CU-U Application Note

CU-U Application Note
E-M-0140-02

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Contents

1 Overview

1.1 Target Modules

CU16024-UX3J	CU16029-UW1J	CU20045-UW5J
CU16025-UW2J	CU20024-UX3J	CU20045-UW7J
CU16025-UW30J	CU20025-UW1J	CU20049-UW2A
CU16025-UW6A	CU20025-UX1J	CU20049-UW2J
CU16025-UW6J	CU20029-UW1J	CU24025-UW1J
CU16025-UX6A	CU20045-UW4J	CU40025-UW6A
CU16025-UX6J	CU20045-UW5A	CU40025-UW6J
DS2045G	DS1625M	DS2025R

CU40045-UW1J is not supported. Please contact a sales engineer for information on this module.

CUrrcch-Ufrl

Font:
J - Katakana
A - International
Product Code Number
Feature:
W-Wide Temperature Ra
X - Brightness Boost
Characters height in mm
Number of Columns
Number of Rows
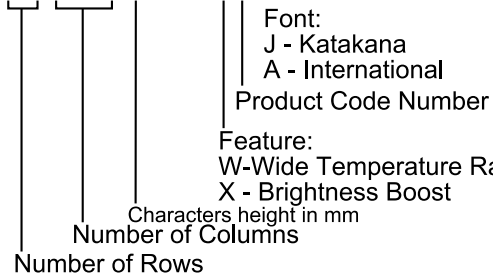
1.2 Introduction

CU-Us are HD44780 LCD-compatible VFD modules.

DS2045G, DS1625M, and DS2025R are BC-VFD with a built-in HD44780 LCD-compatible VFD driver.

This application note discusses the initialization and use of CU-U series modules and BC-VFDs. This document is not a substitute for the specification for the individual module.

For more information on CU-U: http://www.noritake-elec.com/uversion.htm

For more information on BC-VFD: http://www.noritake-elec.com/ds2045g.php

1.3 BC-VFD

BC-VFDs are just the display glass; no module is included with it. BC-VFDs have a controller chip built in.

They operate much the same as CU-U except for two primary differences:

BC-VFD has 16 levels of brightness compared to CU-U's 4 levels

BC-VFD selects its font at via the *Cursor Home* command; CU-U's is fixed or set by jumper

Despite being selectable at via command, the two fonts cannot be used at the same time on screen.

1.4 Code Library

Noritake Co., Inc. provides a C++ code library that handles the details of the interface protocol and sending commands. While standard LCD libraries may work with CU-U modules, this library is recommended for new products.

The following platforms are supported:

Atmel® AVR with AVR Studio 4 or Atmel Studio 6

Arduino 1.0 and 1.1

The library is configurable to work with all of the CU-U product line except CU40045-UW1J.

The included documentation has information on how to set it up.

For more information on the code library:

http://www.noritake-elec.com/codeLibrary.php#cuu

2 Upgrading From LCD

VFDs offer many advantages over LCDs including:

- Higher contrast
- Wider viewing angle
- Greater temperature range
- Less wires and a single power supply
- No need for heaters, backlights, or daughter boards

