1-Wire® Slave Device

type

Liquid Crystal Display Controller V1.00

Data Sheet

Rev 1.7

Date: 28 April 2004

History:

Revision:	Date:	Updated By:	Description:
1.0	9 July 2001	L Swart	Completed Rev 1.0
1.1	9 August 2001	L Swart	Added commands.
1.2	3 September 2001	L Swart	Added timing related information, Schematic and pictures of demo board.
1.3	5 September 2001	L Swart	Final additions.
1.4	26 September 2001	L Swart	Added back-light commands, update schematic Rev 1.0 with Rev 1.1, new input de-bounce time and added applications.
1.5	21 October 2001	L Swart	Corrected number of bytes mentioned in 2. Overview for the EEPROM. Updated photos of 1-Wire LCD.
1.6	18 February 2004	L Swart	Update footnote.
1.7	28 April 2004	L Swart	Nothing new, V1.00 only has new 1-Wire bus interface and out of beta stage.

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1. Scope

This document describes the 1-Wire LCD controller functionality and communications protocol. The document assumes that the user has sufficient knowledge of the Dallas 1-Wire Communications. For more detail, concerning the Dallas 1-Wire communication, refer to the documentation supplied by Dallas. This document only describes the commands and control method of the 1-Wire LCD controller.

The content of this document has been written as accurately as possible. No responsibility will be accepted for any mistakes that were made either in the technical content or in wording.

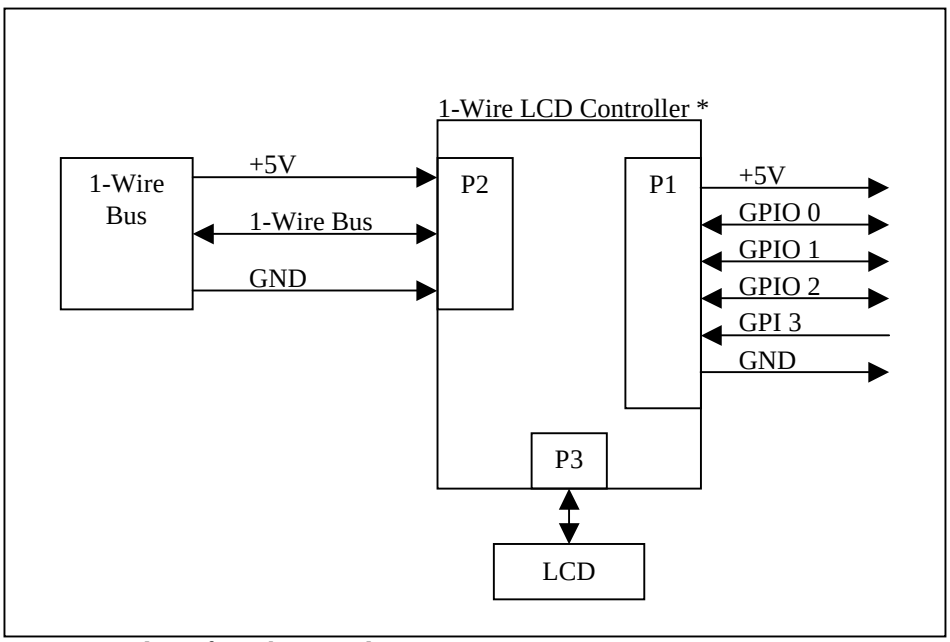
2. Overview

The 1-Wire LCD controller connects to a Dallas 1-Wire network and functions as a slave device. This controller could be used to display information on a LCD under control of a 1-Wire network master. The 1-Wire LCD controller supports different standard text liquid crystal character displays (e.g. 2 Lines x 16 Characters LCD).

The 1-Wire LCD controller has the following built-in functionality:

- Unique serial number.
- Support for a wide range of LCDs, from 1 Line x 8 Characters up to 2 Line x 40 Characters.
- Built-in LCD initialize: to ensure that the LCD is ready to display text after power-up.
- Easy text displaying via scratchpad.
- Direct LCD register and data memory access to enable full control of the LCD.
- LCD power ON/OFF control.
- LCD back-light ON/OFF control.
- 3 Open collector general-purpose input/output pins (GPIO) and 1 general-purpose input only pin (GPI).
- All inputs have de-bounced (25mS) event counters (counts up and down going events).
- Open collector outputs can sink 10mA of current (direct LED drive with internal 470-Ohm resistor).
- 112 bytes of EEPROM (Non-volatile storage).

