

T5S0 Serial-Command Screen Application Guide

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1 Overview

The T5S0-based serial-command screen uses DWIN's economical, low-consumption T5S0 ASIC as its core controller to drive SPI, QSPI, and 8080 parallel-interface LCD panels with resolutions of 480 × 320 or below. It is mainly designed for upgrading conventional digital tube and segment displays with a cost-effective solution.

Features:

- 65K color display (when using serial commands, the color value shall be set in 24-bit RGB format.).
- Features basic drawing commands; supports scalable display of Chinese and ASCII text; supports display of JPEG icons, barcodes, and QR codes.
- Supports external SPI NOR Flash up to 16 Mbytes (1 Mbyte standard).
- 32 KB SRAM data memory with UART read/write access.
- 32 KB Flash data memory accessible via UART read/write operation (non-volatile, 100,000 write cycles).
- Supports serial-port-based parameter configuration and updates for fonts, images, and code.
- Built-in VRAM; display refresh is controlled via the serial interface, facilitating high-quality UI design.
- Supports serial communication speeds up to 7.3728 Mbps, user-defined baud rates, and CRC data verification.

1.1 User Interface Definition (12pin 0.5mm FPC)

PIN#	Definition	I/O	Description	Remarks
1	GND	P	GND, internally connected in parallel.	
2	GND	P		
3	+3.3	P	3.3V power supply, internally connected in parallel.	DC 3.2-3.4 V, 200 mA.
4	+3.3	P		
5	RXD	I	UART input.	Serial interface with 3.3V CMOS/TTL logic level compatibility.
6	TXD	O	UART Output.	Internal 10k pull-up, routed to the interface through a 100R series resistor.
7	TDO	O	Float, do not use.	Internal 10k pull-up, routed to the interface through a 100R series resistor.
8	TDI	I		Internal 10k pull-up, routed to the interface through a 100R series resistor.
9	TCK	I		Internal 10k pull-up, routed to the interface through a 100R series resistor.
10	TMS	I		Internal 10k pull-up, routed to the interface through a 100R series resistor.
11	JIOS	I		Internal 10k pull-up, routed to the interface through a 100R series resistor.
12	SET	I	Work Mode Selection.	Internal 10k pull-down, routed to the interface through a 100R series resistor. Detected by T5S0 at power-up to determine the work mode: When pulled low or left floating, the serial interface operates according to the user-defined configuration. When pulled high, configure the serial baud rate to 921600 bps, 8N1 framing, and disable CRC verification.

2 Serial Command Set

2.1 Display Coordinate Basic Definition



2.2 Serial Data Frame Format

The serial interface operates in a fixed 8N1 frame format, with the baud rate configured by the user.

A serial data frame comprises four parts—Header, Command, Data with CRC Checksum, and Trailer—as detailed below:

Frame Header	Command	Data	CRC Verification (Optional)	Frame Terminator
Fixed to 0xAA	1 byte, see command set description	Maximum 248 bytes.	CRC Verification of Command and Data	Fixed as 0xCC 33 C3 3C

2.3 Command Set

(1) Configuration and Interface Command

Function	Command	Data	Description
Handshake	0x00	Transit: None Receive: 0x4F 0x4B Version Config	Version: Software Version number. Config: the value stored at address 0x0012 within the system configuration file (.CFG). Example: Tx: AA 00 CC 33 C3 3C Rx: AA 00 4F 4B 10 00 CC 33 C3 3C
CRC Report	0xFF	0x01	When serial CRC verification is enabled, this command will be automatically responded to if the CRC verification fails.
Brightness Adjustment	0x30	DIM_Set	DIM_Set: Backlight brightness value, valid over the range of 0x00 (backlight disabled) to 0xFF (maximum luminous intensity) Example: Tx: AA 30 80 CC 33 C3 3C — sets the brightness to 50%.
Write Data Memory	0x31	Transit: 0x5A, Address, Datas Receive: 0x5A 0x4F 0x4B This response is returned after a successful write operation.	Address: 32KB SRAM write address, 0x0000–0x7FFF. Datas: The data string to be written. Example: Tx: AA 31 5A 00 00 31 32 33 34 CC 33 C3 3C Rx: AA 31 5A 4F 4B CC 33 C3 3C
Read Data Memory	0x32	Transit: 0x5A, Address, Length Receive: 0x5A, Address, Length, Datas	Address: 32KB SRAM read address, 0x0000–0x7FFF. Length: Number of bytes to read. Valid range: 0x01 – 0xF0. Datas: The read data string. Example:

Function	Command	Data	Description
			Tx: AA 32 5A 00 00 04 CC 33 C3 3C Rx: AA 32 5A 00 00 04 31 32 33 34 CC 33 C3 3C
Refresh the Display Once	0x3D	Transit: None Response: 0x4F 0x4B The response is returned after refresh completion.	Initiates a one-time display refresh, whereby the content stored in the T5S0 display memory is transferred and rendered on the LCD screen. Example: Tx: AA 3D CC 33 C3 3C Rx: AA 3D 4F 4B CC 33 C3 3C When this command is executed on the DMT32240F028-06WN, a single display refresh cycle takes 10 ms to complete.
On-chip Flash Data Saving/Loading	0x3E	Tx: 0x5A 0xA5 0x00 Mode Rx: Mode 0x4F 0x4B The response is returned after processing completes.	Mode = 0x55, loads data from Flash. Reads data from the 32KB on-chip Flash and loads it into the 32KB SRAM data memory. Data loading takes approximately 32 ms. Example: Tx: AA 3E 5A A5 00 55 CC 33 C3 3C Rx: AA 3E 55 4F 4B CC 33 C3 3C Mode = 0xAA: Saves the data to Flash. Saves the data of the 32KB SRAM data memory to the on-chip 32KB Flash memory. If an abnormal power failure occurs during the data saving process, the original data will be automatically restored. The data saving operation takes up to 3 seconds at most. Example: Tx: AA 3E 5A A5 00 AA CC 33 C3 3C

Function	Command	Data	Description
			Rx: AA 3E AA 4F 4B CC 33 C3 3C
Enter Download Mode	0x3F	Transit: 0x5A A5 BODE_SET Response: 0x4F 0x4B The baud rate switch and download mode entering occurs only after the T5S0 response.	BODE_SET: Configures the serial baud rate for download. 4 bytes. The minimum baud rate is 9600 bps (0x00002580). The maximum baud rate is 7372800bps (0x00708000). Example: Tx: AA 3F 5A A5 00 0E 10 00 CC 33 C3 3C Rx: AA 3F 4F 4B CC 33 C3 3C Enters download mode and sets the baud rate to 921600 bps.

(2) Drawing Command

Command	Data	Description
0x01	Color	Clear screen. Color: defines the clear-screen color, specified in 24-bit RGB format. Example: AA 01 00 00 FF CC 33 C3 3C The DMT32240F028-06WN requires 0.25 ms to execute a sample command.
0x02	Color, N, (X0, Y0)... (Xn, Yn)	Set Point Color: The set point color, specified in 24-bit RGB format. N: Sets the point size. Each point will be drawn as an N×N pixel block. Available values: 0x01 to 0x0F. (Xn, Yn): Coordinate sequence for the set point. Example: AA 02 FF 00 00 04 00 08 00 08 00 80 00 80 CC 33 C3 3C The execution time of the example command on the DMT32240F028-06WN is negligible.
0x03	Color, N, (X0, Y0),... (Xn, Yn)	Endpoint Connection. Color: The connection line color, specified in 24-bit RGB format. N: Line thickness. The actual pixel size of each line segment point is N×N. Valid range: 0x01–0x0F. (Xn, Yn): Coordinates defining the endpoints of the line segment. Example: AA 03 FF FF FF 04 00 08 00 08 00 80 00 80 CC 33 C3 3C The execution time of the example command on the DMT32240F028-06WN is negligible.
0x05	Mode, Color, N, (Xs, Ys), (Xe, Ye)	Rectangular Area Display Mode: Display Mode 0x00: Displays a rectangular frame in the specified