See more benefits at: http://www.noritake-elec.com/whyVFD/default.htm

3 Interface Selection

3.1 Pin Header Location
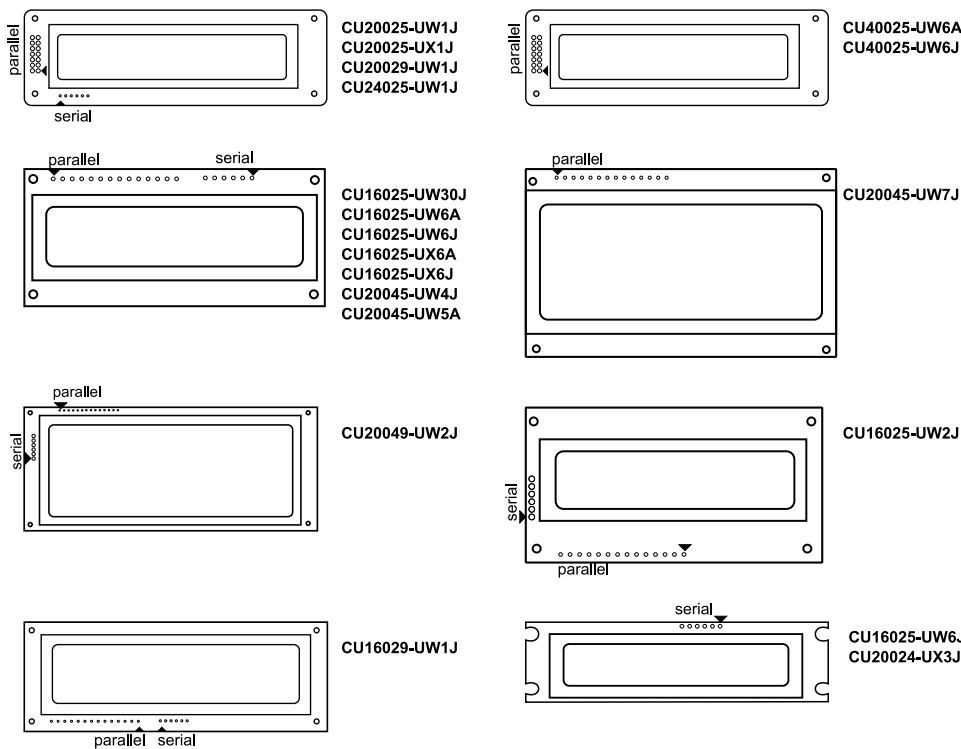
3.2 Parallel Interface

Most CU-U modules have a parallel interface that is compatible with the parallel interface of common HD44780 LCDs.

The following do **not** have the parallel interface:

CU16024-UX3J	DS2045G
CU20024-UX3J	DS1625M
	DS2025R

There are two protocols for parallel: M68 and I80. The protocol is selected by setting a jumper. Both parallel interfaces can operate in 4-bit or 8-bit mode. The serial interface is always 8-bit.

Both interfaces are pin-compatible with most HD44780 LCDs.

Pin 3 is not used to adjust contrast on these modules. It may be enabled for other purposes with the jumper settings.

Pins 15 and 16 are not needed because the module does not require a backlight.

See the module specification section "Jumpers" for information on the interface jumpers.

3.2.1 M68

M68 mode is compatible with common HD44780 LCDs.

Users who are replacing an LCD and do not wish to rewrite software should use this interface.

M68 mode is the default if no jumpers are set.

3.2.1.1 Pin Layout

1:GND	3:NC	5:R/W	7:DB0	9: DB2	11:DB4	13:DB6
2:VCC	4:RS	6:E	8:DB1	10:DB3	12:DB5	14:DB7

3.2.2 I80

I80 is an alternative to the M68 protocol. In this mode, the two separate control signals are used to control the I/O direction: /WR for writing to the module and /RD for reading from the module. There is no separate E signal. If the host does not read from the module, /RD can be held high (inactive).

Most HD44780 LCDs do not use this interface, so minor adjustments may be necessary to the interface code when replacing LCDs.

3.2.2.1 Pin Layout

1:GND	3:NC	5:WR	7:DB0	9: DB2	11:DB4	13:DB6
2:VCC	4:RS	6:RD	8:DB1	10:DB3	12:DB5	14:DB7

3.3 Serial Interface

Unlike most HD44780-compatible LCDs, many CU-Us have an on-board serial interface which reduces the number of pins required to communicate with the module.

The serial interface requires only 5 pins. If space in the application device is at a premium, this interface should be used.