The following diagram shows the connections to the 1-Wire LCD controller:



* See Appendix A for Schematic diagram.
GPIO - General Purpose Input Output.
GPI - General Purpose Input.

2.1. Unique Serial Number

The family code of the 1-Wire LCD controller is FFh showing that it is a non-Dallas slave device. The serial number will start with 0001xxxxxxxxFFh. This 0001h is the upper two bytes of the serial number. Making these two bytes 0001h shifts the serial number beyond the first 4,294,967,295 serial numbers. The FFh family code in combination with the 0001h indicates that it is a 1-Wire LCD controller slave device. Other devices to follow will use 0002h, 0003h and … in these upper two bytes of the serial number giving them a unique serial number under the same family code of FFh.

The above-described method effectively expands one family code into another 65535 family codes by only limiting the total number of serial numbers to 4,294,967,295.

Thus, the complete serial number range for the 1-Wire LCD controller will be as follow:

(8 Bit CRC)000100000001FFh <- Serial number 1 (Start).
(8 Bit CRC)000100000002FFh <- Serial number 2.
.....
(8 Bit CRC)0001FFFFFFFEFFh <- Serial number 4,294,967,294.
(8 Bit CRC)0001FFFFFFFFFFh <- Serial number 4,294,967,295 (End).

2.2. Applications

Below are a few typical applications for the functionality implemented on the 1-Wire LCD controller:

General Purpose Inputs and Outputs:

- Control of door solenoid / magnetic lock.
- Control relays for gate motors.
- Read a door or gate open / close sensor.
- Directly drive LEDs (with series resistor).
- Directly drive Opto-couplers (with series resistor) for TRIAC control and other optically isolated requirements.
- Directly read input states from switches and Opto-couplers (with pull-up resistor).
- Count events from other devices such as door-mats, Infrared Beams, passive Infrared devices, push buttons, limit switches, etc.
- Connect to any other device that can be controlled with a 5V signal or read input from a device with a 5V output.

Display:

- Status information at an access door or gate such as why access is denied or current access time and date.
- Display device, HOT plug-able handheld or wall mounted, for temperature or other sensor readings, system status / diagnostic information, system parameter setup.

EEPROM Storage:

- User information regarding device location, function, system installation and service date time.
- Pre-defined user LCD screens templates.

These are only some of the possibilities of the 1-Wire LCD controller.

3. Description

The LCD controller gives the user the ability to add Liquid Crystal character Display functionality to their existing or new Dallas 1-Wire networks. Each controller has a unique serial number to make it addressable on the Dallas 1-Wire network.

The main function of the controller is to control a LCD display. The ability to connect different size LCDs is important. Thus, the controller supports the LSI HD44780 LCD-II or compatible LCD controllers. This allows the ability to display up to 80 characters in any format (e.g. 2 Lines x 40 Characters). The controller also allows the user to control the power to the LCD and the LCD back-light individually. If the LCD is not used, the 1-Wire master may decide to switch the LCD and / or the back-light power off. When the LCD is powered up again it is ready to display text characters. There is no need to initialize the LCD although direct LCD register and data access is supported via the 1-Wire network. Refer to a HD44780 LCD-II data sheet for more information on the LCD register and data memory.

The controller was also designed with four general-purpose inputs (GPI) or three general-purpose outputs (GPO). These GPOs are open collector and could be used as bi-directional signals. When used as inputs, their internal counters will count input/output events. Thus, any up or down going event on any of the inputs will cause the corresponding pin's event counter to be incremented. These inputs could, for example, be connected to a four-switch keyboard. This enables the network master to accept user input to change the display content. When used as outputs, they can control external devices such as LEDs.

The LCD controller also has user EEPROM storage. This gives the user a non-volatile data storage area of 112 bytes. This storage area could, for example, be used to store predefined display pages.

The figures below show the 1-Wire LCD Demo unit that is available.