Command	Data	Description
		Color, with line thickness defined by Nx and Ny. 0x01: Renders a filled rectangle in the designated Color. 0x02: Applies an XOR (exclusive OR) operation to the rectangular area using the specified Color. Primarily used for menu item selection/deselection highlighting. Color: Color, specified by 24bit RGB format. N: Line thickness, the actual pixel size of line segment points is N*N. Available values: 0x01 to 0x0F. Note: This setting only applies to rectangle frame mode. (Xs, Ys), (Xe, Ye): Top-left and bottom-right corner coordinates of the rectangle. Example: AA 05 02 00 FF 00 02 00 08 00 08 00 80 00 80 CC 33 C3 3C The DMT32240F028-06WN requires 0.1 ms to execute the example command.
0x09	Mode, DIS, Color, (Xs, Ys), (Xe, Ye)	Moves the selected area. Mode: Move Mode .7: Move mode, 0 = Circular shift. 1 = Pan shift; empty space is filled with the selected color. .6-.2: Write 0. .1-.0: Move Direction. 00 = left, 01 = right, 10 = up, 11 = down. DIS: Movement distance, specified in the number of pixels. Valid range: 0x0000 to (horizontal resolution / 2). Data length: 2 bytes. Color: Fill color, specified in 24-bit RGB format. Valid only when Mode.7 = 1. (Xs, Ys): Top-left corner coordinate of the selected region. (Xe, Ye): Bottom-right corner coordinate of the selected

Command	Data	Description
		region. Example: AA 09 00 00 08 FF FF FF 00 10 00 10 00 80 00 80 CC 33 C3 3C The DMT32240F028-06WN requires 0.1 ms to execute the example command.

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(3) Text Command

Command	Data	Description
0x12	Lib_ID, Text_V, Mode, Color0, Color1, (Xs, Ys, Xe, Ye), DX, DY, Strings	String Display Lib_ID: font location, 0x00-0xFF. The font needs to be processed using DWIN software. Text_V: Specifies the size of the text to be displayed (vertical dot count). Valid values range: 0x08 to 0xFF. Auto-scaling enabled. Mode: Display Mode .7 Fill the text box with the background color before displaying the text. 1 = fill; 0 = do not fill. .6 Specifies whether to restore the text box area from the current picture background prior to text output. 1=Restore; 0=Do not restore .5 Space display size 1= Text_V/2, 0= Text_V/4. .4: reserved, write 0. .3-.0: String encoding format. 0 = 8-bit encoding, 1 = GB2312, 2 = GBK, 3 = BIG5, 4 = SJIS, 5 = UNICODE encoding. Color0: Character display color, set in 24-bit RGB format. Color1: Specifies the text box fill color, set in 24-bit RGB format. (Xs, Ys, Xe, Ye): Text box area. DX: The spacing between individual characters. DY: The spacing between the characters in each column. Strings: Specifies the text string that will be displayed on the screen. The text string is displayed from left to right and from top to bottom inside the text box. Example: AA 12 00 20 80 00 00 00 FF FF 0010 0010 00C0 0040 01 00 30 31 32 33 34 35 36 37 38 39 CC 33 C3 3C The typical execution time for the above command on the DMT32240F028-06WN is 0.2 ms (approximately 20 μs per character on average).

