

I²C LC-Display Adapter Manual

IBC Ingenieur Büro
Channaa

Luxemburger Str. 31
D – 13353 Berlin

Phone: +49 – (0)30 – 617 412 48

Fax: +49 – (0)30 – 617 412 47

www.channaa.com

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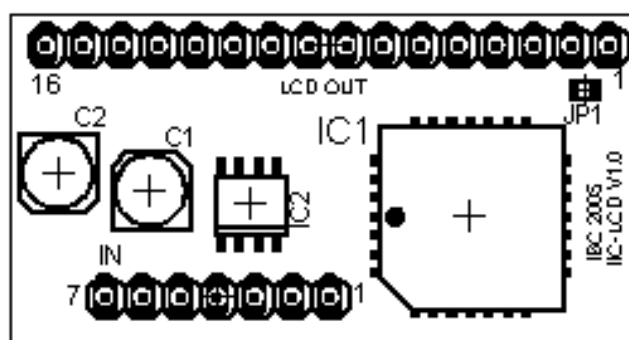
1. General discription

The I²C LC-Display Adapter enables easy interfacing a LC-Display (HD44780) to an I²C-Bus (two wire serial interface). Communication between a host and the I²C LCDC takes places via the two wire bi-directional serial interface. It is possible to connect up to 64 devices on the same bus. Slave addresses are programmable via controller EEPROM.

Features:

- 5 V supply voltage
- Low-level input voltage (SCL,SDA only): min. $-0.5V$ - max. $0.3V_{DD}$
- High-level input voltage (SCL,SDA only): min. $0.7 V_{DD}$ - max. $5.5V$
- 400 kHz byte-wide I2C-bus communication port (it depends on LC-Display)

2. Pinning Information



IN (1 – 7):

Pin		Description
1	SDA Line	serial data line
2	SCL Line	serial clock line
3	GND	0V Ground
4	V _{DD}	5V Supply voltage
5	VO	Input voltage for LCD (Pin 3)
6	LA	light anode for LCD (Pin 15)
7	LK	light cathode for LCD (Pin 16)

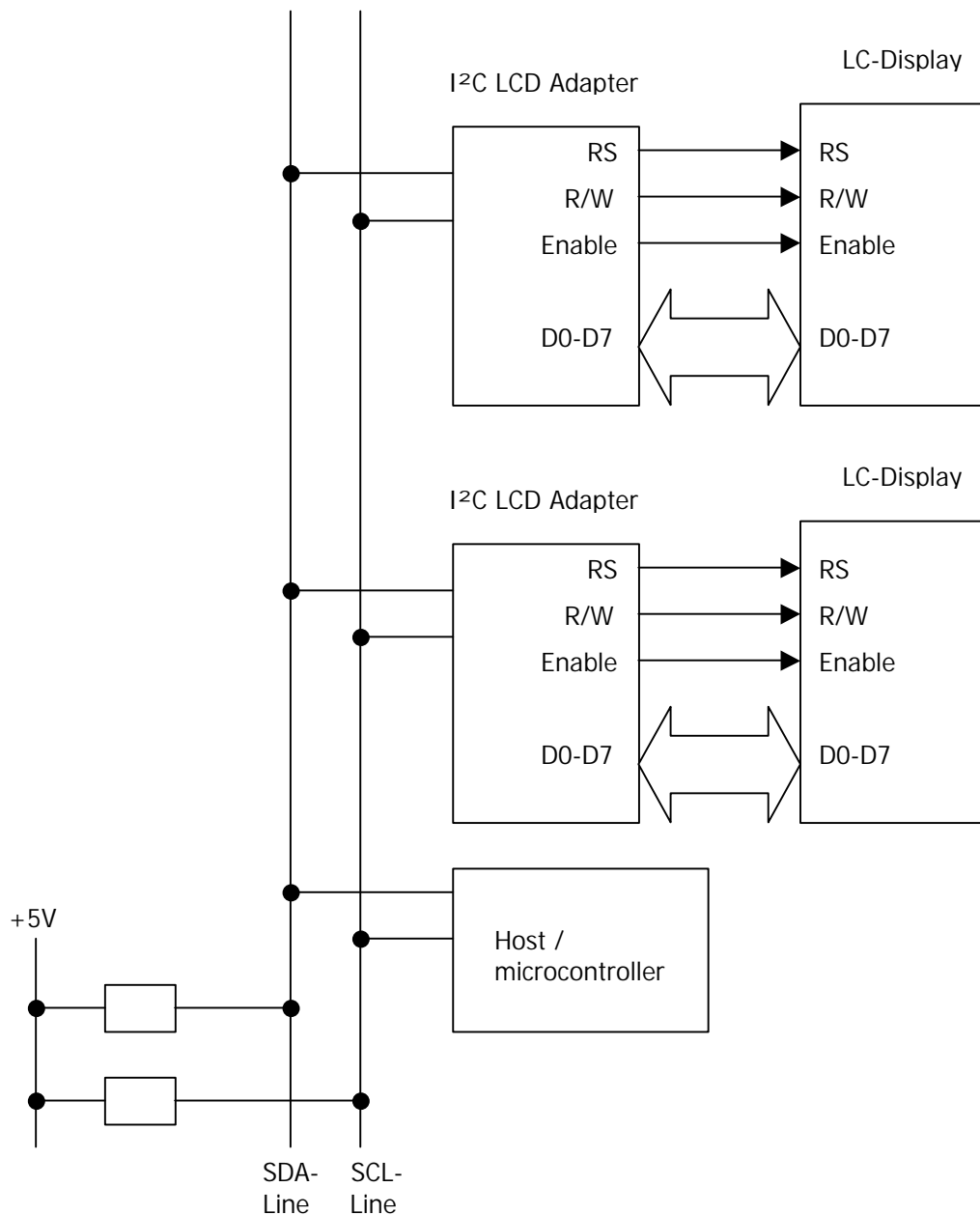
LCD OUT (1 – 16):