Figure 1 is the 1-Wire LCD Demo unit shown in a white Perspex box. On the left side of the display are three blue and one red push button switches that are connected to the four inputs (GPIOs). Below the display on the side of the box is the 6-pin (RJ11) 1-Wire bus connection.

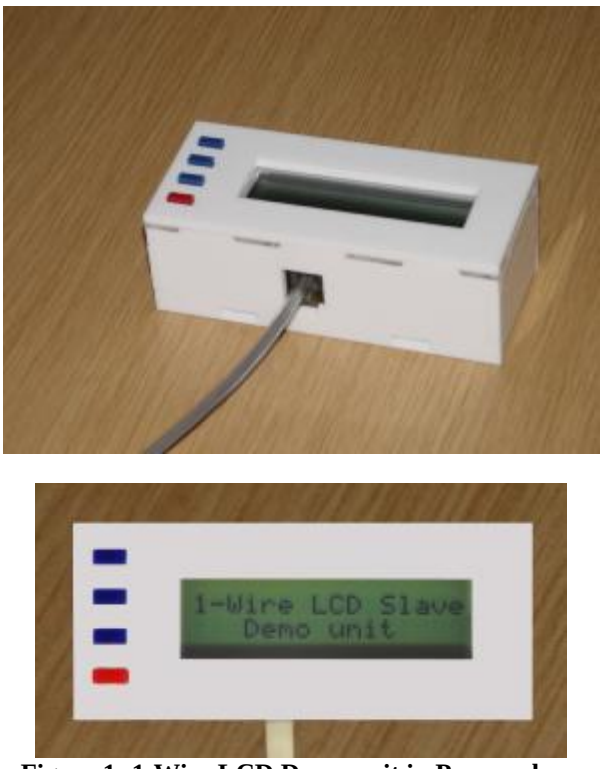


Figure 1: 1-Wire LCD Demo unit in Perspex box.

Figure 2 shows the 1-Wire LCD Demo unit from the 6-pin (RJ11) 1-Wire bus connection side outside the Perspex box.

Figure 2: 1-Wire LCD Demo board and LCD display.

Figure 3 shows the 1-Wire LCD Demo board. At the top of the board is the LCD connector that supports a wide range of displays, from 1 Line x 8 Characters up to 2 Line x 40 Characters. On the left side of the board are the four push button switches that are connected to the four inputs (GPIOs). At the bottom is the 6-pin (RJ11) 1-Wire bus connection. Next to the RJ11 connector are 6 holes for a connector to take the GPIOs external. Underneath the RJ11 connector is also holes for a 4-pin connector to the 1-Wire bus instead of the RJ11.

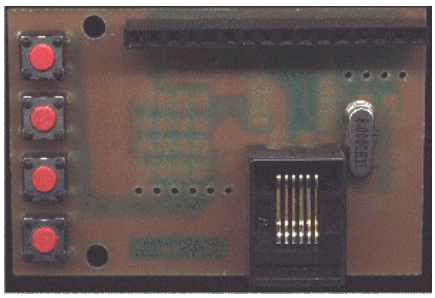


Figure 3: 1-Wire LCD Demo board Top

Figure 4 shows the back of the1-Wire LCD Demo board. The board dimensions are 58.5mm wide by 36.2mm high as seen in this picture.

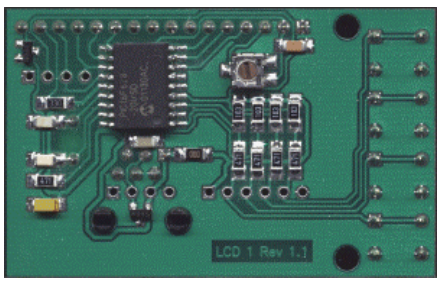


Figure 4: 1-Wire LCD Demo board Back

3.1. Acquirement Options

The 1-Wire LCD has the following options regarding its use with or in other 1-Wire devices:

The client may:

1. Obtain the 1-Wire LCD Demo boards (Figure 3 and 4 above) and use them in custom end products.
2. Obtain the 1-Wire LCD controller IC (a pre-programmed PIC16F628) ready to be used in custom end products. See the schematic in Appendix A.

