

# NHD-C0220AA-FSW-FTW

## Graphic Liquid Crystal Display Module

NHD- Newhaven Display  
C0220- COG, 2 Lines x 20 Characters  
AA- Model  
F- Transflective  
SW- Side White LED Backlight  
F- FSTN Positive  
T- 12:00 Optimum View  
W- Wide Temp  
**RoHS Compliant**

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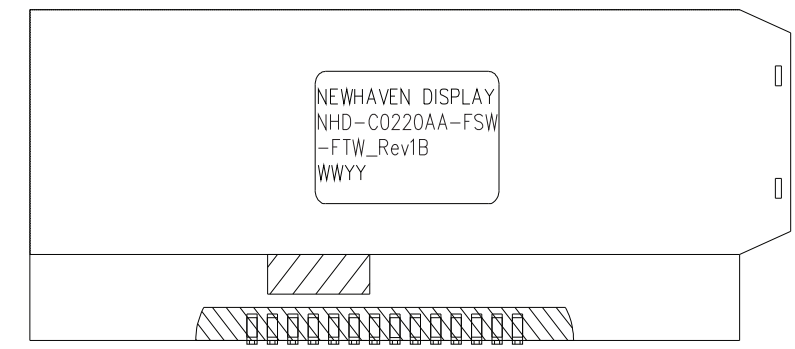
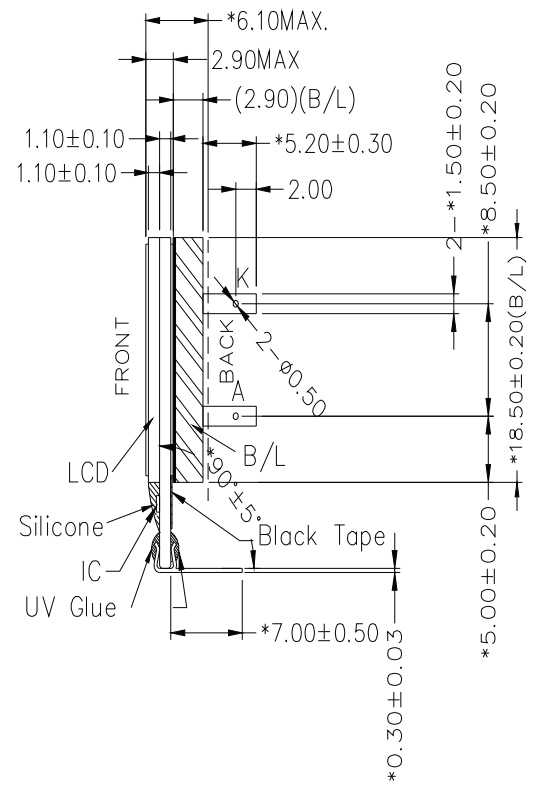
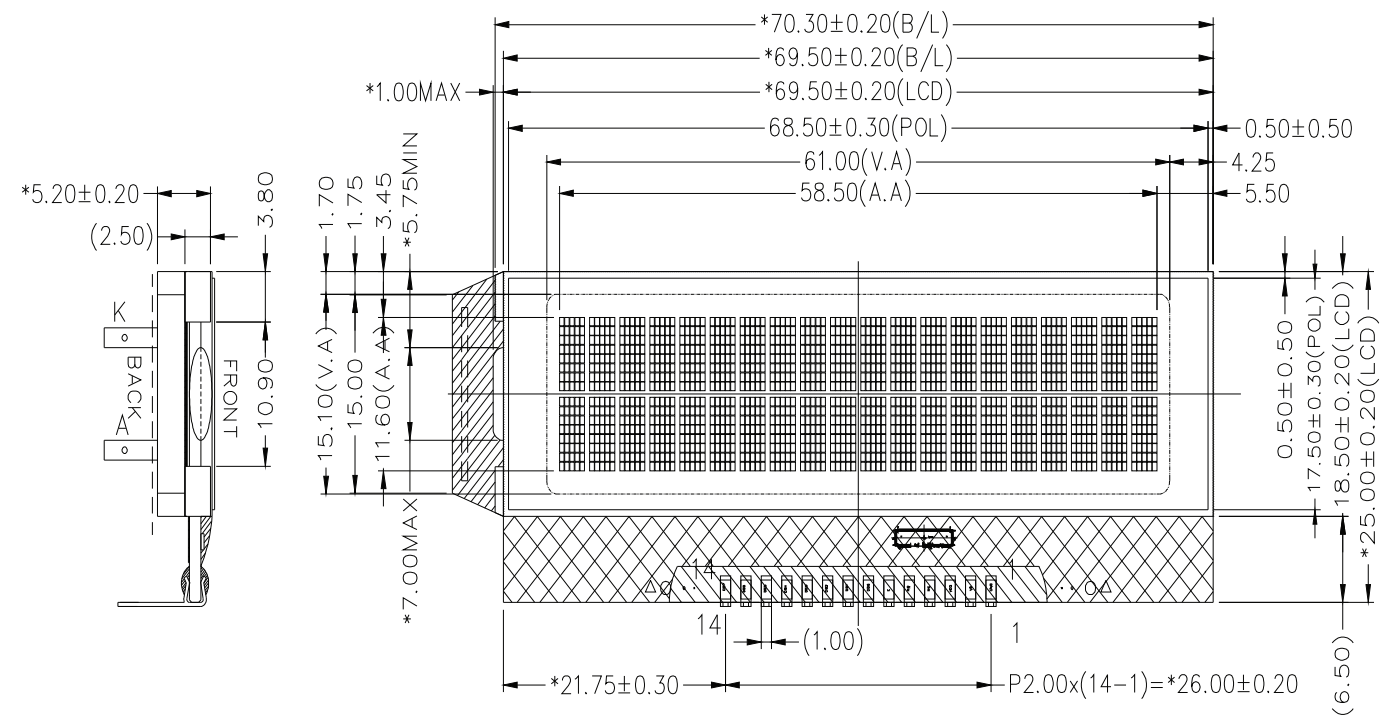
## Document Revision History

