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# Product Specification

Monochrome LCD Character Module  
Element Touch Part ID:  
TLEC1602A21 (STN Yellow Green)  
Ver: B



**Revision History**

| Rev. | Date       | Contents                  | Written | Approved |
|------|------------|---------------------------|---------|----------|
| A    | 2009/08/17 | Preliminary Specification | He      | Zhang    |
| B    | 2017/09/15 | New IC AIP31066L          | Ma      | Zhang    |
|      |            |                           |         |          |
|      |            |                           |         |          |
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Special Notes

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## 1. FUNCTIONS & FEATURES

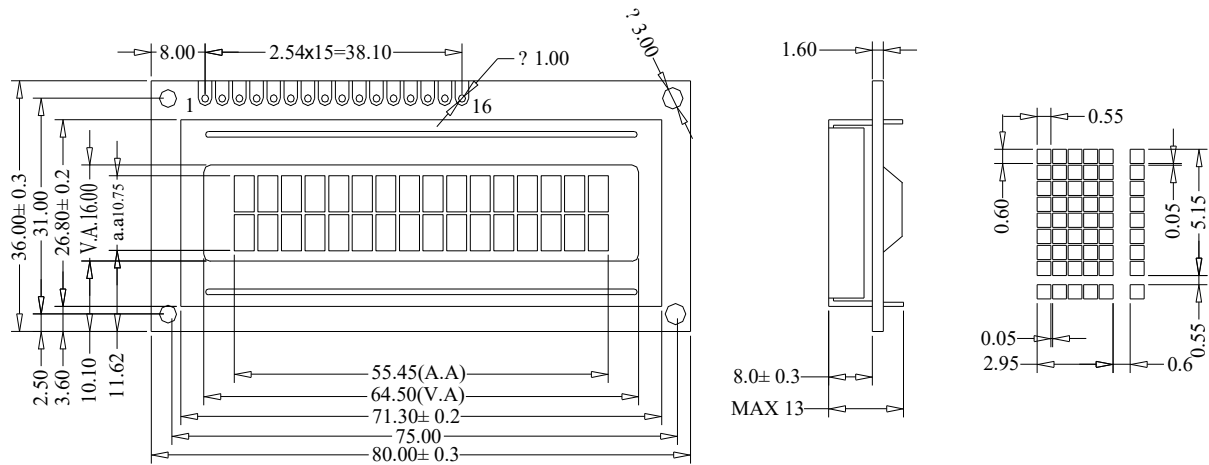
### Features

- Characters: 16 x 2 Lines
- LCD Mode: STN Positive Yellow Green Transflective
- Controller IC: AIP31066L or Equivalent
- Driving Method: 1/16 Duty; 1/5Bias
- Viewing Angie: 6 O'clock direction
- 6800 serial 8-Bit/4-Bit MPU Interface
- Backlight: Yellow Green LED
- Operating Temperature Range: -20 to 70°C;
- Storage Temperature Range : -30 to 80°C;