Command	Data	Description
0x13	Lib_ID, Text_V, Mode, Color0, Color1, Num_I, Num_F, (Xs, Ys, Xe, Ye), Datas	Data variable display. Lib_ID: font location, 0x00-0xFF. The font needs to be processed using DWIN software. When the font library is set to 0xFF, the built-in 8×12 dot-matrix font is used by default, and Text_V is invalid. Text_V: Specifies the text display size (vertical dot count). Valid values range: 0x08 to 0xFF. Auto-scaling enabled. Mode: Display Mode .7: Background fill enable for text box (applied before text output). 1: Fill; 0: No fill. .6: Specifies whether to restore the text box area from the current picture background prior to text output. 1 = Restore; 0 = No restoration. .5 Leading Zero Display Control: 1 = Display leading zeros, 0 = Hide leading zeros. .4 Leading Zero Format: 1 = Show as "0", 0 = Show as space. .3-.2 Data variable format, 00 = Unsigned integer, 01 = Signed integer, 10 = 32-bit single-precision float, 11 = 64-bit double-precision float. .1-.0, Alignment Mode: 00 = Align left, 01 = Align right, 10 = Align center. Color0: Character display color, specified in 24-bit RGB format. Color1: Specifies the text box fill color, set in 24-bit RGB format. Num_I: Specifies the number of integer digits to be displayed. Valid range: 0x01 to 0x14. Num_F: Specifies the number of fractional digits to display. Valid range: 0x00 - 0x14. The sum of Num_I and Num_F must not exceed 20. Datas: Data variable with a maximum capacity of 8 bytes. The characters are displayed as a single line, centered within the text box.

Command	Data	Description
		Example: AA 13 FF 0C 81 00 00 00 FF FF FF 04 04 0010 0010 0080 0050 00 FF FF FF CC 33 C3 3C The DMT32240F028-06WN executes the above example command in 0.12 ms.

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(4) Picture and Icon Command

Command	Data	Description
0x21	(X, Y), Color0, Color1, QR_Pixel, DATA	QR code display. (x, y): (x, y): the coordinates specifying the position where the QR code is displayed. Color0: QR code display color, set in 24-bit RGB format. Black (0x000000) is typically used. Color1: QR code background color, set in 24-bit RGB format. White (0xFFFFFFFF) is typically used. QR_Pixel: Specifies the pixel size for each QR code module. Valid range: 0x01-0x07. DATA: Display data, up to 154 bytes in length. The QR code size is $(46 * \text{QR_Pixel}) * (46 * \text{QR_Pixel})$ Matrix Pixels. Example: AA 21 00 08 00 08 000000 FFFFFFFF 03 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 The DMT32240F028-06WN executes the example command with a typical speed of 2.6 ms.
0x22	ICL_ID, JPEG_ID	JPEG image is displayed in full screen, with a processing speed of approximately 20 ns per pixel. ICL_ID: Specifies the ICL file ID in which the JPEG image is stored. Valid range: 0x00–0xFF. JPEG_ID: JPEG image ID to be displayed. Valid range: 0x0000–0xFFFF. When performing a background restoration, the image last displayed by the 0x22 command serves as the current background image. Example: AA 22 08 00 00 CC 33 C3 3C On the DMT32240F028-06WN, executing this command to display one 320×240 image takes 1.5 ms (typically 1.3–2.0 ms, depending on the JPEG file size).
0x23	ICL_ID, Mode, Color,	JPEG icon display, with a processing speed of approximately 20 ns

Command	Data	Description
	(Xs, Ys, Xe, Ye), DX, Icon_IDs	per pixel. ICL_ID: Specifies the ICL file ID in which the JPEG image is stored. Valid range: 0x00–0xFF. Mode: Icon Display Mode. .7: Pre-fill the icon frame with the background color before rendering the icon. 1 = Fill, 0 = No fill. .6: Pre-restore the icon frame from the current image background before rendering the icon. 1 = Restore, 0 = Do not restore. .5: Icon background display setting. 0 = Background filtered out (not displayed), 1 = Background displayed. .4 undefined, write 0. .3–.0: Background filter strength control (active only when .5=0). 0x0 = Min (weakest), 0xF = Max (strongest). Color: Icon frame fill color. Set in 24-bit RGB format. (Xs, Ys, Xe, Ye): Icon frame area. The display position of the first icon is at (Xs, Ys). DX: Adjusts the spacing between icons. It accepts values from 0x00 to 0xFF, and is stored as an 8-bit signed integer. Icon_IDs: Specifies the ID of the icons to be displayed. Valid range: 0x0000 - 0xFFFF. Example: AA 23 08 48 00 00 00 0010 0010 00E0 0080 00 0001 0002 0003 0004 CC 33 C3 3C The DMT32240F028-06WN requires 1.5 ms to display a 320×240 icon via this command when the background is shown. If the background is filtered out, the execution time decreases to typically 0.8–1.2 ms.
0x2A	(X, Y), DATA	EAN-13 barcode display. (x, y): Barcode display position coordinates. DATA: the 12-byte barcode data, encoded in HEX format (0x00 to 0x09). The barcode is rendered with a fixed module width of 2 pixels. The