| Revision | Date     | Description                                        | Changed by |
|----------|----------|----------------------------------------------------|------------|
| 0        | 11/5/10  | Initial Release                                    | -          |
| 1        | 5/27/11  | Display character address code updated             | AK         |
| 2        | 6/2/11   | Timing characteristics updated                     | AK         |
| 3        | 9/28/15  | Electrical characteristics, response times updated | SB         |
| 4        | 12/28/17 | Backlight Characteristics Updated                  | SB         |
| 5        | 2/19/19  | Backlight Current Updated                          | SB         |
| 6        | 7/5/19   | Added PCB Footprint Drawing                        | AS         |
| 7        | 11/26/19 | Electrical Characteristics Updated                 | SB         |

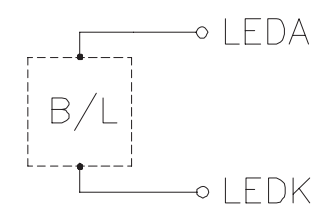
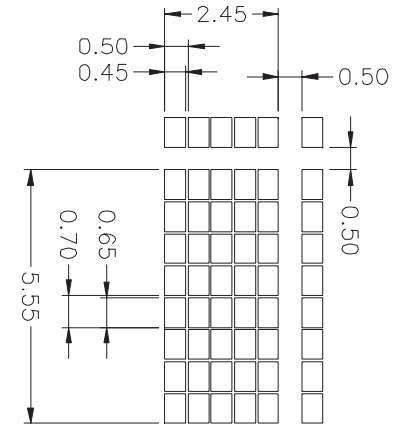
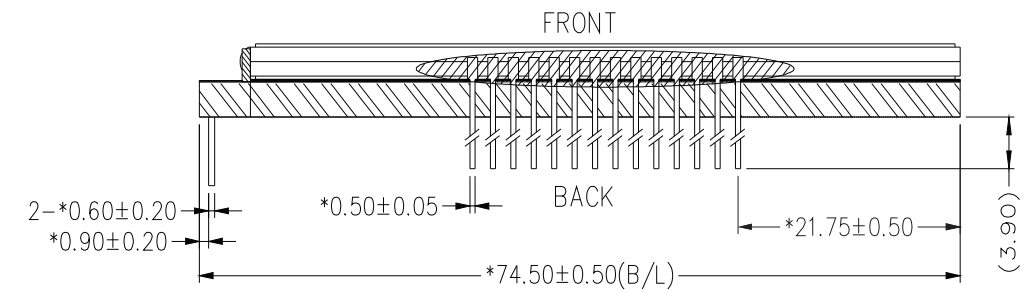
## Functions and Features

- 2 lines x 20 characters
- Built-in NT7605 controller
- 3.3V power supply
- 1/16 duty, 1/5 bias

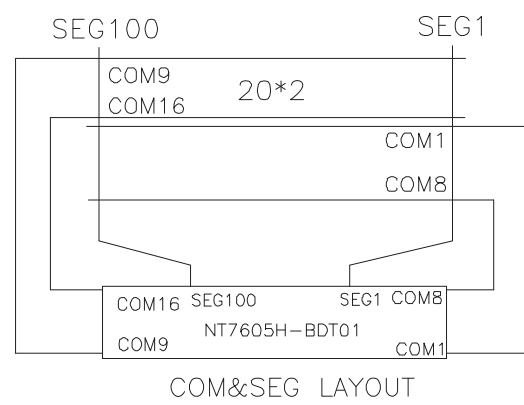
| SYMBOL | REVISION | DATE |
|--------|----------|------|
|        |          |      |



BACK VIEW



CONSTANT CURRENT:30mA,3.00±0.20V  
BACKLIGHT DRIVER CIRCUIT DIAGRAM



## Pin Assignments

|            |     |     |     |     |     |     |     |
|------------|-----|-----|-----|-----|-----|-----|-----|
| PIN        | 1   | 2   | 3   | 4   | 5   | 6   | 7   |
| CONNECTION | GND | V5  | VDD | RS  | R/W | E   | DB0 |
| PIN        | 8   | 9   | 10  | 11  | 12  | 13  | 14  |
| CONNECTION | DB1 | DB2 | DB3 | DB4 | DB5 | DB6 | DB7 |

| ITEM                  | PARAMETERS          | ITEM                  | PARAMETERS          |
|-----------------------|---------------------|-----------------------|---------------------|
| DISPLAY TYPE          | FSTN, POSITIVE      | VIEWING DIRECTION     | 12 O'CLOCK          |
| DRIVING METHOD        | 1/16 DUTY, 1/5 BIAS | OPERATING TEMPERATURE | -20°C TO +70°C      |
| POLARIZER TYPE        | TRANSFLECTIVE       | STORAGE TEMPERATURE   | -30°C TO +80°C      |
| LCD OPERATING VOLTAGE | 3.2V(REF)           | IC                    | NT7605H-BDT01       |
| LOGIC VOLTAGE(VDD)    | 3.3V                | BACKLIGHT             | EDGE, WHITE(2 LEDS) |