The following modules do **not** support the serial interface:

    CU20045-UW7J
    CU40025-UW6A
    CU40025-UW6J

3.3.1.1 Pin Layout

1:VCC	2:SI / SO	3:GND	4:STB	5:SCK	6:NC

4 Interface Protocol

4.1 Parallel Interface Protocol

4.1.1 M68 Read / Write Cycle

1. Lower E on startup
2. Set RS=0 for command; 1 for data
3. For writing, lower R/W; for reading, raise R/W
4. Raise E
5. Set the data bits
6. Lower E
7. Wait for command to finish
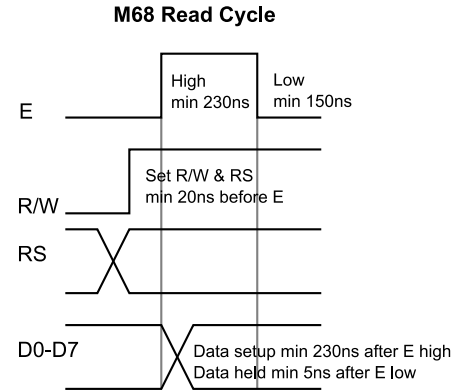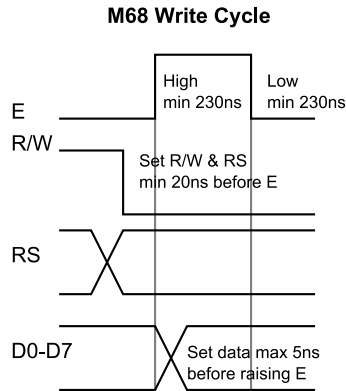
4.1.2 I80 Read / Write Cycle

1. Raise WR and RD on startup
2. Set RS=0 for command; 1 for data
3. For writing, lower WR; for reading, lower RD
4. Set the data bits
5. Raise WR and RD
6. Wait for the command to finish

M68 Write Cycle

E — High min 230ns — Low min 230ns
R/W — Set R/W & RS min 20ns before E
RS
D0-D7 — Set data max 5ns before raising E

M68 Read Cycle

E — High min 230ns — Low min 150ns
Set R/W & RS min 20ns before E
R/W
RS
D0-D7 — Data setup min 230ns after E high / Data held min 5ns after E low

I80 Write Cycle

WR — Low min 60ns — High min 150ns
RS — Set RS min 5ns before WR
D0-D7 — Set data max 5ns before raising WR

I80 Read Cycle

RD — Low min 190ns — High min 150ns
RS — Set RS min 5ns before RD
D0-D7 — Data setup min 190ns after RD low / Data held min 5ns after RD high

4.1.3 4-bit Mode

For 4-bit mode, only pins D4-D7 are used. The full 8-bit byte is written by initiating two cycles: the first sending the high four bits, the second sending the low four bits.

Both M68 and I80 may be used in 4-bit mode. Serial does not have a 4-bit mode.

4.2 Serial Interface Protocol

1. Raise SCK and STB at startup
2. Lower STB to begin cycle
3. Send the Start Byte bits high to low (bit 7 to bit 0); for each bit:
   a. Lower SCK
   b. Set SO high for 1 and low for 0.
   c. Raise SCK
4. Leave STB low and send the data/command or receive the response from the module by:
   a. Lower SCK
   b. Wait at least 150ns
   c. Read the bit
   d. Raise SCK
5. Raise STB to end the cycle

Start Byte

7 6 5 4   3 2 1 0

| 1 | 1 | 1 | 1 | 1 R/W RS 0 |
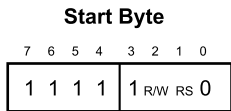
0xF8   Send Command
0xFA   Write Data
0xFC   Read Address & Busy
0xFE   Read Data

STB

| Start Byte | Input / Output | min 500ns between cycles |

Serial Write Cycle

SCK

Lower min 200ns

Raise min 200ns

Bit 7   Bit 6   Bit 5   ...

SO

min 500ns before raising STB

Serial Read Cycle

SCK

Wait 1µs after Start Byte
Lower SCK min 200ns
Raise SCK min 200ns

Bit 7   Bit 6   Bit 5   ...

SI / SO

min 500ns before raising STB

max 150ns before data is ready
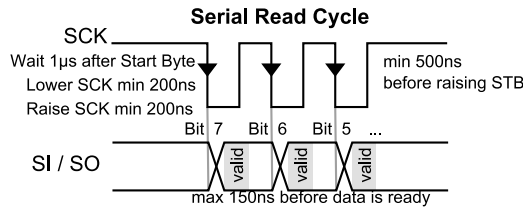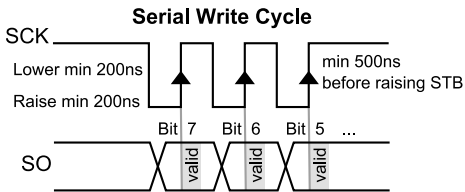
5 Font Selection

CU-U has two fonts that emulate variants of the HD44780: Katakana and International.

