

A photograph of a green printed circuit board (PCB) featuring a large, rectangular, black LCD screen. The screen is currently blank and displays a dark, slightly textured surface. The PCB is populated with various electronic components, including small gold-colored solder pads and a small white label with the text 'LC1' in the upper left corner. The text 'LCD kijelző' is overlaid in white on the center of the screen.

LCD kijelző

T-Bird GPIO-A/T			
2	PF1	LCD_RS	OUT
3	PF2	LCD_R/W	OUT
4	PF3	LCD_E	OUT
5	PE4	LCD_DATA4	OUT
6	PE5	LCD_DATA5	OUT
7	PE6	LCD_DATA6	OUT
8	PE7	LCD_DATA7	OUT
13	VCC	VCC	VCC
14	GND	GND	GND

```
#define LCD_CMD_DDR      (DDRF)
#define LCD_DATA_DDR     (DDRE)

#define LCD_CMD_PORT     (PORTF)
#define LCD_DATA_PORT    (PORTE)
#define LCD_DATA_PIN     (PINE)

#define LCD_RS           (PF1)
#define LCD_RW           (PF2)
#define LCD_EN           (PF3)

#define LCD_E    2    //enable
#define LCD_CUR  1    //cursor
#define LCD_BL   0    //blink
```

## Pin Functions

Signal	No. of Lines	I/O	Device Interfaced with	Function
RS	1	I	MPU	Selects registers. 0: Instruction register (for write) Busy flag: address counter (for read) 1: Data register (for write and read)
$R/\overline{W}$	1	I	MPU	Selects read or write. 0: Write 1: Read
E	1	I	MPU	Starts data read/write.
DB4 to DB7	4	I/O	MPU	Four high order bidirectional tristate data bus pins. Used for data transfer and receive between the MPU and the HD44780U. DB7 can be used as a busy flag.
DB0 to DB3	4	I/O	MPU	Four low order bidirectional tristate data bus pins. Used for data transfer and receive between the MPU and the HD44780U. These pins are not used during 4-bit operation.