STANDARD TOLERANCE: (UNLESS OTHERWISE SPECIFIED)

LINEAR: ±0.3mm

UNLESS OTHERWISE SPECIFIED: - DIMENSIONS ARE IN MILLIMETERS - THIRD ANGLE PROJECTION

DO NOT SCALE DRAWING

NEWHAVEN DISPLAY INTERNATIONAL

DRAWING/PART NUMBER: NHD-C0220AA-FSW-FTW

REVISION: 1B

SIZE: A3

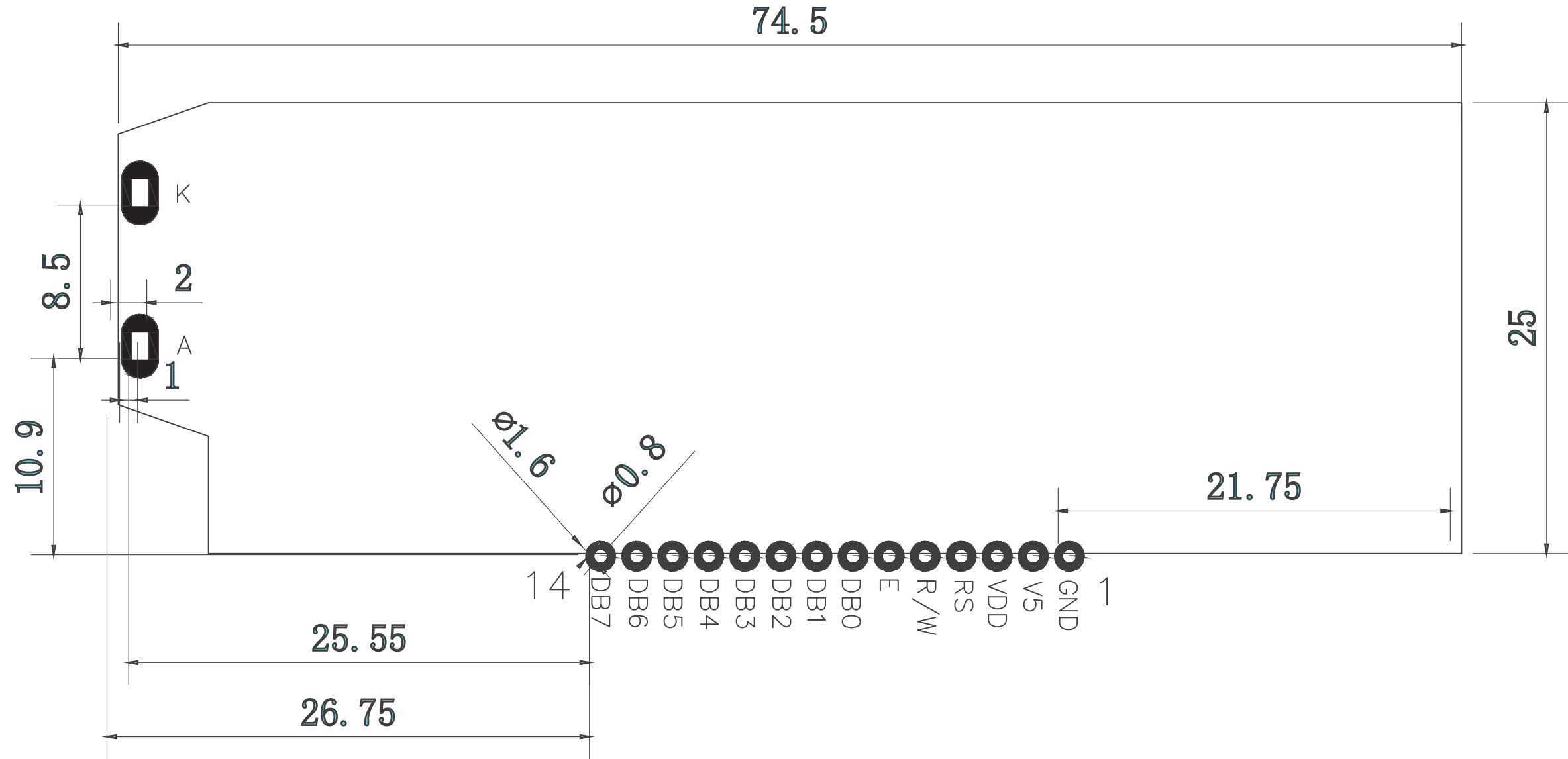
SCALE: NS

SHEET 1 OF 1



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# Recommended PCB Footprint

| SYMBOL | REVISION | DATE |
|--------|----------|------|
|        |          |      |
|        |          |      |



**Applicable Displays:**  
 1) NHD-C0220AA-FSW-FTW  
 2) NHD-C0220AZ-FSW-FTW

|                                                                                                                                                                                                                             |  |                                                                                                                             |                          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|-----------------------------------------------------------------------------------------------------------------------------|--------------------------|
| STANDARD TOLERANCE:<br>(UNLESS OTHERWISE SPECIFIED)                                                                                                                                                                         |  |  <b>NEWHAVEN DISPLAY INTERNATIONAL</b> |                          |
| LINEAR: $\pm 0.3\text{mm}$                                                                                                                                                                                                  |  |                                                                                                                             |                          |
| UNLESS OTHERWISE SPECIFIED:                                                                                                                                                                                                 |  | DRAWING/PART NUMBER:<br><b>NHD-C0220(AZ&amp;AA) Footprint</b>                                                               |                          |
| - DIMENSIONS ARE IN MILLIMETERS                                                                                                                                                                                             |  | DRAWN BY:<br>A. Shah                                                                                                        | APPROVED BY:<br>A. Khan  |
| - THIRD ANGLE PROJECTION                                                                                                               |  | DRAWN DATE:<br>7/1/19                                                                                                       | APPROVED DATE:<br>7/1/19 |