BC-VFD selects its font at via the *Cursor Home* command; CU-U's is fixed or set by jumper

Despite being selectable at via command, the two fonts cannot be used at the same time on screen.

Other modules select the font via a jumper. Please check the Jumper section of the specification for information setting the font jumper.

6 Programming

6.1 Initialization

Like all HD44780-compatibles, the module must be initialized.

Initialization sets up the bus width (4-bit or 8-bit), cursor settings, and brightness.

6.1.1 Serial and 8-bit mode Parallel

1. Wait at least 260 ms after $V_{CC} > 4.75V_{DC}$
2. Function Set   38H   RS=0   Select 8-bit bus mode
3. Function Set   38H   RS=0   Select 8-bit bus mode
4. Brightness Set   00H   RS=1   Select 100% Brightness (Use 02H for 100% on brightness boost modules)
5. Display OFF   08H   RS=0   Turn display, blinking, and cursor off
6. Display Clear   01H   RS=0   Clear display
7. Wait 2.3 ms   Wait for command to complete
8. Display ON   0CH   RS=0   Display on; cursor and blinking off
9. Entry Mode   06H   RS=0   Left-to-right (Cursor Increment)

6.1.2 4-bit mode Parallel

1. Wait at least 260 ms after $V_{CC} > 4.75V_{DC}$
2. Function Set   3FH   RS=0   Select 8-bit bus mode (sent in 8-bit mode with one toggle of E)
3. Function Set   3FH   RS=0   Select 8-bit bus mode (sent in 8-bit mode with one toggle of E)

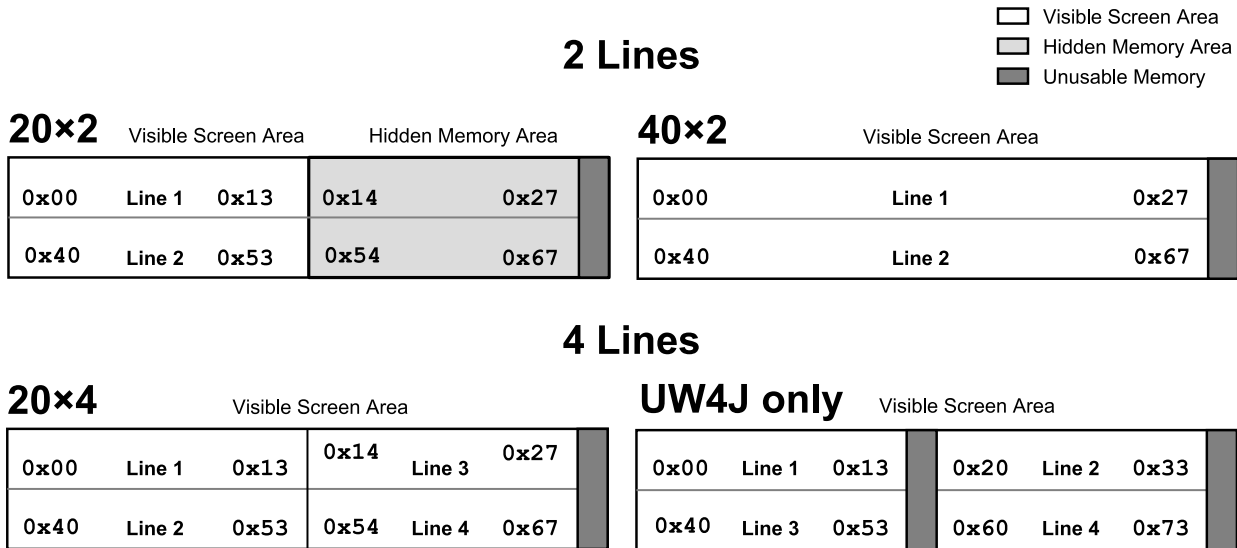| 4. | Function Set | 3FH | RS=0 | Select 8-bit bus mode (sent in 8-bit mode with one toggle of E) |
5.	Function Set	20H	RS=0	Select 4-bit bus mode
6.	Brightness Set	0H, 0H	RS=1	Select 100% Brightness (Use 02H for 100% on brightness boost modules)
7.	Display OFF	0H, 8H	RS=0	Turn display, blinking, and cursor off
8.	Display Clear	0H, 1H	RS=0	Clear display
9.	Wait 2.3 ms			Wait for command to complete
10.	Display ON	0H, CH	RS=0	Display on; cursor and blinking off
11.	Entry Mode	0H, 6H	RS=0	Left-to-right (Cursor Increment)