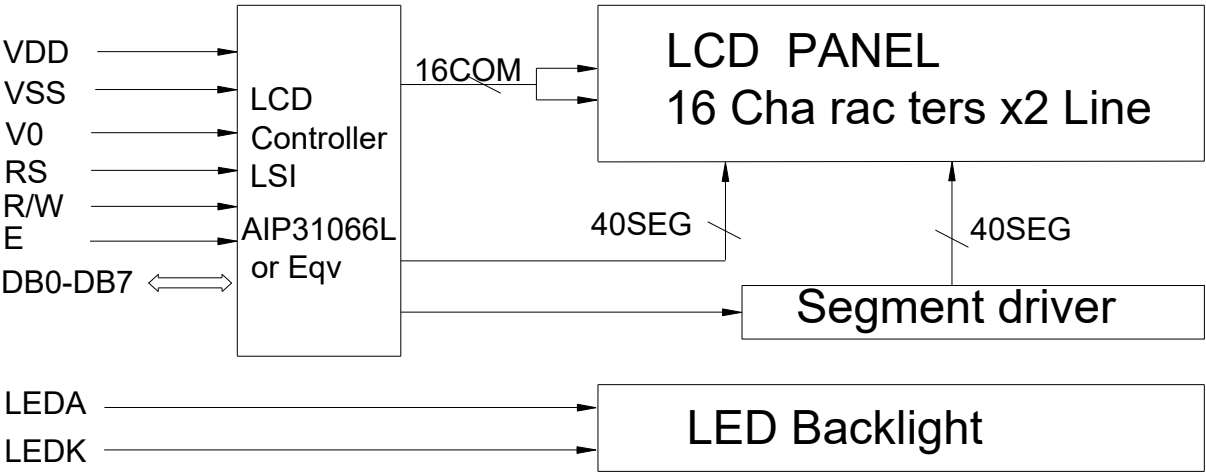
## 2. MECHANICAL SPECIFICATIONS

| ITEM                | SPECIFICATIONS               | UNIT |
|---------------------|------------------------------|------|
| Module Size         | 80.0L x 36.0W x 13.0 (max) H | mm   |
| View Area           | 64.5 x 16.0/13.8             | mm   |
| Number of Character | 16 x 2 Lines                 | -    |
| Character Size      | 2.95 x 5.15                  | mm   |
| Character Pitch     | 3.50 x 5.60                  | mm   |

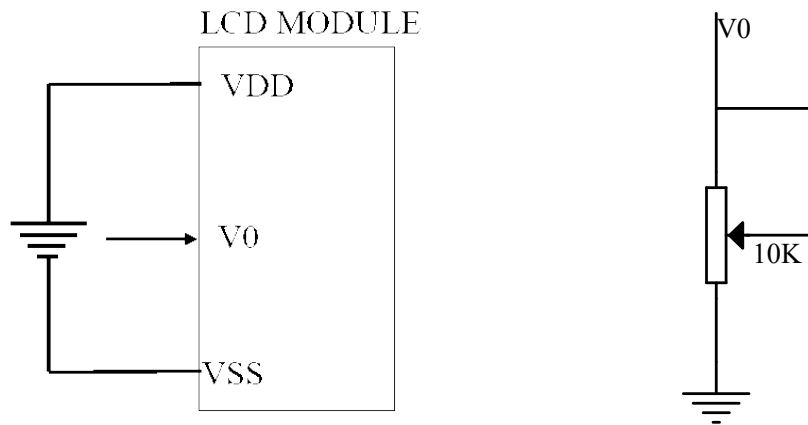
3. EXTERNAL DIMENSIONS



4. BLOCK DIAGRAM



## 5. POWER SUPPLY



$VDD - V0$  = Operating voltage for LCD

## 6. PIN DESCRIPTION

| ITEM | SYMBOL | LEVEL   | FUNCTION                       |
|------|--------|---------|--------------------------------|
| 1    | VSS    | 0V      | Power Ground                   |
| 2    | VDD    | 5.0V    | Power Supply For Logic         |
| 3    | V0     | -       | Contrast Adjust                |
| 4    | RS     | H/L     | H+ Data L+ Command             |
| 5    | R/W    | H/L     | H+ Read L+ Write               |
| 6    | E      | H' H->L | Enable Signal                  |
| 7    | DB0    | H/L     | Data Bus                       |
| 14   | DB7    |         |                                |
| 15   | LEDA   | 5.0V    | Power Supply For LED Backlight |
| 16   | LEDK   | 0V      |                                |

## 7. MAXIMUM ABSOLUTE LIMIT (T=25°C)

| Items                 | Symbol | Min | Max | Unit | Condition       |
|-----------------------|--------|-----|-----|------|-----------------|
| Supply Voltage        | Vdd    | 0   | 5.0 | V    | Vss=0V          |
| Input Voltage         | Vin    | 0   | Vdd | V    | Vss=0V          |
| Operating Temperature | Top    | -20 | 70  | ℃    | No Condensation |
| Storage Temperature   | Tst    | -30 | 80  | ℃    | No Condensation |