|                                                                                                                                                                                                                             |  | DO NOT SCALE DRAWING                                                                                                        |                          |
|                                                                                                                                                                                                                             |  | SHEET 1 OF 1                                                                                                                |                          |
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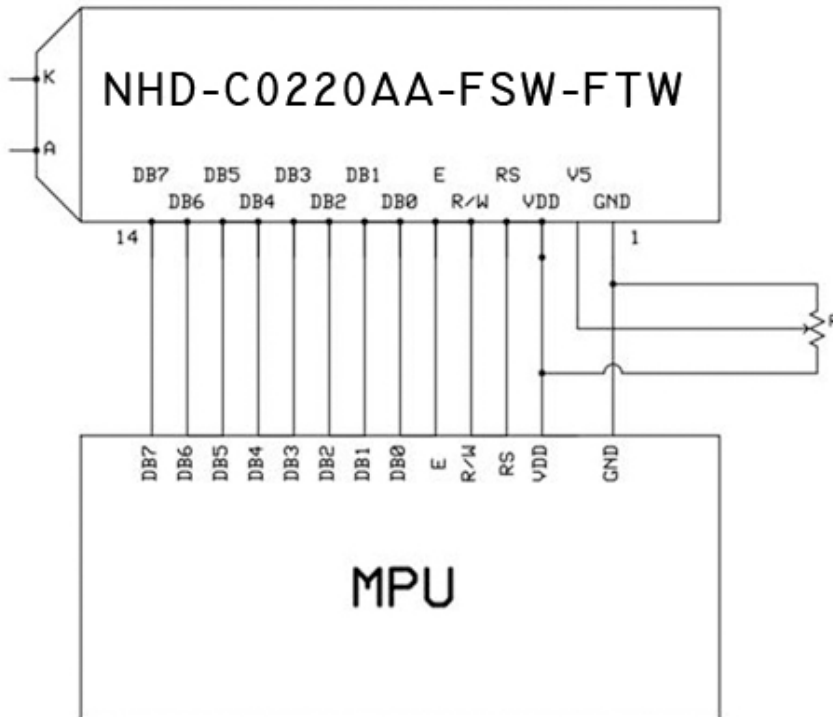
## Pin Description and Wiring Diagram

| Pin No. | Symbol          | External Connection | Function Description                                                                                      |
|---------|-----------------|---------------------|-----------------------------------------------------------------------------------------------------------|
| 1       | GND             | Power Supply        | Ground                                                                                                    |
| 2       | V <sub>s</sub>  | Adj. Power Supply   | Supply Voltage for Contrast (approx. 0.1V)                                                                |
| 3       | V <sub>DD</sub> | Power Supply        | Supply Voltage for LCD and Logic                                                                          |
| 4       | RS              | MPU                 | Register Select: 0=Instruction, 1=Data                                                                    |
| 5       | R/W             | MPU                 | Read / Write select: 0=Write, 1=Read                                                                      |
| 6       | E               | MPU                 | Operation Enable Signal.                                                                                  |
| 7-10    | DB0 – DB3       | MPU                 | Four low order bi-directional three-state data bus lines. These four are not used during 4-bit operation. |
| 11-14   | DB4 – DB7       | MPU                 | Four high order bi-directional three-state data bus lines.                                                |
| A       | LED +           | Power Supply        | Backlight Anode (30 mA @ 3V)                                                                              |
| K       | LED -           | Power Supply        | Backlight Cathode (Ground)                                                                                |