4. Commands

4.1. Commands Summary

The tables below give a summary of the 1-Wire commands that have been implemented on the 1-Wire LCD controller:

ROM Commands	Description	Command Byte	Communication Sequence
Read ROM.	Reads the Serial Number from the Slave device.	33h	<Master TX 1 byte>, then <Master RX 8 bytes>.
Skip ROM.	Skip the ROM Match and allows slave device access.	CCh	<Master TX 1 byte>.
Match ROM.	Matches the given serial number to allow slave device access.	55h	<Master TX 9 bytes>.
Search ROM	Enables the host to search the 1-Wire bus for device Ids of connected devices.	F0h	See the Dallas 1-Wire Standard for details.
Conditional ROM Search.	Enables the host to search the 1-Wire bus for device Ids that have alarm conditions.	ECh	See the Dallas 1-Wire Standard for details.

Scratchpad Commands	Description	Command Byte	Communication Sequence
Read Scratchpad.	Reads the slave device scratchpad area.	BEh	<Master TX 1+n bytes>. (n = number of bytes to be read from the scratch pad.)
Write Scratch Pad.	Writes data into the scratchpad area.	4Eh	<Master TX 1+n bytes>. (n = number of bytes to copy into scratch pad.)

Function Commands	Description	Command Byte	Communication Sequence
Switch LCD ON.	Switches the power to the LCD ON.	03h	<Master TX 1 bytes>.
Switch LCD OFF.	Switches the power to the LCD OFF.	05h	<Master TX 1 bytes>.
Switch LCD back-light OFF.	Switches the power to the LCD back-light OFF.	07h	<Master TX 1 bytes>.
Switch LCD back-light ON.	Switches the power to the LCD back-light ON.	08h	<Master TX 1 bytes>.
Writes to LCD register memory.	Writes a single byte directly to the LCD register memory.	10h	<Master TX 2 bytes>.
Copy LCD Register memory to Scratchpad.	Copies the LCD Register memory content to the scratchpad area.	11h	<Master TX 1 bytes>.
Writes to LCD data memory.	Writes a single byte directly to the LCD data memory.	12h	<Master TX 2 bytes>.
Copy LCD Data memory to Scratchpad.	Copies the LCD Data memory content to the scratchpad area.	13h	<Master TX 1 bytes>.
Write to GPIO Output States.	Changes the state of the open collector outputs.	21h	<Master TX 2 bytes>.
Copy GPIO Input States to the Scratchpad.	Copies the state of the inputs to the scratchpad area.	22h	<Master TX 1 bytes>.
Copy GPIO counters to the Scratchpad.	Copies the input counter values to the scratchpad area.	23h	<Master TX 1 bytes>.
Copy user EEPROM to Scratchpad.	Copies the user EEPROM content to the scratchpad area.	37h	<Master TX 1 bytes>.
Copy Scratchpad to user EEPROM.	Copies the scratchpad area to the user EEPROM.	39h	<Master TX 1 bytes>.
Copy Version information to Scratchpad.	Copies the LCD device Version information to the scratchpad area.	41h	<Master TX 1 bytes>.
Copy Scratchpad to LCD.	Copies the scratchpad area to the LCD display area.	48h	<Master TX 1 bytes>.
Clear the LCD.	Clears the LCD display area.	49h	<Master TX 1 bytes>.

4.2. Command Description

4.2.1. Read ROM Command (33h)

This command allows the Master to read the serial number of the LCD slave device. Only one device must be connected to the 1-Wire bus if this command is to be used. All the devices on the bus will respond to this command and it will cause the incorrect serial number to be read by the master because of the wired AND configuration.

The structure of this command is given in the table below:

Master	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX	0	Read ROM Command (33h)							
RX	1	Family Code.							
RX	2	LSB of the Device Serial Number.							
RX	3	Device Serial Number.							
RX	4	Device Serial Number.							
RX	5	Device Serial Number.							
RX	6	Device Serial Number.							
RX	7	MSB of the Device Serial Number.							
RX	8	CRC Code.							

4.2.2. Skip ROM Command (CCh)

This command will skip the ROM Match procedure and allow direct access to the LCD slave device. This command should only be used if there is one device connected to the bus. All the devices on the bus will respond to this command and it will cause the incorrect data to be written or read by the master because of the wired AND configuration.