Command	Data	Description
		overall barcode area measures 222 × 94 pixels. Example: AA 2A 00 08 00 08 09 07 08 07 05 03 09 09 08 03 02 04 CC 33 C3 3C On DMT32240F028-06WN, executing the example command takes 0.6 ms.
0x2C	ICL_ID, JPEG_ID, (Xs, Ys, Xe, Ye), (x, y)	This command copies a selected area from a JPEG image and pastes it at a designated location on the current screen. ICL_ID: Specifies the ICL file ID in which the JPEG image is stored. Valid range: 0x00–0xFF. JPEG_ID: JPEG image ID to be displayed. Range: 0x0000–0xFFFF. (Xs, Ys, Xe, Ye): Region on the JPEG image. (x, y): Specifies the position where the copied content is pasted on the current display area. Example: AA 2C 03 00 01 00 08 00 08 00 80 00 80 00 20 00 20 CC 33 C3 3C The DMT32240F028-06WN requires 1.6 ms to execute the example command, with a typical range of 1.4 to 2.1 ms depending on the JPEG file size.

3 Download Mode

3.1 Enter Download Mode

Transmit AA 3F 5A A5 BODE_SET (4 bytes) CC 33 C3 3C via the serial port to enter download mode.

BODE_SET: Configures the serial baud rate for downloads. For instance, a value of 0x000E1000 sets the baud rate to 921600 bps.

3.2 Download Mode Command Format

\0x5AA5 (frame header) + LEN_H:L (command and data length) + CMD (command) + DATAs (data) + CRC_H:L (CRC check)

The data length field LEN_H:L specifies the total byte count of CMD and DATAs combined. This length does not include the CRC bytes, and the maximum value is 0x1010.

CRC_H:L is the 16-bit MODBUS CRC check value for the command (CMD) and data (DATAs).

3.3 Download Mode Command Set

CMD (Command)	Function	DATAs
0x50	Handshake	Tx: null Rx: 0x4F 0x4B
0x52	Clear screen	Tx: COLOR_R:G:B Rx:0x4F 0x4B
0x53	Text Display	Tx: COLOR_R:G:B + B_COLOR_R:G:B + (x,y) + Strings + 0x00 Rx: 0x4F 0x4B COLOR_R:G:B specifies the character color, while B_COLOR_R:G:B defines the background color. The 8×12 dot-matrix text display supports only ASCII characters in the range 0x20–0x5F.
0x55	Data Download	Tx: Start Address (ADR_H:M_H:M_L:L) + Data (up to 4KB) Rx: Start Address + 0xFF (OK) / 0x00 (Error) Reponce can be received only after a successful T5S0 write operation The start address must be aligned to a 4 KB boundary (the

CMD (Command)	Function	DATAs
		lower 12 address bits must be zero). 4 KB blocks are erased per operation. If the data length is less than 4 KB, the T5S0 automatically pads the remainder with 0x00 bytes.
0x5A	4KB Block CRC Verification	Tx: Start address (ADR_H:M_H:M_L:L) Rx: Start Address + CRC_H:: L The start address must be aligned to a 4 KB boundary (i.e., the lower 12 address bits must be zero). Additionally, the code region of the T5S0 is not subject to CRC checking. In an OTA update, the system first performs a CRC check on the Flash data. The download proceeds only if the CRC value calculated from the Flash differs from the CRC value of the upgrade package. This mechanism effectively improves download efficiency.
0x5E	Exit Download	Tx: null Rx: 0x4F 0x4B The T5S0 automatically exits download mode after sending the response and restores the serial port settings to the original state.
0x5F	Reset Restart	Tx: null Rx: 0x4F 0x4B Reset and restart after T5L0 response.