**Recommended LCD connector:** 2.0mm pitch, 14pins Soldered to PCB, or JST p/n: PHR-14

**Backlight connector:** A and K pins **Mates with:** Solder to wires or PCB

**Recommended Breakout Board:** [NHD-PCB40](#)



## Electrical Characteristics

| Item                        | Symbol                           | Condition                | Min.                  | Typ. | Max.                  | Unit |
|-----------------------------|----------------------------------|--------------------------|-----------------------|------|-----------------------|------|
| Operating Temperature Range | T <sub>OP</sub>                  | Absolute Max             | -20                   | 25   | +70                   | °C   |
| Storage Temperature Range   | T <sub>ST</sub>                  | Absolute Max             | -30                   | 25   | +80                   | °C   |
| Supply Voltage              | V <sub>DD</sub>                  | -                        | 3.0                   | 3.3  | 3.5                   | V    |
| Supply Current              | I <sub>DD</sub>                  | V <sub>DD</sub> = 3.3V   | 0.3                   | 0.6  | 2                     | mA   |
| Supply for LCD (contrast)   | V <sub>DD</sub> - V <sub>5</sub> | T <sub>OP</sub> = 25°C   | 3.0                   | 3.2  | 3.5                   | V    |
| "H" Level input             | V <sub>IH</sub>                  | -                        | 0.8 * V <sub>DD</sub> | -    | V <sub>DD</sub>       | V    |
| "L" Level input             | V <sub>IL</sub>                  | -                        | 0                     | -    | 0.2 * V <sub>DD</sub> | V    |
| "H" Level output            | V <sub>OH</sub>                  | -                        | V <sub>DD</sub> - 0.6 | -    | V <sub>DD</sub>       | V    |
| "L" Level output            | V <sub>OL</sub>                  | -                        | GND                   | -    | GND + 0.6             | V    |
| Backlight Supply Current    | V <sub>LED</sub>                 | -                        | -                     | 30   | 36                    | mA   |
| Backlight Supply Voltage    | I <sub>LED</sub>                 | I <sub>LED</sub> = 30 mA | 2.8                   | 3.0  | 3.3                   | V    |

\*The LED of the backlight is driven by current; drive voltage is for reference only. Drive voltage must be selected to ensure backlight current drain is below MAX level stated.

## Optical Characteristics

| Item                   | Symbol         | Condition | Min. | Typ. | Max. | Unit |
|------------------------|----------------|-----------|------|------|------|------|
| Optimal Viewing Angles | Top            | CR ≥ 2    | -    | 40   | -    | °    |
|                        | Bottom         |           | -    | 40   | -    | °    |
|                        | Left           |           | -    | 35   | -    | °    |
|                        | Right          |           | -    | 35   | -    | °    |
| Contrast Ratio         | CR             | -         | -    | 6    | -    | -    |
| Response Time (rise)   | T <sub>R</sub> | -         | -    | 100  | 160  | ms   |
| Response Time (fall)   | T <sub>F</sub> | -         | -    | 150  | 200  | ms   |

## Controller Information

Built-in NT7605H-BDT01 Controller.

Please download specification at [http://www.newhavendisplay.com/app\\_notes/NT7605.pdf](http://www.newhavendisplay.com/app_notes/NT7605.pdf)

**NOTE:** The Busy Flag of the NT7605 controller may not always be responsive. Add sufficient delays and/or a time-out check routine to continue operation if busy flag is not cleared.

Note: during internal operation, busy flag (DB7) is read "High".  
 Busy flag check must be preceded by the next instruction.

## DDRAM Address

|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 00 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 0A | 0B | 0C | 0D | 0E | 0F | 10 | 11 | 12 | 13 |
| 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 4A | 4B | 4C | 4D | 4E | 4F | 50 | 51 | 52 | 53 |