Pin		Description
1	VSS	0V Ground
2	VDD	5V Supply voltage for Logic
3	VO	Input voltage for LCD
4	RS	H: Data signal, L: Instruction signal
5	R / W	H: Read mode, L: Write mode
6	E	Chip enable signal
7	DB0	Data Bit 0
8	DB1	Data Bit 1
9	DB2	Data Bit 2
10	DB3	Data Bit 3
11	DB4	Data Bit 4
12	DB5	Data Bit 5
13	DB6	Data Bit 6
14	DB7	Data Bit 7
15	LA	light anode
16	LK	light cathode

3. Communication via I²C-Bus

3.1 I²C-Bus configuration

I²C-Bus uses two wires (SDA and SCL) to transfer information between devices connected to the bus. Each device connected to the bus is software addressable by a unique address and simple master/slave relationship exists at all times.



Example of an I²C-bus configuration

3.2 Address of the circuit

This circuit operates in slave mode. Each circuit must be provided with a physical address on order to discern this circuit from other ones on the I²C-bus. This address is coded on 7 bits and one bit is hardwired to '1', so that it is possible to connect 64 different circuits on the same bus. The address is always 0xFE at delivery.

3.3 The I²C Bus specification

3.3.1 Start and Stop conditions

Within the procedure of the I²C bus, unique situations arise which are defined as START (S) and STOP (P) conditions.

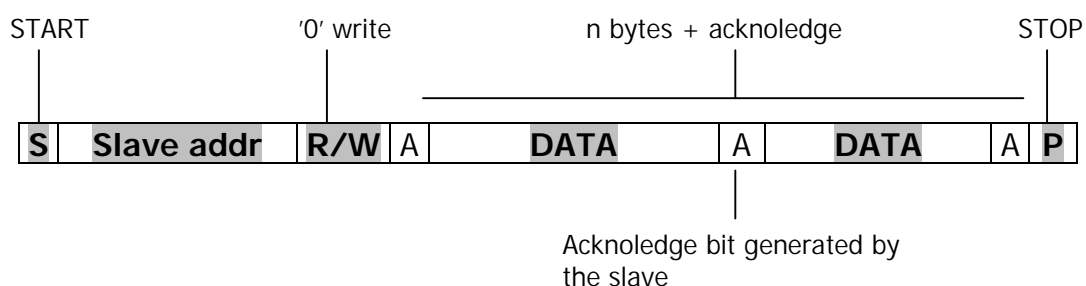
- A HIGH to LOW transtion on the SDA line while SCL is HIGH defines a Start condition.
- A LOW to HIGH transtion on the SDA line while SCL is HIGH defines a Stop condition.

Start and Stop conditions are always generated by the master. The bus is considered to be busy after a START condition. The bus is considered to be free again a certain time after a STOP condition.