Note: Voltage greater than above may damage the module

All voltages are specified relative to Vss=0V

## 8. ELECTRICAL CHARACTERISTICS

### 8.1 DC Characteristics (VDD=+5V, VSS=0V, Ta=-0~+50°C)

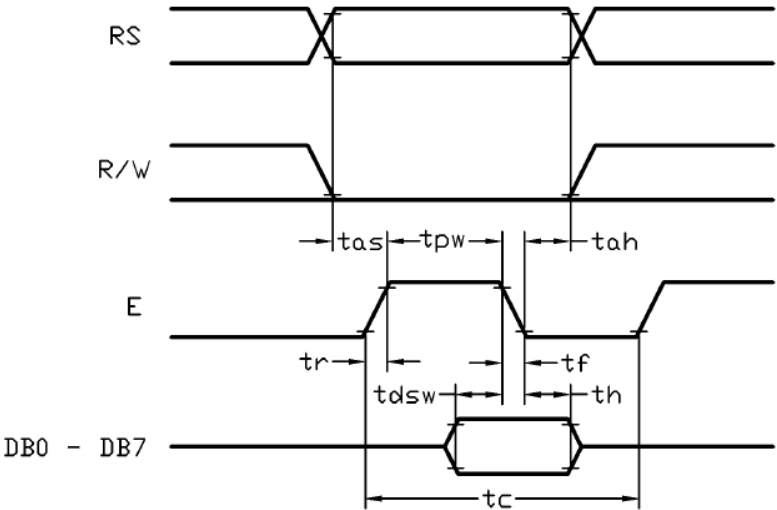
| Items               | Symbol | Min      | TYP | Max | Unit | Condition            |
|---------------------|--------|----------|-----|-----|------|----------------------|
| Operating Voltage   | Vdd    | 4.7V     | 5.0 | 5.3 | V    | Vdd                  |
| Supply Current      | Idd    | -        | 1.5 | 3.5 | mA   | except LED backlight |
| Input High Voltage  | Vin    | 0.8h Vdd | -   | Vdd | V    | RS,RW,E,DB0-DB7      |
| Input Low Voltage   | Vil    | Vss      | -   | 0.5 | V    |                      |
| Output High Voltage | Voh    | 0.7h Vdd | -   | Vdd | V    | Ioh=-0.1mA,DB0-DB7   |
| Output Low Voltage  | Vol    | Vss      | -   | 0.5 | V    | Iol=0.1mA,DB0-DB7    |
| LCD Driving Voltage | Vlcd   | 4.6      | 4.8 | 5.0 | V    | Vdd-V0               |

### 8.2 AC Characteristics (VDD=+5V, VSS=0V, TTa=-20~75 °C)

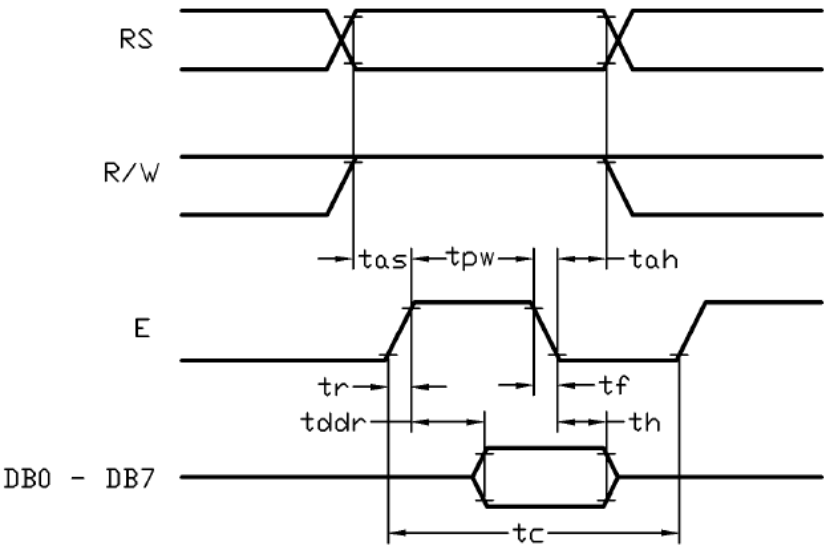
| Items               | Symbol | Min  | TYP | Max | Unit |
|---------------------|--------|------|-----|-----|------|
| E cycle time        | tc     | 1500 | -   | -   | nS   |
| E high level width  | tpw    | 175  | -   | -   | nS   |
| E rise time         | tr     | -    | -   | 20  | nS   |
| E fall time         | tf     | -    | -   | 20  | nS   |
| Address set-up time | tas    | 5    | -   | -   | nS   |
| Address hold time   | tah    | 13   | -   | -   | nS   |
| Data set-up time    | tdsw   | 50   | -   | -   | nS   |
| Data delay time     | tddr   | -    | -   | 125 | nS   |

|                |    |    |   |   |    |
|----------------|----|----|---|---|----|
| Data hold time | th | 13 | - | - | nS |
|----------------|----|----|---|---|----|