# Működés

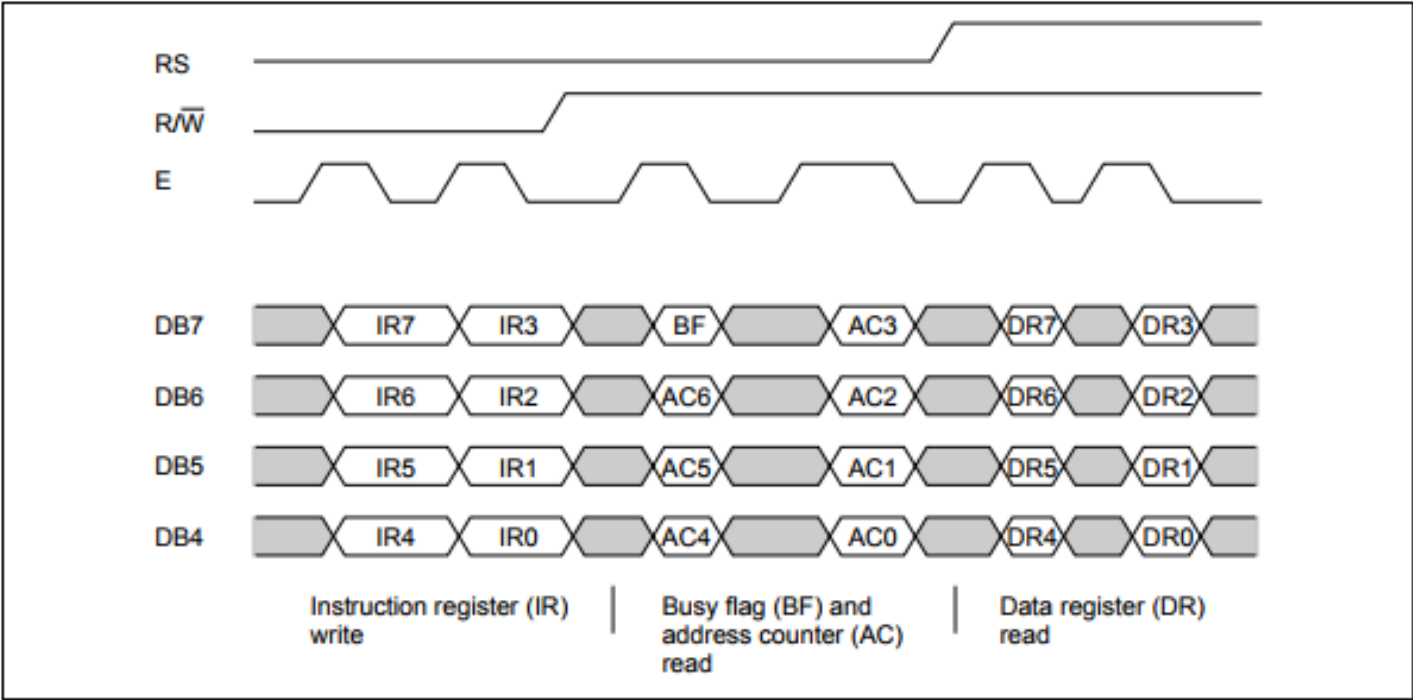


Figure 9 4-Bit Transfer Example

RS	0	Parancsküldés	0	Státuszinformáció	1	Adatregiszter	1	Adatregiszter
R/W	0		1	kiolvasása	0	írása	1	olvasása
E	0-1-0		0-1-0		0-1-0		0-1-0	

# Parancsok - 1

Instruction	Code										Description	Execution Time (max) (when $f_{cp}$ or $f_{osc}$ is 270 kHz)
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear display	0	0	0	0	0	0	0	0	0	1	Clears entire display and sets DDRAM address 0 in address counter.	
Return home	0	0	0	0	0	0	0	0	1	—	Sets DDRAM address 0 in address counter. Also returns display from being shifted to original position. DDRAM contents remain unchanged.	1.52 ms
Entry mode set	0	0	0	0	0	0	0	1	I/D	S	Sets cursor move direction and specifies display shift. These operations are performed during data write and read.	37 $\mu$ s
Display on/off control	0	0	0	0	0	0	1	D	C	B	Sets entire display (D) on/off, cursor on/off (C), and blinking of cursor position character (B).	37 $\mu$ s
Cursor or display shift	0	0	0	0	0	1	S/C	R/L	—	—	Moves cursor and shifts display without changing DDRAM contents.	37 $\mu$ s
Function set	0	0	0	0	1	DL	N	F	—	—	Sets interface data length (DL), number of display lines (N), and character font (F).	37 $\mu$ s
Set CGRAM address	0	0	0	1	ACG	ACG	ACG	ACG	ACG	ACG	Sets CGRAM address. CGRAM data is sent and received after this setting.	37 $\mu$ s
Set DDRAM address	0	0	1	ADD	ADD	ADD	ADD	ADD	ADD	ADD	Sets DDRAM address. DDRAM data is sent and received after this setting.	37 $\mu$ s
Read busy flag & address	0	1	BF	AC	AC	AC	AC	AC	AC	AC	Reads busy flag (BF) indicating internal operation is being performed and reads address counter contents.	0 $\mu$ s

# Parancsok - 2

**Table 6 Instructions (cont)**

Instruction	Code										Description	Execution Time (max) (when $f_{cp}$ or $f_{osc}$ is 270 kHz)
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Write data to CG or DDRAM	1	0	Write data								Writes data into DDRAM or CGRAM.	37 $\mu$ s $t_{ADD} = 4 \mu$ s*
Read data from CG or DDRAM	1	1	Read data								Reads data from DDRAM or CGRAM.	37 $\mu$ s $t_{ADD} = 4 \mu$ s*
	I/D = 1: Increment I/D = 0: Decrement										DDRAM: Display data RAM CGRAM: Character generator RAM	Execution time changes when frequency changes Example: When $f_{cp}$ or $f_{osc}$ is 250 kHz, $37 \mu$ s $\times \frac{270}{250} = 40 \mu$ s
	S = 1: Accompanies display shift										ACG: CGRAM address	
	S/C = 1: Display shift										ADD: DDRAM address	
	S/C = 0: Cursor move										(corresponds to cursor address)	
	R/L = 1: Shift to the right										AC: Address counter used for both DD and CGRAM addresses	
	R/L = 0: Shift to the left											
	DL = 1: 8 bits, DL = 0: 4 bits											
	N = 1: 2 lines, N = 0: 1 line											
	F = 1: 5 $\times$ 10 dots, F = 0: 5 $\times$ 8 dots											
	BF = 1: Internally operating											
	BF = 0: Instructions acceptable											