The structure of this command is given in the table below:

Master	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX	0	Skip ROM Command (CCh)							
		Wait 25uS for LCD to complete this command. (When using a DS9097 or DS2480 this wait time may be ignored.)							

4.2.3. Match ROM Command (55h)

This command will compare the received serial number from the Master to the internal serial number of the LCD slave device. If the serial number matches, the LCD slave device will respond to function commands that follow, otherwise it will be silent until the next reset pulse.

The structure of this command is given in the table below:

Master	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX	0	Match ROM Command (55h)							
TX	1	Family Code.							
TX	2	LSB of the Device Serial Number.							
TX	3	Device Serial Number.							
TX	4	Device Serial Number.							
TX	5	Device Serial Number.							
TX	6	Device Serial Number.							
TX	7	MSB of the Device Serial Number.							
TX	8	CRC Code.							
		Wait 150uS for LCD to complete this command. (When using a DS9097 or DS2480 this wait time may be ignored.)							

4.2.4. Search ROM Command (F0h)

For more information on this command please refer to the Dallas 1-Wire standard document.

4.2.5. Conditional ROM Search Command (ECh)

For more information on this command please refer to the Dallas 1-Wire standard document.

This search enables the 1-Wire bus master to only read the serial numbers of devices that have pending alarm conditions. The LCD slave device will have a pending alarm condition when one of the inputs have changed state. This alarm condition will be cleared when the input counters are copied to the Scratchpad area. This command works the same as the ROM Search command, the only difference is that the command changes from "0Fh" to "ECh".

4.2.6. Read Scratchpad Command (BEh)

This command will read the content of the scratchpad area. The content will depend on the information that was previously copied to the scratchpad by one of the other function commands. The number of bytes to be read will differ according to the previous command involving the scratchpad.

The structure of this command is given in the table below:

Master	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX	0	Read Scratchpad Command (BEh)							
RX	1	Read Byte.							
RX	2	Read Byte.							
RX	3	Read Byte.							
RX	…	Read Byte.							
RX	n ≤ 16	Read Byte.							

4.2.7. Write Scratchpad Command (4Eh)

This command will write data to the scratchpad area. The data to be written to the scratchpad will depend on the function command that is intended to follow this command.

The structure of this command is given in the table below:

Master	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX	0	Write Scratchpad Command (4Eh)							
TX	1	Write Byte.							
TX	2	Write Byte.							
TX	3	Write Byte.							
TX	…	Write Byte.							
TX	n ≤ 16	Write Byte.							

4.2.8. Switch LCD ON (03h)

This command will switch the power to the LCD on. The power to the LCD is on by default. Calling this command, while the LCD is already on, will cause the LCD initialize sequence to be executed. This will cause the memory content of the LCD as well as the displayed information to be cleared.

The structure of the command is given in the table below:

Master	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX	0	Switch LCD ON (03h)							
		Wait 35mS for LCD to complete this command. Communication to other 1-Wire devices may continue during this time.							

4.2.9. Switch LCD OFF (05h)

This command will switch the power to the LCD off. This will cause the memory content of the LCD to be lost. To power the LCD again use the "Switch LCD ON" command.

The structure of the command is given in the table below:

Master	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX	0	Switch LCD OFF (05h)							

4.2.10. Switch LCD back-light OFF (07h)

This command will switch the power to the LCD back-light off. To power the LCD back-light again use the "Switch LCD back-light ON" command. This command will only work on a LCD with an LED back-light installed.

The structure of the command is given in the table below:

Master	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX	0	Switch LCD back-light OFF (07h)							

4.2.11. Switch LCD back-light ON (08h)

This command will switch the power to the LCD back-light on. To remove the LCD back-light power again use the "Switch LCD back-light OFF" command. This command will only work on a LCD with an LED back-light installed.

The structure of the command is given in the table below:

Master	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX	0	Switch LCD back-light OFF (08h)							

4.2.12. Write to LCD register memory (10h)

This command will write the data following this command, directly to the LCD register memory. Refer to a HD44780 LCD-II data sheet for more information on the LCD register and data memory or request the information from the supplier or manufacturer of the particular LCD device.