6.2 Sending Characters

After initialization, characters can be displayed by using the *DDRAM Address Set* command and writing the ASCII character code as data. See the *DDRAM Layout* section for the meaning of DDRAM addresses.

6.3 DDRAM Layout

HD4470 exposes its raw memory layout to the host program as DDRAM (display memory). Lines do not wrap automatically. Therefore, when one row has been filled, the program must manually set the cursor to the beginning of the next row.
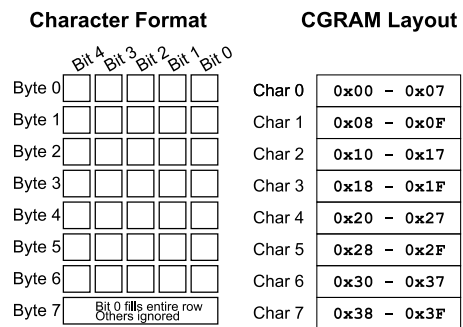
The hidden memory area is used to store characters that will be scrolled onto the screen. Note that not all of the modules have hidden memory areas.

□ Visible Screen Area
▨ Hidden Memory Area
▧ Unusable Memory

2 Lines

20×2   Visible Screen Area   Hidden Memory Area

| 0x00 | Line 1 | 0x13 | 0x14 | | 0x27 |
| 0x40 | Line 2 | 0x53 | 0x54 | | 0x67 |

40×2   Visible Screen Area

| 0x00 | Line 1 | 0x27 |
| 0x40 | Line 2 | 0x67 |

4 Lines

20×4   Visible Screen Area

| 0x00 | Line 1 | 0x13 | 0x14 | Line 3 | 0x27 |
| 0x40 | Line 2 | 0x53 | 0x54 | Line 4 | 0x67 |

UW4J only   Visible Screen Area

| 0x00 | Line 1 | 0x13 | 0x20 | Line 2 | 0x33 |
| 0x40 | Line 3 | 0x53 | 0x60 | Line 4 | 0x73 |

6.4 Creating User-Defined Fonts (UDF)

Like HD44780, CU-U can set up to 8 UDF characters.

- Characters are stored in CGRAM (Character Generator RAM)
- Characters are numbered 0 – 7
- Character n's CGRAM address is 8 × n (e.g. 0x28 for char 5)
- Use the Set CGRAM Address command to move to CGRAM
- Write the 8 bytes of the character
- Use Set DDRAM Address command to move back to DDRAM
- Write the character number as data to print it

Character Format

Bit 4 Bit 3 Bit 2 Bit 1 Bit 0

Byte 0
Byte 1
Byte 2
Byte 3
Byte 4
Byte 5
Byte 6
Byte 7   Bit 0 fills entire row
Others ignored

CGRAM Layout

Char 0	0x00 – 0x07
Char 1	0x08 – 0x0F
Char 2	0x10 – 0x17
Char 3	0x18 – 0x1F
Char 4	0x20 – 0x27
Char 5	0x28 – 0x2F
Char 6	0x30 – 0x37
Char 7	0x38 – 0x3F