MPU write timing



MPU read timing



9. FUNCTION SPECIFICATIONS

## 9.1. Basic Setting

To drive the LCD module correctly and provide normal display, please use the following setting:

- N=1, 2-line display
- F=0, 5h 8 dots font
- D=1, display on

Note:

- These setting/commands should issue to the LCD module while start up.
- See the Display Commands section for details.

## 9.2. Resetting The LCD Module

When turning on the VDD and VSS power supply, LCD module will execute the reset routine automatically. It takes about 50ms. After the reset routine, the LCD module status will be as follow:

- N=1, 2-line display
- Display clear
- DL=1, 8-bit interface
- F=0, 5h 8 dot character font
- D=0, Display off
- C=0, Cursor off
- B=0, Blinking off
- I/D=1, Increment by 1
- S=0, No shift

NOTE:

- Reset routine could not generate the Basic Setting

## 9.3. Display Memory Map

There are two main memory-areas in the LCD module for display.

Character Generator RAM(CGRAM)

- Display Data RAM(DDRAM)

### 9.3.1. Character Generator RAM(CGRAM)

Character Generator RAM is for storing the User-defined Characters(5 x 8 dots font). Totally 8 User-defined Characters(character code = 00h-07h) could be created.



The User-defined Character Codes are 00h and 07h. They could be called into DDRAM as normal character.

| User-defined<br>Character<br>Code | CGRAM<br>Address              | CGRAM Data (Font Pattern) |                            |
|-----------------------------------|-------------------------------|---------------------------|----------------------------|
|                                   |                               | D7 ~ D5                   | D4 ~ D0                    |
| 00h<br>(08h)                      | 00h<br>01h<br>⋮<br>06h<br>07h | Not Use                   | 5 x 8 dots<br>font pattern |
| 01h<br>(09h)                      | 08h<br>09h<br>⋮<br>0Eh<br>0Fh | Not Use                   | 5 x 8 dots<br>font pattern |
| 02h<br>(0Ah)                      | 10h<br>11h<br>⋮<br>16h<br>17h | Not Use                   | 5 x 8 dots<br>font pattern |
| 03h<br>(0Bh)                      | 18h<br>19h<br>⋮<br>1Eh<br>1Fh | Not Use                   | 5 x 8 dots<br>font pattern |
| 04h<br>(0Ch)                      | 20h<br>21h<br>⋮<br>26h<br>27h | Not Use                   | 5 x 8 dots<br>font pattern |
| 05h<br>(0Dh)                      | 28h<br>29h<br>⋮<br>2Eh<br>2Fh | Not Use                   | 5 x 8 dots<br>font pattern |
| 06h<br>(0Eh)                      | 30h<br>31h<br>⋮<br>36h<br>37h | Not Use                   | 5 x 8 dots<br>font pattern |
| 07h<br>(0Fh)                      | 38h<br>39h<br>⋮<br>3Eh<br>3Fh | Not Use                   | 5 x 8 dots<br>font pattern |

**CGRAM Address Map**

### 9.3.2. Character code ROM

Please refer to AIP31066L datasheet.