The structure of the command is given in the table below:

Master	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX	0	Write to LCD register memory (10h)							
TX	1	The data byte to be written to the LCD register memory.							
		Wait 100uS for LCD to complete this command. Communication to other 1-Wire devices may continue during this time. (When using a DS9097 or DS2480 this wait time may be ignored.)							

4.2.13. Copy LCD Register memory to Scratchpad (11h)

This command will copy the LCD Register memory content to the scratchpad area. Executing this command will enable the user to read the content from the scratchpad area. Refer to a HD44780 LCD-II data sheet for more information on the LCD register and data memory or request the information from the supplier or manufacturer of the particular LCD device.

The structure of the command is given in the table below:

Master	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX	0	Copy LCD Register memory to Scratchpad (11h)							
		Wait 150uS for LCD to complete this command. Communication to other 1-Wire devices may continue during this time. (When using a DS9097 or DS2480 this wait time may be ignored.)							

4.2.14. Write to LCD data memory (12h)

This command will write the data, following this command, to the LCD data memory. Refer to a HD44780 LCD-II data sheet for more information on the LCD register and data memory or request the information from the supplier or manufacturer of the particular LCD device.

The disadvantage of this command is that only one character can be written to the LCD display area at a time. It is advisable to rather use the "Copy Scratchpad to LCD" function command that is capable of sending more characters to the LCD display area.

The structure of the command is given in the table below:

Master	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX	0	Write to LCD data memory (12h)							
TX	1	The data byte to be written to the LCD data memory.							
		Wait 100uS for LCD to complete this command. Communication to other 1-Wire devices may continue during this time. (When using a DS9097 or DS2480 this wait time may be ignored.)							

4.2.15. Copy LCD Data memory to Scratchpad (13h)

This command will copy the LCD data memory content to the scratchpad area. Executing this command will enable the user to read the content from the scratchpad area. Refer to a HD44780 LCD-II data sheet for more information on the LCD register and data memory or request the information from the supplier or manufacturer of the particular LCD device.

The structure of the command is given in the table below:

Master	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX	0	Copy LCD Data memory to Scratchpad (13h)							
		Wait 150uS for LCD to complete this command. Communication to other 1-Wire devices may continue during this time. (When using a DS9097 or DS2480 this wait time may be ignored.)							

4.2.16. Write to GPIO Output States (21h)

This command will set the state of the general-purpose Input Output (GPIO) pins according to the value, directly following this command. These pins have external pull-ups and can be pulled low by either writing a zero value to the corresponding pin's bit (see table below) or by an external connection to ground (e.g. a keyboard switch contact).

The structure of the command is given in the table below:

Master	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX	0	Write to GPIO Output States (21h)							
TX	1	X	X	X	X	X	GPIO 2 State.	GPIO 1 State.	GPIO 0 State.
		Wait 20uS for LCD to complete this command. Communication to other 1-Wire devices may continue during this time. (When using a DS9097 or DS2480 this wait time may be ignored.)							

4.2.17. Copy GPIO Input States to the Scratchpad (22h)

This command will copy the current state of the inputs to the scratchpad area. These states are not de-bounced. They represent the instantaneous state of the inputs at the time when the command was received.

The structure of the command is given in the table below:

Master	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX	0	Copy GPIO Input States to the Scratchpad (22h)							
		Wait 70uS for LCD to complete this command. Communication to other 1-Wire devices may continue during this time. (When using a DS9097 or DS2480 this wait time may be ignored.)							

The scratchpad will contain the following content after the above command has been sent to the LCD slave device:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	GPIO 3 In State.	GPIO 2 In State.	GPIO 1 In State.	GPIO 0 In State.

4.2.18. Copy GPIO counters to the Scratchpad (23h)

This command will copy the four 16 bit event counters of the four inputs to the scratchpad area. These counters will count both up and down going events on the inputs, even when they are used as outputs. Thus, changing the state of an output will also cause the corresponding input counter to increment. Each time these event counters are copied to the scratchpad they are cleared.

The structure of the command is given in the table below:

Master	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX	0	Copy GPIO counters to the Scratchpad (23h)							
		Wait 80uS for LCD to complete this command. Communication to other 1-Wire devices may continue during this time. (When using a DS9097 or DS2480 this wait time may be ignored.)							