## Table of Commands

| Instruction                        | INSTRUCTION CODE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |     |            |     |     |     |     |     |                                             |                                                          | Description                                                                                                                                                                    | Execution Time (Max)<br>(fosc = 540KHZ)                                                                                       |        |
|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------------|-----|-----|-----|-----|-----|---------------------------------------------|----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|--------|
|                                    | RS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | R/W | DB7        | DB6 | DB5 | DB4 | DB3 | DB2 | DB1                                         | DB0                                                      |                                                                                                                                                                                |                                                                                                                               |        |
| Clear Display                      | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0   | 0          | 0   | 0   | 0   | 0   | 0   | 0                                           | 0                                                        | 1                                                                                                                                                                              | Clear entire display area. Restore display from shift, and load address counter with DDRAM address 00H                        | 1.64ms |
| Display/<br>Cursor Home            | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0   | 0          | 0   | 0   | 0   | 0   | 0   | 0                                           | 1                                                        | -                                                                                                                                                                              | Restore display from shift and load address counter with DDRAM address 00H                                                    | 1.64ms |
| Entry mode Set                     | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0   | 0          | 0   | 0   | 0   | 0   | 0   | 1                                           | I/D                                                      | S                                                                                                                                                                              | Specify direction of cursor movement and display shift mode. This operation takes place after each data transfer (read/write) | 40µs   |
| Display ON/<br>OFF control         | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0   | 0          | 0   | 0   | 0   | 0   | 1   | D                                           | C                                                        | B                                                                                                                                                                              | Set activation of display (D), cursor (C), and Blinking of cursor (B)                                                         | 40µs   |
| Display/<br>Cursor                 | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0   | 0          | 0   | 0   | 0   | 1   | S/C | R/L                                         | -                                                        | -                                                                                                                                                                              | Shift display or move cursor                                                                                                  | 40µs   |
| Function set                       | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0   | 0          | 0   | 1   | DL  | N   | F   | -                                           | -                                                        | -                                                                                                                                                                              | Set interface data length (DL) number of the display line (N), and character font (F)                                         | 40µs   |
| RAM Address Set                    | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0   | 0          | 1   | ACG |     |     |     |                                             |                                                          | Set CGRAM address in address counter.                                                                                                                                          | 40µs                                                                                                                          |        |
| DDRAM Address Set                  | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0   | 1          | ADD |     |     |     |     |                                             | Set DDRAM address in address counter.                    | 40µs                                                                                                                                                                           |                                                                                                                               |        |
| Busy Flag/<br>Address Counter Read | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1   | BF         | AC  |     |     |     |     |                                             | Read Busy Flag (BF) and contents of Address Counter (AC) | 1µs                                                                                                                                                                            |                                                                                                                               |        |
| CGRAM/<br>DDRAM Data Write         | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0   | Write Data |     |     |     |     |     | Write data into internal RAM (DDRAM/CGRAM). | 40µs                                                     |                                                                                                                                                                                |                                                                                                                               |        |
| CGRAM/<br>DDRAM Data Read          | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1   | Read Data  |     |     |     |     |     | Read data from internal RAM (DDRAM/CGRAM).  | 40µs                                                     |                                                                                                                                                                                |                                                                                                                               |        |
|                                    | I/D = 1 : Increment                      I/D = 0 : Decrement<br>S = 1 : Display Shift On<br>D = 1 : Display On<br>C = 1 : Cursor Display On<br>B = 1 : Cursor Blink On<br>S/C = 1 : Shift Display                      S/C = 0 : Move Cursor<br>R/L = 1 : Shift Right                      R/L = 0 : Shift Left<br>DL = 1 : 8-Bit                                  DL = 0 : 4-Bit<br>N = 1 : Dual Line                              N = 0 : Single Line<br>F = 1 : 5x10 dots                              F = 0 : 5x8 dots<br>BF = 1 : Internal Operation<br>BF = 0 : Ready for Instruction |     |            |     |     |     |     |     |                                             |                                                          | DDRAM : Display Data Ram<br><br>CGRAM : Character Generator RAM<br><br>ACG : Character Generator RAM Address<br><br>ADD : Display Data RAM Address<br><br>AC : Address Counter |                                                                                                                               |        |

# Timing Characteristics

## Write from MPU to NT7605

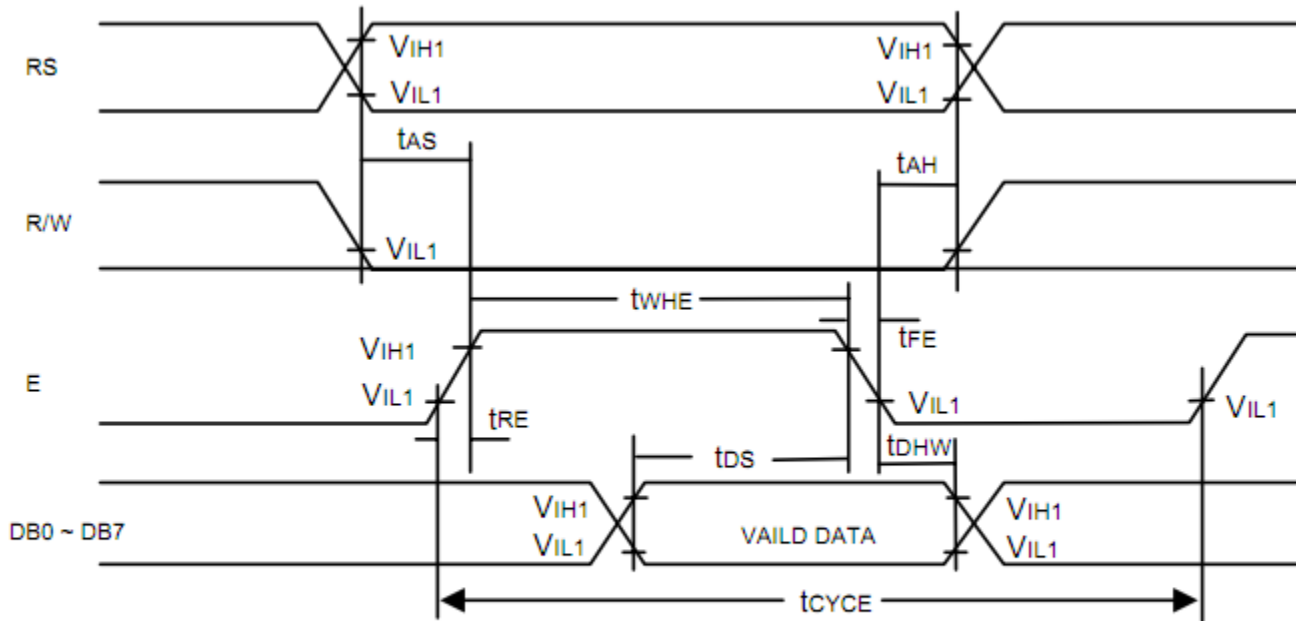


Figure 2. Bus Write Operation Sequence  
(Writing data from MPU to NT7605)