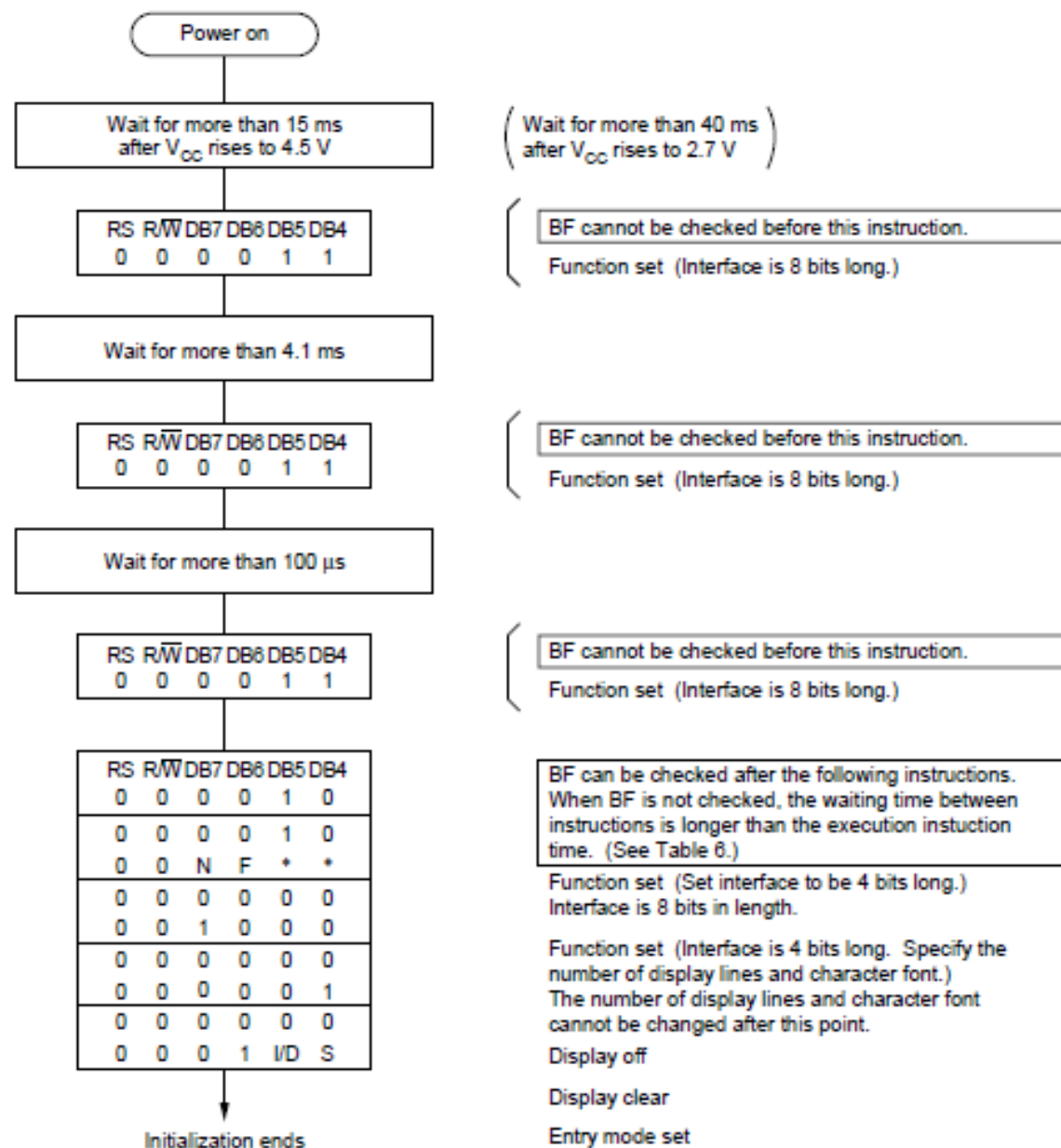
Note: — indicates no effect.