3.3.1 Write data to I²C LCD Controller

Writing data to a device on the I²C-Bus is agreed as follow:

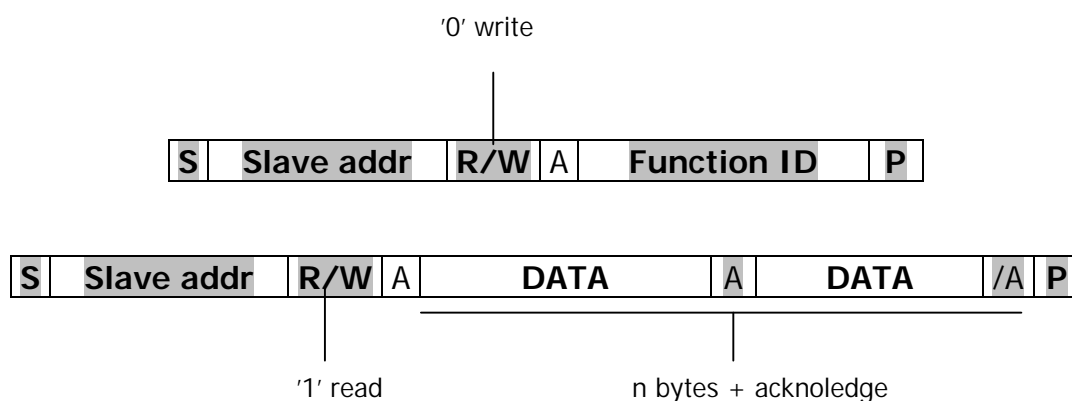
After the START condition, a slave address is sent. This address is 7 bits long followed by an eight bit which is a data direction bit ('0'=write, '1'=read) and an acknoledge bit. Any further data byte is followed by an acknoledge bit. A data transfer is always terminated by a STOP condition.



3.3.1 Read data from I²C LCD Controller

Reading data from a device on the I²C-Bus is agreed as follow and it consists of two sequences:

1. The first sequence consists of two bytes of data. The first byte is the slave address and write bit. The second consists of the function ID which reads the data from the LCD CG- or GGRAM and stores them in an internal register of the I²C LCD Controller.
2. The second sequence consists of the slave address and the read bit. Then the master can read the data. After each byte of data the master has to acknowledge correct data reception. The last byte is not to acknowledge by the master and therefore the slave knows the end of transmission.



For further information about the I²C-Bus specification please visit philips semiconductors on the internet at <http://www.semiconductors.philips.com> and download the datasheet.

4. Commands description

4.1 Command Overview

Command	Function	Command Byte
ClrDisplay	Clears LC-Display	0x61
ReturnHome	Sets cursor address / display to zero	0x62
SetCursor	Programmes a new cursor address	0x63
CharToLCD	Writes a character on the LCD	0x64
CMDToLCD	Sends a command to the LCD	0x65
Delete	Deletes characters from LCD	0x66
Copy	Copies characters into a temporary storage	0x67
Paste	Inserts characters to LCD (from temporary storage)	0x68
GetCursorAdr	Returns actual cursor address	0x69
GetCharAtCur	Returns character at actual cursor address	0x6A
ReadRAM	Returns character at actual address of CG- or GGRAM	0x6B
DisplayON_OFF	Sets display's parameters	0x6C
Shift	Sends shift command to LCD	0x6D
SetEntryMode	Sets display's Entry Mode	0x6E
SetFunction	Sets display's function (e.g. 2 or 1 lines)	0x6F
SetCGRAMAdr	Sets the CG-RAM address	0x70
SetGGRAMAdr	Sets the GG-RAM address	0x71
WriteSlvAdr	Programmes and stores slave address	0x72
SaveLCDIni	Saves LCD parameters into EEPROM	0x73
WriteUserDefChr	Writes a user defined character to LCD	0x74
SaveUserDefChr	Saves a user defined character into EEPROM	0x75
WriteString	Writes a string on the LCD	0x76
LCDType	Selects a LCD type e.g. 4x20 or 4x16	0x77

4.2 Command Description

4.2.1 ClrDisplay

In order to clear the LC-Display issue the following command by the master.