Write Cycle ( $V_{DD} = 4.5V \sim 5.5V$ ,  $GND = 0V$ ,  $T_A = 25^\circ C$ )

| Symbol   | Parameter                    | Min.             | Typ. | Max. | Unit | Conditions |
|----------|------------------------------|------------------|------|------|------|------------|
| tCYCE    | Enable Cycle Time            | 500              | -    | -    | ns   | Figure 2   |
| twHE     | Enable "H" Level Pulse Width | 300              | -    | -    | ns   | Figure 2   |
| tRE, tFE | Enable Rise/Fall Time        | -                | -    | 25   | ns   | Figure 2   |
| tAS      | RS, R/W Setup Time           | 60 <sup>1</sup>  | -    | -    | ns   | Figure 2   |
|          |                              | 100 <sup>2</sup> |      |      |      |            |
| tAH      | RS, R/W Address Hold Time    | 10               | -    | -    | ns   | Figure 2   |
| tDS      | Data Output Delay            | 100              | -    | -    | ns   | Figure 2   |
| tDHW     | Data Hold Time               | 10               | -    | -    | ns   | Figure 2   |

Notes: 1: 8-bit operation mode

2: 4-bit operation mode



## Read from NT7605 to MPU

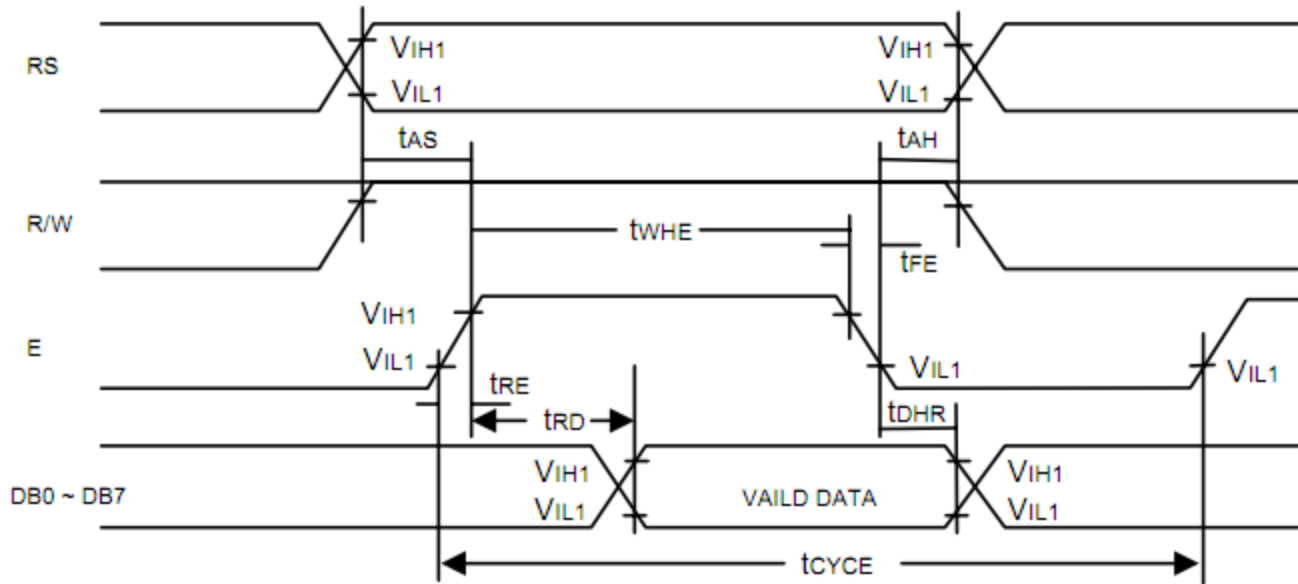


Figure 1. Bus Read Operation Sequence  
(Reading out data from NT7605 to MPU)

Read Cycle ( $V_{DD} = 4.5V \sim 5.5V$ ,  $GND = 0V$ ,  $T_A = 25^\circ C$ )

| Symbol   | Parameter                    | Min.             | Typ. | Max. | Unit | Conditions |
|----------|------------------------------|------------------|------|------|------|------------|
| tCYCE    | Enable Cycle Time            | 500              | -    | -    | ns   | Figure 1   |
| tWHE     | Enable "H" Level Pulse Width | 300              | -    | -    | ns   | Figure 1   |
| tRE, tFE | Enable Rise/Fall Time        | -                | -    | 25   | ns   | Figure 1   |
| tAS      | RS, R/W Setup Time           | 60 <sup>1</sup>  | -    | -    | ns   | Figure 1   |
|          |                              | 100 <sup>2</sup> |      |      |      |            |
| tAH      | RS, R/W Address Hold Time    | 10               | -    | -    | ns   | Figure 1   |
| tRD      | Read Data Output Delay       | -                | -    | 190  | ns   | Figure 1   |
| tDHR     | Read Data Hold Time          | 20               | -    | -    | ns   | Figure 1   |