- \* After execution of the CGRAM/DDRAM data write or read instruction, the RAM address counter is incremented or decremented by 1. The RAM address counter is updated after the busy flag turns off. In Figure 10,  $t_{ADD}$  is the time elapsed after the busy flag turns off until the address counter is updated.



No	HEX Value	COMMAND TO LCD
1	0x01	Clear Display Screen
2	0x30	Function Set: 8-bit, 1 Line, 5x7 Dots
3	0x38	Function Set: 8-bit, 2 Line, 5x7 Dots
4	0x20	Function Set: 4-bit, 1 Line, 5x7 Dots
5	0x28	Function Set: 4-bit, 2 Line, 5x7 Dots
6	0x06	Entry Mode
7	0x08	Display off, Cursor off
8	0x0E	Display on, Cursor on
9	0x0C	Display on, Cursor off
10	0x0F	Display on, Cursor blinking
11	0x18	Shift entire display left
12	0x1C	Shift entire display right
13	0x10	Move cursor left by one character
14	0x14	Move cursor right by one character
15	0x80	Force cursor to beginning of 1st row
16	0xC0	Force cursor to beginning of 2nd row





# 4bites mód beállítása

Instruction	Code										Description	Execution Time (max) (when $f_{cp}$ or $f_{osc}$ is 270 kHz)
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear display	0	0	0	0	0	0	0	0	0	1	Clears entire display and sets DDRAM address 0 in address counter.	
Return home	0	0	0	0	0	0	0	0	0	1	Sets DDRAM address 0 in address counter. Also returns display from being shifted to original position. DDRAM contents remain unchanged.	1.52 ms
Entry mode set	0	0	0	0	0	0	0	1	I/D	S	Sets cursor move direction and specifies display shift. These operations are performed during data write and read.	37 $\mu$ s
Display on/off control	0	0	0	0	0	0	1	D	C	B	Sets entire display (D) on/off, cursor on/off (C), and blinking of cursor position character (B).	37 $\mu$ s
Cursor or display shift	0	0	0	0	0	1	S/C	R/L	—	—	Moves cursor and shifts display without changing DDRAM contents.	37 $\mu$ s
Function set	0	0	0	0	1	DL	N	F	—	—	Sets interface data length (DL), number of display lines (N), and character font (F).	37 $\mu$ s
Set CGRAM address	0	0	0	1	ACG	ACG	ACG	ACG	ACG	ACG	Sets CGRAM address. CGRAM data is sent and received after this setting.	37 $\mu$ s
Set DDRAM address	0	0	1	ADD	ADD	ADD	ADD	ADD	ADD	ADD	Sets DDRAM address. DDRAM data is sent and received after this setting.	37 $\mu$ s
Read busy flag & address	0	1	BF	AC	AC	AC	AC	AC	AC	AC	Reads busy flag (BF) indicating internal operation is being performed and reads address counter contents.	0 $\mu$ s

Code											Execution Time (max) (when $f_{cp}$ or $f_{osc}$ is 270 kHz)	
Instruction	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Description	
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Read data from CG or DDRAM	1	1	Read data								Reads data from DDRAM or CGRAM.	37 $\mu$ s $t_{ADD} = 4 \mu$ s*
I/D = 1: Increment I/D = 0: Decrement S = 1: Accompanies display shift S/C = 1: Display shift S/C = 0: Cursor move R/L = 1: Shift to the right R/L = 0: Shift to the left DL = 1: 8 bits, DL = 0: 4 bits N = 1: 2 lines, N = 0: 1 line F = 1: 5 $\times$ 10 dots, F = 0: 5 $\times$ 8 dots BF = 1: Internally operating BF = 0: Instructions acceptable											DDRAM: Display data RAM CGRAM: Character generator RAM ACG: CGRAM address ADD: DDRAM address (corresponds to cursor address) AC: Address counter used for both DD and CGRAM addresses	Execution time changes when frequency changes Example: When $f_{cp}$ or $f_{osc}$ is 250 kHz, $37 \mu$ s $\times \frac{270}{250} = 40 \mu$ s