6.4.1 Example

This example creates a speaker and sound wave in characters 0 and 1.

```
uint8_t udf0[] = {
        0b00000,
        0b00001,
        0b00011,
        0b00111,
        0b00111,
        0b00011,
        0b00001,
        0b0
};
```

```
uint8_t udf1[] = {
        0b00000,
        0b00100,
        0b10010,
        0b01010,
        0b01010,
        0b10010,
        0b00100,
        0b0,
};
```
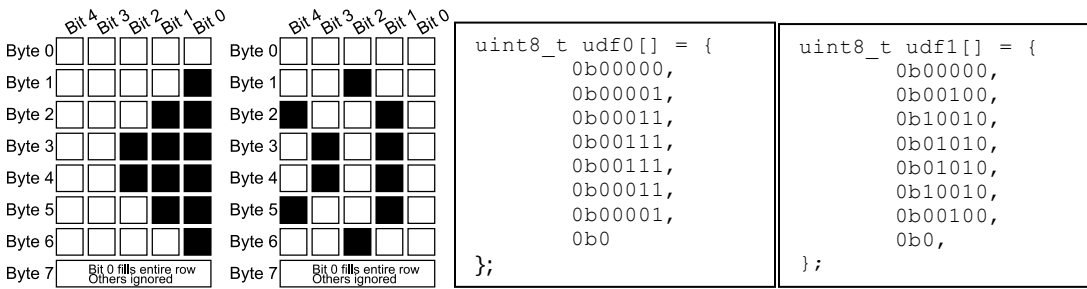
6.5 Brightness Control

Unlike HD44780 LCDs, the brightness of the module can be controlled through software. At startup, the brightness is automatically set to 100% (200% for brightness boost models). Send the Function Set command and send a data byte before the next command is sent to adjust the brightness.

6.5.1   CU-U Modules without Brightness Boost

03H=25%
02H=50%
01H=75%
00H=100%.

6.5.2   CU-U Modules with Brightness Boost

For brightness boost models, using 100% brightness when high visibility is not necessary decreases power consumption and increases the product lifetime.

03H=50%
02H=100%
01H=150%
00H=200%

6.5.3   BC-VFD Modules

00H=100%	04H=75%	08H=50%	0CH=25%
01H=93.75%	05H=68.75%	09H=43.75%	0DH=18.75%
02H=87.50%	06H=62.50%	0AH=37.50%	0EH=12.50%
03H=81.25%	07H=56.25%	0BH=31.25%	0FH=6.25%

6.6 Sleep Mode

Sleep mode reduces the power consumption and extends the life of the module when not in active use.

Activate sleep mode with the Display ON/OFF command.

When the module is asleep, the DC/DC converter and the filament are turned off.

7 Value Added Services

7.1 Color Filters

Color filters increase the contrast of the display as well as act as a protective shield.

For more information on color filters: http://www.noritake-elec.com/colorFilter.html

7.2 Products and Services

Value added services are available for connectors, cables, conformal coating, power supplies and other services upon request.

For more information on services offered: http://www.noritake-elec.com/NTC/

8 Troubleshooting

8.1 No characters appear on the screen

Confirm that the module is being initialized correctly and that all connections are firmly connected.
If no filter is applied, check to see that the filament is lit. It appears as a thin orange lines on the face of the display. It is difficult to see in normal light, so you may need to darken the area.
If the filament is not on, contact technical support.

8.2 Upgrading from ECPB

In the transition from the ECPB to the new technology, the timings of the interface have changed. Confirm that the interface timings are correct according to the replacement product's specification.

8.3 Characters overlap when updated quickly

This effect is caused by updating the screen too fast for the eyes to see separate frames. You can prevent this by adding delays to the program.
This effect may not be visible or may appear as "ghosts" on LCDs since VFDs update much faster than LCDs.

8.4 Multiple characters appear when one is transmitted

If multiple characters appear when only one write cycle was performed, there may be signal noise on the E or WR line. Examine the signal being emitted from the device and make sure the signal is clear and within the rise and fall tolerances allowed in the product specification.

9 Revision Notes

File	Date	Revision
E-M-0140-01	January 04, 2013	Clarified *4.2 Serial Interface* diagram. Now indicates SCK trigger and valid polling time.
E-M-0140-02	January 15, 2013	Changed 1.1 *Model Number* "Revision" to "Product Code Number". Added section 5 *Font Selection*.