*240 DMT32240C035_04WN 0x03=240*320 DMT32240C028_04WN 0x04=320*480 DMT48320C035_04WN 0x05=240*320 DMT32240C024_04WN (EWTN screen) 0x06=320*480 DMT48320C035_04WN*(IPS screen) 0x07=240*320 DMT32240C024_04WN* (IPS screen) 0x08=240*320 DMT32240C020_04WN*(IPS screen)
System clock calibration	0x06	2	System clock calibration	Write 0x5AA5 to start the system clock calibration. During the calibration process, the UART2 serial port is 115200bps, 8N1 mode, 30mS interval timing Send more than 30 data packets with 0x55 data per packet. It has been calibrated before leaving the factory, no additional calibration is required during use.
Baud rate setting	0x08	2	Serial port baud rate setting	Setting value=7833600/set baud rate. Setting value range = 1-1023, the lowest baud rate is 7757bps. 0x0044=115200bps.
Screen selection enable	0x0A	1	Screen selection enable	0x5A=0x05 The screen selection configuration of the address is valid. Other=The configuration is invalid.

During the download process, the screen displays blue, and the screen resets or displays red after the download is complete.

Appendix 1 Revision History

date	modify the content	version
2017.04.17	First release.	V1.0
2017.09.25	Unified into the T5UIC1 platform.	V1.0
2018.02.23	Flash expands by 512Kbytes, adds 16*16 dot matrix GB2312 Chinese character library, and expands the number of pictures to 16; Add 0x21 QR code display instruction.	V1.1
2018.03.14	Added support for 480*320 display screen.	V1.2
2018.04.13	Use the 16*16 dot matrix Chinese characters as the benchmark to zoom to expand the display range of Chinese characters to 12*12-64*64.	V1.3
2018.11.21	Added 250MHz/400MHz main frequency selection; Added the option to display 0# picture or black screen at boot; Added reference for instruction processing time under 400MHz main frequency, 250MHz time*1.6 times calculation; Added 0x23 icon library ICON display instruction; Added 0x24 SRAM memory ICON display command for real-time JPEG image display; Added 0x27 0# copy and paste instructions in virtual display area; Added 0x28, 0x29 animation icon commands; Added 0x31, 0x32 read and write data memory (16KB Flash or 32KB SRAM) instructions; Added 0x33 to write the contents of 32KB SRAM data memory into picture memory command for online picture update; Added 0x34 display direction adjustment command.	V2.0
2019.12.02	Added CRC check option to the serial port.	V2.1
2020.04.07	Added 0x08 two-color bitmap filling command. Added 0x2A EAN-13 barcode display.	V2.2
2021.03.03	CFG file 0x0A address adds the screen selection enable setting.	V2.3

If you have any questions during the use of this document or Diwen products, or if you want to know more about the latest information about Diwen products, please contact us in time:

400 toll free: 400 018 9008

Enterprise QQ and WeChat: 400 018 9008

Corporate mail: dwinhmi@dwin.com.cn

Thank you for your continued support to Diwen, your support is the driving force for our progress!

thank you all!