ClrDisplay command (0x61)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	ClrDisplay	0	1	1	0	0	0	0	1

4.2.2 ReturnHome

This command is provided to the circuit to return cursor / display home

ReturnHome command (0x62)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	ReturnHome	0	1	1	0	0	0	1	0

4.2.3 SetCursor

In order to set the cursor address issue the following command

SetCursor command (0x63)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	SetCursor	0	1	1	0	0	0	1	1
2	Cursor address	cursor address							

4.2.4 CharToLCD

To write a character on the LCD issue the following command

CharToLCD command (0x64)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	CharToLCD	0	1	1	0	0	1	0	0
2	Character	a byte as the standard character pattern of the LCD							

4.2.5 CMDToLCD

Some times it is necessary to a single command to the LCD. In order to send a command as agreed for the LCD issue this command.

CMDToLCD command (0x65)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	CMDToLCD	0	1	1	0	0	1	0	1
2	Command	Dsiplay command							

4.2.6 Delete

In order to delete a character, two characters or a complete line proceed as follow:

Delete command (0x66)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	Delete	0	1	1	0	0	1	1	0
2	Line	Number of line (1-4)							
3	Index	Start-Index on the selected line (1-20)							
4	Length	Length, characters should be deleted (1-20)							

4.2.7 CopyToClipboard

This function Copies a set of characters (1-20) to a temporary storage, which could be written to the LCD later.

CopyToClipboard command (0x67)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	CopyToClipboard	0	1	1	0	0	1	1	1
2	Line	Number of line (1-4)							
3	Index	Start-Index on the selected line (1-20)							
4	Length	Length, characters should be copied (1-20)							

4.2.8 Paste

This command is provided by the master to insert the copied characters in the temporary storage on the LCD

Paste command (0x68)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	Paste	0	1	1	0	1	0	0	0

4.2.9 GetCursorAdr

This function returns two bytes: 1. the slave address of the selected device and 2. the actual cursor address.

GetCursorAdr command (0x69)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	GetCursorAdr	0	1	1	0	1	0	0	1

GetCursorAdr Response									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address (W)	M7	M6	M5	M4	M3	M2	1	1
1	Slave address	Slave address of the selected device							
2	Cursor Address	Actual cursor address							

4.2.10 GetCharAtCur

This function returns two bytes: 1. the slave address of the selected device and 2. the character at the actual cursor address.

GetCharAtAdr command (0x6A)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	GetCharAtAdr	0	1	1	0	1	0	1	0

GetCharAtAdr Response									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address (W)	M7	M6	M5	M4	M3	M2	1	1
1	Slave address	Slave address of the selected device							
2	Cursor Address	Character at actual cursor address							

4.2.11 ReadRAM

This function returns two bytes: 1. the slave address of the selected device and 2. a data byte from the selected CG- or GGRAM address of the LC-Display. In order to read a RAM content select first the address by using the functions SetCGRAMAdr or SetGGRAMAdr.

ReadRAM command (0x6B)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	GetCharAtAdr	0	1	1	0	1	0	1	1

ReadRAM Response									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address (W)	M7	M6	M5	M4	M3	M2	1	1
1	Slave address	Slave address of the selected device							
2	CG- or GGRAM	Data byte from the selected RAM address							

4.2.12 DisplayON_OFF

In order to change display's paramters issue this command and write the paramters as a byte to the selected device.

DisplayON_OFF command (0x6C)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	DisplayON_OFF	0	1	1	0	1	1	0	0
2	Config. Byte	0	0	0	0	1	D	C	B

Bit	L	Function	comment
D	1	display ON	
	0	display OFF	
C	1	Cursor ON	
	0	Cursor OFF	
B	1	Blinking ON	
	0	Blicking OFF	

4.2.13 Shift

For shifting display or moving the cursor use the following command. In order to configure the direction set or clear the R/L.

Shift command (0x6D)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	Shift	0	1	1	0	1	1	0	1
2	Shift Byte	0	0	0	1	S/C	R/L	X	X

Bit	L	Function	comment
S/C	1	Display shift	
	0	Cursor move	
R/L	1	Right shift	
	0	Left shift	
X	X	n.a.	Do not care

4.2.14 SetEntryMode

In order to change the Entry Mode of the display issue this command and write the config. byte to the selected device.