3.4 Flash Address Mapping Table

Start Address	Data Location	Space Size	Description
0xFF F0 00 00	On-chip Flash	64KB	GUI code, T5S0_UI*.BIN
0xFF F1 00 00	On-chip Flash	64KB	TPS04 code, T5S0_OS*.BIN
0xFF F2 00 00	On-chip Flash	64KB	Reserved for system use. Do not write.
0xFF F3 00 00	On-chip Flash	32KB	On-chip 32KB Flash database.
0xFF F3 80 00	On-chip Flash	4KB	CFG file, T5S0*.CFG.
0xFF F3 90 00	On-chip Flash	12KB	Reserved for system use. Do not write.
0xFF F3 C0 00	On-chip Flash	16KB	INI file, T5S0*.INI.
0x00 00 00 00	Off-chip Flash	Max 16MB	Font file, numeric ID (0-255) *.BIN or .ICL. File start address = File ID * 0x01: 0000. For example, the start address for file #12 is 0x000C: 0000.

4 Hardware Configuration File Format (*.CFG)

Type	Address	Length	Definition	Description
Configuration Identification	0x00	4	0x54 0x35 0x53 0x30	Fixed content.
Reserved	0x04	12	Reserved	Write 0x00.
System Configuration	0x10	2	System Configuration Enable	0x5AA5 indicates that the current configuration modification is valid.
	0x12	1	System Configuration	.7 Power-on Display Settings 0 = display boot image; 1 = clear the display and set the screen to black. .6 Serial CRC Verification Switch 0 = off; 1 = on. .5-.2 undefined, write 0 .1-.0 Power-On Display Orientation 0x00 (00) = 0°, no rotation. 0x01 (01) = Rotated 90°. 0x02 (10) = 180°, vertically flipped. 0x03 (11) = Rotated 270°. The factory default setting is 0x80 (clear the screen to black on power-on; CRC disabled; no rotation).
	0x13	4	UART Baud Rate	Specifies the target baud rate value (e.g., 115200 bps = 0x00 01 C2 00). The reference base frequency is 7.3728 Mbps. If the calculated division factor (Division Factor = 7372800/Baud Rate) is not an integer, rounding off the factor will introduce a slight deviation in the actual baud rate. Factory Configuration: 0x00 01 C2 00 (115200 bps).
	0x17	1	Backlight brightness setting at power-on	Value range: 0x00 - 0xFF, where 0x00 completely turns off the backlight, and 0xFF sets it to maximum brightness.

Type	Address	Length	Definition	Description
				Factory configuration: 0xFF.
	0x18	8	Reserved	Write 0x00.
Display configuration	0x20	2	Display configuration enable.	0x5AA5 indicates that the current configuration modification is valid. This setting is pre-configured at the factory and should not be modified by the user.
	0x22	2	Display horizontal resolution	The resolution should be set according to the display's actual physical resolution, without considering the screen rotation configuration.
	0x24	2	Display vertical resolution	
	0x26	4	Reserved	Write 0x00.
Boot Image Configuration	0x2A	2	Boot Image Configuration Enable	0x5AA5 indicates that the current configuration modification is valid.
	0x2C	2	Picture ICL file location	0x0000-0x00FF.
	0x2E	2	Picture ID	0x0000-0xFFFF.
Reserved	0x30	208	Reserved	Write 0x00.

Revision Record

Version	Date	Description	Translated By
V1.0	2026-08-17	First Release	Jiang Yi

Please contact us if you have any questions about the use of this document or our products, or if you would like to know the latest information about our products:

Customer service Tel: +86 400 018 9008

Customer service email: dwinhmi@dwin.com.cn

DWIN Developer Forum: <http://inforum.dwin.com.cn:20080/forum.php>

Thank you all for continuous support of DWIN, and your approval is the driving force of our progress!