Notes: 1: 8-bit operation mode  
2: 4-bit operation mode

# Built-in Font Table

|                                                        |   | Higher 4-bit (D4 to D7) of Character Code (Hexadecimal) |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|--------------------------------------------------------|---|---------------------------------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|                                                        |   | 0                                                       | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
| Lower 4-bit (D0 to D3) of Character Code (Hexadecimal) | 0 | CG RAM (1)                                              |   |   | G | O | P | ^ | P |   |   |   | — | 3 | E | o | p |
|                                                        | 1 | CG RAM (2)                                              |   | ! | 1 | A | O | a | a |   |   |   | # | 7 | * | 4 | a |
|                                                        | 2 | CG RAM (3)                                              |   | " | 2 | B | R | b | r |   |   |   | " | 4 | Y | x | p |
|                                                        | 3 | CG RAM (4)                                              |   | * | 3 | O | S | s | s |   |   |   | ! | o | T | e | e |
|                                                        | 4 | CG RAM (5)                                              |   | * | 4 | O | T | t | t |   |   |   | \ | o | T | t | o |
|                                                        | 5 | CG RAM (6)                                              |   | % | 5 | E | U | u | u |   |   |   | . | * | * | 1 | u |
|                                                        | 6 | CG RAM (7)                                              |   | % | 6 | F | V | v | v |   |   |   | 9 | o | c | e | p |
|                                                        | 7 | CG RAM (8)                                              |   | 7 | W | w | w | w |   |   |   |   | 7 | * | * | 7 | g |
|                                                        | 8 | CG RAM (1)                                              |   | 8 | X | x | x | x |   |   |   |   | 4 | o | * | u | x |
|                                                        | 9 | CG RAM (2)                                              |   | 9 | Y | y | y | y |   |   |   |   | o | o | u | u | y |
|                                                        | A | CG RAM (3)                                              |   | * | U | Z | z | z |   |   |   |   | o | o | v | u | z |
|                                                        | B | CG RAM (4)                                              |   | + | K | K | K | K |   |   |   |   | * | * | o | o | K |
|                                                        | C | CG RAM (5)                                              |   | . | < | * | U | U |   |   |   |   | * | o | o | o | U |
|                                                        | D | CG RAM (6)                                              |   | — | — | M | N | N |   |   |   |   | u | * | N | o | * |
|                                                        | E | CG RAM (7)                                              |   | # | > | N | N | N |   |   |   |   | # | o | * | * | N |
|                                                        | F | CG RAM (8)                                              |   | / | ? | O | o | o |   |   |   |   | u | u | * | o | o |

## Example Initialization Program

```
'INIT-----
A = &H30
Call Writecom                                'wake up
Waitms 100
Call Writecom                                'wake up
Waitms 10
Call Writecom                                'wake up
Waitms 10
A = &H38
'function set
Call Writecom
A = &H10
'shift display=no
Call Writecom
A = &H0C
'display on
Call Writecom
A = &H06
'entry mode set
Call Writecom
'-----
Sub Writecom
P1 = A
Reset P3.0
'instruction
Reset P3.7
'RW
Waitms 1
Set P3.4
'E
Waitms 1
Reset P3.4                                'E
End Sub
'-----
Sub Writedata
P1 = A
Set P3.0
'data
Reset P3.7
'RW
Waitms 1
Set P3.4
'E
Waitms 1
Reset P3.4                                'E
End Sub
'-----
```

## Quality Information

| Test Item                             | Content of Test                                                                                                                 | Test Condition                                                                      | Note |
|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------|
| High Temperature storage              | Endurance test applying the high storage temperature for a long time.                                                           | +80°C , 120 Hrs.                                                                    | 2    |
| Low Temperature storage               | Endurance test applying the low storage temperature for a long time.                                                            | -30°C , 120 Hrs.                                                                    | 1,2  |
| High Temperature Operation            | Endurance test applying the electric stress (voltage & current) and the high thermal stress for a long time.                    | +70°C , 120 Hrs.                                                                    | 2    |
| Low Temperature Operation             | Endurance test applying the electric stress (voltage & current) and the low thermal stress for a long time.                     | -20°C , 120 Hrs.                                                                    | 1,2  |
| High Temperature / Humidity Operation | Endurance test applying the electric stress (voltage & current) and the high thermal with high humidity stress for a long time. | +40°C , 90% RH , 120 Hrs.                                                           | 1,2  |
| Thermal Shock resistance              | Endurance test applying the electric stress (voltage & current) during a cycle of low and high thermal stress.                  | -20°C,30min -> 25°C,5min -> 70°C,30min = 1 cycle<br>10 cycles                       |      |
| Vibration test                        | Endurance test applying vibration to simulate transportation and use.                                                           | 10-55Hz , 15mm amplitude.<br>60 sec in each of 3 directions X,Y,Z<br>For 15 minutes | 3    |
| Static electricity test               | Endurance test applying electric static discharge.                                                                              | Air Discharge= ±8kV,<br>Contact Discharge = ±4kV<br>Five Times                      |      |

**Note 1:** No condensation to be observed.

**Note 2:** Conducted after 4 hours of storage at 25°C, 0%RH.

**Note 3:** Test performed on product itself, not inside a container.

## Precautions for using LCDs/LCMs

See Precautions at [www.newhavendisplay.com/specs/precautions.pdf](http://www.newhavendisplay.com/specs/precautions.pdf)

## Warranty Information and Terms & Conditions

[http://www.newhavendisplay.com/index.php?main\\_page=terms](http://www.newhavendisplay.com/index.php?main_page=terms)