SetEntryMode command (0x6E)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	SetEntryMode	0	1	1	0	1	1	1	0
2	Config. Byte	0	0	0	0	0	1	I/D	SH

Bit	L	Function	comment
I/D	1	Increase	Set cursor move
	0	Decrease	
SH	1	Display is shifted	
	0	Display is not shifted	

4.2.15 SetFunction

In order to change display's parameters issue this command and write the parameters as a byte to the selected device. After a new startup the LCD will be initialised automatically with the new parameters.

SetFunction command (0x6F)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	SetFunction	0	1	1	0	1	1	1	1
2	Config. Byte	0	0	1	DL	N	F	X	X

Bit	L	Function	comment
DL	1	8 bits interface	8 bits interface is always selected.
	0	4 bits interface	
N	1	2 line display	
	0	1 line display	
F	1	5 x 10 dots	
	0	5 x 7 dots	
X	X	n.a.	Do not care

4.2.16 SetCGRAMAdr

In order to read a CGRAM address select first the address of the CGRAM with the following command. After the CGRAM address is successfully selected, the RAM content could be read.

SetCGRAMAdr command (0x70)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	SetCGRAMAdr	0	1	1	1	0	0	0	0
2	CGRAM Address	The CGRAM address to select							

4.2.17 SetGGRAMAdr

In order to read a GGRAM address select first the address of the GGRAM with the following command. After the GGRAM address is successfully selected, the RAM content could be read.

SetGGRAMAdr command (0x71)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	SetGGRAMAdr	0	1	1	1	0	0	0	1
2	GGRAM Address	The GGRAM address to select							

4.2.17 WriteSlvAdr

In order to change the slave address issue this command and then send the new slave address. Bit 1 is hardwired to **1**.

SlvAdr command (0x72)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	WriteSlvAdr	0	1	1	1	0	0	1	0
2	Slave Address	upper 6 bits of Slave address (7:2)						X	X

X	Do not care
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4.2.18 SaveLCDIni

This command is provided by the master to save the configuration bytes for the LCD. The following Bytes will be saved:

1. SetFunction
2. SetEntryMode
3. DisplayON_OFF

On startups the LCD will be initialised with these settings.

SaveLCDIni command (0x73)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	SaveLCDIni	0	1	1	1	0	0	1	1

4.2.19 WriteUserDefChr

This command is provided by the master to create a user defined characters and to load them to the CGRAM of a LCD. A LC-Display allows 8 users defined characters to be loaded to the CGRAM. These are the first 8 characters (0x00–0x07) in the standard character pattern of a LCD.

The character number ist a number between 0x00 and 0x07.

WriteUserDefChr command (0x74)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	WriteUserDefChr	0	1	1	1	0	1	0	0
2	Character Number	X	X	X	X	X	Char.Nr. (3:0)		
3	Character Byte 0	X	X	X	5 dots (4:0)				
4	Character Byte 1	X	X	X	5 dots (4:0)				
5	Character Byte 2	X	X	X	5 dots (4:0)				
6	Character Byte 3	X	X	X	5 dots (4:0)				
7	Character Byte 4	X	X	X	5 dots (4:0)				
8	Character Byte 5	X	X	X	5 dots (4:0)				
9	Character Byte 6	X	X	X	5 dots (4:0)				
10	Character Byte 7	X	X	X	5 dots (4:0)				

X	Do not care
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4.2.20 SaveUserDefChr

After loading a user defined character to the LCD, the character could be saved, and after a startup the 8 characters will be automatically loaded to the CGRAM. In order to save a character issue this command and send the character number (0x00 – 0x07) to the controller.

SaveUserDefChr command (0x75)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	SaveUserDefChr	0	1	1	1	0	1	0	1
2	Character Number	X	X	X	X	X	Char.Nr. (3:0)		

X	Do not care
----------	-------------

4.2.21 WriteString

To write a String (1 to 40 characters) on the LCD issue the following command

WriteString command (0x76)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	WriteString	0	1	1	1	0	1	1	0
2	Character (1)	a byte as the standard character pattern of the LCD							
...							
42	Character (40)	a byte as the standard character pattern of the LCD							

4.2.22 LCDType

In order to select the type of your LC-Display issue the following command by the master.

LCDType command (0x77)									
Byte	content	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Slave Address	M7	M6	M5	M4	M3	M2	1	0
1	LCDType	0	1	1	1	0	1	1	1
2	Type	X	X	X	X	X	X	X	TP

Bit	L	Type	comment
TP	1	4x20	4x20 is preselected
	0	else (e.g. 4x16)	
X	X	n.a.	Do not care