## 9.4. Display Commands

| Instruction                        | Instruction Code |    |     |     |     |     |     |     |     |     | Description                                                                                                                           | Execution time<br>(fosc=270KHz) |
|------------------------------------|------------------|----|-----|-----|-----|-----|-----|-----|-----|-----|---------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
|                                    | RS               | RW | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |                                                                                                                                       |                                 |
| Clear Display                      | 0                | 0  | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | Write "20H" to DDRAM and set DDRAM address to "00H" from AC                                                                           | 1.52ms                          |
| Return Home                        | 0                | 0  | 0   | 0   | 0   | 0   | 0   | 0   | 1   | -   | Set DDRAM address to "00H" from AC and return cursor to its original position if shifted. The contents of DDRAM are not changed.      | 1.52ms                          |
| Entry Mode Set                     | 0                | 0  | 0   | 0   | 0   | 0   | 0   | 1   | I/D | S   | Assign cursor moving direction and enable the shift of entire display                                                                 | 38μs                            |
| Display ON/OFF Control             | 0                | 0  | 0   | 0   | 0   | 0   | 1   | D   | C   | B   | Set display(D), cursor(C), and blinking of cursor(B) on/off control bit.                                                              | 38μs                            |
| Cursor or Display Shift            | 0                | 0  | 0   | 0   | 0   | 1   | S/C | R/L | -   | -   | Set cursor moving and display shift control bit, and the direction, without changing of DDRAM data.                                   | 38μs                            |
| Function Set                       | 0                | 0  | 0   | 0   | 1   | DL  | N   | F   | -   | -   | Set interface data length (DL: 8-bit/4-bit), numbers of display line (N: 2-line/1-line) and, display font type (F:5x10 dots/5x8 dots) | 38μs                            |
| Set CGRAM Address                  | 0                | 0  | 0   | 1   | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 | Set CGRAM address in address counter.                                                                                                 | 38μs                            |
| Set DDRAM Address                  | 0                | 0  | 1   | AC6 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 | Set DDRAM address in counter                                                                                                          | 38μs                            |
| Read Busy Flag and Address Counter | 0                | 1  | BF  | AC6 | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 | Whether during internal operation or not can be known by reading BF. The contents of address counter can also be read.                |                                 |
| Write Data to RAM                  | 1                | 0  | D7  | D6  | D5  | D4  | D3  | D2  | D1  | D0  | Write data into internal RAM (DDRAM/CGRAM).                                                                                           | 38μs                            |
| Read Data from RAM                 | 1                | 1  | D7  | D6  | D5  | D4  | D3  | D2  | D1  | D0  | Read data from internal RAM (DDRAM/CGRAM).                                                                                            | 38μs                            |

NOTE:

Do not use any other commands not listed, or the system malfunction may result.  
For the details of rte display commands, please refer to AIP31066L datasheet.

## 10. DESIGN AND HANDING PRECAUTION

- 10.1. The LCD panel is made by glass. Any mechanical shock (eg. Dropping from high place) will damage the LCD module. Do not add excessive force on the surface of the display, which may cause the Display color change abnormally.
- 10.2. The polarizer on the LCD is easily get scratched. If possible, do not remove the LCD protective film until the last step of installation.
- 10.3. Never attempt to disassemble or rework the LCD module.
- 10.4. Only Clean the LCD with Isopropyl Alcohol or Ethyl Alcohol. Other solvents (eg. water) may damage the LCD.
- 10.5. When mounting the LCD module, make sure that it is free from twisting, warping and distortion.
- 10.6. Ensure to provide enough space (with cushion) between case and LCD panel to prevent external force adding on it, or it may cause damage to the LCD or degrade the display result
- 10.7. Only hold the LCD module by its side. Never hold LCD module by add force on the heat seal or TAB.
- 10.8. Never add force to component of the LCD module. It may cause invisible damage or degrade of the reliability.
- 10.9. LCD module could be easily damaged by static electricity. Be careful to maintain an optimum anti-static work environment to protect the LCD module.
- 10.10. When peeling of the protective film from LCD, static charge may cause abnormal display pattern. It is normal and will resume to normal in a short while.
- 10.11. Take care and prevent get hurt by the LCD panel edge.
- 10.12. Never operate the LCD module exceed the absolute maximum ratings.
- 10.13. Keep the signal line as short as possible to prevent noisy signal applying to LCD module.
- 10.14. Never apply signal to the LCD module without power supply.
- 10.15. IC chip (eg. TAB or COG) is sensitive to the light. Strong lighting environment could possibly cause malfunction. Light sealing structure casing is recommend.
- 10.16. LCD module reliability may be reduced by temperature shock.
- 10.17. When storing the LCD module, avoid exposure to the direct sunlight, high humidity, high temperature or low temperature. They may damage or degrade the LCD module.