0x28-> 4bits, 2 lines, 5x8 dots

1. Felső 4 bit
2. Alsó 4 bit

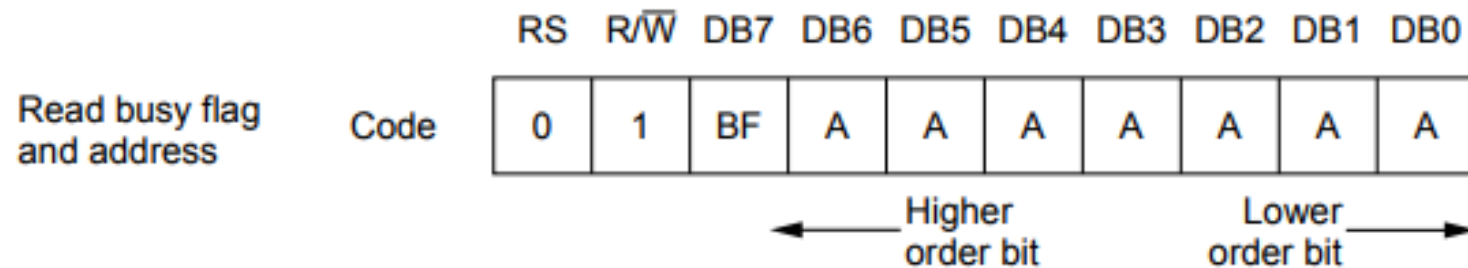
# Kurzor beállításai

- Display on/off control
  - 00001DCB
    - D: display on/off
    - C: Cursor on/off
    - B: Cursor blinking on/off

Display on/off control	0	0	0	0	0	0	1	D	C	B	Sets entire display (D) on/off, 37 $\mu$ s cursor on/off (C), and blinking of cursor position character (B).
------------------------------	---	---	---	---	---	---	---	---	---	---	---

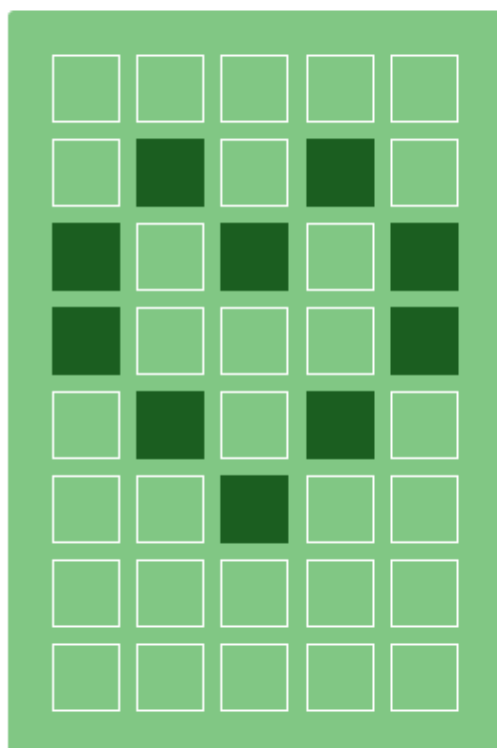
# Busy flag

- When the busy flag is 1, the HD44780U is in the internal operation mode, and the next instruction will not be accepted. When  $RS = 0$  and  $R/\bar{W} = 1$  the busy flag is output to DB7. The next instruction must be written after ensuring that the busy flag is 0.



# LCD Custom Character Generator

Support character lcd and create code for Arduino.



Clear

Invert

Color

☒ Green

☐ Blue

Microcontroller

☒ Arduino

Interfacing

☒ Parallel

☐ I2C

Data Type

☒ Binary

☐ Hex

Code

```
#include <LiquidCrystal.h>
```

```
LiquidCrystal lcd(12, 11, 5, 4, 3, 2); // RS, E, D4, D5, D6, D7
```

```
byte customChar[] = {
```

```
  B00000,
```

```
  B01010,
```

```
  B10101,
```

```
  B10001,
```

```
  B01010,
```

```
  B00100,
```

```
  B00000,
```

```
  B00000
```

```
};
```

# Ajánlott irodalom

- HD44780U (LCD-II)
  - <http://lcd-linux.sourceforge.net/pdtdocs/hd44780.pdf>