The scratchpad will contain the following content after the above command has been sent to the LCD slave device:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	GPIO 0 Input counter value (Lower Significant 8 bits).							
1	GPIO 0 Input counter value (Upper Significant 8 bits).							
2	GPIO 1 Input counter value (Lower Significant 8 bits).							
3	GPIO 1 Input counter value (Upper Significant 8 bits).							
4	GPIO 2 Input counter value (Lower Significant 8 bits).							
5	GPIO 2 Input counter value (Upper Significant 8 bits).							
6	GPI 3 Input counter value (Lower Significant 8 bits).							
7	GPI 3 Input counter value (Upper Significant 8 bits).							

4.2.19. Copy user EEPROM to Scratchpad (37h)

This command will copy the content of the user EEPROM to the scratchpad area. Before this command may be executed, the scratchpad should be setup with the retrieval information given in the second table below. Care should be taken not to request more data bytes than the amount contained in the user EEPROM or the capacity of the scratchpad, as this will cause the command to be ignored and the scratchpad area to be left unchanged.

The structure of the command is given in the table below:

Master	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX	0	Copy user EEPROM to Scratchpad (37h)							
		Wait 400uS for LCD to complete this command. Communication to other 1-Wire devices may continue during this time.							

The scratchpad should contain the following content before the above command is sent to the LCD slave device:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	The start address of where the data bytes should be retrieved from in the user EEPROM.							
1	The number of bytes to be retrieved from the user EEPROM (max of 16 bytes).							

4.2.20. Copy Scratchpad to user EEPROM (39h)

This command will copy the content of the scratchpad area to the user EEPROM. Before this command may be executed, the scratchpad should be setup with the information given in the second table below. Care should be taken not to write more data bytes than the amount contained in the user EEPROM or the capacity of the scratchpad as this will cause the command to be ignored and the EEPROM will not be updated.

The structure of the command is given in the table below:

Master	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX	0	Copy Scratchpad to user EEPROM (39h)							
		Wait typically 4mS per byte (max 8mS per byte) for LCD to complete this command. Communication to other 1-Wire devices may continue during this time. (e.g. 16 bytes x 4mS = 64mS)							

The Scratchpad should contain the following content before the above command is sent to the LCD slave device:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	The start address of where the data bytes should be retrieved from in the user EEPROM.							
1	The first data byte to be stored in the user EEPROM.							
…								
$n \leq 16$	The last data byte to be stored in the user EEPROM.							

4.2.21. Copy Version information to Scratchpad (41h)

This command copies the firmware version information to the scratchpad area. After executing this command the scratchpad will contain the information example given in the second table below.

The structure of the command is given in the table below:

Master	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX	0	Copy Version information to Scratchpad (41h)							
		Wait 500uS for LCD to complete this command. Communication to other 1-Wire devices may continue during this time.							

The scratchpad will contain the following version string after the execution of the above command. The string ("LCD0.2b 05/14/01") given below is only an example of what may be expected.

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
String	L	C	D	0	.	2	b		0	5	/	1	4	/	0	1
Description	Device Name			Firmware Rev.					Manufacture date. (mm/dd/yy)							

4.2.22. Copy Scratchpad to LCD (48h)

This command will copy the content of the scratchpad area to the LCD display area. The second table below gives the information that should be in the scratchpad area when this command is executed. Thus, the scratchpad area should first be prepared before executing this command.

The structure of the command is given in the table below:

Master	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX	0	Copy Scratchpad to LCD (48h)							
		Wait typically 120uS per byte for LCD to complete this command. Communication to other 1-Wire devices may continue during this time. (e.g. 16 bytes x 120uS = 1.92mS)							

The scratchpad should contain the following content before the above command is sent to the LCD slave device:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	LCD display area start address (see LCD data memory tables below).							
1	First character code of the ASCII character to be displayed (e.g. 41h = character "A").							
…								
n ≤ 16	Last character code of character to be displayed.							

The following table lists the LCD memory addresses for the different LCD size configurations.

1-Line by 16 Character display:

Character	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Line 1 Adr	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F

2-Line by 16 Character display:

Character	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Line 1 Adr	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
Line 2 Adr	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F

2-Line by 40 Character display:

Character	1	2	3	4	5	6	…	…	33	34	35	36	37	38	39	40
Line 1 Adr	00	01	02	03	04	05	…	…	20	21	22	23	24	25	26	27
Line 2 Adr	40	41	42	43	44	45	…	…	60	61	62	63	64	65	66	67

4-Line by 16 Character display (LM041L):

Character	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Line 1 Adr	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
Line 2 Adr	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F
Line 3 Adr	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F
Line 4 Adr	50	51	52	53	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F

4-Line by 20 Character display (LM044L):

Character	1	2	3	4	5	6	…	…	13	14	15	16	17	18	19	20
Line 1 Adr	00	01	02	03	04	05	…	…	0C	0D	0E	0F	10	11	12	13
Line 2 Adr	40	41	42	43	44	45	…	…	4C	4D	4E	4F	50	51	52	53
Line 3 Adr	14	15	16	17	18	19	…	…	20	21	22	23	24	25	26	27
Line 4 Adr	54	55	56	57	58	59	…	…	60	61	62	63	64	65	66	67

4.2.23. Clear the LCD (49h)

This command will clear the display area of the LCD slave device.

The structure of the command is given in the table below:

Master	Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
TX	0	Clear the LCD (49h)							
		Wait 2.5mS for LCD to complete this command. Communication to other 1-Wire devices may continue during this time.							

5. Command Method

5.1. Example

These are examples of command sequences for basic control of the LCD slave device.

5.1.1. Writing Text

This example shows how to write the characters in the example string "This Text" to the LCD slave device.

Master Data Direction	Data Bytes	Description
TX	Reset	Reset pulse.
RX	Presence	Presence pulse.
TX	CCh	Skip ROM Command.
TX	4Eh	Write Scratchpad Command.
TX	<1 data byte>	Write the LCD data memory address (e.g. 00h)
TX	<9 data bytes>	Write the nine text character ASCII values for the string "This Text" (they are: 54h, 68h, 69h, 73h, 20h, 54h, 65h, 78h and 74h)
TX	Reset	Reset pulse.
RX	Presence	Presence pulse.
TX	CCh	Skip ROM Command.
TX	48h	Copy Scratchpad to LCD.
TX	Reset	Reset pulse.
RX	Presence	Presence pulse.
Sequence completed.		

5.1.2. Storing display pages in the EEPROM

This example shows how to store predefined display pages in the EEPROM.

Master Data Direction	Data Bytes	Description
TX	Reset	Reset pulse.
RX	Presence	Presence pulse.
TX	CCh	Skip ROM Command.
TX	4Eh	Write Scratchpad Command.
TX	<1 data byte>	Write the EEPROM address to store the page at (e.g. 10h)
TX	<1 data byte>	Write the LCD data memory address (e.g. 00h)
TX	<9 data bytes>	Write the nine text character ASCII values for the string "This Text" (they are: 54h, 68h, 69h, 73h, 20h, 54h, 65h, 78h and 74h)
TX	Reset	Reset pulse.
RX	Presence	Presence pulse.
TX	CCh	Skip ROM Command.
TX	39h	Copy Scratchpad to user EEPROM.
Now the EEPROM, at address 10h, contains the following display page information: LCD data memory address and the text to be displayed.		
TX	Reset	Reset pulse.
RX	Presence	Presence pulse.
TX	CCh	Skip ROM Command.
TX	4Eh	Write Scratchpad Command.
TX	<1 data byte>	Write the EEPROM address to store the page at (e.g. 10h)
TX	<1 data byte>	Write the EEPROM page length (e.g. 0Ah)
TX	Reset	Reset pulse.

RX	Presence	Presence pulse.
TX	CCh	Skip ROM Command.
TX	37h	Copy user EEPROM to Scratchpad.
Now the scratchpad contains the display page information that is required by the " Copy Scratchpad to LCD" function command.		
TX	Reset	Reset pulse.
RX	Presence	Presence pulse.
TX	CCh	Skip ROM Command.
TX	48h	Copy Scratchpad to LCD.
The LCD should now display the text string.		
TX	Reset	Reset pulse.
RX	Presence	Presence pulse.
Sequence completed.		

6. Appendix A (Schematic Diagram)